DART+ West

Updates to Chapter 13 Climate

October | 2023

Tionscadal Éireann
Project Ireland
2040

NTA
Údarás Náisiúnta Iompair
National Transport Authority

CIE

Iarnród Éireann
Irish Rail

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1. INTRODUCTION

In December 2022 Transport Infrastructure Ireland (TII) published new guidance documents and standards for the EIAR with respect to Climate:

- PE-ENV-01104: Climate Guidance for National Roads, Light Rail and Rural Cycleways (offline & Greenways) – Overarching Technical Document, and
- PE-ENV-01105: Climate Assessment of Proposed National Roads – Standard.

These guidance documents were issued in December 2022 and supersede the 2011 Transport Infrastructure Ireland '*Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes'*, which covered climate assessments. The methodology for assessing national roads and other specified infrastructure projects, such as light rail, in PE-ENV-01106 is based on the methodology employed in the UK, namely Highways England 2019 guidance *'Design Manual for Roads and Bridges (DMRB) LA 114'* (an older version is referred to in the TII Air Quality Guidelines)'. LA 114 was used as the basis of the Climate assessment within the EIAR.

Section of 1.5 of PE-ENV-01105 (Climate Assessment Standard for Proposed National Roads) states that:

'where projects requiring approval under Section 51, Section 177AE or Part 8 have, at the date of publication of this SD, commenced planning and design, and in particular, where technical advisor contracts have been executed, this *SD should be:*

- treated as advice and guidance;
- employed to the greatest extent reasonably practicable; and
- applied in a proportionate manner, having regard to the characteristics and location of the project/maintenance works and the type and characteristics of potential impacts.'

It is noted that, Córas Iompair Éireann, hereafter referred to as CIÉ or 'the Applicant', is applying to An Bord Pleanála for a Railway Order ("RO") for the DART+ West project ("the proposed project" or "proposed development") under the Transport (Railway Infrastructure) Act 2001 (as amended and substituted) ('the 2001 Act"). Although the statutory requirements for a Railway Order application and the requirement to prepare an EIAR arises under the 2001 Act and the EIA Directive, the appropriate guidance has been applied.

2. GREENSHOUSE GAS ASSESSMENT

In order to ensure no additional impacts occur as a result of the updated TII guidance (TII 2022a) updates, AWN Consulting have conducted a sensitivity analysis of the updated carbon tool.

2.1 Errors in TII Carbon Tool V2.1

Section 13.3.3.1 of Chapter 13 (Climate) of the EIAR details the method for the calculation of embodied carbon from construction. The section details that embodied construction emissions for the proposed development were calculated using the TII Carbon Assessment Tool (Version 2.1) (TII 2021). The V2.1 of the TII Carbon Tool (TII 2021) used emission factors from recognized sources including the Civil Engineering Standard Method of Measurement (CESSM) Carbon and Price Book database (CESSM, 2013). This model has since been updated (See Section 2.2). On comparison between the two models a number of inbuilt errors within V2.1 of the TII Carbon Tool (TII 2021) were identified.

- An error that over calculates the maintenance on the rail emissions calculations in the breakdown by stage by assuming the maintenance occurs annually over the design life rather than over the maintenance period listed in the database;

- Maintenance emissions for rail only include one maintenance cycle within the emissions breakdown by activity, irrespective of the project lifespan;

- An error which does not include rail water use during construction in the emissions breakdown by activity, but does in the breakdown by stage emissions; and

- An error that does not include water use during pre-construction in the breakdown by stage but does include it in the emissions breakdown by activity.

The modelling outputs from the EIAR have been adjusted to account for these errors.

Section 13.5.1.2 detailed the emissions from the V2.1 TII Carbon Tool (TII 2021), which had been adjusted for the inbuilt errors detected. Within the tables changes to the figures are illustrated as follows:

- Text to be removed is identified as ~~red text and struck through,~~
- Text to be added is identified as green and underlined.

The breakdown of the activities between the different phases of the proposed development has been assessed. As shown in Table 1 and Table 2, the assessment indicates that the key phases of the GHG generation are the embodied carbon of the construction materials and maintenance (use), which when combined account for almost 57% of all carbon emissions. Pre-construction and construction activities is expected to account for approximately 25% of all emissions.

Construction waste is predicted to account for 17.9% of the overall emissions. 35% of the soil removed from the proposed Spencer Dock station are assumed to be reused onsite. Overall, the proposed development achieves a 60% onsite reusability for waste materials. The potential for reuse of soils is discussed in Chapter 9 Land and Soils. The reuse and minimization of other waste materials is discussed in Chapter 19 Material Assets: Resource and Waste Management of the EIAR.

The proposed Spencer Dock station accounts for the highest volume of the overall embodied carbon. The station requires significant volumes of excavation, steel and concrete in order to construct it.

The proposed development is estimated to result in total Construction phase (including maintenance over a 60-year period) GHG emissions of 148,745 tonnes embedded CO_{2eq} for materials over the 47-month period. This is equivalent to an annualised total of 0.44% of Ireland's non-ETS 2030 target. Over the predicted 60-year lifespan the annualised emissions due to the initial Construction phase and ongoing maintenance of the proposed development is projected to reach, at most, 0.011% of Ireland's non-ETS 2030 emissions target (Table 1). The significance criteria for impacts (IEMA 2022) states that the impact significance must be taken from the project as a whole over its lifecycle rather than individual elements. Mitigation will be required in order to minimise the contribution of the embodied carbon from the construction of the proposed development and therefore the overall significance rating.

Table 1: Construction & Maintenance Stage Greenhouse Gas Emissions

Project Element	Before Use ($kgCO_2e$)				Use: Including Maintenance ($kgCO_2e$)	Total
	Pre-Construction	Embodied Carbon	Construction Activities	Construction Waste		

Ashtown Footbridge	22	806,439	213	-	1,012	807,686
Coolmine Footbridge	-	728,498	2,804	-	457	731,759
Connolly Station	-	2,125,559	4,001	-	~~1,481,038~~ 145,676	~~3,610,598~~ 2,275,235
Depot	-	15,184,209	99,929	-	~~2,004,103~~ 61,644	~~17,288,241~~ 15,345,782
OHLE	-	3,050,009	24,758	-	~~8,655,967~~ 851,407	~~11,730,735~~ 3,926,174
Permanent Way	-	16,680,385	141,068	-	~~61,874,417~~ 1,529,760	~~78,695,870~~ 18,351,213
Spencer Dock Station	-	24,376,266	168,346	-	~~1704245~~ 167,631	~~26,248,857~~ 24,711,939
Substations	453	991,917	9,014	-	~~92153~~ 92,153	~~1093537~~ 1,093,537
Level Crossings	6,349	17,478,948	43,405	-	1,763,296	1763296
General	~~293,018~~ 293,282	-	35,525,492	26,361,826	~~-~~	~~62,180,336~~ 62,180,599
Total ($kgCO_2e$)	~~299,842~~ 300,106	81,422,229	36,019,030	26,361,826	~~77,576,690~~ 4,613,036	~~221679618~~ 14,871,5924
% Of Total	~~0.14%~~ 0.2%	~~36.73%~~ 54.75%	~~16.25%~~ 24.2%	~~11.89%~~ 17.7%	~~34.9%~~ 3.1%	100%

Table 2: Summary of Construction & Maintenance Stage Greenhouse Gas Emissions

Project Element	Total (kgCO2e)	Total (KiloTonneCO$_2$e)	% Of overall total (kgCO$_2$e)	Total Annualised (KiloTonneCO$_2$e)	Annualised as % of 2030 Target
Ashtown Footbridge	807,686	0.81	0.4%	0.013	0.00004%
Coolmine Footbridge	731,759	0.73	0.3%	0.011	0.00003%
Connolly Station	~~3610598~~ 2,275,235	~~3.61~~ 2.27	~~0.016%~~ 0.015%	~~0.056~~ 0.036	~~0.0000017%~~ 0.00000107%
Depot	~~17288241~~ 15,345,782	~~17.29~~ 15.35	~~0.078%~~ 0.103%	~~0.27~~ 0.24	~~0.0000081%~~ 0.00000719%
OHLE	~~11730735~~ 3,926,174	~~11.73~~ 3.93	~~0.053%~~ 0.026%	~~0.184~~ 0.061	~~0.0000055%~~ 0.00000184%
Permanent Way	~~78695870~~ 18,351,213	~~78.7~~ 18.35	~~0.355%~~ 0.123%	~~1.231~~ 0.287	~~0.0000369%~~ 0.0000086%
Spencer Dock Station	~~26248857~~ 24,711,939	~~26.25~~ 24.71	~~0.118%~~ 0.166%	~~0.411~~ 0.387	~~0.0000123%~~ 0.00001158%
Substations	~~1093537~~ 1,093,537	~~1.09~~ 1.09	~~0.005%~~ 0.007%	~~0.017~~ 0.017	~~0.0000005%~~ 0.00000051%
Level Crossings	19,291,999	19.29	~~0.087%~~ 0.13%	0.302	0.000009%
General	~~62180336~~ 62,180,599	~~62~~ 62.18	~~0.28%~~ 0.418%	~~0.973~~ 0.973	~~0.0000291%~~ 0.00002914%
Total	~~221679618~~ 148,715,924	~~221.68~~ 148.7	100%	~~3.468~~ 2.327	~~0.0001039%~~ 0.0000697%

2.1.1.1 EIAR Summary of Residual Emissions Update

The significance criteria for impacts (IEMA 2022) from Chapter 13 (Climate) of the EIAR stated that the impact significance must be taken from the project as a whole over its lifecycle. Considering the IEMA significance criteria set out in Section 13.3.5.1 of Chapter 13 (Climate) of the EIAR the operational phase of the proposed development can be considered to beneficially contribute to Ireland's target of net zero. However, the impacts of embodied carbon from the construction phase results with a residual impact of 132 tonnes CO_2 annually or 0.0004% of Ireland's 2030 CO_2 targets. The residual impact when updated for the errors found in V2.1 of the TII carbon tool is equivalent to a single one-way flight Dublin to New York annually. Figures from July 203 from the EPA[1] state that carbon emissions per capita were 11.9 tonnes CO_2e/person in 2022, therefore the proposed DART+West residual emissions are estimated to be the equivalent of 11 people's annual emissions.

The proposed development aims to assist in the transition to a low carbon and climate-resilient society. As a result of the proposed development there is an 80% reduction in CO_2 emissions on a per carriage km for the direct operational phase rail impacts of the proposed development as per Table 3. The assessment is based on 80% renewables for the DN and DS power. If the percentage of renewables is further decreased as Ireland

1https://www.epa.ie/our-services/monitoring--assessment/climate-change/ghg/latest-emissions-data/#:~:text=Emissions%20per%20capita%20decreased%20from,ten%20years%20were%2012.7%20tonnes.

transitions to net carbon zero by 2050 then the impact of the proposed development will further decrease resulting in a beneficial impact in future. In addition, future changes in DMU efficiency or technologies may result in lower emissions from the remaining DMU within the rail stock.

IMEA significance (IEMA 2022) notes that:

> *"Minor adverse impact (not significant): A project that is compatible with the budgeted, science based 1.5°C trajectory (in terms of rate of emissions reduction) and which complies with up-to-date policy and 'good practice' reduction measures to achieve that has a minor adverse effect that is not significant. The project may have residual impacts but is doing enough to align with and contribute to the relevant transition scenario. A 'minor adverse' or 'negligible' non-significant effect conclusion does not necessarily refer to the magnitude of GHG emissions being carbon neutral[2] (i.e. zero on balance) but refers to the likelihood of avoiding severe climate change and achieving net zero by 2050. A 'minor adverse' effect or better is a high bar and indicates exemplary performance where a project meets or exceeds measures to achieve net zero earlier than 2050.*
>
> *Negligible Impact (not significant): A project that achieves emissions mitigation that goes substantially beyond the reduction trajectory, or substantially beyond existing and emerging policy compatible with that trajectory, and has minimal residual emissions, is assessed as having a negligible effect that is not significant."*

The operational phase of the DART+ project is consistent with and supports Project Ireland 2040, the National Development Plan 2017 to 2028, the National Planning Framework, the Sustainable Mobility Policy Action Plan 2022 – 2025 and the Climate Action Plan 2021. DART+ is a key deliverable measure in the Climate Action Plan 2019 to achieve targets for modal shift. The National Planning Framework and the National Development Plan list the DART+ Programme as a cornerstone project to assist in transition to a low carbon society. By creating a resilient, accessible public transport network, DART+ West project will provide an attractive alternative to private car travel, encouraging more passenger travel by more sustainable modes.

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

The Promotion of the Use of Energy from Renewable Sources Directive (EU) 2018/2001 specifies a legally binding 14% renewable energy in transport target to be achieved by all Member States by 2030. Given its use of electricity, the proposed development has an ability to utilise renewable energy throughout its operation and assist in Ireland meeting this target.

In line with the IEMA significance criteria set out in Section 13.3.5.1 of Chapter 13 (Climate) of the EIAR the overall residual impact of the proposed development is considered non-significant and negligible as once the construction phase has occurred the operational phase annual emissions will be beneficial compared to the current emissions on the railline while providing a significantly improved in frequency public transportation. As Ireland further progresses towards net carbon zero and the percentage of renewables within electricity utilised for rail further increases the long-term impact of the proposed development has the potential to be considered *significant and beneficial*.

[2] Carbon Neutral: "*When anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period irrespective of the time period or magnitude of offsets required.*"

Table 3: Summary of Predicted Construction and Operational phase Residual Impacts

Project Phase		CO_2 Tonnes Annualised
Construction phase	Embodied Carbon	~~3,468~~ 2,327
	Road Vehicle Emissions	15
Operational phase	Rail Emissions	-3,702
	Power and Heat	841
	Road Vehicle Emissions	651
Annual CO_2 Emissions		~~1,273~~ 132
As % of Irelands 2030 CO_2 targets		~~0.0038%~~ 0.0004%

2.2 Methodology Updates Since Publication of the EIAR

The Climate Chapter of the EIAR (Chapter 13) details the calculated embodied carbon associated with construction phase of the proposed development in Section 13.3.3.1. The assessment commences with the high-level design, through the pre-construction (site clearance) stage, followed by the assessment of the embodied carbon associated with all materials used in the construction of the proposed development, the emissions during the Construction phase and additionally emissions related to waste generated during the Construction phase. The tool also assesses on-going maintenance associated with the default 60-year lifetime of the development. It is generally assumed that end-of-life demolition is not relevant and thus there are no emissions associated with this stage. In Chapter 13 of the EIAR the embodied construction emissions for the proposed development were calculated using the TII Carbon Assessment Tool (Version 2.1) (TII 2021).

Since the publication of the EIAR additional guidance has been provided by TII regarding climate, namely *PE-ENV-01104: Climate Guidance for National Roads, Light Rail and Rural Cycleways (offline & Greenways) – Overarching Technical Document*, and *PE-ENV-01105: Climate Assessment of Proposed National Roads – Standard* as well as the publication of an online carbon tool. TII *GE-ENV-01106: TII Carbon Assessment Tool for Road and Light Rail Projects and User Guidance Document* provides guidance on the use of the TII Carbon Tool for assessing lifecycle carbon emissions for national road and light rail infrastructure projects in Ireland. This guidance is paired with a new online version of the TII tool which is available on the TII Web Application Portal. The tool aligns with Section 7 of PAS 2080, which was published by the British Standards Institution (BSI), the Construction Leadership Council and the Green Construction Board in 2016.

Compared to the methodology undertaken for the proposed DART+ project, which used the TII Carbon Tool Version 2.1, the approach is generally similar in the updated guidance and tool, with all ICE/CESMM4 factors remaining the same. A previous version of this tool was used for the climate assessment within Chapter 13 (Climate) of the EIAR as the updated tool (GE-ENV-01106) was published in December 2022, after the submission of the EIAR. The main difference between the online version of the tool and version 2.1 used in Chapter 13 (Climate) of the EIAR is the requirement for the tool to be held centrally by TII. This allows TII to update the tool regularly and not have uncontrolled versions with outdated databases. One element which differs from the version included within the EIAR is the removal of emissions associated with international transport of materials.

In addition to the construction phase carbon emissions, user emissions from the operational phase road or rail user emissions can be imported into the tool. However, for the purposes of this update these calculations have not been included within the online TII carbon tool. These are reported separately as per the Chapter 13 (Climate) of the EIAR. A separate Updates to Chapter 12 (Air Quality) of the EIAR has been prepared for the updates to road user emissions in the construction and operational phases associated with the new TII Roads Emission Model (REM). The REM also published in December 2022, alongside updated air quality assessment guidance.

In addition to the changes in the TII carbon tool since the publication of the EIAR, there have been new carbon budgets set by the Government in order to meet Ireland's trajectory to net zero by 2050 and new significance criteria provided by TII in PE-ENV-01105 and PE-ENV-01104.

2.2.1 Carbon Budgets and Sectoral Ceilings

The 2021 Climate Act (as discussed in Chapter 13 Section 13.2 of the EIAR) outlines a series of specific actions to provide for carbon budgets and sectoral emissions ceilings for different sectors of the economy. These carbon budgets are to be determined as part of a grouping of three five-year periods calculated on an economy-wide basis, starting with the periods 2021 to 2025, 2026 to 2030, and 2031 to 2035 (refer to Table 4). In September 2022, the Government adopted Sectoral Emissions Ceilings (Government of Ireland, Sectoral Emissions Ceilings September 2022) for each relevant sector within the limits of each carbon budget and, against which the impact of the proposed development can be evaluated. At the time of publication of the EIAR the carbon budgets were not finalised and therefore emissions were compared against Ireland's total non-ETS 2030 target. The Sectoral Emissions Ceilings published for 2030 are outlined in Table 5.

Table 4 Carbon Reduction Required for the Next Thee 5-Yearly Periods Commencing with 2021 – 2025

Budget Period	Reduction Required (Mt CO_{2e})[1]	2018 Emissions (Mt CO_{2e})
2021 - 2025	295	Reduction in emissions of 4.8% per annum for the first budget period
2026 - 2030	200	Reduction in emissions of 8.3% per annum for the second budget period
2031 - 2035	151	Reduction in emissions of 3.5% per annum for the third budget period

Note 1: Source (Department of Taoiseach 2022)

For the construction phase of the proposed development, the relevant sector emissions ceiling which applies is the 'Industry' sector which has a 35% reduction required by 2030 and an emissions ceiling of 4Mt CO_{2e} (or 4,000kt (kilotonnes) CO_{2e}). For the transport emissions associated with the construction phase (i.e. delivery of goods), the relevant sector emissions ceiling which applies is the 'Transport' sector, which has a 50% reduction required by 2030 and an emissions ceiling of 6Mt CO_{2e} (or 6,000kt (kilotonnes) CO_{2e}). It should be noted that for this comparison only emissions associated with transport within Ireland are included. International transport is not included. The sector emissions ceiling which applies to the waste generated due to construction of the proposed development is 'Other' (sub-category 'Waste'), which has a 50% reduction required by 2030 and an emissions ceiling of 1Mt CO_{2e} (or 1,000kt CO_{2e}). Within the 'Other' sector, the sub-category of 'Waste' has an emissions ceiling of 0.6Mt CO_{2e} (or 600kt CO_{2e}). Energy such as electricity and fuel usage during construction have also been included within the carbon calculations and will be compared with the relevant carbon budgets. Land Use, Land-Use Change and Forestry (LULUCF) does not yet have a finalised carbon budget however the emissions associated with the proposed development will be noted.

Table 5 Sectoral Emissions Ceilings and Total Amount of Permitted GHG Emissions Per Sector to 2030 Compared to 2018 Emissions Baseline (Sectoral Emissions Ceilings, Government of Ireland 2022)

Sector	Baseline (Mt CO_{2e})	Carbon Budgets (Mt CO_{2e})		2030 Emissions (Mt CO_{2e})	Indicative Emissions % Reduction in Final Year of 2025-2030 Period (Compared to 2018)
	2018	2021-2025	2026-2030		
Transport	12	54	37	6	50
Electricity	10	40	20	3	75
Built Environment - Residential	7	29	23	4	40

Sector	Baseline ($Mt\ CO_{2e}$)	Carbon Budgets ($Mt\ CO_{2e}$)		2030 Emissions ($Mt\ CO_{2e}$)	Indicative Emissions % Reduction in Final Year of 2025-2030 Period (Compared to 2018)
	2018	2021-2025	2026-2030		
Built Environment - Commercial	2	7	5	1	45
Agriculture	23	106	96	17.25	25
LULUCF[1]	5	xxx	xxx	xxx	xxx
Industry	7	30	24	4	35
Other (F-gases, waste, petroleum refining)	2	9	8	1	50
Unallocated Savings	-	7	5	-5.25	-
Total	**68**	**xxx**	**xxx**	**-**	**-**
Legally Binding Carbon Budgets and 2030 Emission Reduction Targets	**-**	**295**	**200**	**-**	**51**

Note 1: LULUCF – Land Use, Land-Use Change and Forestry

2.2.2 Significance Criteria Updates

PE-ENV-01105 (TII, 2022b) states that the significance of GHG effects is based on IEMA guidance (IEMA, 2022) which is consistent with the terminology contained within Figure 3.4 of the EPA (2022) *'Guidelines on the information to be contained in Environmental Impact Assessment Reports'*.

The 2022 Guidance (IEMA, 2022) document 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; and
- Where GHG emissions remain significant, but cannot be further reduced, approaches to compensate the project's remaining emissions should be considered.

TII states that professional judgement must be taken into account when contextualising and assessing the significance of a project's GHG impact (TII, 2022b). In line with IEMA Guidance (IEMA, 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".

The IEMA guidance also states that *"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"*, to account for the potential for a development to replace existing development or baseline activity with higher GHG emissions.

Significance is determined using the table below (derived from Table 3.29 of PE-ENV-01105 (TII, 2022b)) along with a 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.

This differs from the approach included in Chapter 13 (Climate) of the EIAR and provides additional guidance on how to describe GHG impacts. The focus is now clearly on showing mitigation and, where possible, how the project will align with Ireland's GHG trajectory to net zero by 2050.

Table 6 GHGA Significance Matrix

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

2.3 Impact Assessment

The assessment for construction and maintenance phase embodied carbon emissions is contained within Chapter 13 of the EIAR (Section 13.5.1.2). Detailed project information including tonnage of materials was obtained from the Engineering Design Team for both the carbon assessment within the EIAR and updated assessment. The design team have included grey mitigation within the assessment, which is designed-in mitigation which reduces the embodied carbon. Mitigation is an iterative process, and will be re-examined at detailed design to ensure the embodied carbon is minimised where possible, taking advantage of modern methods of construction, as per the 2023 Climate Action Plan.

The proposed development is expected to have a construction phase of approximately 47 months and an operational lifespan of 60 years. The operational lifespan of 60 years is the default used in the TII Carbon Tool and is the default in LA 114 Climate (UKHA 2019). The predicted GHG emissions can be averaged over the full construction phase and the lifespan of the proposed development to give the predicted annual emissions, which allows for direct comparison with annual emissions and targets.

The assessment has been broken down into a number of segments within Chapte3 13 Section 13.5.1.2 of the EIAR;

- Ashtown Footbridge;
- Coolmine Footbridge;
- Connolly Station;
- Depot;
- OHLE;
- Permanent Way (including over bridge works);
- Spencer Dock Station;
- Substations;
- Level Crossings; and
- General Quantities.

In addition, the sensitivity assessment for the new TII online carbon tool has added two new areas of the assessment, Clonsilla and Porterstown.

General Quantities accounts for all; fuel usage, water usage, site clearance, travel to site, and waste. Where travel distances for material sourcing are currently unknown the following assumptions have been made:

- Locally – 50km;
- Regionally – 100km; and
- Nationally – 250 km.

Using the same operational lifespan and construction period the assessment has been completed using the TII Carbon Assessment Tool (TII 2022c) as per PE-ENV-01105 (TII 2022a) and PE-ENV-01104 (TII 2022b).

2.3.1 Construction Embodied Carbon Impacts

2.3.1.1 EIAR

Chapter 13 (Climate) of the EIAR states that the proposed development is estimated to result in total construction phase (including maintenance over a 60-year period) GHG emissions of 221,679 tonnes embedded CO_{2eq} for materials over the 47-month period (Table 7). This is equivalent to an annualised total of 0.64% of Ireland's non-ETS 2030 target. Over the predicted 60-year lifespan the annualised emissions due to the initial construction phase and ongoing maintenance of the proposed development is projected to reach, at most, 0.010% of Ireland's non-ETS 2030 emissions target.

Table 7 Construction & Maintenance Stage Greenhouse Gas Emissions within EIAR

Project Element	Before Use (Tonnes CO_2e)				Use: Including Maintenance (Tonnes CO_2e)	Total
	Pre-Construction	Embodied Carbon	Construction Activities	Construction Waste		
Ashtown Footbridge	0	806	0	-	1	808
Coolmine Footbridge	-	728	3	-	0	732
Connolly Station	-	2,248	4	-	1,481	3,733
Depot	-	16,094	100	-	2,004	18,198
OHLE	-	3,050	25	-	8,656	11,731
Permanent Way	-	17,584	141	-	61,874	79,600
Spencer Dock Station	-	27,597	168	-	1,704	78,247
Substations	0	1,105	9	-	92	1,206

Level Crossings	6	17,964	43	-	1,763	19,777
General	293	-	35,525	12,156	-	47,975
Total (kgCO_2e)	300	87,176	36,019	12,156	77,577	262,006
% Of Total	0.114%	33.273%	13.747%	4.640%	29.609%	100.000%

2.3.1.2 Sensitivity Analysis for New TII Online Carbon Tool

Comparing the Chapter 13 (Climate) EIAR carbon figures (Table 7) with those calculated using the TII Online Carbon Tool (TII 2022c) (Table 8), there is a significant reduction of 92,044 tonnes CO_2e over the construction and maintenance phases in embodied carbon, with the majority (85%) of it being associated with the Permanent Way. Upon review of these figures, AWN Consulting found errors in the calculations built into the 2021 TII Carbon Tool model. This error is indicated in a Section 2.1 of this document submitted at the time of the Oral Hearing. These errors are:

- An error that over calculates the maintenance on the rail emissions calculations in the breakdown by stage by assuming the maintenance occurs annually over the design life rather than over the maintenance period listed in the database;
- Maintenance emissions for rail only include one maintenance cycle within the emissions breakdown by activity, irrespective of the project lifespan;
- An error which does not include rail water use during construction in the emissions breakdown by activity, but does in the breakdown by stage emissions; and
- An error that does not include water use during pre-construction in the breakdown by stage but does include it in the emissions breakdown by activity.

The modelling outputs have been adjusted to account for these errors. This resulted in significant over calculations of the maintenance of materials. Comparing the updated carbon figures detailed in Section 2.1 (total embodied carbon of 148,715 tonnes CO_2e) with those calculated using the TII Online Carbon Tool (TII 2022c) there is a still a reduction of 19,080 tonnes CO_2e. This is a 13% reduction.

While there have been some modification to the footbridge designs between the submission of the EIAR and the Oral Hearing, the proposed footbridge has not resulted in significant reductions in carbon emissions. This is a result of additional piling requirements associated with the steel structures. Further investigations into this will occur during detailed design regarding methods to reduce the embodied carbon associated with the footbridges and all elements of the design. Table 9 compares the newly calculated carbon emissions with relevant carbon budgets detailed in Table 5.

Table 8 Construction & Maintenance Stage Greenhouse Gas Emissions using New TII Online Carbon Tool (TII 2022c)

Project Element	Before Use (Tonnes CO_2e)				Use: Including Maintenance (Tonnes CO_2e)	Total
	Pre-Construction	Embodied Carbon	Construction Activities	Construction Waste		
Ashtown Footbridge	0	815	0	-	3	818
Clonsilla				-	260	1,409
Coolmine Footbridge				-	-1	711
Connolly Station	0	713	0	-	226	2,137
Depot	-	2,135	3	-	48	14,315
OHLE	-	14,220	95	-	181	3,048

Project Element	Before Use (Tonnes CO_2e)				Use: Including Maintenance (Tonnes CO_2e)	Total
	Pre-Construction	Embodied Carbon	Construction Activities	Construction Waste		
Permanent Way	-	3,024	24	-	1,890	19,795
Porterstown	0	20,756	135	-	54	1,096
Spencer Dock Station	-	23,181	161	-	39	23,342
Substations	0	1,128	9	-	113	1,137
Level Crossings	4	16,699	342	-	1,687	17,045
General	293	-	33,894	11,685	-1,089	44,782
Total	**298**	**82,671**	**34,661**	**11,685**	**3,411**	**129,635**
% of Total	**0.23%**	**63.77%**	**26.74%**	**9.01%**	**2.63%**	**100%**

Table 9 Comparison with Carbon Budgets

Project Element	Total Industrial (tonnes CO_2e)	Total Transport (tonnes CO_2e)	Total Waste (tonnes CO_2e e)	Land Use and Vegetation (tonnesCO_2e)	Total (tonnes CO_2e)
Ashtown Footbridge	771	47	-	-	818
Clonsilla	1,341	69	-	-	1,409
Coolmine Footbridge	701	10	-	-	711
Connolly Station	2,071	66	-	-	2,137
Depot	11,445	2,870	-	-	14,315
OHLE	2,785	262	-	-	3,048
Permanent Way	14,248	5,547	-	-	19,795
Porterstown	1,036	60	-	-	1,096
Spencer Dock Station	21,628	1,714	-	-	23,342
Substations	1,093	44	-	-	1,137
Level Crossings	16,257	787	-	-	17,045
General	33,961	4,546	7,138	-863	44,782
Total (TonnesCO_2e)	107,337	16,023	7,138	-863	129,635
Total (TonnesCO_2e) Annualised	1,679	251	112	-14	2,028
Total (non-annualised) as % of Relevant Climate Budget	2.683%	0.267%	0.714%	No set budget	2.16%
Over 45 Month Construction period	0.685%	0.068%	0.182%	No set budget	1.10%
Over 60-year lifespan	0.001%	0.000%	0.000%	No set budget	0.001%

2.3.2 Updated Summary of Residual Impacts

Section 13.8 of Chapter 13 (Climate) in the EIAR discusses the residual effects of the proposed development and details a summary of predicted construction and operational phase residual impacts in Table 13.24. In the EIAR this table indicated that the beneficial effect of the electrification of the rail line would be outweighed by the annualised construction and maintenance phase carbon emissions. The EIAR stated that there was a residual 1,273 tonnes CO_2e annually (0.0038% of Irelands 2030 CO_2 targets). Upon the discovery of an error embedded error in the TII tool, Section 2.1 of this document to the EIAR revised the embodied carbon down to a residual 132 tonnes CO_2e annually (0.0004% of Irelands 2030 CO_2 targets).

When the carbon emissions (Table 8) associated with the construction and maintenance phase have been updated to the TII Online Carbon Tool (TII 2022c) as per PE-ENV-01104 the residual impact on climate becomes beneficial as shown in Table 10. The DART+ West is estimated to result in total annualised GHG emissions savings of 490 tonnes CO_2e, equivalent to an annualised total of 0.0015% of Ireland's non-ETS 2030 emissions target and 0.0082% of Ireland's carbon sectoral ('Transport) budget for 2030.

The road vehicle emissions shown in Table 10 have also been updated to the new Roads Emission Model (REM) as per the Transport Infrastructure Ireland (TII) guidance document *Air Quality Assessment of Proposed National Roads – Standard (PE-ENV-01107)* (TII, 2022a) using the intermediate fleet scenario. An Updates to Chapter 12 covering the construction and operational traffic updates has been completed. The TII REM uses county-based Irish fleet composition for different road types, for different European emission standards from pre-Euro to Euro 6/VI with scaling factors to reflect improvements in fuel quality, retrofitting, and technology conversions.

As noted in Section 13.8.3 of Chapter 13 of the EIAR as Ireland further progresses towards net carbon zero and the percentage of renewables within electricity utilised for rail further increases the long-term impact of the proposed development has the potential become more beneficial. In addition, further investigation will be undertaken during detailed design to mitigate the embodied carbon.

Table 10 Summary of Predicted Construction and Operational phase Residual Impacts

Project Phase		CO_2 Tonnes Annually
Construction Phase (annualised over the project life span)	Embodied Carbon	2,028
	Road Vehicle Emissions	6
Operational Phase (these will occur annually over the project)	Rail Emissions	-3,702
	Power and Heat	841
	Road Vehicle Emissions	337
Annual CO_2 Emissions		-490
As % of Irelands 2030 CO_2 targets		-0.0015%
As % of Transport Budget 2030		-0.0082%

2.4 Summary

The DART+ cWest is estimated to result in total annualised GHG emissions savings of 490 tonnes CO_2e equivalent to an annualised total of 0.0015% of Ireland's non-ETS 2030 emissions target and 0.0082% of Ireland's carbon sectoral ('Transport) budget for 2030 based on updated carbon modelling using the TII Online Carbon Tool (TII 2022c).

Significance is determined using the table below (derived from Table 3.29 of PE-ENV-01105 (TII, 2022b)) along with a 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.

Based on the significance criteria outlined in Table 6, the residual impact will be negligible to beneficial in the long-term. The proposed development must ensure that embodied carbon is mitigated further during detailed design through modern methods of construction and ensure it goes well beyond existing and emerging policy requirements to assist the reduction of the payback period for embodied carbon. As Ireland further progresses towards net carbon zero and the percentage of renewables within electricity utilised for rail further increases the long-term impact of the proposed development has the potential to be more significantly beneficial.

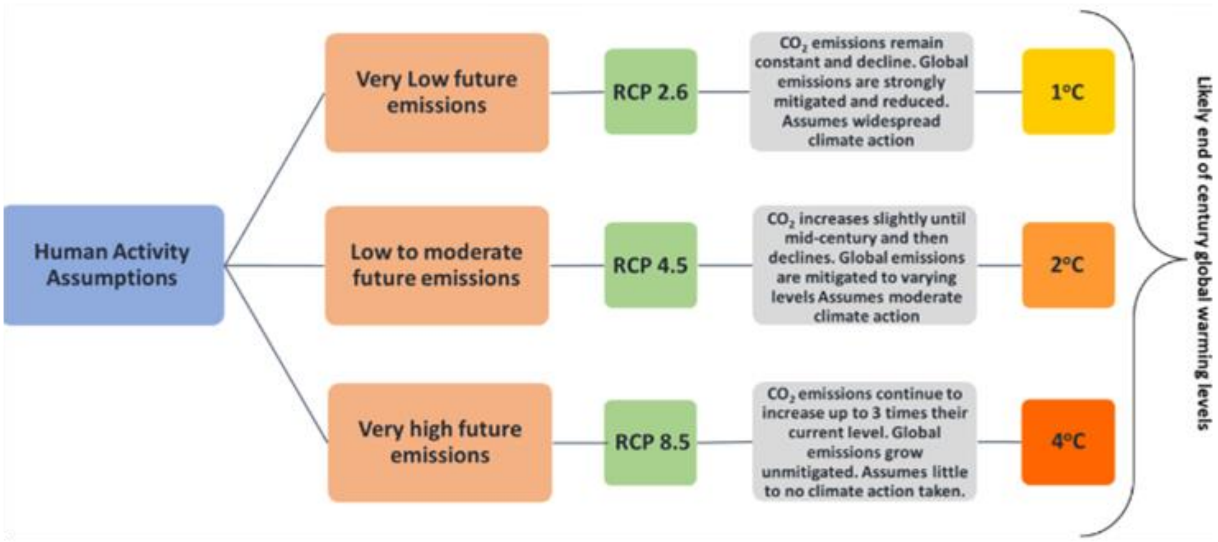
3. CLIMATE CHANGE RISK ASSESSMENT

AWN Consulting have conducted a sensitivity review of the updated climate change risk (CCR) assessment provided in PE-ENV-01104 (TII, 2022a) as this has changed from the risk assessment contained within the Chapter 13 (Climate) of the EIAR. While PE-ENV-01104 (TII, 2022a) recommend the use of a specific risk assessment for climate change, it does state that alternatives may be used.

"An alternative risk framework *can be adopted for the assessment if the Climate Practitioner deems appropriate. For example, a project specific risk framework may have been established to ensure consistency in the assessment and discussion on project risks, which the Climate Practitioner may deem relevant for the assessment of climate risk."*

3.1 Future Climate Data Updates

Since the publication of the EIAR additional modelling of future climate change related impacts have been published. The 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, 2023) 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 1.

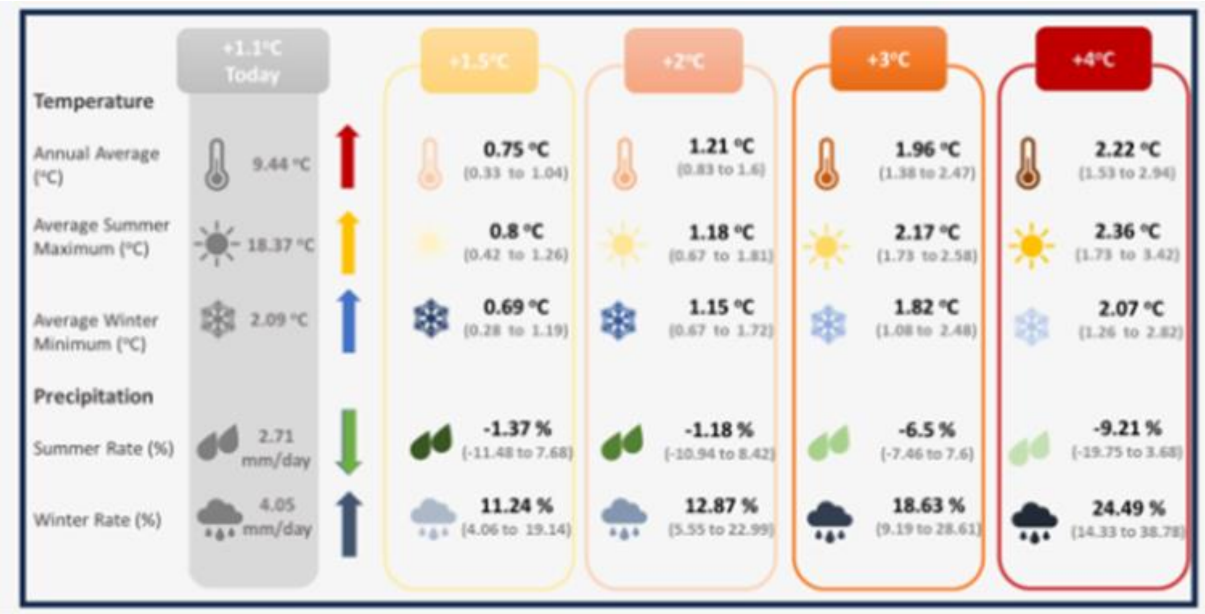


*Source: TRANSLATE project storymap (*Met Éireann *2023)*

Figure 1 Representative Concentration Pathways associated emission levels

TRANSLATE (Met Éireann 2023) 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 (SST)s (Met Éireann, 2023). 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 2). 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, *2023)*

Figure 2 Change of climate variables for Ireland for different Global warming thresholds

Climate Ireland (2023) have a future projections tool which facilities the viewing of observation data and future predicted modelling scenarios RCP4.5 and RCP8.5 in a web-based GIS format (Climate Ireland 2023). Future projections using the tool for the area in proximity to onshore infrastructure (projections are only available for mainland Ireland) are shown in Table 11. The location chosen was Casement Aerodrome due to the benchmark against the Met Eireann station. These projections are based on EPA modelling in Research 339 (EPA, 2020b).

Table 11 Future Projections (All Seasons - Annual) in proximity to the Project's onshore infrastructure (Casement Aerodrome) (Climate Ireland, 2023)

	Projection for 2041-2060 (change relative to 1981-2000)	
	RCP4.5	**RCP8.5**
Projected change in average temperature at 2 m	1.2°C	1.6°C
Heatwaves - Projected change in the number of heatwave events (periods of at least three consecutive days where maximum temperatures exceed >95% of the normal monthly distribution)	4.7	8.1
Dry Periods - Projected change number of dry periods (%) defined as at least 5 consecutive days on which daily precipitation is less than 1 mm	16.2%	15.7%
Precipitation - Projected percentage (%) change in average levels of precipitation	-3.6%	-3%

	Projection for 2041-2060 (change relative to 1981-2000)	
	RCP4.5	RCP8.5
Wet Days - Projected change (%) in number of days with rainfall >20 mm	6.4%	5.1%
Frost days. Projected change (%) in the number of days when minimum temperatures are <0°C	-45.2%	-60.7%
Ice Days - Projected change (%) in the number of days when maximum temperatures are <0°C	-68.7%	-79.7%
Snowfall - Projected change (%) snowfall	-54.3%	-66.7%
Wind Speed - Projected change (%) in wind speed at 10 m	-1.9%	-2.7%
Wind Energy - Projected change (%) in wind energy resource at 120m elevation (onshore)	-4.4%	-6.1%

3.2 Methodology Updates

In Chapter 13 (Climate) of the EIAR the guidance outlined in LA 114 Climate (UKHA 2019) was used to conduct a high-level climate change risk (CCR) assessment. The approach was based on the likelihood and consequence of the impact occurring, leading to the evaluation of the impact significance as shown below. This assessment approach was approved as an appropriate method in the IEMA EIA Guide to: Climate Change Resilience and Adaptation (IEMA 2020a). The key parameters selected were flood risk and the impact of extreme weather.

Table 12 Measure of Likelihood in LA 114 Climate

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

Note: NS = Not significant; S = Significant

The CCR assessment outlined in the new TII guidance (TII 2022a) published since the submission of the EIAR has expanded on the previous approach however the new approach does align with the ultimate goal of improving resilience of projects to future climate change related risk. The approach to the risk assessment in the new TII guidance (TII 2022a) is based on the EU Technical Guidance On Climate Proofing (EU, 2021).

The TII (TII 2022a) recommend climate screening risk assessment or vulnerability assessment is carried out by determining the sensitivity and exposure of the project to climate change. Firstly the project asset categories must be assigned a level of sensitivity to climate hazards irrespective of the project location (example: sea level rise will affect seaport projects regardless of specific location). PE-ENV-01104 (TII, 2022a) provides the below list of asset categories and climate hazards to be considered. The asset categories will vary for project type and need to be determined on a project-by-project basis.

- Receptors/Assets 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 and is critical event that requires extraordinary /emergency business continuity action. 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, it is a serious event that requires additional emergency business continuity actions. 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, it is an adverse event that can be absorbed by taking business continuity actions. 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, as shown in Table 13. If the project scores a high or medium vulnerability, the project should proceed to a detailed assessment.

3.3 Significance Criteria Updates

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 project to various climate hazards.

Vulnerability = Sensitivity x Exposure

The vulnerability assessment takes any proposed mitigation into account. Table 13 details the vulnerability matrix; vulnerabilities are scored on a high, medium and low scale. 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.

Table 13 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

3.3.1.1 Detailed Assessment

As part of the detailed climate change risk assessment, once the hazards and benefits of the climate change impacts have been identified, the Operational Phase assessment assesses the likelihood and impact for each climate hazard using the framework outlined in Table 14 and Table 15. The detailed assessment helps to ensure cost and effort associated with climate proofing is proportional with benefits. Information on the baseline environment and input from other experts working on the DART+ West (i.e., hydrologists) should be used in order to assess the likelihood of a climate hazard. A risk register is generated in order to document the risk assessment process. Table 15 includes an indicative scale to characterise the impact across specific risk areas. Not all these risk areas will apply to each climate hazard.

Table 14 Detailed Assessment: Likelihood Categories

Indicative Scale for assessing the likelihood of a climate hazard:		
Term	**Qualitative**	**Quantitative**
Rare	Very unlikely to occur	5% chance of occurring per year
Unlikely	Unlikely to occur	20% chance of occurring per year
Moderate	As likely to occur as not	50% chance of occurring per year
Likely	Likely to occur	80% chance of occurring per year
Almost Certain	Very likely to occur	95% chance of occurring per year

Table 15 Detailed Assessment: Impact Analysis

Indicative Scale for assessing the likelihood of a climate hazard:					
Risk Areas:	**Insignificant**	**Minor:**	**Moderate**	**Major**	**Catastrophic**
Asset damage, engineering, operational	Impact can be absorbed through normal activity	An adverse event which can be absorbed through business continuity actions	A serious event which requires additional emergency business continuity actions	A critical event which requires extraordinary / emergency business continuity actions	Disaster with potential to lead to shut down or collapse of the asset /network
Safety and health	First Aid Case	Minor Injury, Medical Treatment Case with/or Restricted Work Case.	Serious injury or Lost Work Case	Major or Multiple Injuries, permanent injury or disability	Single or Multiple Fatalities
Environmental	No impact on baseline environment. Localized to point source. No recovery required	Localized within site boundaries. Recovery measurable within 1 month of impact	Moderate harm with possible wider effect. Recovery in 1 year.	Significant harm with local effect. Recovery longer than 1 year. Failure to comply with environmental regulations / consents.	Significant harm with widespread effect. Recovery longer than 1 year. Limited prospect of full recovery.
Social	No impact on society	Localised, temporary social impacts	Localised, long term social impacts	Failure to protect poor or vulnerable groups. National, long term social impacts.	Loss of social license to operate. Community protests.
Financial	Example indicators: x % Internal rate of return (IRR) <2% Turnover	Example indicators: x % IRR 2 – 10% Turnover	Example indicators: x % IRR 10 – 25% Turnover	Example indicators: x % IRR 25 – 50% Turnover	Example indicators: x % IRR >50% Turnover
Reputational	Localised temporary impact on public opinion	Localised, short-term impact on public opinion	Local, long-term impact on public opinion with adverse local media coverage	National, short-term impact on public opinion; negative national media coverage	National, long-term impact with potential to affect stability of Government
Cultural Heritage and cultural premises	Insignificant Impact	Short term impact. Possible to recover or repair	Serious damage with wider impact to tourism industry	Significant damage with national or international impact	Permanent loss with resulting impact on society

The likelihood and impact are then combined in the form of a matrix to identify the significance (high, medium or low risk) of each impact, as outlined in Table 16. The significance conclusions for each impact should be based on the confirmed design and mitigation measures. This level of risk assessment is considered appropriate for the design stage, and will be developed further during future design, construction, operation and maintenance stages.

A risk that is low or medium is classed as non-significant, while a high or extreme risk is classed as a significant risk. The intention of the assessment is to increase the resilience of the asset, through design or other mechanisms, and reduce the number of risks classified as significant.

Table 16 Detailed Assessment: Risk Assessment Significance Matrix

Likelihood	Magnitude of consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Rare	Low Risk	Low Risk	Medium Risk	High Risk	Extreme Risk
Unlikely	Low Risk	Low Risk	Medium Risk	High Risk	Extreme Risk
Moderate	Low Risk	Medium Risk	High Risk	Extreme Risk	Extreme Risk
Likely	Medium Risk	High Risk	High Risk	Extreme Risk	Extreme Risk
Almost Certain	High Risk	High Risk	Extreme Risk	Extreme Risk	Extreme Risk

3.3.1.2 Significance Criteria for Detailed Assessment

The significance rating for the CCR assessment is provided on the basis that all adaptation/mitigation measures have been implemented. Any risks that remain significant (i.e. a high or extreme risk) should be prioritised in the monitoring and reviews of the risk assessment.

Table 17 Risk profile comparison

Risk Rating	Number of Risks	
	Initial risk rating	Residual risk rating
Low Risk	No. of low risk	No. of low risk
Medium Risk	No. of medium risk	No. of medium risk
High Risk	No. of high risk	No. of high risk
Extreme Risk	No. of extreme risk	No. of extreme risk

3.4 Impact Assessment

In the context of the proposed development, the potential impact of climate change related impacts on the proposed development must be considered for each of two distinct phases:

- Construction Phase; and
- Operational Phase.

During the Construction Phase, the potential impacts on of climate related hazards include severe weather events which may weaken the structural integrity of activities or cause dangerous disruption. During the operational phase the impacts from climate change require consideration of the future climate change scenarios and the exposure of the proposed development to such events.

3.4.1 Construction Phase

During the Construction Phase of the proposed development, works will be undertaken to construct and install infrastructure. The construction activities and phasing for the Construction Phase of the proposed development are described in greater detail in Chapter 5 (Construction Strategy) of the EIAR. While the total Construction Phase period will be approximately 47 months to the final Operational Phase, individual activities will have shorter durations. The program detailed in the Construction Environmental Management Plan (CEMP) identifies the estimated duration of works at each sub-section. Works are envisaged to proceed concurrently on multiple work-fronts to minimise the overall construction duration.

The Construction Phase construction activities will predominately involve site clearance, earthworks and excavation, transportation of materials to and from site, construction of temporary construction compounds, trenching, construction of access and internal roads, foundation laying, reinforced concrete works, erection of structural frames, buildings, and OHLE.

During the Construction Phase, all of these activities will have the potential to generate GHG emissions on-site. Examples of potential climate impacts during operation are included in Annex D (Climate Proofing and Environmental Impact Assessment) of the Technical Guidance on the Climate Proofing of Infrastructure (European Commission, 2021a). Potential impacts of climate change on the proposed development include:

- 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;
- Geotechnical impacts; and
- Major storm damage – including wind damage.

Each of these potential risks are considered with respect to the operational phase of the proposed development as detailed in Section 3.2 but also Chapter 13 (Climate) of the EIAR in Section 3.5.4. and Chapter 5 (Construction Strategy). During construction, the main 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, 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 specific risk assessments and method statements.

Based on the current design details and construction timelines (47 months) it is anticipated that site specific risk assessments and method statements will be required in order to ensure climate hazards do not significantly impact the construction phase.

In addition to the construction contractor's own climate hazard preparedness, Iarnród Éireann have a management protocol (CCE-TMS-311 Iarnród Éireann Weather Management Procedures) for preparedness and response to extreme weather events. This protocol includes assessing the operability of the network for services and co-operating and communicating with emergency services and national stakeholders, including participation in the National Emergency Coordination Group.

During construction potential hazards that may occur include:

- Extreme weather event results in an inaccessible construction site or health and safety risk to workers, causing restricted working hours and a delay in operations;
- Extreme weather events cause damage to construction materials, plant, and equipment;
- Extreme heat impacts concrete curing process resulting in damaged infrastructure components and rework;

- Warm and dry conditions exacerbate dust generation and dispersion, health risks to construction workers; and
- Extreme rainfall event results in flooding onsite causing soil erosion during early works or damage to partially constructed infrastructure, resulting in programme delays and/or increased costs.

3.4.2 Operational Phase

To determine the vulnerability of the proposed development to climate change, the sensitivity and exposure of the development to various climate hazards must first be determined. The following climate hazards have been considered in the context of the proposed development: flooding (coastal, pluvial, fluvial); extreme heat; extreme cold; wildfire; drought; extreme wind; lightning, hail, landslides and fog.

The sensitivity of the proposed DART+ West to the above climate hazards is assessed irrespective of the project location. Table 18 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 13. The results of the vulnerability assessment are detailed in Table 18.

Table 18 Climate Change Vulnerability Assessment

Climate Hazard	Sensitivity	Exposure	Vulnerability
Flood (coastal, pluvial or fluvial)	2 (Medium) – Sensitivity increased in particular at Spencer Dock. Only moderate risk future scenario considered	2 (Medium)	4 (Medium Risk)
Extreme Heat	1 (Low)	2 (Medium)	2 (Low Risk)
Extreme Cold	1 (Low)	2 (Medium)	2 (Low Risk)
Drought	2 (Medium) – Landscaping vulnerability to drought	2 (Medium)	4 (Medium Risk)
Wind	2 (Medium) – OHLE may have residual vulnerability to severe storms	2 (Medium)	4 (Medium Risk)
Wildfire	1 (Low)	1 (Low)	1 (Low Risk)
Fog	1 (Low)	1 (Low)	1 (Low Risk)
Lightning & Hail	1 (Low)	1 (Low)	1 (Low Risk)
Landslides	1 (Low)	1 (Low)	1 (Low Risk)

Climate vulnerability with respect to flood risk is discussed in Section 13.5.4.1 of Chapter 13 of the EIAR, it is also address in Chapter 4 (Description of the Proposed Development) and Chapter 5 (Construction Strategy) of the EIAR. Flooding of the local transport infrastructure is a potential impact of climate change on the proposed development. The EIAR notes that a comprehensive Site Specific Flood Risk Assessment (SSFRA) has been carried out, full details can be found in the supporting document SSFRA to the EIAR. The SSFRA included climate change factors as per the OPW Mid-Range Future climate scenario (RCP4.5) (+20%) as part of the assessment. Existing information indicates that the Docklands / Newcomen area is liable to flood in extreme events with increased flooding likely due to future effects of climate change. Currently the Docklands / Newcomen area is defended to the 0.5%AEP coastal event (1 in 200 year). These municipal defences managed by the local authority and OPW will require adaption to reduce the impact of climate change in the future. It is envisaged that flooding will be managed at this location through the adoption of flood resilient design and materials, flood warning systems and flood emergency response planning and implementation. Flood forecasting is appropriate as tidal inundation is the primary flood source. While flood risk design mitigation is put in place and Spencer Dock station is designed to be below the water table, there is a known risk at Spencer Dock of flooding in the occurrence of an extreme event.

As discussed in Section 13.5.4.1 of Chapter 13 (Climate) of the EIAR, the hydraulic modelling undertaken as part of the SSFRA has identified significant flooding between Maynooth and Kilcock. The track at this location cannot be raised due to potential conflicts with preserving heritage aspects of Jackson's Bridge. In order to provide a sufficient level of protection to the line from flood risk, the development has been moved offline on a raised embankment over the floodplain. Proposed crossings have been sized to maintain existing flood levels. Bridges soffits are to maintain a freeboard of >300mm above the 1%AEP (+ 20% climate change) flood level while the minimum rail level will maintain a freeboard of >500mm above the 0.1%AEP (+ 20% climate change) events.

The depot level will be a minimum of 300mm above the 0.1%AEP flood level (+ climate change). Residual flood risk will be managed by the implementation of a flood emergency response plan which will form part of the facilities management plan. The depot area and minor watercourse were not covered by the CFRAMS study.

The proposed development will be designed to incorporate flood resilient construction measures and materials. The proposed development including flood risk management elements will be subject to a maintenance plan. The maintenance of the proposed development will be undertaken by the relevant competent authority. In the case of a flood event exceeding the design event, the flood emergency response plans will ensure safe egress to appropriate refuge locations.

Chapter 5 Section 5.4.1 of the EIAR discusses the standards for the OHLE system with respect to the impact of wind speeds and loading. Wind speeds are taken into account when setting the max distance between posts and foundations. In addition, the OHLE system are subject to regular maintenance and replacement cycles in accordance with European Design standards (Design Life for new civil engineering structures (IE Standard CCE-TMS-410 (2019)). Wind loads on bridge structures will be determined as defined in I.S. EN 1991: Eurocode 1, Action on structures, Part 1-4 General actions – Wind actions, and the associated Irish National Annex, or otherwise as detailed in the TII Standards. Buildings are designed to be robustly assembled, using building techniques designed to withstand wind loading, with reduced vulnerability to building elements becoming detached from facades in extreme wind events. Design mitigation is in place to prevent this however there may be some residual vulnerability during severe storms.

Landslide susceptibility has been reviewed through the use of the Geological Survey Ireland (GSI) Landslide Susceptibility Map Viewer[3] at the proposed development redline boundary. This mapping did not indicate any areas of landslide susceptibility within the proposed development boundary. Any areas with embankment along the rail track will be designed to resist any potential landslides.

A Vegetation Management Plan will be put in place in order to maintain vegetation in the vicinity of the proposed development. Vegetation clearance and management for the safe operation of the OHLE equipment shall ensure that vegetation is kept at least 1.5 m from the rear of the OHLE mast or 1.5 m from any wire running between masts. This vegetation management also had the potential to ensure the potential for wind related vegetation effects and wildfires is minimised. The proposed development is not in areas which have a high risk for wildfires (i.e. forestry or areas of dense shrub). A high proportion is in urban areas with other sections within agricultural land.

Extreme temperatures, both extreme heat and extreme cold, have the potential to impact the proposed infrastructure. During winter and sudden cold spells, frozen tracks result in speed restrictions and potential termination of service. Overhead line equipment has the potential to be impacted by ice or snow events. Unmitigated, this is likely to occur with a high consequence of impact. The overhead line equipment will be designed to take into account a range of minimum and maximum temperatures (-20^{o}C to +40^{o}C) and loads under current and future climate conditions. The contact and messenger overhead wires will be automatically tensioned which will adjust for additional loading from ice, snow or wind. Ice loading has been considered within the design and a 9.5 mm radial thickness of ice coating has been applied for protection. The mechanical tension in the contact and messenger wires will be maintained within the system design parameters. In addition, Iarnród Éireann have a Snow Plan in place which can be activated if snow or ice are forecast. In

[3] https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=b68cf1e4a9044a5981f950e9b9c5625c Accessed 26/09/2023.

addition, point heaters are in place at essential crossing points along the track. Point heaters use electric heating elements, clipped to the rails to heat a set of points, to prevent ice forming and keep the switch blades moving. Such elements will be upgraded and serviced with regular maintenance to ensure extreme cold temperatures can be absorbed by taking business continuity actions. The depot and Spencer Dock station design will ensure that the building envelope and insulation will be designed using high insulation values to reduce thermal losses, which will prevent extreme temperatures affecting the assets within the buildings. Their design also takes into account solar control which will allow solar radiation to enter the building in cold months, whilst preventing it in warmer months.

These increased temperatures have the potential to cause the temperature of materials, such as tracks / OHLE / asphalt / bitumen, to increase resulting in thermal movements. The design of these elements includes an allowance for expansion/thermal movements. The inclusion of the thermal joints prevents track buckling during extreme heat events.

The buildings (including Spencer Dock station and the depot) detailed design will be finalised with potential future climate hazards in mind. Where applicable, during detailed design updated guidance such as second generation of Eurocodes which are to include impacts of future climate change will be reviewed. Table 4-2 of Chapter 4 (Description of the Proposed Development) of the EIAR details a list of the current design standards used as part of the EIAR.

The electrical supply will be direct to the project by way of an underground cable which will be resistant to storm damage. The substations have looped connections with the ESB (redundant connection) and therefore already have a backup which will be used prior to a back-up generator being required. There is a single 80 KVA diesel generator in the proposed substations as a backup in the event of storm damage. The detailed design of the proposed development will be in accordance with all relevant codes and standards, including IS EN 1991-1-4:2005 Eurocode 1: Actions on structures – general actions - Wind actions. In addition, mitigation against lightning strikes will be accounted for by utilisation of methods contained in IEC 62305 'Protection Against Lightning, Part 2, Risk Management'.

The design working life of the proposed development is based on the current generation of Eurocodes which include climate data that is 10-15 years old. During the operation and maintenance of infrastructure, it will be essential to revisit the available climate data and any critical assumptions. This can be carried out at regular intervals (e.g. 5-10 years) as part of the asset management to address evolving climate risks (European Commission, 2021a).

Therefore, overall the proposed development has a worst-case medium vulnerability due to potential future climate change risk. A risk that is low or medium is classed as non-significant, while a high or extreme risk is classed as a significant risk. 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. Given the medium residual risk a detailed assessment of future climate change risk will be conducted during the detailed design phase. This detailed assessment, alongside a climate risk register, will seek to further strengthen the resilience of the DART+ West to hazards associated with future climate change. Mitigation measures to be considered in detailed design will fall into three main categories which are in line with Ireland's National Adaptation Framework (Department of the Environment, Climate and Communications, 2018):

- Grey Actions: technical or engineering oriented responses to climate impacts (i.e. drainage design);
- Green Actions: nature-based solutions to develop the resilience of human and natural systems;
- Soft Actions: involve the alterations in behaviour, regulation, or systems of management (i.e. increased monitoring or management plans).

3.5 Summary

The TII Guidance documents PE-ENV-01104 (TII 2022a) and PE-ENV-01105 (TII 2022b) set out a methodology for the assessment of climate risk. Both of these documents were published after the submission of the EIAR. A climate risk assessment was conducted within Chapter 13 (Climate) of the EIAR however this utilised the criteria within the guidance document LA 114 – Climate (UKHA 2019) published by the UK Highways Agency. While PE-ENV-01104 (TII, 2022a) recommend the use of a specific risk assessment for climate change, it does state that alternatives may be used.

"An alternative risk framework can be adopted for the assessment if the Climate Practitioner deems appropriate. For example, a project specific risk framework may have been established to ensure consistency in the assessment and discussion on project risks, which the Climate Practitioner may deem relevant for the assessment of climate risk."

The aim of both the methodology in the 2022 TII guidance documents and the LA 114 guidance used in the EIAR is to ensure that adaptation or mitigation measures are implemented in any proposed development in order to minimise risks due to climate change.

The proposed development has a worst-case medium vulnerability due to potential future climate change risk. This risk is associated with sensitivity of sites such as Spencer Dock to flood risk, the use of only the moderate (RCP4.5) future scenarios for climate change being accounted for within flood risk calculations and the potential effect of drought on landscaping. The potential effect of severe storms on OHLE is also considered higher sensitivity due to storm related damage. Design mitigation is in place to prevent this however there may be some residual vulnerability to be investigated in detailed design.

During the detailed design, the moderate (RCP4.5) and high-risk (RCP8.5) future scenarios for climate change will be considered across all design elements to further strengthen the resilience of the DART+ West to hazards associated with future climate change.

Where residual risk of future climate change remains, additional mitigation will be applied. These include management plans, monitoring or communication with relevant bodied on updated potential risks. Mitigation measures include time scales (i.e. annually, after a climate hazard event) and the responsible party. To ensure mitigation and adaptation measures to combat residual risks are binding, they will be included in the appropriate project documentation. Monitoring should be undertaken to assist with the ongoing management of adaptation and mitigation actions identified through the climate assessment process in order to measure their effectiveness.

4. REFERENCES

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