Wicklow County Council

N11/M11 Junction 4 to Junction 14 Improvement Scheme

Option Selection Report Appendix D6 – Air Quality and climate

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1 Air Quality and Climate

1.1 Introduction

This report details the environmental assessment of the Stage 2 Project Appraisal Matrix for the N11/M11 Scheme with respect to the Air quality and climate constraints identified in **Section 5 (**Air quality and climate) of **Volume B**.

For the corridor assessment, the overall scheme has been split into two sections, i.e. the Northern Section and the Southern Section and the corridor options assessed are those discussed in **Chapter 8** of **Volume A**.

There are two zones associated with each corridor option referred to in the corridor assessment:

- The potential road "footprint" which is the potential landtake required to construct or improve the road; and
- The road "corridor" which is a 200m wide corridor centred around the alignment centre line for all off-line corridors. For the on-line Corridor Options 1 (North), 1 (South) and 5 (South), the width is variable, but is typically narrower than the width of the off-line corridors. The "footprint" sits inside the "corridor" boundary.

A transport assessment forms part of this Stage 2 Project Appraisal Matrix. This assessment is included in **Section 1.5**. The transport scenarios that were assessed are as follows:

- Transport Scenario 5A – Parallel Links + Junction Rationalisation;
- Transport Scenario 5B – N11/M11 Additional Lane(s) + Junction Improvements; and
- Transport Scenario 4 – Bus Service Enhancements.

Section 1.2 outlines the methodology that was used to carry out the assessment, **Sections 1.3** and **1.4** outline the assessment criteria which were used, and **Section 1.5** outlines the Baseline Environment. The Stage 2 assessment is presented in **Section 1.6** (Air quality corridor assessment) and **1.7** (Climate corridor assessment) and **Section 1.8** (Air quality and climate Transport Scenario assessment). References are listed in **Section 1.9**.

1.2 Methodology

1.2.1 TII Project Appraisal Guidelines

The corridor options were assessed comparatively for the northern and southern sections.

The multi-criteria air and climate assessments were undertaken with reference to the TII Project Appraisal Guidelines for National Roads (PAG) Unit 7.0 – Multi Criteria Analysis[1] (hereafter referred to as TII PAG). The assessment includes both a quantitative and qualitative element. Each impact is scored quantitatively based on the seven-point scale below and an integer is assigned according to the impact level.

- 7 – Major or highly positive;
- 6 – Moderately positive;
- 5 – Minor or slightly positive;
- 4 – Not significant or neutral;
- 3 – Minor or slightly negative
- 2 – Moderately negative; or
- 1 – Major or highly negative.

Using the impact scores and professional judgement a determination is made as to whether each corridor option assessed is 'Preferred', 'Intermediate' or 'Least Preferred'. The Environmental Protection Agency (EPA) Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports[2] were also referred to when undertaking this assessment, particularly **Table 3.3** in determining the significance of the impact.

The air quality assessment has been prepared in accordance with the Transport Infrastructure Ireland (TII), formerly, the National Roads Authority, Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes[3] (hereafter referred to as the TII Guidelines).

Property counts from Ordnance Survey Ireland data[4] and granted residential/sensitive receptor planning applications from Geohive[5] were used to determine the proximity and number of sensitive receptors in the air quality assessment.

[1]Transport Infrastructure Ireland (TII) Project Appraisal Guidelines for National Roads Unit 7.0 - Multi-Criteria Analysis, 2016. Available from: https://www.tiipublications.ie/library/PE-PAG-02031-01.pdf

[2] Environmental Protection Agency (EPA), Guidelines on the Information to be Contained in Environmental Impact Assessment Reports, Draft 2017. Available from: https://www.epa.ie/pubs/advice/ea/EPA%20EIAR%20Guidelines.pdf

[3] Transport Infrastructure Ireland Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes, 2011. Available from https://www.tii.ie/technical-services/environment/planning/Guidelines-for-the-Treatment-of-Air-Quality-during-the-Planning-and-Construction-of-National-Road-Schemes.pdf

[4] Ordnance Survey Ireland. Licence Number 2020/35/CCMA/Wicklow County Council, OSI Digital Terrain Data (Prime 2) [Received from Wicklow County Council: 20 September 2019]

[5]Department of House, Planning and Local Government, National Planning Applications. Available from: https://data.gov.ie/dataset/national-planning-applications [Accessed: 16 December 2020]

Sensitive receptor locations are defined in the TII Guidelines[3] as residential housing, schools, hospitals, places of worship, sports centres and shopping areas, i.e. locations where members of the public are likely to be regularly present. Planning applications were also identified to give an indication of the potential number of future sensitive receptors adjacent to corridors.

Projected 2042 Do-Something traffic volumes, in the form of Annual Average Daily Traffic (AADTs), have been provided for the two northern corridor options, the four southern corridor options and the two transport scenarios. These traffic flows were assessed using the Design Manual for Roads and Bridges Screening Method, TII Carbon Tool and ADMS-Roads modelling software, to inform the air quality and climate impact assessments.

1.2.2 Air quality assessment

1.2.2.1 Design Manual for Roads and Bridges (DMRB)

In accordance with the TII Guidelines[3] and the DMRB LA 105 Guidance[6], the DMRB Screening Method (Version 8.0) spreadsheet is used in this assessment. This spreadsheet calculates annual average concentrations of PM, NO_x and CO_2 (as required for the operational air quality and carbon assessment) and was used to assess the local and regional air quality impacts to undertake a comparative assessment of the scheme options.

The DMRB spreadsheet method computes concentrations of pollutants at a regional level based on factors including:

- Annual average daily traffic (AADT) flows, refer to the Transport Modelling Report in **Appendix F3.1** of **Volume F**.
- Average speed of traffic;
- Traffic composition; and
- Road type and length.

The corridor options modelled for the purpose of the air quality and climate assessment are described below:

Northern Section corridor options

- Corridor Option 1A (North); and
- Corridor Option 1B (North).

Southern Section corridor options

- Corridor Option 1 (South);
- Corridor Option 2 (South);
- Corridor Option 5 (South); and

[6] Design Manual for Roads and Bridges (DMRB) Sustainability & Environment LA 105 Air Quality

- Corridor Option 6 (South).

The transport scenarios assessed are listed in **Section 1.1.** In relation to the Transport Scenarios 5A and 5B, the transport scenario which generates the higher AADT for the corridor options has been assessed for comparative purposes. The air quality assessment utilises traffic predictions for 2027 (Opening Year) and 2042 (Design Year) outlined in the **Transport Modelling Report** in **Appendix F3.1** of **Volume F**.

1.2.2.2 Ecological sites - ADMS-Roads

In order to predict local concentrations for ecological sites, the ADMS-Roads atmospheric dispersion model has been used. The assessment follows the methodology set out in DEFRA's Local Air Quality Management Technical Guidance (LAQM.TG16)[7] for aspects not covered by the TII Guidelines[3].

ADMS-Roads modelling software has been used to predict the impact of emissions of NO_x, NO_2[8] and PM_{10} as part of the air quality assessment. ADMS-Roads is a more complex model for the prediction of concentrations of pollutants, particularly in close proximity to roads compared to the DMRB spreadsheet. The model uses the same inputs as the DMRB approach, i.e. AADT flows and average speed of traffic. However, ADMS also requires additional detail including carriageway width, meteorological data, emission profiles and fleet mix, and time - varying emission profiles.

Emissions factors and fleet mix projections based on the National Transport Authority's (NTA) ENEVAL modelling software have been used for the ADMS modelling assessment. The fleet mix projections allow for the increased use of electric vehicles and subsequent reduction of diesel and petrol cars over time. Two sets of fleet mixes have been used for the 2027 (Opening Year) and 2042 (Design Year) projections. It is observed that over time, the projected use of electric vehicles increases, and the use of diesel and petrol cars reduces. In respect of vehicular emissions, the 2042 Design Year fleet mix is considered to have lower emissions and therefore be more favourable than the 2027 Opening Year fleet mix.

Using 2027 and 2042 AADTs for Corridor Option 1 (South) (through Glen of the Downs SAC), a transect of 200m at 10m intervals has been modelled to represent ecological receptors. As a worst case, the results from this assessment were used for assessing the impact at representative ecological receptors for the other corridor options.

[7] UK Government, Department for Environment Food & Rural Affairs (DEFRA) Local Air Quality Management Technical Guidance (TG16), February 2018. Available from: https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf

[8] Predicted NO_2 values have been calculated using the ADMS predicted NO_x values multiplied by a ratio of NO_x/NO_2 from the DMRB Screening spreadsheet (0.32).

1.2.3 Carbon assessment

1.2.3.1 TII Carbon Tool

The TII Carbon Tool calculates the carbon footprint of road projects for the construction phase, as required by the revised Environmental Impact Assessment (EIA) Directive 2014/52/EU. The tool is customised for road projects in Ireland and uses emission factors for a wide range of activities and materials to predict the total carbon generated by a project. The tool was used to assess carbon emissions during the construction stage. For this Stage 2 assessment, the embodied carbon for the concrete, pavement and earthworks volumes has been assessed for each option. A transport distance of 25km has been assumed for importing concrete and black-top to the site.

1.3 Assessment criteria – Air quality

1.3.1 Introduction

The following extract from Section 2.3, *Route Selection Process Stage 1 Preliminary Options Assessment,* of the TII Guidelines[3] includes the initial steps to assess air quality within a study area as follows:

"*The air quality input for the refined route options should consider the relative impacts of each of the route options on exposure to air pollution at sensitive locations. The assessment should focus on nitrogen dioxide and PM_{10} which are the pollutants of greatest concern with respect to road traffic emissions. The input should:*

- *consider any changes to baseline air quality noted in the Stage 1 assessment. This should include updating any available monitoring data, information about existing pollution sources and the location of sensitive receptors;*
- *compare the relative impact of each of the route options on the likely population exposure to nitrogen dioxide* (in accordance with the TII Guidelines[3], the assessment is actually undertaken for nitrogen oxides as per this guidance) *and PM_{10} concentrations. This should involve calculating the Index of Overall Change in Exposure for the existing route and each route option in the opening year);*
- *depending upon local circumstances, determine the magnitude of changes in nitrogen dioxide and PM_{10} concentrations as a result of the route options at a few worst-case locations for the opening year, and*
- *if there are any relevant designated habitat sites within 200m of any route options with significant changes in emissions, calculate the nitrogen oxides concentrations and nitrogen deposition rates at these locations*".

1.3.2 Changes to baseline air quality conditions

The TII Guidelines[3] require the following for assessing changes to baseline air quality conditions:

"The information collated during the Stage 1 Preliminary Options Assessment should be reviewed to include any new monitoring data that have become available and to take into account any new pollution sources and/or new sensitive receptors along each feasible route option."

Baseline air quality information is taken from published EPA data over the past three years. **Section 1.4** provides this information in detail.

1.3.3 Calculation of the index of overall change in exposure

Guidance for calculating the index of overall change in exposure is included in the TII Guidelines[3] as follows:

"*Calculation of the Index of Overall Change in Exposure allows a comparison of the overall impact on people of each route option to be carried out.*

The Index is based on taking the number of sensitive receptor locations within 50m of the carriageway of all road links that would experience a significant change in traffic for each of the route options."[3]

"The number of properties is then multiplied by the predicted change in the emission rate along that link and then summed across all links for that route option."[3]

An assessment of the Index of Overall Exposure is included in **Section 1.5.2**, as is deemed sufficient for comparative purposes. For the corridor options assessment, the number of sensitive receptor locations within 50m of each corridor has been used.

1.3.4 Calculation of local-scale pollutant concentrations

The TII Guidelines[3] include guidance for calculating the local-scale pollutant concentrations as follows:

"If there is limited information about existing air quality near to roads, or there are sensitive receptors within close proximity to one or more route options, i.e. within 10m of the edge of the road, it will be necessary to predict pollutant concentrations at the Stage 2 Project Appraisal. It would be appropriate, in these circumstances, to calculate concentrations of both nitrogen dioxide and PM_{10} at a small number of 'worst case' receptor locations for the opening year."

An assessment of local scale pollutant concentrations using ADMS modelling software has been undertaken to predict pollutant concentrations at nearby sensitive receptors.

1.3.5 Impacts on sensitive ecosystems

Guidance on assessing impacts on sensitive ecosystems is included in the TII Guidelines[3], as follows:

"Any assessment of air quality impacts on sensitive ecosystems should be discussed and agreed with the Ecologist. The potential impact of the road scheme on sensitive ecosystems is limited to the local level. Consideration should therefore be given to all designated sensitive sites that are within 200m of any road that could be affected by the proposed scheme, both during operation and construction."

An assessment of the impacts of the corridor options on Glen of the Downs SAC has been included in the Stage 2 Biodiversity assessment for the Opening and Design Year AADTs. The assessment undertaken as part of this air quality assessment was used to predict potential impacts at other ecological receptors; Kilmacanoge Marsh pNHA, Ballywaltrim ecological site (EC45), Druids Glen and Coyne's Cross for Design Year AADTs. The ecological assessment focuses on exceedances of NOx which vegetation may be sensitive to. Based on the comparison of results for Glen of the Downs SAC (Design Year vs Opening Year) a statement of likely impact for the Opening Year at the other ecological receptors is made, in the absence of Opening Year AADTs.

1.4 Assessment criteria - Climate

The climate assessment evaluates annual predictions of carbon emissions from road traffic during the operational stage while also considering potential embodied carbon from the construction phase of each corridor option.

1.5 Baseline environment

1.5.1 EPA Monitoring data

Table 1.1 outlines the baseline environment for Zone C from EPA published data for 2019-2020. Zone C is defined in the Air Quality Standards Regulations (SI 180 of 2011) as 'other cities and large towns' and includes Bray and environs comprising the following Electoral Divisions: Bray Nos. 1, 2, 3 and 4; Rathmichael (Bray); and Kilmacanoge.

Table 1.1: Baseline annual average concentrations of pollutants – Zone C

Year	Pollutants	Measured concentrations µg/m^3	Air Quality Standard (AQS) Limit µg/m^3	% of AQS Limit
2020	NO_2	10.1	40	25.3
	NO_x	19	30	63.3
	PM_{10}	14.3	40	35.8
2019	NO_2	9.3	40	23.3
	NO_x	13.9	30	46.3
	PM_{10}	14.8	40	37.0
2018	NO_2	8.5	40	21.3
	NO_x	11.5	30	38.3
	PM_{10}	11.0	40	27.5

1.5.2 Onsite measured data

The measured onsite data concentrations presented are based on the following:

- Monitoring of nitrogen dioxide and nitrogen oxides was completed from 01 January 2020 to 19 February 2020 and 01 September 2020 to 08 January 2021 at Glen of the Downs at three sampling locations, refer to **Figure 1.1**.
- Period averages (01/01/20 to 19/02/20 and 01/09/20 to 31/12/20) from Zone C monitoring locations (Dundalk, Limerick, Navan, Portlaoise, Waterford is used to annualise local monitoring data in accordance with TII Guidelines[1].
- Diffusion tube bias included in the results.

As the monitoring for NO_2 and NO_x has been carried out over a period of seven months, concentrations are not directly comparable to the annual mean limits outlined in the Air Quality Standards (here in referred to as AQS). Appendix 2 of the TII Guidelines[3] provides a methodology to calculate the annual mean from short-term monitoring. This is based on long term published monitoring data from the EPA for appropriate monitoring stations. Using this approach, predicted annual mean concentrations of NO_2 and NO_x were calculated. The AQS state that the minimum annual data capture required to allow comparison with limit values is 90%.

The EPA manages the national ambient air quality monitoring network which consists of a network of air quality monitoring stations across the country and monitoring data is publicly available online from the EPA's SAFER-Data database[9].

[9] Environmental Protection Agency, Secure Archive for Environmental Research Data (SAFER). Available from: http://erc.epa.ie/safer/ [Accessed: 1 February 2021]

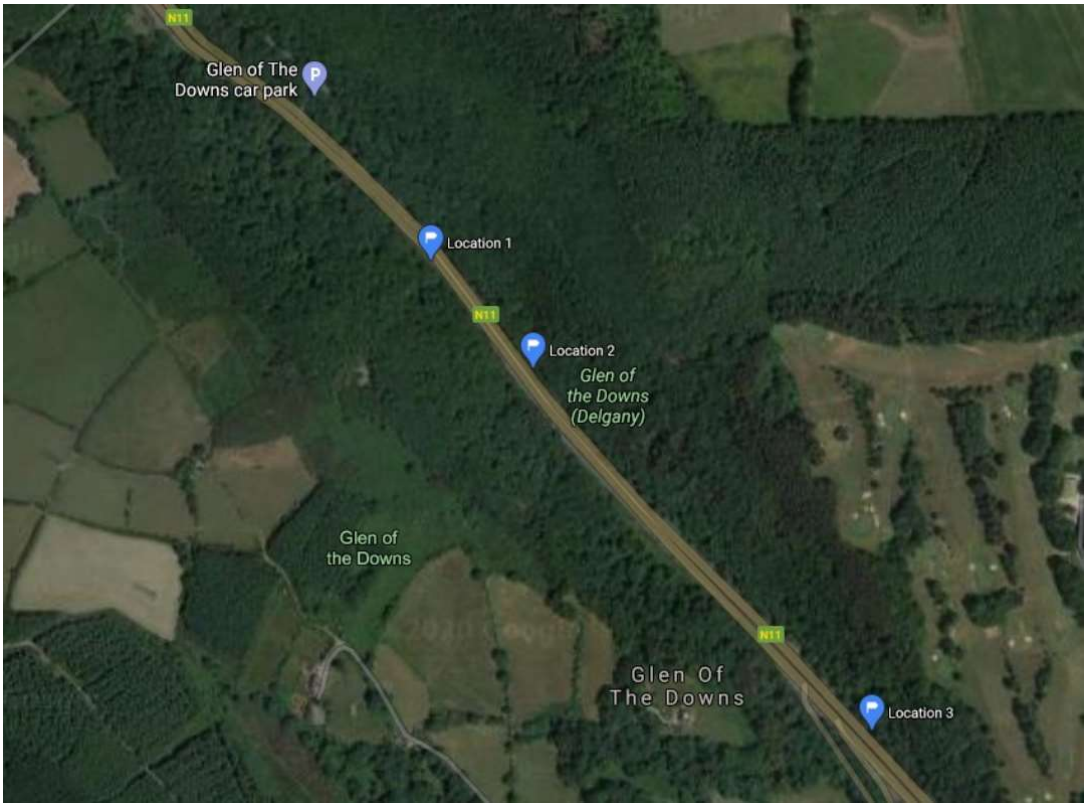

Figure 1.1: Air Quality Monitoring Locations

Table 1.2 outlines the results from onsite monitoring at the Glen of the Downs in 2020. **Table 1.3** outlines the calculations for predicting the annual mean based on the long-term EPA monitoring data as outlined above.

Table 1.2: Results of monitoring at the Glen of the Downs, 2020 measurements only.

Location	**Dates**	**Result**	
		Concentration (µg/m^3)	**Concentration (µg/m^3)**
		NO_2	**NO_x**
Glen of the Downs 2020	20/12/2019 - 19/02/2020. 01/09/2020 – 08/01/2021.	15.8	32.2
AQS Annual Average Limit Value (µg/m^3)		40	30

Table 1.3: Adjusted annual mean

Parameter	Abbrev.	NO_2 Concentration (µg/m^3)					NO_x Concentration (µg/m^3)				
		Dundalk	Limerick	Navan	Portlaoise	Waterford	Dundalk	Limerick	Navan	Portlaoise	Waterford
Measured mean period for 20/12/19 to 19/02/20 and 01/09/20 to 08/01/21 at Glen of the Downs[10]	M	15.8					32.2				
2020 Annual Mean for Zone C (Dundalk, Limerick, Navan, Portlaoise, Waterford)	AM	10	10	19	11	7	17.8	15.7	52	11.5	10.6
Period mean for 01/01/20 to 19/02/20 and 01/09/20 to 31/12/20 (Dundalk, Limerick, Navan, Portlaoise, Waterford)	PM	13.37	12.24	20.70	9.73	8.29	24.04	20.56	63.16	15.93	13.99
Ratio of AM/PM	R	0.75	0.82	0.92	1.13	0.84	0.74	0.76	0.82	0.72	0.76
Average of R	RA	0.89					0.76				
Estimated annual mean 2020 (M x RA)	EV	**14.1**					**24.5**				
AQS Annual Average Limit Value (µg/m3)		40					30				

Given the high predicted annual mean of NO_x, the assessment below includes background values in addition to the contribution from the ADMS modelling results. From a review of NO_2 and PM_{10}, background concentrations are not included as the limit thresholds are not considered at risk of being exceeded.

[10] Due to the changeover dates, monthly data beginning the 20 December 2019 and ending on the 8 January 2021 has been included. There was a pause on air quality monitoring from 19/02-2020 to 01/09/2020 due to reduced traffic levels as a result of Covid-19 restrictions.

1.6 Stage 2 Project Appraisal Matrix – Air quality corridor assessment

1.6.1 Northern Section

1.6.1.1 Local – ecological

Table 1.4 presents the predicted NO_x concentrations for indicative ecological receptors along each corridor option for the Design Year. Results are compared to the AQS limit value for NO_x.

Table 1.4: Air quality assessment, Local – ecological - Northern Section

Corridor Option	Transect used (m)	Estimated concentrations NO_x for Design Year including background conc. (µg/m³)	AQS limit value (µg/m³)	Impact Level for Assessment
Kilmacanoge Marsh pNHA				
Option 1A (North)	10m	25.3	30	2
Option 1B (North)	10m	25.5	30	2
Ballywaltrim Lane				
Option 1A (North)	10m	20.1	30	3
Option 1B (North)	10m	20.2	30	3

Kilmacanoge Marsh pNHA

In the Design Year, the impact levels for both Corridor Option 1A (North) and 1B (North), are assigned *moderately negative* as the predicted NO_x level is approaching the threshold limit.

Based on the ratio of impact presented for Glen of the Downs SAC for Opening Year and Design Year, and in the absence of Opening Year AADTs at Kilmacanoge Marsh pNHA, it is likely that the estimated NO_x concentration for the Opening Year at Kilmacanoge Marsh pNHA will be near, or at, the air quality standard of 30µg/m³. However, due to required reductions in pollutant emissions from vehicles and the projected increase in electric vehicles (EV), pollutant concentrations are expected to be significantly reduced by the Design Year.

Ballywaltrim Lane

At Ballywaltrim Lane, NOx concentrations are affected mainly by local traffic on the R768 rather than traffic on the N11 carriageway which is located approximately 200m west of Ballywaltrim ecological site (EC45).

The impact levels for both Corridor Option 1A (North) and 1B (North), are both assigned *minor or slightly negative* as the predicted NOx concentrations are below the air quality standard in the design year.

Based on the ratio of impact presented at Glen of the Downs SAC for Opening Year and Design Year, and in the absence of Opening Year AADTs at Ballywaltrim Lane, it is likely that the estimated NO_x concentration for the Opening Year at Ballywaltrim Lane will be below the standard of 30µg/m³ for NO_x.

1.6.1.2 Local – human health

Table 1.5 presents the NO_2 and PM_{10} concentration at indicative sensitive receptors located 20m from the corridor options, for the Northern Section, using the highest 2042 Design Year AADTs. Results are compared to the AQS limit value for NO_2 and PM_{10}.

Table 1.5: Local – Human health - NO_2 and PM_{10} for sensitive receptors - Northern Section

Corridor Option	Estimated NO_2 based on from Design Year AADTs (µg/m³)	AQS NO_2 limit value (µg/m³)	Estimated PM_{10} based on Design Year AADTs (µg/m³)	AQS PM_{10} limit value (µg/m³)	Impact Level for Assessment
Option 1A (North)	6.7	40	2.7	40	4
Option 1B (North)	6.3	40	2.5	40	4

The impact levels for both Corridor Option 1A (North) and Corridor Option 1B (North) are assigned as *not significant or neutral*. These ratings are brought forward to the overall Northern Section ranking for air quality presented in **Table 1.8**.

1.6.1.3 Regional

Table 1.6 and **Table 1.7** present the NO_x and PM_{10} indices (see **Section 1.3.1**), respectively for the Northern Section using 2042 Design AADTs.

Table 1.6: Regional - NO_x Index - Northern Section

Corridor Option	Properties within 50m	AADT Link length (km)	NO_x emissions (tonnes/yr)	NO_x emission rate (tonnes/km/yr)	NO_x index	Impact Level for Assessment
Option 1A (North)	493	19.5	37.4	1.9	937	3
Option 1B (North)	500	17.7	34.9	2.0	1,000	3

Table 1.7: Regional - PM_{10} Index - Northern Section

Corridor Option	Properties within 50m	AADT Link length (km)	PM_{10} emissions (tonnes/yr)	PM_{10} emission rate (tonnes/km/yr)	PM_{10} index	Impact Level for Assessment
Option 1A (North)	493	19.5	6.4	0.33	163	3
Option 1B (North)	500	17.7	6.1	0.34	172	3

The impact levels for both Corridor Option 1A (North) and Option 1B (North) were assigned as *minor or slightly negative*. These impact levels are brought forward to the overall Northern Section ranking for air quality presented in **Table 1.8**.

1.6.1.4 Air quality summary Northern Section -

Based on the results presented in **Table 1.4**, **Table 1.5**, **Table 1.6** and **Table 1.7**, a combined corridor option assessment for the Northern Section is presented in **Table 1.8.**

Table 1.8: Air quality corridor assessment – Northern Section

Assessment Criteria	Corridor Option 1A (North)	Corridor Option 1B (North)
Local – Pollutant Impact (Ecological)	2	2
Local – Pollutant Impact (Human Health)	4	4
Regional - NO_x Index	3	3
Regional - PM_{10} Index	3	3
Overall Qualitative Assessment	Minor or Slightly Negative	Minor or Slightly Negative
Score / Impact Level	3	3
Preference	Preferred	Intermediate

As outlined in **Table 1.6** and **Table 1.7**, Corridor Option 1B (North) has a slightly higher number of both existing and potential receptors than Corridor Option 1A (North).

Based on the slightly lower index rating for NO_x and PM_{10} (see **Table 1.7**), Corridor Option 1A (North) is rated as preferred and Corridor Option 1B (North) is assigned as intermediate. This preference is marginal.

1.6.2 Southern Section

1.6.2.1 Local – ecological

Glen of the Downs

Table 1.9 presents the predicted NO_x concentrations from ADMS modelling for indicative ecological receptors along each corridor option for both the Opening Year and Design Year at Glen of the Downs SAC. Results are compared to the AQS limit value for NO_x.

Table 1.9: Air quality assessment, Local – ecological - Southern Section (Glen of the Downs)

Corridor Option	Transect used (m)	Estimated NO_x for Opening Year including background conc. (µg/m³)	AQS limit value (µg/m³)	Impact Level for Assessment	Estimated NO_x for Design Year including background conc. (µg/m³)	AQS limit value (µg/m³)	Impact Level for Assessment
Option 1 (South)	10	31.4	30	2	26.3	30	3
Option 2 (South)	90	18.4	30	3	17.6	30	4
Option 5 (South)	10	31.4	30	2	26.3	30	3
Option 6 (South)	40	22.4	30	3	20.2	30	4

In the Opening Year, the impact levels for both Corridor Option 1 (South) and Corridor Option 5 (South) are assigned as *moderately negative.* Concentrations of NO_x are predicted to exceed the AQS of 30µg/m³ for the protection of vegetation. Corridor Option 6 (South) and Corridor Option 2 (South) are assigned as *minor or slightly negative*.

In the Design Year, the impact levels for both Corridor Option 1 (South) and Corridor Option 5 (South) are assigned *minor or slightly negative* as the predicted NO_x concentration is below the threshold limit. Corridor Option 6 (South) and Corridor Option 2 (South) are assigned as *not significant or neutral*.

Druids Glen and Coyne's Cross

Table 1.10 presents the predicted NO_x concentrations from DMRB modelling (with the primary assessment ADMS calibration, detailed in **Section 1.2.2.2**) for indicative ecological receptors at 15m along each corridor option for both the Opening Year and Design Year at Druids Glen and Coyne's Cross. Results are compared to the AQS for NO_x.

Table 1.10: Air quality assessment, Local – ecological – Southern Section (Druids Glen and Coyne's Cross).

Corridor Option	Estimated NO_x for Opening Year including background conc. (µg/m³) DMRB/ADMS ratio	Impact Level for Assessment	Estimated NO_x for Design Year including background conc. (µg/m³)	AQS (µg/m³)	Impact Level for Assessment
Druids Glen					
Option 1	29.6	2	24.8	30	3
Option 2	30	2	25.1		3
Option 5	29.6	2	24.8		3
Option 6	29.6	2	24.8		3
Coyne's Cross					
Option 1	30.2	2	25.3	30	3
Option 2	30.2	2	25.3		3
Option 5	30.2	2	25.3		3
Option 6	30.2	2	25.3		3

At Druids Glen and Coyne's Cross in the Opening Year, the impact levels for Corridor Options 1 (South), 2 (South), 5 (South) and 6 (South) are assigned *moderately negative* as the predicted NO_x concentration is at or near the threshold limit.

In the Design Year, the impact levels for Corridor Options 1 (South), 2 (South), 5 (South) and 6 (South) are assigned *minor or slightly negative* as although the predicted NO_x level is below the threshold limit, it remains elevated.

Given the particular ecological sensitivities at Glen of the Downs SAC, the Opening Year impact levels are brought forward to the overall Southern Section ranking for air quality presented in **Table 1.14**, as a worst case.

1.6.2.2 Local – human health

Table 1.11 presents the predicted NO_2 and PM_{10} concentration for sensitive receptors at 20m for each corridor option for the Southern Section, using the highest 2042 Design Year AADTs. Results are compared to the AQS limit value for NO_2 and PM_{10}.

Table 1.11: NO_2 and PM_{10} concentration for sensitive receptors – Southern Section

Corridor Option	Transect used (m)	Estimated NO_2 from Design Year AADTs (µg/m³)	AQS NO_2 limit value (µg/m³)	Estimated PM_{10} from Design Year AADTs (µg/m³)	AQS PM_{10} limit value (µg/m³)	Impact Level for Assessment
Option 1	20m	6.1	40	2.3	40	4
Option 2		1.3		0.5		

Corridor Option	Transect used (m)	Estimated NO_2 from Design Year AADTs (µg/m³)	AQS NO_2 limit value (µg/m³)	Estimated PM_{10} from Design Year AADTs (µg/m³)	AQS PM_{10} limit value (µg/m³)	Impact Level for Assessment
Option 5		6.1		2.3		
Option 6		6.1		2.3		

The impact levels for Corridor Option 1 (South), Corridor Option 2 (South), Corridor Option 5 (South) and Corridor Option 6 (South) are all assigned as *not significant or neutral*. These impact levels are brought forward to the overall Southern Section ranking for air quality presented in **Table 1.14**.

1.6.2.3 Regional

Table 1.12 and **Table 1.13** present the NO_x and PM_{10} indices (See **Section 1.3.3**) respectively for the Southern Section using 2042 Design Year AADTs.

Table 1.12: Regional – NO_x Index – Southern Section

Corridor Option	Properties within 50m	Link length (km)	NO_x emissions (tonnes/yr)	NO_x emission rate (tonnes/km/yr)	NO_x index	Impact Level for Assessment
Option 1	166	13.9	27.4	2.0	327	2
Option 2	85	20.7	30.0	1.4	123	3
Option 5	166	13.9	27.4	2.0	327	2
Option 6	171	15.3	25.9	1.7	290	2

Table 1.13: Regional – PM_{10} Index – Southern Section

Corridor Option	Properties within 50m	Link length (km)	PM_{10} emissions (tonnes/yr)	PM_{10} emission rate (tonnes/km/yr)	PM_{10} index	Impact Level for Assessment
Option 1	166	13.9	4.9	0.35	59	2
Option 2	85	20.7	5.4	0.26	22	3
Option 5	166	13.9	4.9	0.35	59	2
Option 6	171	15.3	4.7	0.31	53	2

The impact levels for Corridor Option 1 (South), Corridor Option 5 (South), and Corridor Option 6 (South) are all assigned as *moderately negative*. The reduced number of receptors along Corridor Option 2 (South) allows the impact level to be assigned as *minor or slightly negative*. These impact levels are brought forward to the overall Southern Section ranking for air quality presented in **Table 1.14**.

1.6.2.4 Air quality summary Southern Section

Based on the results presented in **Table 1.9**, **Table 1.10**, **Table 1.11**, **Table 1.12** and **Table 1.13,** the overall corridor options assessment for the Southern Section is presented in **Table 1.14**.

Table 1.14: Air quality corridor assessment – Southern Section

Assessment Criteria	Corridor Option 1 (South)	Corridor Option 2 (South)	Corridor Option 5 (South)	Corridor Option 6 (South)
Local – Pollutant Impact (Ecological at Glen of the Downs)	2	3	2	3
Local – Pollutant Impact (Human Health)	4	4	4	4
Regional - NO_x Index	2	3	2	2
Regional - PM_{10} Index	2	3	2	2
Overall Qualitative Assessment	Moderately Negative	Minor or Slightly Negative	Moderately Negative	Moderately Negative
Score / Impact Level	2	3	2	2
Preference	Least Preferred	Preferred	Least Preferred	Intermediate

Due to the predicted exceedance of the annual AQS for NO_x, Corridor Option 1 (South) and Corridor Option 5 (South) are ranked as least preferred.

Corridor Option 6 (South) is ranked as intermediate, as while it is not predicted to exceed the AQS for NO_x, all other impact levels are the same as Corridor Option 1 (South) and Corridor Option 5 (South).

Corridor Option 2 (South) is ranked as preferred as the overall impact is considered *minor or slightly negative.*

For the purposes of undertaking the comparative assessment of corridor options during Stage 2, it is important to note that the predicted NO_x concentrations for the opening and design years are based on a 'worst case' traffic profile on the N11 through the Glen of the Downs SAC. Conservatively, the ADMS modelling for all corridor options is based on the AADT volumes projected for Transport Scenario 5B. As indicated in **Table 8.67** in **Chapter 8**, Scenario 5B is projected to generate the highest AADT volumes along the N11/M11 corridor across all future year scenarios, largely as a consequence of the additional lane added along the northern section of the scheme. By comparison, the projected AADT along the N11 mainline between Junction 9 (Glenview) and Junction 10 (Delgany/Drummin) is lower for Scenario 5A, and lower again when the impact of the bus service enhancements within Scenario 4 are considered.

As presented in **Table 8.67**, the predicted Design Year AADT for the combined Scenario 4+5A (bus and road improvement) is lower than the projected AADT for the Reference Case scenario. This indicates that Scenario 4+5A is expected to reduce traffic volumes on the N11 through the Glen of the Downs when compared to the scenario where the scheme is not progressed. This reduction in AADT for Scenario 4+5A is attributable to the proposed closure of certain mainline junctions within Scenario 5A and the improved public transport mode share because of Scenario 4. Hence, while the air quality impacts of the on-line corridor options compare negatively to the off-line corridor options, they may represent an

improvement to the baseline Reference Case depending on what transport scenario is deployed along the route. Moreover, it should be noted also that the predicted NO_x values from the ADMS modelling can be expected to reduce over time as a result of changes to emission profiles and vehicle fleet mix, as discussed in **Section 1.2.2.2**. As indicated in Tables 1.09 and 1.10, higher concentrations are predicted for the scheme Opening Year (2027) with a reduction in NO_x concentrations predicted by the Design Year (2042) due to reduced emissions from improved vehicle technology and an increase in EV.

1.7 Stage 2 Project Appraisal Matrix - Climate corridor assessment

1.7.1 Construction stage

Section 1.2.3.1 outlines the methodology used for the construction carbon assessment.

1.7.1.1 Northern Section

Table 1.15 presents the estimated embodied carbon (tonnes CO_2e), for the Northern Section.

Table 1.15: Climate corridor assessment – construction – Northern Section

Assessment Criteria	Corridor Option 1A (North)	Corridor Option 1B (North)
Estimated embodied carbon (tonnes CO_2e)	2,700	2,057
Qualitative Assessment	Minor or slightly negative	Minor or slightly negative
Score / Impact Level	3	3
Preference	Intermediate	Preferred

The slightly higher predicted embodied carbon for Corridor Option 1A (North) results in a rating of intermediate with Corridor Option 1B (North) assigned as preferred.

1.7.1.2 Southern Section

Table 1.16 presents the estimated embodied carbon (tonnes CO_2e), for the Southern Section.

Table 1.16: Climate corridor assessment – construction – Southern Section

Assessment Criteria	Corridor Option 1 (South)	Corridor Option 2 (South)	Corridor Option 5 (South)	Corridor Option 6 (South)
Estimated embodied	375	28,870	978	28,858

Assessment Criteria	Corridor Option 1 (South)	Corridor Option 2 (South)	Corridor Option 5 (South)	Corridor Option 6 (South)
Carbon (tonnes CO_2e)				
Qualitative Assessment	Minor or slightly negative	Major or highly negative	Minor or slightly negative	Major or highly negative
Score / Impact Level	3	1	3	1
Preference	Preferred	Least Preferred	Intermediate	Least Preferred

In the Southern Section, the construction of on-line Corridor Options 1 (South) and 5 (South) involve significantly lower quantities of embodied carbon in comparison to off-line Corridor Options 2 (South) and 6 (South). Corridor Option 5 (South) is considered intermediate on balance as it incurs more embodied carbon than Corridor Option 1 (South).

1.7.2 Operational stage

The operational assessment uses the DMRB methodology in **Section 1.2.2.1** and presents estimations of tonnes of CO_2e per annum based on Design Year AADTs. The results are based on total traffic volumes predicted to access each corridor option and not a change in projected traffic as a result of the corridor option being implemented. Therefore, the absolute levels of CO_{2e} are presented for comparison purposes only.

1.7.2.1 Northern Section

Table 1.17 outlines the corridor climate assessment for the Northern Section during the operational stage.

Table 1.17: Climate corridor assessment - operational – Northern Section

Assessment Criteria	Corridor Option 1A (North)	Corridor Option 1B (North)
Tonnes CO_2 per annum (Design Year AADTs)	51,019	48,648
Qualitative Assessment	Not significant or neutral	Not significant or neutral
Score / Impact Level	4	4
Preference	Intermediate	Preferred

As the operational stage of Corridor Option 1B (North) is predicted to generate less CO_2 per annum, it has been assigned as preferred with Corridor Option 1A (North) being assigned as intermediate.

1.7.2.2 Southern Section

Table 1.18 outlines the corridor assessment for the Southern Section during the operational stage.

Table 1.18: Corridor climate assessment – operational - Southern Section

Assessment Criteria	Corridor Option 1 (South)	Corridor Option 2 (South)	Corridor Option 5 (South)	Corridor Option 6 (South)
Tonnes CO_2 per annum (Design Year AADTs)	39,667	44,738	39,667	37,905
Qualitative Assessment	Not significant or neutral	Moderately negative	Not significant or neutral	Not significant or neutral
Score / Impact Level	4	2	4	4
Preference	Preferred	Least Preferred	Preferred	Preferred

Based on the slightly lower estimation of CO_{2e} for Corridor Option 1 (South), Corridor Option 5 (South) and Corridor Option 6 (South) each have been assigned as preferred. Corridor Option 2 (South) is assigned as least preferred.

1.7.3 Climate assessment summary - corridor options

Table 1.19 outlines the combined construction and operation climate assessment for the Northern Section.

Table 1.19: Corridor climate assessment – Northern Section

Assessment Criteria	Corridor Option 1A (North)	Corridor Option 1B (North)
Construction	Intermediate	Preferred
Score / Impact Level	3	3
Operational	Intermediate	Preferred
Score / Impact Level	4	4
Combined		
Score / Impact Level	3	3
Combined Qualitative Assessment	Minor or slightly negative	Minor or slightly negative
Combined Assessment	Intermediate	Preferred

For both the construction and operational stages, Corridor Option 1B (North) is the preferred option. Corridor Option 1A (North) is intermediate. Corridor Option 1A (North)) is predicted to generate slightly more CO_{2e} per annum, and it has a higher predicted embodied carbon than Corridor Option 1B (North). The marginal differences between the corridor options in this assessment is resulting in an intermediate preference as opposed to least preferred for Corridor Option 1A (North)

Table 1.20 outlines the combined construction and operational assessment for the Southern Section.

Table 1.20: Corridor climate assessment – Southern Section

Assessment Criteria	Corridor Option 1 (South)	Corridor Option 2 (South)	Corridor Option 5 (South)	Corridor Option 6 (South)
Construction	Preferred	Least Preferred	Intermediate	Least Preferred
Score / Impact Level	3	1	3	1
Operational	Preferred	Least Preferred	Preferred	Preferred
Score / Impact Level	4	2	4	4
Combined				
Score / Impact Level	4	1	4	2
Combined Qualitative Assessment	Not significant or neutral	Major or highly negative	Not significant or neutral	Moderately Negative
	Preferred	Least Preferred	Preferred	Intermediate

Corridor Option 2 (South) is ranked least preferred for both the construction and operational stage assessments and therefore is ranked least preferred overall.

Corridor Option 6 (South) is ranked least preferred for the construction stage assessment and preferred for the operational stage assessment. Again, given the marginal differences between all corridor options for the operational stage assessment, Corridor Option 6 (South) is ranked intermediate overall.

Corridor Option 1 (South) and Corridor Option 5 (South) are ranked as preferred and intermediate respectively, for the construction stage assessment and both are ranked as preferred for the operational stage assessment. The difference between these options in the construction stage is marginal in comparison to the other corridor options and they are therefore both ranked as preferred overall.

1.8 Stage 2 Project Appraisal Matrix – Transport Scenarios

1.8.1 Air quality

The difference in regional emissions of NO_x and PM_{10} are not significant enough to differentiate between Transport Scenario 5A and Transport Scenario 5B. Both are ranked intermediate as a result.

1.8.2 Climate

1.8.2.1 Construction stage

Table 1.21 outlines the construction stage assessment for Transport Scenario 5A and Transport Scenario 5B.

Table 1.21: Transport scenario climate assessment (construction) – Northern Section

Assessment Criteria	Transport Scenario 5A	Transport Scenario 5B
Embodied Carbon (tonnes CO_2e)	5,169	3,995
Qualitative Assessment	Minor or Slightly Negative	Minor or Slightly Negative
Preference	Intermediate	Preferred

Transport Scenario 5B is the preferred scenario. Transport Scenario 5A is intermediate. These preference rankings are brought into the overall assessment in **Table 1.23**.

1.8.2.2 Operational stage

The operational stage climate assessment for the transport scenarios has considered the projected future distances travelled by vehicles on the network within the study area. The scenario which results in the lowest overall travel distance is considered preferable from an operational carbon perspective. Using transport modelling results extracted from the 2042 Design Year N11/M11 Local Area Model, **Table 1.22** presented the Total Travel Distance (pcu.kms) for each of Transport Scenarios 5A and 5B. The difference in total travel distance compared against the 2042 Reference Case is shown in brackets below each figure.

Table 1.22: Climate transport assessment – operational – Northern Section

Assessment Criteria	Transport Scenario 5A		Transport Scenario 5B	
	AM peak	PM peak	AM peak	PM peak
Total Distance Travelled 2042 (pcu.kms)	355,080 (-74)	346,150 (+7,071)	366,165 (+11,011)	350,977 (+11,898)
Qualitative Assessment	Minor or Slightly Negative		Minor or Slightly Negative	
Preference	Preferred		Least Preferred	

Transport Scenario 5A is the preferred scenario. Transport Scenario 5B is Least preferred. These preference rankings are brought into the overall assessment in **Table 1.23**.

1.8.3 Climate assessment summary – transport scenarios

Table 1.23 outlines the combined embodied carbon and operational stage assessment for the transport scenarios.

Table 1.23: Transport assessment – Southern Section

Assessment Criteria	Transport Scenario 5A	Transport Scenario 5B
Embodied Carbon	Intermediate	Preferred
Operational	Preferred	Least Preferred
Combined		
Combined Assessment	Preferred	Intermediate

The higher overall preference for Transport Scenario 5A (due to its positive impact during operation) results in it being assigned as preferred. Transport Scenario 5B is assigned as intermediate.

1.8.4 Scenario 4 – Bus Service Enhancements

1.8.4.1 Operational air quality

Transport scenario 4 coupled with either Transport Scenarios 5A and 5B will result in a reduction in congestion and a modal shift away from private car due to the provision of improved bus services. This will have the effect of reducing pollutant concentrations in proximity to the N11/M11 corridor. Therefore, either Transport Scenario 5A or 5B coupled with Transport scenario 4 is likely to result in a *slightly positive* impact, compared to the Reference Case Scenario.

1.8.4.2 Operational climate

For each of Transport Scenarios 5A and 5B, the total travel distances have again been extracted from the 2042 Design Year N11/M11 Local Area Model to include the impact of the bus services included as part of Scenario 4. **Table 1.24** presents the travel distance (pcu.kms) for the combined 4 + 5A and 4 + 5B scenarios. In both cases, the impact of the bus services is evident with a reduction in total distance travelled on the network in both the AM and PM peaks.

Table 1.24: Travel distance (pcu.kms) for the combined Transport Scenario 4 + 5A and Transport Scenario 4 + 5B scenarios

Assessment Criteria	**Transport Scenario 4 + 5A**		**Transport Scenario 4 + 5B**	
	AM peak	**PM peak**	**AM peak**	**PM peak**
Total Distance Travelled 2042 (pcu.kms)	348,610 (-6,544)	337,510 (-1,569)	352,246 (-4,050)	335,195 (-3,884)
Qualitative Assessment	Minor or slightly positive		Minor or slightly positive	

Transport Scenario 4, coupled with either Transport Scenario 5A or 5B is likely to result in a *neutral* to *minor or slightly positive* impact, compared to the Reference Case Scenario.

1.9 References

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