Contents

16 Air Quality and Climate

16.1 Introduction

This chapter of the EIAR consists of an appraisal of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development under the heading of air quality and climate.

This chapter initially sets out the methodology followed (**Section 16.2**), describes the receiving environment (**Section 16.3**), and summarises the main characteristics of the proposed road development which are of relevance for air quality and climate (**Section 16.4**). The evaluation of impacts of the proposed road development on air quality and climate impacts are described (**Section 16.5**). Measures are proposed to mitigate these impacts (**Section 16.6**) and residual impacts are described (**Section 16.7**). The chapter concludes with a summary (**Section 16.8**) and reference section (**Section 16.9**).

This chapter has utilised the information gathered during the pre-application stage of the proposed road development to inform the air quality and climate impact appraisal. **Sections 4.4**, **6.5.9** and **7.6.9 of the Route Selection Report** considered the air quality and climate constraints within the scheme study area and compared the potential of air quality impacts of the proposed route options respectively. These assessments and sections of the Route Selection Report contributed to the design of the proposed road development which this chapter appraises.

16.2 Methodology

16.2.1 Introduction

This chapter is prepared having regard to the requirements of the Transport Infrastructure Ireland (TII, formerly National Roads Authority (NRA)) document *'Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes*', 2011.

The impact of the proposed road development on air quality is assessed for both the construction and operational phases by considering the pollutant background concentrations, emissions from road traffic, potential for construction dust and emissions from construction traffic. Predicted concentrations are compared to the relevant limit values.

Carbon emissions are considered in terms of Ireland's obligations to reduce its carbon emissions.

This chapter has also been prepared having regard to the following guidelines:

- Guidelines on the information to be contained in environmental impact assessment reports (EPA, Draft 2017)
- Revised Guidelines on the Information to be contained in Environmental Impact Statements (EPA, Draft 2015)

- Advice Notes for Preparing Environmental Impact Statements (EPA, draft 2015)
- Guidelines on the Information to be contained in Environmental Impact Statements (EPA 2002)
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA 2003)

16.2.2 Legislation and Guidelines

This section sets out the legislation and guidelines under the headings of:

- Air quality standards and limits
- Climate change obligations and policy
- Transport Infrastructure Ireland Guidance

16.2.2.1 Air Quality Standards and Limits

In order to reduce the risk of poor air quality, national and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values are set for the protection of human health and ecosystems.

On 12 April 2011, the Air Quality Standards Regulations (AQS) 2011 (S.I. No. 180 of 2011) came into force and transposed EU Directive 2008/50/EC on ambient air quality and cleaner air for Europe (the Air Quality Directive) into Irish law. The purpose of the 2011 Regulations is to establish limit values and alert thresholds for concentrations of certain pollutants, to provide for the assessment of certain pollutants using methods and criteria common to other European Member States, to ensure that adequate information on certain pollutant concentrations is obtained and made publicly available and to provide for the maintenance and improvement of ambient air quality where necessary. These standards were introduced to avoid, prevent or reduce harmful effects on human health and the environment as a whole.

The limit values established under these regulations relevant to the assessment of road schemes are included in **Table 16.1**.

Table 16.1: Air Quality Standards (AQS) from Regulations 2011 (S.I No. 180 of 2011)

Pollutant	Limit value for the protection of:	Averaging period	Limit value ($\mu g/m^3$)	Basis of application of limit value	Limit value attainment date
NO_2	Human Health	1-hour	200	≤18 exceedances p.a. (99.79 % ie)	1 January 2010
		Calendar year	40	Annual mean	1 January 2010
NO_x	Vegetation	Calendar year	30	Annual mean	1 January 2010
PM_{10}	Human Health	24-hours	50	≤35 exceedances p.a. (98.1%ile)	1 January 2005
		Calendar year	40	Annual mean	1 January 2005
$PM_{2.5}$	Human Health	Calendar year	20	Annual mean	1 January 2020

Pollutant	Limit value for the protection of:	Averaging period	Limit value (µg/m^3)	Basis of application of limit value	Limit value attainment date
CO	Human Health	8-hour Annual Average	10,000	8-hour Average	1 January 2005
Benzene	Human Health	Calendar year	5	Annual mean	1 January 2010

According to the *UK Design Manual for Roads and Bridges (DMRB, Volume 11, Section 3, Annex F, 2007*) (hereafter referred to as DMRB) road transport represents a negligible source (less than 1%) of UK sulphur dioxide emissions. Concentrations may have been slightly elevated at heavily trafficked roadside locations in the past, but because the maximum permitted sulphur content of road fuels has periodically been reduced, the contribution is now much lower. On this basis, sulphur dioxide is not considered further.

The TII guidelines state that air quality and climate predictions should be carried out using the screening model method described in the DMRB.

The WHO *Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide, Global update 2005* provide limit values for those pollutants. **Table 16.2** outlines those guidelines for PM_{10}, (particles of 10 microns or more) $PM_{2.5}$ (particles of 2.5 microns or more) and nitrogen dioxide.

Table 16.2: WHO Air quality guidelines

Pollutant	Averaging period	Limit value (µg/m^3)
NO_2	Annual mean	40
	1-hour mean	200
PM_{10}	24-hour (99 percentile)	50
	Annual mean	20
$PM_{2.5}$	24-hour (99 percentile)	25
	Annual mean	10

The guidelines for NO_2 are the same as the air quality standards. Guidelines for PM_{10} and $PM_{2.5}$ are substantially lower than the standards. As the air quality standards are the statutory limits that apply in Ireland, baseline and predicted values are compared to these levels. However, an assessment of compliance with the WHO guideline values is also included for completeness.

Ultrafine particles (UFP) are the smallest constituents of airborne particulate matter at less than 0.1 micrometres. UFP can be inhaled more deeply into the lungs than larger particles, and are likely to have adverse health effects. However, as yet, no air quality standard has been set by the EU as further monitoring and assessment of potential effects is ongoing. The WHO concluded that while there is considerable toxicological evidence of potential detrimental effects of ultrafine particles on human health, the existing body of epidemiological evidence is insufficient to reach a conclusion on the exposure response relationship of ultrafine particles (WHO Air quality guidelines, 2005).

There are no national or EU limits for dust deposition. However, the *Technical Instructions on Air Quality Control* (TA Luft, 2002) provide a guideline for the rate of dust deposition of 350 mg/m^2/day averaged over one year.

The Environmental Protection Agency (EPA) concurs that this guideline may be applied, although applied as a 30-day average, in its document *Environmental Management in the Extractive* Industry (Non-Scheduled Minerals) (EPA, 2006).

Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, was published in December 2016. The directive specifies reductions for nitrogen oxides, particulate matter and non-methane Volatile Organic Compounds (NMVOC) for the period from 2020 to 2019 and from 2030 onward compared with 2005 levels. The limits that apply to Ireland are outlined in **Table 16.3**.

Table 16.3: Directive (EU) 2016/2284 emission limits

Pollutant	Reduction compared with 2005 in 2020-2029 (%)	Reduction compared with 2005 in 2020-2029 (kilotonnes)[1]	Reduction compared with 2005 in 2030 (%)	Reduction compared with 2005 in 2030 (kilotonnes) [1]
Nitrogen oxides	49	61.9	69	87.2
Particulate matter	18	n/a	41	n/a
NMVOC	25	14.7	32	18.8

[1] Based on the following 2005 values: nitrogen oxides-126.4kt, NMVOC- 58.8kt, no PM data available

The impact of nitrogen deposition is also considered in the assessment at ecologically sensitive areas. The TII Guidelines quotes the United Nations Economic Commission for Europe (UNECE) Critical Loads[1]for Nitrogen. As the Lough Corrib candidate, Special Area of Conservation (cSAC) is designated for the protection of a multitude of habitats including, hard water lakes, floating river vegetation, raised bogs, alkaline fens, bog woodland, a number of UNECE Critical Loads could be selected for assessment. The most stringent of these is for inland and surface water habitats (5-10kg(N)/ha/yr) and therefore, this is used in this assessment in **Section 16.5.4.2**. Critical levels[2] are also included in this assessment

1 Critical Loads are defined as: " a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge"
(Source: http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm)

2 Critical levels are defined as "concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge".
(Source: http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm)

for various relevant pollutants. These are not habitat specific, as in critical loads, but are set to cover broad vegetation types. They are defined as pollutant concentrations, as opposed to deposition values for critical loads.

16.2.2.2 Climate change obligations and policy

Ireland's climate obligations

In December 2008, the European Union (EU) Climate Change and Renewable Energy Package set out a number of commitments. This package commits to reduce the EU's Greenhouse Gas (GHG) emissions from non-Emission Trading Scheme (ETS) sectors (such as transport, agriculture, residential and waste) by 20% on 2005 levels by 2020 or by a more ambitious 30% in the event of a comprehensive global agreement.

As part of the effort-sharing proposal of this package, Ireland is one of the countries facing the highest target of a 20% reduction on 2005 levels for non-ETS sectors. This will result in a limit of approximately 38 million tonnes of carbon dioxide equivalent (Mt CO_2 eq) for Ireland's non-ETS emissions in 2020, together with annual binding limits for each year from 2013 to 2020.

In October 2014, EU leaders agreed a 2030 policy framework to reduce greenhouse gas emissions by at least 40% compared to a 1990 baseline. No agreement on the contribution of individual EU Member states has yet been reached.

National Policy on Climate Action

The Climate Action and Low-Carbon Development National Policy Position for Ireland was published in 2014. The Position provides a high-level policy direction for the adoption and implementation by Government of plans to enable the State to move to a low carbon economy by 2050.

The Climate Action and Low Carbon Development Act was published by government in January 2015. The Act sets out the national objective of transitioning to a low carbon, climate resilient and environmentally sustainable economy in the period up to 2050. The act provides for the preparation of National Mitigation Plans and Sectoral Plans which will specify policies to reduce greenhouse gas emissions for each sector, including transport. The first National Mitigation Plan was published in July 2017 by the Department of Communications, Climate Action and Environment. The Plan is designed to be a whole-of-Government approach to tackling greenhouse gas emissions, particularly, in the key sectors i.e. electricity generation, the built environment, transport and agriculture.

Climate Action and Transport Sector

In 2013, an Issues Paper for Consultation on the Preparation of Low-Carbon Roadmap for Transport was prepared by the Department of Transport, Tourism and

Sport. This paper proposed the following relevant policy measures to contribute to a low carbon future:

- Engines and fuels (efficiencies and alternatives)
- Travel demand
- Modal shift

The document Smarter Travel - A Sustainable Transport Future, A New Transport Policy for Ireland 2009 – 2020 includes a number of targets to reduce carbon emissions:

- Work-related commuting by car will be reduced from a current modal share of 65% to 45%, which will mean that between 500,000 and 600,000 commuters will be encouraged to take means of transport other than car driver (of these 200,000 would be existing car drivers)
- Car drivers will be accommodated on other modes such as walking, cycling, public transport and car sharing (to the extent that commuting by these modes will rise to 55% by 2020) or through other measures such as e-working
- The road freight sector will become more energy efficient, with a subsequent reduction in emissions
- Transport will make a meaningful contribution to Ireland's commitment under the proposed EU effort-sharing arrangement in relation to climate change and real reductions on current levels of emissions will be achieved

Policies to reduce transport emissions include the reduction of travel demand, increase use of alternatives to the private car and improve the efficiency of motorised transport.

Ireland's first National Climate Change Adaptation Framework (NCCAF), which was published in December 2012 by the Department of Environment, Community and Local Government, aims to ensure that adaptation actions are taken across key sectors and also at local level to reduce Ireland's vulnerability to climate change. This Framework is currently under review. Climate change adaptation measures have been considered through the provision of attenuation storage to accommodate the 100-year storm event with climate change, refer to **Chapter 11, Hydrology**.

16.2.2.3 Transport Infrastructure Ireland Guidelines

Operational Criteria

The TII Guidelines specifies that the changes in pollutant concentrations alongside roads with a significant change in traffic should be determined. It states that receptors should be considered at all road links where a greater than 5% change in Annual Average Daily Traffic (AADT) is predicted for the "Do-Something" option during the operational phase and during the construction phase where an increase of AADT greater than 10% is predicted.

Significance criteria have been adopted from the TII guidelines, these are presented in **Tables 16.4**, **16.5** and **16.6**.

Table 16.4: Definition of Impact Magnitude for Changes in Ambient Pollutant Concentrations

Magnitude of Change	Annual Mean NO2/PM10	No. days with PM10 concentration greater than 50 ug/m3	Annual Mean PM2.5
Large	Increase/decrease ≥ 4μg/m^3	Increase/decrease >4 days	Increase/decrease ≥2.5 μg/m^3
Medium	Increase/decrease 2-<4μg/m^3	Increase/decrease 3 or 4 days	Increase/decrease 1.25 -<2.5μg/m^3
Small	Increase/decrease 0.4-<2μg/m^3	Increase/decrease 1 or 2 days	Increase/decrease 0.25-<1.25μg/m^3
Imperceptible	Increase/decrease <0.4μg/m^3	Increase/decrease <1day	Increase/decrease <0.25μg/m^3

Table 16.5: Air Quality Impact Descriptors for Changes to Annual Mean Nitrogen Dioxide and PM_{10} and $PM_{2.5}$ Concentrations at a Receptor

Absolute Concentration in Relation to Objective/Limit Value	Change in Concentration[3]		
	Small	**Medium**	**Large**
Increase with Proposed Road Development			
Above Objective/Limit Value With Proposed Road Development (≥40 μg/m^3 of NO_2 or PM_{10}) (≥25μg/m^3 of $PM_{2.5}$)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective/Limit Value With Proposed Road Development (36≤40 μg/m^3 of NO_2 or PM_{10}) (22.5≤25μg/m^3 of $PM_{2.5}$)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective/Limit Value With Proposed Road Development (30≤36 μg/m^3 of NO_2 or PM_{10}) (18.75≤22.5 μg/m^3 of $PM_{2.5}$)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective/Limit Value With Proposed Road Development (<30 μg/m^3 of NO_2 or PM_{10}) (<18.75μg/m^3 of $PM_{2.5}$)	Negligible	Negligible	Slight Adverse
Decrease with Proposed Road Development			
Above Objective/Limit Value Without Proposed Road Development (≥40 μg/m^3 of NO_2 or PM_{10}) (≥25μg/m^3 of $PM_{2.5}$)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective/Limit Value Without Proposed Road Development (36-<40 μg/m^3 of NO_2 or PM_{10}) (22.5-<25μg/m^3 of $PM_{2.5}$)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective/Limit Value Without Proposed Road Development (30-<36 μg/m^3 of NO_2 or PM_{10}) (18.75-<22.5 μg/m^3 of $PM_{2.5}$)	Negligible	Slight Beneficial	Slight Beneficial

[3] Where the impact magnitude is imperceptible, then the impact description is negligible.

Absolute Concentration in Relation to Objective/Limit Value	Change in Concentration[3]		
	Small	Medium	Large
Well Below Objective/Limit Value Without Proposed Road Development (<30 μg/m^3 of NO_2 or PM_{10}) (<18.75μg/m^3 of $PM_{2.5}$)	Negligible	Negligible	Slight Beneficial

Table 16.6: Air Quality Impact Descriptors for Changes to Number of Days with PM_{10} Concentration Greater than 50μg/m^3 at a Receptor

Absolute Concentration in Relation to Objective/Limit Value	Changes in Concentration[4]		
	Small	Medium	Large
Increase with Proposed Road Development			
Above Objective/Limit Value with Proposed Road Development (≥35 days)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective/Limit Value with Proposed Road Development (32-<35 days)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective/Limit Value with Proposed Road Development (26-<32 days)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective/Limit Value with Proposed Road Development (<26 days)	Negligible	Negligible	Slight Adverse
Decrease with Proposed Road Development			
Above Objective/Limit Value Without Proposed Road Development (≥35 days)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective/Limit Value Without Proposed Road Development (32-<35 days)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective/Limit Value Without Proposed Road Development (26-<32 days)	Negligible	Slight Beneficial	Slight Beneficial
Well Below Objective/Limit Value Without Proposed Road Development (<26 days)	Negligible	Negligible	Slight Beneficial

The significance criteria outlined above varies slightly from that outlined in the EPA guidelines. A substantial impact is rated as a significant/profound impact from the EPA guidelines.

Due to the number of sensitive ecological sites in the vicinity of the proposed road development, a detailed assessment of the potential impacts upon sensitive ecosystems has been carried out. The significance criteria is applied to the assessment of NO_x impacts at the ecological sensitive sites as described in **Tables 16.4, 16.5** and **16.6**.

[4] Where the impact magnitude is imperceptible, then the impact description is negligible.

Construction criteria

As stated in the TII Guidance it is *"very difficult to accurately quantify dust emissions arising from construction activities". "A semi quantitative approach is recommended to determine the likelihood of a significant impact, which should be combined with an assessment of the proposed mitigation measures"*. The semi-quantitative assessment methodology outlined in **Table 16.7** is used to assess the impact of dust during the construction phase.

Table 16.7: Assessment Criteria for the Impact of Dust Emissions from Construction Activities with Standard Dust Control Measures Mitigation in Place

Source		**Potential distance for Significant Effects (Distance from Source)**		
Scale	**Description**	**Soiling**	**PM_{10}[a]**	**Vegetation Effects**
Major	Large construction sites, with high use of haul routes	100 m	25 m	25 m
Moderate	Moderate sized construction sites, with moderate use of haul routes	50 m	15 m	15 m
Minor	Minor construction sites, with limited use of haul routes	25 m	10 m	10 m

Note: [a] Significance based on the PM_{10} Limit Values specified in SI No. 180 of 2011, which allows 35 daily exceedances/year of 50 $\mu g/m^3$

TII guidance states that dust emissions from construction sites can lead to elevated PM_{10} concentrations and can cause soiling of properties.

The potential impact of dust emissions during the construction phase is assessed by estimating the area over which there is a risk of significant impacts, in line with the TII guidance. The impact of construction dust on sensitive habitats is also considered, and additional mitigation measures proposed, as required. The TII Guidelines do not provide a definition of 'standard mitigation', however, the following is assumed:

- Spraying of exposed earthwork activities and site haul roads during dry weather
- Provision of wheel washes at exit points
- Control of vehicle speeds and speed restrictions. It is proposed that site traffic is restricted to 20km/hr. This will help to minimise the occurrence of dust re-suspension.
- Sweeping of hard surface roads

16.2.3 Data Sources and Consultations

The Environmental Protection Agency (EPA) is responsible for coordinating and managing air quality monitoring in accordance with relevant legislation. This includes a nationwide network of 33 monitoring stations which measures levels of air pollutants and delivers this information in real-time. This data along with on-site monitoring data is used to establish the baseline air quality in the study area.

Consultations were undertaken with stakeholders during the design development process, refer to **Chapter 1, Introduction**. Any comments that related to air quality and climate were considered during the preparation of this chapter.

16.2.4 Study area and Baseline Data Collection

The DMRB states *that only properties and designated sites within 200m of the roads affected by the project need be considered*. On this basis, properties located within 200m of the edge of the proposed road development are considered in the assessment and is the extent of the study area for the air quality and climate appraisal for this EIAR.

As described in **Section 16.2.3**, long-term baseline data provided by the EPA is used in the assessment. Since the commencement of the environmental studies for the proposed road development, the EPA has published air quality data for 2014 and 2015, this is included in the description of the receiving environment in **Section 16.3**.

16.2.5 Impact Assessment Methodology

16.2.5.1 Air Quality

Monitoring data conversion methodology

Three months of site specific air quality monitoring was carried out in the vicinity of the proposed road development. Appendix 2 of the TII *Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes, 2011* provides a methodology to calculate the annual mean from short-term monitoring. This is based on long term published monitoring data from the EPA from appropriate monitoring stations. Using this approach, predicted annual mean concentrations of PM and NO_2 were made. **Table 16.8** outlines the calculation method for estimating annual mean averages of pollutant concentrations.

Table 16.8: Formula for calculating annual average concentration from short term data

Abbreviation	Unit	Description
M	µg/m^3	Measured average from monitoring carried out (06/02/17 to 01/05/17).
A	µg/m^3	Annual average from Zone C monitoring station. As taken from EPA published data for 2014, 2015 and 2016.
P	µg/m^3	Period mean from Zone C monitoring station (06/02/17 to 01/05/17). As taken from EPA published datasets.
R		Ratio of A/P.
E	µg/m^3	Estimated annual mean (M x R).

DMRB methodology

In accordance with the TII guidelines, the DMRB Screening Method (Version 1.03c) spreadsheet is used in this assessment. This spreadsheet calculates annual average concentrations of NOx (for the assessment of nitrogen deposition), NO_2, CO, benzene, PM_{10} and $PM_{2.5}$ and was used to assess the air quality impact of the proposed road development.

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

- Location and distance of sensitive receptors to proposed road development
- Annual average daily traffic (AADT) flows, refer to **Chapter 6, Traffic Assessment and Route Cross-section**
- Average speed of traffic
- Traffic composition
- Road type and length
- Background pollutant concentrations

The spreadsheet was used to assess the potential local and regional air quality impacts and potential climate impacts.

The scenarios modelled for the purpose of the air quality assessment are described below:

- The 'Do-Minimum' (DM) Scenario assumes that the proposed road development is not constructed with traffic scenarios for 2024 (Opening Year) and 2039 (Design Year)
- The 'Do-Something' (DS) Scenario assumes that the proposed road development is constructed with traffic scenarios for 2024 and 2039

The air quality assessment utilises traffic predictions for 2024 and 2039 outlined in **Chapter 6, Traffic Assessment and Route Cross-section**.

The M17/M18 Junction with the M6 is a committed development in the area. Traffic associated with this development has been included in all the scenarios.

Potential air quality impacts at all sensitive receptors are considered. Sensitive receptors are described in the TII guidelines as residential housing, schools, hospitals, places of worship, sports centres and shopping areas as well as designated ecological areas.

ADMS-Roads model

The Environmental Protection Agency (EPA) State of the Environment Report, 2016 – An Assessment states that the *failure of real-world emissions of NOx Euro 5 class vehicles to meet the standards set for them has had a disproportionate impact on ambient air (EEA, 2015). Euro 5 class vehicles showed a reduction in* NO_2 *emissions in laboratory tests; however, these reductions were not observed in real world driving. As a result, projections of* NO_2 *emission reductions did not come true and an increase in vehicle numbers actually led to increasing* NO_2 *levels across*

Europe. In order to fully consider the potential air quality impacts associated with actual vehicle emissions compared to laboratory tests, the ADMS-Roads version 4 atmospheric dispersion model has been used.

The assessment follows the methodology set out in Defra's Local Air Quality Management Technical Guidance (LAQM.TG16) for aspects not covered by the TII Guidelines. The Defra guidance also states that exceedances of the NO_2 1-hour mean is unlikely to occur where the annual mean is below 60µg/m^3. Both the DMRB and ADMS-Roads models only predict annual means for NO_2.

The assessment scenarios are as prepared for the DMRB screening model.

ADMS-Roads has been used to predict NO_x, PM_{10} and $PM_{2.5}$ concentrations. Predicted NO_x concentrations have been processed to determine annual mean NO_2 concentrations for comparison with the annual mean NO_2 objectives.

Vehicle emissions and background air quality are predicted to improve over time due to the introduction of cleaner vehicles into the vehicle fleet. However, there is uncertainty as to how successful the implementation of stricter controls of vehicle emissions will be. To account for this uncertainty modelling has been carried out assuming no improvement in vehicle emissions nor background concentrations for the future scenarios. This represents a worst case scenario, as some improvements are likely during this period.

The traffic data used for this assessment consisted of 24-hour AADT flows, the percentage of heavy goods vehicles (HGVs) and free flow speeds, refer to **Chapter 6, Traffic Assessment and Route Cross-section** for traffic data. The speeds provided were based on the free flow speeds for each road link. As recommended in TII Guidelines, traffic speeds were slowed at junctions to 20kph, for a distance of 50m from the yield/stop line.

In accordance with TII guidelines, emission rates have been calculated using the Defra Emissions Factor Toolkit (EFT) v7[5]. Emission factors from 2015 have been used in all modelled scenarios as a worst-case.

Details of the locations and heights of the proposed noise barriers were also considered in this assessment. Noise barriers located close to the modelled sensitive air receptors have been included in the air modelling. Modelling has been carried out with and without the noise barriers, to determine their potential to change air quality at the receptor. Refer to **Chapter 17, Noise and Vibration** and **Figures 17.1.101** to **17.1.114** for details on these noise barriers.

Receptor Locations

Worst-case receptors, such as close to junctions and those close to the kerbside, were selected as part of the DMRB and ADMS assessments. Their locations are shown in **Figures 16.1.1** to **16.1.14**, except where the receptors are located away from the proposed road development. The location and height of the receptors are

[5] Defra Emission Factor Toolkit v7 (http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html) accessed September 2016

given in **Table 16.9Table** . A height of 1.5m corresponds to typical inhalation height at a ground floor property.

Table 16.9: Modelled Receptors

Receptor ID	Receptor type	OS Grid Ref.		Receptor height (m)
		X m	Y m	
R01	Existing residential	536,615	727,586	1.5
R02	Existing residential	535,241	725,853	1.5
R03	Existing residential	534,969	726,070	1.5
R04	Existing residential	521,445	722,560	1.5
R05	Existing residential	522,744	724,933	1.5
R06	Existing residential	531,123	728,633	1.5
R07	Existing residential	531,798	729,727	1.5
R08	Existing residential	534,233	729,639	1.5
R09	Existing residential	520,933	722,606	1.5
R10	Existing residential	524,663	724,483	1.5
R11	Existing residential	525,399	725,642	1.5
R12	Existing residential	525,456	725,772	1.5
R13	Existing residential	527,200	727,837	1.5
R14	Existing residential	534,360	727,286	1.5
R15	Existing residential	534,058	727,892	1.5
R16	Existing residential	531,883	728,299	1.5
R17	Existing residential	527,677	727,212	1.5
R18	Existing residential	527,140	727,585	1.5
R19	Existing residential	527,119	726,074	1.5
R20	Existing residential	527,179	726,411	1.5

Receptor ID	Receptor type	OS Grid Ref.		Receptor height (m)
		X m	Y m	
R21	Existing residential	526,125	726,154	1.5
R22	Existing residential	525,409	725,641	1.5
R23	Existing residential	524,461	725,030	1.5
R24	Existing residential	522,053	723,855	1.5
R25	Existing residential	521,600	723,561	1.5
R26	Existing residential	546,359	726,194	1.5
R27	Existing residential	549,739	726,283	1.5
R28	Existing residential	545,146	727,935	1.5

An air quality modelling assessment was undertaken using ADMS to consider potential additional impacts at the locations of the proposed tunnel portals. Details of the tunnels as modelled are given in **Table 16.10**.

Table 16.10: Tunnel locations

Tunnel		OS Grid Ref	Bore depth (m)	Outflow link	Outflow width (m)
Galway Racecourse eastbound	Entrance portal	533809, 728070	6	51_T_EB_W	13.45
	Exit portal	533973, 727894	6	51_T_EB_E	11.95
Galway Racecourse westbound	Entrance portal	533962, 727885	6	51_T_WB_E	13.0
	Exit portal	533799, 728059	6	51_T_WB_W	13.0
Lackagh eastbound	Entrance portal	530107, 728408	8.1	53_T_EB_W	10.9
	Exit portal	530372, 728444	6	53_T_EB_E	10.9
Lackagh westbound	Entrance portal	530357, 728420	6	53_T_WB_E	10.9
	Exit portal	530108, 728387	8.1	53_T_WB_W	10.9

The proposed road development crosses the Lough Corrib cSAC. Concentrations of NO_x along four 200m transects from where the proposed road development crosses the Lough Corrib cSAC have been modelled. Transects 1 to 3 were selected due to their proximity to the Lackagh Tunnel portals. Transect 4 was selected as the location where the Lough Corrib cSAC is closest to the proposed road development. The ecological transects and their location in relation to the proposed road development, Lackagh Tunnel portals and Lough Corrib cSAC are shown in **Plate 16.1** and **16.2**.

Plate 16.1: Lough Corrib cSAC, Lackagh Tunnel portals and ecological transects 1 to 3

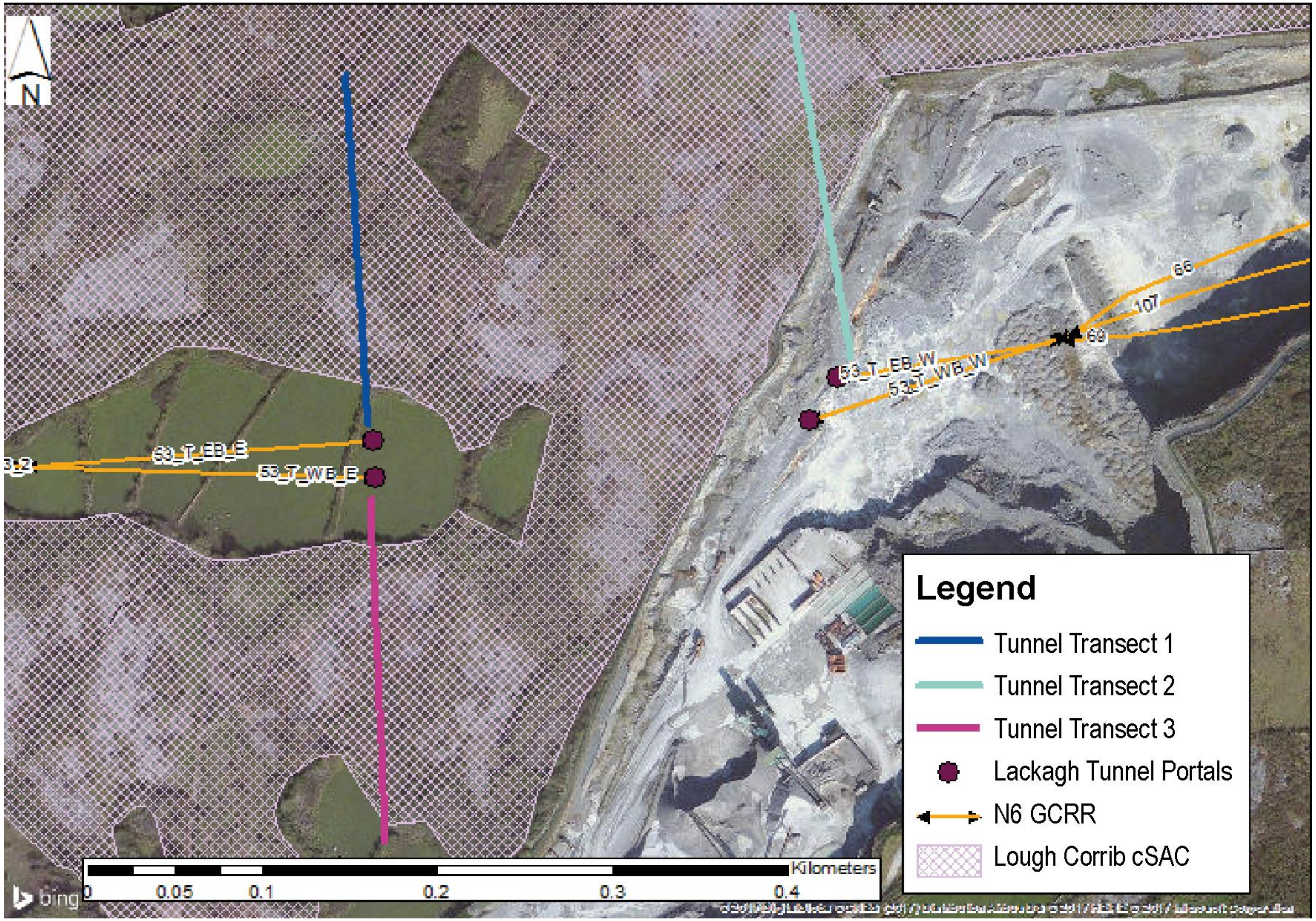
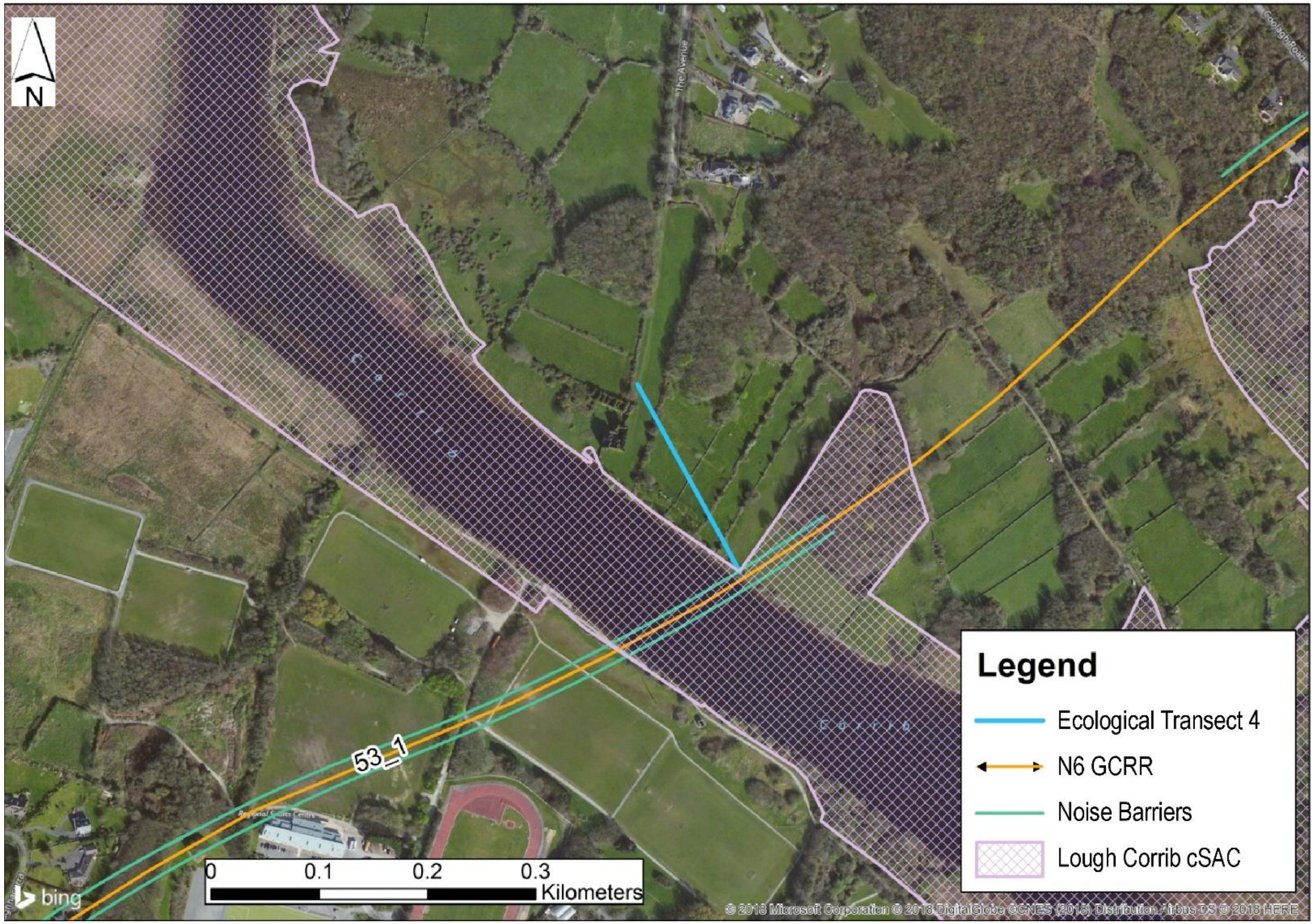


Plate 16.2: Lough Corrib cSAC and ecological transect 4



Ecological impact assessment

The UK DMRB states that some air pollutants can have an effect on vegetation. Concentrations of pollutants in air and deposition of particles can damage vegetation directly or affect plant health and productivity. It states that the pollutants of most concern for sensitive vegetation near roads, and perhaps the best understood, is NO_x. It refers to the EU limit set for NO_x for the protection of vegetation. This value was based on the work of UNECE and WHO and has been implemented into the Irish air quality standards. The report states that *'critical loads for the deposition of nitrogen represents the exposure below which there should be no significant harmful effects on sensitive elements of the ecosystem (according to current knowledge)'*. In relation to heavy metals, the manual states that *small quantities of heavy metals released during combustion and from vehicle wear and tear may accumulate in soils near the road. However, such emissions cannot be reliably quantified or the negative ecological effects determined*.

The manual describes the assessment procedure to be used to assess the impact of air pollution on ecologically sensitive sites. The procedure was developed in collaboration with the Joint Nature Conservation committee and Natural England and adopted by the TII in its guidelines.

The Natural England report 'the Ecological Effects of Air Pollution from Road Transport' published in 2004 and the 2016 update were reviewed in the context of this assessment. These reports were commissioned to assess the potential risk to biodiversity due to air pollution from roads.

The reports summarise studies carried out to determine the effect of traffic emissions on NOx and nitrogen deposition on various species. In general, the study concludes that a review of relevant studies *provides further evidence of the impacts on individual species from exposure to NO_x and NO_2 associated with vehicle emissions and that these are greatest within the first 50-100m from the roads but may be discernible at greater distances.*

In relation to Volatile Organic Compounds (VOCs), the report states that most studies testing the responses of plants exposure to VOCs have used high concentrations over short exposure periods (hours or days). Therefore, the effects of exposure to low concentrations of VOC is difficult to determine. Also, few of the studies tested the responses of vegetation to the species of VOCs emitted by vehicles. Studies have generally concentrated on the effects of ethylene which is emitted by motor vehicles and naturally occurring in plants. The report also states that *levels of ethylene likely to be found in the vicinity of roads may be high enough to adversely affect sensitive species*. Sensitive species include flowers, fruit, seed production and morphology. *The report concludes that the response of vegetation to other VOCs emitted by motor vehicles is unclear; although possible effects are degradation of leaf surface waxes, pigment bleaching and ultra-structural changes.*

In relation to metals, the report states:

The studies also evidence that traffic emissions are a significant source of metal contamination for vegetation close to roads, although the leaf concentrations recorded are unlikely to present a significant immediate toxic risk to plants.

Metals are likely to persist in soils and levels may therefore build up over time in the vicinity of roads. A number of laboratory studies have cultured a variety of plant species in soil containing elevated concentrations of heavy metals and have found a range of tolerances depending on the species tested.

There is the potential for elevated concentrations of metals in soils close to roads. However, the report also states that soil metal content is generally only substantially elevated within 20-30m from even the busiest of roads.

In relation to ammonia, the report states:

Ammonia is emitted in small amounts by vehicles with catalytic converters and roadside atmospheric concentrations are well below critical levels for this pollutant (UK Critical Levels Advisory Group, 1996). Gaseous ammonia is thus unlikely to be a key issue, and effects on vegetation are more likely to arise from enhanced deposition of nitrogen to the soil environment. This elevation in soil nitrogen will be limited to areas within tens of metres of roads due to the high rates of deposition of this gas.

In relation to particulates/dust, the following is stated:

Few attempts have been made to assess the impacts of particulates and dust from motor vehicles on vegetation under controlled conditions… The authors conclude that it is difficult to assess the significance of these results for roadside plants under realistic conditions.

16.2.5.2 Climate

The Construction Carbon Calculator was published by the UK Environment Agency in July 2012. The carbon calculator measures the greenhouse gas impacts of construction activities in terms of carbon dioxide equivalency (CO_2e). It does this by calculating the embodied CO_2e of materials plus the CO_2e associated with their transportation. It also considers personnel travel, site energy use and waste management.

The potential impact of the proposed road development on carbon emissions was assessed using the DMRB spreadsheet as described in **Section 16.2.8.1**.

The potential micro-climatic impacts of the proposed road development were assessed in relation to existing micro-climatic conditions, the size of the proposed road development and the nature of use of the surrounding environment.

16.3 Receiving Environment

16.3.1 Introduction

The receiving environment for this appraisal comprises of local air quality, national air quality and climate.

Road traffic on the national routes (including the existing N6, N83[6], N67, N59 and N84) and on the local road network is currently generating levels of pollution. Emissions are higher under congested traffic conditions, such as those experienced in certain areas of Galway City, particularly during peak times. The EPA carries out air quality monitoring at Bodkin Junction in Galway. PM_{10} and heavy metals levels are shown to comply with air quality standards in 2017 (www.epa.ie).

Heating for residential and commercial premises currently generates levels of pollution, particularly in the areas of higher density population in Galway City and suburbs. Agricultural activities also generate pollution due to farming plant and dust generating activities.

There are operational quarries located in proximity to the proposed road development. There is the potential for windblown dust to be generated from open faces and stockpiles.

Table 16.11 presents a list of industrial facilities licenced by the EPA within the study area, under Industrial Emissions (IE) or Integrated Pollution Licence (IPC).

Table 16.11: EPA IE/IPC Licence holders within the vicinity of the proposed road development

Licence No	Company	Address	IPC/IED
P0264-02	Medtronic Vascular Galway	Parkmore Industrial Estate, Galway	IPC
P0725-01	Boston Scientific Ireland Limited	Ballybrit Upper Industrial Estate, Galway	IPC
P0994-01	Ingersoll Rand Limited	Monivea Road, Mervue, Galway	IE
P0339-01	F & T Buckley Limited	Wellpark, Galway, Co Galway	IPC
P0324-01	Hygeia Chemicals Limited	Carrowmoneash, Oranmore, Co Galway	IPC
P0056-01	Cold Chon (Galway) Limited	Oranmore, Co Galway	IE
P0133-02	APW Galway Limited	Deerpark Industrial Estate, Oranmore, Co Galway	IPC
P1006-02	Galway Metal Company Limited	Carrowmoneash, Oranmore, Co Galway	IE

[6] Formally known as the N17 Tuam Road

Licence No	Company	Address	IPC/IED
P0264-02	Medtronic Vascular Galway	Parkmore Industrial Estate, Galway	IPC

In addition to the air emission sources outlined above, the effect of the emission sources presented in the above table are likely to be reflected in the baseline air monitoring data presented in **Table 16.12**.

Sensitive receptor locations within the scheme study area are defined in the guidelines 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. In addition, sensitive ecological sites are considered in the assessment.

16.3.2 Local Air Quality data from EPA long-term monitoring

The TII Guidelines advise that if sufficient data is available and pollutant concentrations are well below air quality standards then existing published data can be used as a baseline.

The Air Quality Standards (AQS) Regulations describe the air quality zoning adopted in Ireland as follows:

- Zone A (Dublin Conurbation)
- Zone B (Cork Conurbation)
- Zone C (16 Cities and Towns with population greater than 15,000, including Naas)
- Zone D (Rural Ireland: areas not in Zones A, B and C)

The proposed road development falls within the vicinity of Galway City and is therefore considered in Zone C.

Background levels from 2016, 2015 and 2014 air quality monitoring of NO_x, NO_2, CO, benzene, $PM_{2.5}$ and PM_{10} in Zone C provided by the EPA are presented in **Table 16.12**.

Concentrations of each pollutant recorded in Zone C are averaged to represent typical background levels. Average concentrations were obtained from all Zone C stations where 90% data capture was achieved. This is in accordance with the air quality standards which specifies that any site used for assessment purposes must comply with 90% data capture. For pollutants where the 90% capture rule was not achieved at any Zone C sites, the average of other sites was taken instead. Where no validated data exists for Zone C, Zone B data was used as it is expected to be similar or higher than Zone C data, resulting in a worst-case.

Table 16.12: Annual Mean Background Pollutant Concentrations for Zone C

Year	Pollutants	Time Period	Location	Measured concentrations μg/m^3	Air Quality Standard μg/m^3	% of Air Quality Standard
2016	NO_2	Annual average	Zone C	8.8	40	22
	NO_x	Annual average	Zone C	14.3	30	47.6
	CO	8-hour annual average	Zone C	400	10,000	4
	$PM_{2.5}$	Annual average	Zone B	7	25	28
	PM_{10}	Annual average	Zone C	15.3	40	38.2
	Benzene	Annual average	Zone A	1.01	5	20.2
2015	NO_2	Annual average	Zone C	7.5	40	18.8
	NO_x	Annual average	Zone C	11.5	30	38.3
	CO	8-hour annual average	Zone C	400	10,000	4
	$PM_{2.5}$	Annual Average	Zone C	9.5	25	38
	PM_{10}	Annual Average	Zone C	15	40	37.5
	Benzene	Annual Average	Zone C	0.1	5	2.6
2014	NO_2	Annual average	Zone C	5	40	12.5
	NO_x	Annual average	Zone C	8	30	26.7
	CO	8-hour annual average	Zone C	200	10,000	3
	$PM_{2.5}$	Annual average	Zone B	12	25	48
	PM_{10}	Annual average	Zone C	21	40	52.5
	Benzene	Annual average	Zone B	0.1	5	2.6

All current baseline concentrations are in compliance with AQS. Note that concentrations of PM_{10} slightly exceed the WHO guideline of 20μg/m^3 in 2014. Concentrations of $PM_{2.5}$ slightly exceed the WHO guideline of 10μg/m^3 in 2014.

The EPA State of the Environment Report, 2016 – An Assessment states that in recent years while *exhaust emission limits become stricter, this is offset by increases in the numbers of cars. New EU emissions standards for vehicles, cleaner technology, and a reduction in the number of vehicles using the roads as a result of the economic downturn led to a decrease in NO_2 in our urban centres. However, this is unlikely to continue into the future. Economic recovery will most likely lead to an increase in NO_2 levels. The failure of real-world emissions of NOx Euro 5 class vehicles to meet the standards set for them has had a disproportionate impact on ambient air (EEA, 2015). Euro 5 class vehicles showed a reduction in NO_2 emissions in laboratory tests; however, these reductions were not observed in real world driving. As a result, projections of NO_2 emission reductions did not come true and an increase in vehicle numbers actually led to increasing NO_2 levels across Europe.*

Average background concentrations are provided in **Table 16.13**. The TII Guidance provides correction factors to predict background levels for future assessment years to take into account concentration decreases in future years due to improved vehicle technology etc. However, in order to consider a worst-case scenario, no improvement is assumed and current values are used for future years. Although uncertainty regarding future year emission factors relates primarily to NO_x emissions, it should be noted that the same approach of holding vehicle emission factors and background pollutant concentrations has been taken for PM_{10} and $PM_{2.5}$ concentrations.

Table 16.13: Average background concentrations

Pollutant	Average concentration µg/m^3 (2014 to 2016)	Air Quality Standard µg/m^3
NO_2	7.1	40
NO_x	11.2	30
CO	333	10,000
$PM_{2.5}$	9.5	20
PM_{10}	17.1	40
Benzene	0.4	5

Average background concentrations are in compliance with Air Quality Standards.

Modelled background concentrations for 1990, 2000 and 2020 nitrogen deposition are provided in the EPA research document *'Development of Critical Loads for Ireland: Simulating Impacts on Systems (SIOS)*, Aherne, Henry and Wolniewicz. In the area of the proposed road development, background levels are in the range of 1 to 2.5kg(N)/ha/yr.

16.3.3 Site specific air quality monitoring

16.3.3.1 Monitoring results

Site specific monitoring of PM and NO_2 was carried out over a period of three months, refer to **Appendix 16.1** for full monitoring report. As outlined in **Section 16.2.5.1**, concentrations can be adjusted using TII methodology for comparison with annual mean limits outlined in the air quality standards.

This approach utilises data from each of the monitoring stations contained within the appropriate zone, in this case Zone C. Individual annual average concentrations for PM and NO_2 have been calculated using three years of monitoring data (2014-2016) from all Zone C stations where 90% data capture was achieved. This is in accordance with the air quality standards which specifies that any site used for assessment purposes must comply with 90% data capture. Where the 90% capture rule was not achieved at any Zone C sites, Zone B data was used as it is expected to be similar or higher than Zone C data, resulting in a worst-case.

It should be noted that only datasets with sufficient coverage over the three month period from 6 February to 2 May for each assessment year have been used, in accordance with air quality standards.

PM_{10} and $PM_{2.5}$

Schedule 11 of the Air Quality Standards Regulations states that PM_{10} concentrations should not exceed 50µg/m^3 more than 35 times in a calendar year over one day periods (24-hours) or exceed 40µg/m^3 over an annual period. For $PM_{2.5}$, concentrations should not exceed 25µg/m^3 over an annual period. There were no such exceedances during the monitoring period.

Table 16.14 outlines the monitoring data for PM_{10} and $PM_{2.5}$ from 6 February to 2 May 2017.

Table 16.14: Average PM_{10} and $PM_{2.5}$ concentration (µg/m^3) for 24-hour period from 6 February - 2 May 2017

Monitoring Period	**Daily average (µg/m^3)**	
	PM_{10}	**$PM_{2.5}$**
6 February to 2 May 2017	9.72	5.36

Table 16.15 outlines the calculated average concentrations of PM_{10} based on the method outlined in **Table 16.8.**

Table 16.15: Predicted annual average PM_{10} concentration (µg/m^3)

Zone C Monitoring station	**Galway**	**Portlaoise**	**Ennis**	**Ennis**
Year	**2016**	**2015**	**2015**	**2014**
Measured 3-month average (µg/m^3) - M	9.72			
Annual average (µg/m3) –A	15.3	12	18	21
Period average (3-month average) (µg/m^3) – P	16	15.9	22.4	21.3
Ratio of A/P - R	0.95	0.75	0.8	0.98
Estimated annual average (µg/m^3) - E	8.83	7.29	7.77	9.52
Average of estimated annual averages (µg/m^3)	8.35			

The predicted annual average PM_{10} concentration is in compliance with the annual air quality standard of 40µg/m^3 and the WHO guideline of 20µg/m^3.

Table 16.16 outlines the calculated average concentrations of $PM_{2.5}$ based on the method outlined in **Table 16.8**.

Table 16.16: Predicted annual average PM2.5 concentration (μg/m^3)

Zone C Monitoring station	**Heatherton Park***	**Bray**	**Ennis**	**Coleraine St****	**Rathmines****	**Finglas****	**Marino****
Year	**2016**	**2015**	**2015**	**2014**	**2014**	**2014**	**2014**
Measured 3-month average (μg/m^3) - M	5.36						
Annual average (μg/m^3) –A	7	7	12	9	9	7	8
Period average (3-month average) (μg/m^3) – P	8.1	8	13	10.1	9.7	9.5	8.6
Ratio of A/P - R	0.86	0.87	0.92	0.89	0.92	0.73	0.93
Estimated annual average (μg/m^3) - E	4.6	4.6	4.93	4.77	4.93	3.91	4.98
Average of estimated annual averages (μg/m^3)	4.67						

* Data obtained from Zone B Monitoring Station as no data available from Zone C Stations where 90% data capture was achieved
** Data obtained from Zone A Monitoring Stations as no data available from Zone C or Zone B Stations where 90% data capture was achieved

The predicted annual average $PM_{2.5}$ concentration is in compliance with the annual air quality standard of 20μg/m^3 and the WHO guideline of 10μg/m^3.

NO_2

Table 16.17 outlines the monitoring data for NO_2 from the 6 February to 2 May 2017.

Table 16.17: Average NO_2 concentration (μg/m^3) for monthly period from 6 February - 2 May 2017

Time Period	Location 1 (μg/m^3)	Location 2 (μg/m^3)	Location 3 (μg/m^3)	Location 4 (μg/m^3)
6 February to 6 March 2017	8.2	9.09	11.06	20.45
6 March to 6 April 2017	5.58	6.29	9.29	8.66
3 April to 2 May 2017	8.75	4.22	7.02	10.82
Average (μg/m^3)	7.51	6.53	9.12	13.31
Average for all four locations (μg/m^3)	9.12			

Table 16.18 outlines the calculated average concentrations of NO_2 based on the method outlined in **Table 16.8**.

Table 16.18: Predicted annual average NO_2 concentration (μg/m^3)

Zone C Monitoring station	Kilkenny Seville Lodge	Portlaoise	Kilkenny Seville Lodge	Kilkenny Seville Lodge
Year	**2016**	**2016**	**2015**	**2014**
Measured 3-month average (μg/m^3) - M	9.12			
Annual average (μg/m^3) –A	6.6	11.1	5	5
Period average (3-month average) (μg/m^3) – P	6.9	10.1	5.03	4.7
Ratio of A/P - R	0.95	1.09	0.99	1.06
Estimated annual average (μg/m^3) - E	8.66	9.94	9.02	9.66
Average of estimated annual averages (μg/m^3)	9.32			

The predicted annual average NO_2 concentration is in compliance with the annual air quality standard of 40μg/m^3 and the WHO guideline of 40μg/m^3.

16.3.3.2 Selection of background data for modelling assessments

Table 16.19 presents background data from EPA published data and from the assessment presented in **Section 16.3.3.1**.

Table 16.19: Background pollutant concentrations

Pollutant	Average concentration 2014 to 2016 (μg/m³)	Predicted average concentration from monitoring data (μg/m³)	Background value selected for assessments (μg/m³)	Air Quality Standard (μg/m³)
NO_2	7.1	9.3	9.3	40
PM_{10}	17.1	8.4	17.1	40
$PM_{2.5}$	9.5	4.7	9.5	20
Benzene	0.4	n/a	0.4	5
NO_x	11.2	n/a	11.2	30
CO	333	n/a	333	10,000

As a worst case, the highest level background data has been selected for use in the modelling assessments.

16.3.4 National Air Quality

In 2015, the EPA in a press release reported that emissions of nitrogen oxides (NO_x) decreased by 45% between 1990 and 2013. Between 2010 and 2011 there was a 10% reduction, caused by reductions across all sectors and in particular power generation. Despite this reduction, Ireland is currently exceeding its 2010 NO_x ceiling of 65 kilotonnes by 11 kilotonnes in 2013.

The road transport sector represents the largest source of NO_x emissions, accounting for 53% of total NO_x emissions in 2013.

The national total emissions of VOC were 90 kilotonnes in 2013 which exceeds the ceiling of 55 kilotonnes. Transport emissions comprise approximately 8% of total VOC emissions. However, technological controls for VOCs in motor vehicles have led to a significant reduction in emissions from road transport in recent years.

16.3.5 Macro climate

In April 2017, the EPA produced the report 'Ireland's final greenhouse gas emissions in 2015'. This concluded that there was an increase of 4.2% or 0.48Mtonnes of CO_{2eq} from the transport sector in 2015. This is the third year of increases in transport emissions following five consecutive years of decreases since 2007. The increase primarily reflects higher usage of diesel with gasoline usage decreasing. It is noted that biofuels use increased in 2015 by 10.3%.

In March 2016, the EPA reported that Ireland is unlikely to meet 2020 EU greenhouse gas targets for all sectors including transport. Current projections indicate that Ireland will be 6-11% below 2005 levels by 2020. This falls well short of the target of 20% below 2005 levels by 2020. Transport is predicted to constitute 29% of Ireland's non-Emissions Trading Scheme (ETS) emissions in 2020.

16.3.6 Micro-climate

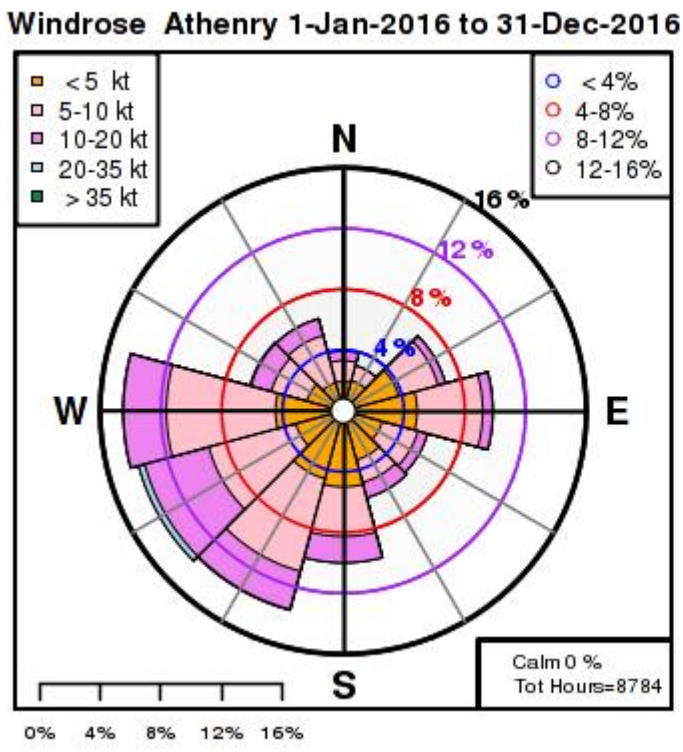
The nearest representative Met Éireann synoptic meteorological station is at Athenry which is located approximately 20km east of the proposed road development at 47m above mean sea level. Meteorological data is only available at this station from July 2011. All climate data cited below is taken from the 6 year averages reported for Athenry meteorological station (www.met.ie).

The annual mean temperature is 9.8ºC. The annual mean of daily maxima is 13.6ºC and of daily minima is 6ºC.

The mean annual rainfall is 1,004mm.

The annual mean wind speed is 3.9m/s (7.5 knots). A windrose for Athenry meteorological station is provided in **Plate 16.3** (www.met.ie).

Plate 16.3: Windrose for Athenry 2016



16.4 Characteristics of the Proposed Development

16.4.1 Construction Phase

The construction of the proposed road development will require earthworks, particularly during site clearance and excavation, refer to **Chapter 7, Construction Activities** for further details. Dust emissions are likely to arise from the following activities:

- Site earthworks
- Windblow from temporary stockpiles
- Handling of construction materials
- Landscaping
- Construction traffic movements
- Demolitions
- Concrete batching and crushing

In general, any additional airborne concentrations of particulate matter arising from construction would be small and very local to the construction activity (minimising human exposure). Particles generated by most construction activities tend to be larger than 10µm in diameter which are too large to enter the human lung.

Based on the assessment criteria outlined in **Table 16.7**, the potential dust impacts at locations where the main construction works will occur are assessed in **Section 16.5**.

A number of construction compounds are proposed, refer to **Figures 7.101** to 7.**123** for the locations of these compounds. The main construction compound will be located at Lackagh Quarry. It is assumed that concrete batching and rock crushing plant will be utilised at each compound.

It is also expected that a mobile crushing plant will be used in areas where extensive cut is required.

16.4.2 Operational Phase

The proposed road development comprises the construction of a single carriageway from the western side of Bearna as far as the Ballymoneen Road and a dual carriage from here to the eastern tie in with the existing N6 at Coolagh with associated link roads.

Predicted traffic volumes are outlined in **Chapter 6, Traffic Assessment and Route Cross-section**.

16.5 Evaluation of Impacts

16.5.1 Introduction

The following sections consider the potential impact of the proposed road development on air quality and climate during the construction and operational phases. The construction assessment considers potential impacts due to construction activities and traffic. The operational phase assesses the potential impact locally and regionally due to traffic emissions.

16.5.2 Do-Nothing Impact

The Do-nothing impact is considered and compared to the Do-Something scenarios in **Section 16.5.4**.

16.5.3 Potential Construction Impacts

16.5.3.1 Construction Activities

As outlined in **Section 16.4**, the construction of the proposed road development will require earthworks, particularly during site clearance and excavation.

Based on the assessment criteria outlined in **Table 16.7**, the potential dust impacts at locations where the main construction works will occur are assessed. The proposed road development has been split into six sections for the purpose of this assessment as outlined below. The sensitive receptors are shown on **Figures 16.01** to **16.14**.

Section 1: Ch. 0+000 to 5+600 (R336 to Ballymoneen Road Junction)

A single carriageway is proposed from Ch. 0+000 to Ch. 5+600 totalling 5.6km in length. This section of the proposed road development includes one new roundabout with a number of side road realignments, refer to **Table 5.2** of **Chapter 5, Description of proposed road development**. Works associated with Section 1 are considered to be of a major scale (refer to **Table 16.7**). There is potential for soiling effects at receptors located within 100m of the site works and PM_{10} and vegetation effects at receptors located less than 25m from the site works with standard dust control mitigation measures in place.

There are approximately 42 sensitive receptors located within 100m at which there is the potential for significant soiling effects with standard dust control mitigation measures in place. Approximately seven receptors are located less than 25m from the proposed site works at which there is the potential for significant PM_{10} and vegetation effects with standard dust control mitigation measures in place.

Section 2: Ch. 5+600 to 9+250 (Ballymoneen Road Junction to River Corrib Bridge)

A dual carriageway is proposed from Ch. 5+600 to Ch. 9+300 totalling 3.7km in length. This section of the proposed road development includes the N59 Letteragh Junction and approximately 2.2km of single carriageway for the N59 Link Road

North and South at Ch. 7+550. The scale of these works is considered to be of a major scale (refer to **Table 16.7**). There is potential for soiling effects at receptors located within 100 m of the site works and PM_{10} and vegetation effects at receptors located less than 25 m from the site works with standard mitigation in place.

There are approximately 39 sensitive receptors located within 100m of the works at which there is the potential for significant soiling effects with standard dust control mitigation measures in place. Approximately six receptors are located less than 25m from construction works at which there is the potential for PM_{10} and vegetation effects with standard dust control mitigation measures in place.

Section 3: Ch. 9+250 to 12+150 (River Corrib Bridge to N84 Headford Road Junction)

Section 3 of the proposed road development is also a dual carriageway and includes the construction of the River Corrib Bridge, 650m in length at Ch. 8+840, Menlough Viaduct, 30m in length at Ch. 10+090, Lackagh Tunnel, 270m in length at Ch. 11+140 and the N84 Headford Road Junction at Ch. 12+150. The scale of these works is considered to be of a major scale (refer to **Table 16.7**). There is potential for soiling effects at receptors located within 100m of the site works and PM_{10} and vegetation effects at receptors located less than 25m from the site works with standard mitigation in place.

There are approximately 13 sensitive receptors located within 100m at which there is the potential for significant soiling effects with standard dust control mitigation measures in place. Approximately three receptors are located less than 25m from construction works at which there is the potential for significant PM_{10} and vegetation effects with standard dust control mitigation measures in place.

Construction works will also take place in or adjacent to the Lough Corrib cSAC in Section 3. There is the potential for significant PM_{10}, soiling and vegetation effects at these locations with standard dust control mitigation measures in place.

Section 4: Ch. 12+150 to 14+300 (N84 Headford Road Junction to N83 Tuam Road Junction)

Section 4 of the proposed road development is also a dual carriageway and includes the N83 Tuam Road Junction. The construction works are considered to be of a major scale (refer to **Table 16.7**), including the construction of the N83 Tuam Road Junction.

The remainder of the works in Section 4 are considered to be of a major scale with the potential to result in soiling effects within 100m, PM_{10} and vegetation effects within 25m with standard mitigation in place.

There are approximately 29 sensitive receptors located within 100m of the works at which there is the potential for significant soiling effects with standard dust control mitigation measures in place. Approximately five receptors less than 25m from construction works at which there is the potential for significant PM_{10} and vegetation effects within 25m of the works and the potential for significant soiling effects within 100m of the works with standard dust control mitigation measures in place.

Section 5: Ch. 14+300 to 15+900 (N83 Tuam Road Junction to R339 Monivea Road) including Parkmore

Section 5 of the proposed road development is also a dual carriageway and includes the Galway Racecourse Tunnel at Ch. 14+950 to Ch. 15+200. This is considered to be of a major scale (refer to **Table 16.7**). There is potential for soiling effects at receptors located within 100m of the site works and PM_{10} and vegetation effects at receptors located less than 25m from the site works with standard mitigation in place.

There are approximately 14 sensitive receptors located within 100m at which there is the potential for significant soiling effects with standard dust control mitigation measures in place. Approximately two receptors are located less than 25 m from construction works at which there is the potential for significant PM_{10} and vegetation effects with standard dust control mitigation measures in place.

Section 6: Ch. 15+900 to 17+450 (R339 Monivea Road to Coolagh Junction)

Section 6 of the proposed road development is also a dual carriageway and includes the Coolagh Junction. This section is considered to be of a major scale (refer to **Table 16.7**). There is potential for soiling effects at receptors located within 100m of the site works and PM_{10} and vegetation effects at receptors located less than 25m from the site works with standard mitigation in place.

There are a number sensitive receptors located within 100m of the works at which there is the potential for significant soiling effects with standard dust control mitigation measures in place.

16.5.3.2 Construction Compounds

There are twelve sites identified as potential site compounds across the proposed road development. They have been identified at strategic locations across the proposed road development to minimise the distance for site construction traffic and personnel to travel. Sites identified have been chosen taking cognisance of proximity to major structures, excavations and embankments, proximity to residential properties, environmental constraints and current land use and ownership. Larger area compounds have the potential for material stockpiling, crushing, regrading and delivery in tandem with site offices. Refer to **Table 7.9** in **Chapter 7, Construction Activities** and **Figures 7.1.101** to **7.1.123**, for potential site compound locations.

One of the construction compounds (SC08/01) will be for the storage of materials only and therefore its impact on dust emissions has been categorised as minor scale. All other construction compounds have been categorised as moderate scale, see **Table 16.7**.

In total, approximately 16 sensitive receptors are located with 50m of the potential construction compounds at which there is the potential for significant soiling effects with standard dust control mitigation measures in place. Approximately, two receptors are located less than 15m of the construction compounds at which there is the potential for significant PM_{10} and vegetation effects with standard dust control mitigation measures in place.

16.5.3.3 Construction traffic

As stated in **Section 16.2.5**, construction traffic impacts are assessed when traffic generated (AADT) of greater than 10% are predicted to occur due to the proposed road development. Only three links are predicted to generate traffic volumes greater than 10% during the construction phase, i.e. R336 Bearna Moycullen Road, Cappagh Road and Menlough Road. **Table 16.20** provides the predicted concentrations at the worst-case receptor (5m from the centre of the road) for each road link. All predicted concentrations are in compliance with AQS.

Table 16:20: Predicted Pollutant Concentrations Including Background Concentrations – Construction Phase

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
R336 Bearna Moycullen Road	DN	9.82	17.24	9.57	<1	343	0.5
	DS	9.92	17.26	9.58	<1	343	0.5
	DS – DN	0.1	0.02	0.01	0	0	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	Negligible	Negligible
Cappagh Road	DN	9.49	20.59	9.5	<1	334.8	0.5
	DS	9.6	20.6	9.51	<1	336.4	0.5
	DS – DN	0.11	0.01	0.01	0	1.6	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	Negligible	Negligible
Menlough Road	DN	10.22	17.34	9.66	<1	345	0.5
	DS	10.3	17.36	9.67	<1	347	0.5
	DS – DN	0.08	0.02	0.01	0	2	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	Negligible	Negligible

The impact ratings for NO_2, PM_{10} and $PM_{2.5}$ are negligible. No impact rating is provided for benzene or CO in the TII Guidance. However, due to the small changes in concentrations and the easy compliance with limit values, a rating of negligible would be expected for all pollutants.

16.5.4 Potential Operational Impacts

16.5.4.1 Local air quality impacts based on DMRB screening model

The potential impact on air quality is assessed for the Opening Year (2024) and Design Year (2039) under the 'Do-Minimum' (DM) and 'Do-Something' (DS) scenarios respectively. Pollutant concentrations are provided at the worst-case receptors, i.e. those properties that are closest to the affected links.

The results provided are based on the use of the DMRB model (refer to **Section 16.2.5.1** for methodology).

Opening Year (2024)

Predicted concentrations (including background concentrations) for the DM, and DS scenarios for the Opening Year 2024 are presented in **Table 16.21**.

The receptor where the highest concentration of pollutants are predicted (including the background concentrations) as a result of the DS scenario is Receptor 17 for NO_2, PM_{10}, $PM_{2.5}$, CO and Benzene (refer to **Figure 16.1.06**).

At this receptor, annual average concentrations of NO_2 are predicted to be 14.42µg/m^3, which complies with the AQS of 40µg/m^3; annual average concentrations of $PM_{2.5}$ are predicted to be 11.3µg/m^3, which complies with the proposed limit value of 20µg/m^3 and the annual average concentrations of PM_{10} are predicted to be 19.2µg/m^3 which complies with the limit value of 40µg/m^3. The number of annual days which PM_{10} levels is predicted to exceed the limit of 50µg/m^3 is <3 days. This complies with the limit of 35 days. Annual average concentrations of benzene are predicted to be 0.48µg/m^3, which complies with the AQS of 5µg/m^3 and 8 hour concentrations of CO are predicted to be 387.2µg/m^3, which complies with the AQS of 10,000µg/m^3.

From **Tables 16.4**, **16.5** and **16.6**, the predicted changes in concentration of all pollutants are rated as negligible or imperceptible impacts at all receptors except at receptors, R16 and R17 where an impact of slight adverse is predicted for NO_2. No impact rating is provided for benzene or CO in the TII Guidance. However, due to the small changes in concentrations and the easy compliance with limit values, a rating of negligible would be expected for all pollutants.

Under the 2024 DS scenario, all predicted pollutant concentrations comply with the relevant limit values at all worst-case receptors selected. Following guidance provided in LAQM.TG16 [7], as all modelled results predict annual mean concentrations less than 60µg/m^3, it is unlikely that this area would exceed the hourly mean NO_2 objective.

[7] Defra (2016) Local Air Quality Management Technical Guidance TG16

It should also be noted that predicted concentrations comply with the PM_{10} WHO guideline values at all locations.

The WHO $PM_{2.5}$ annual mean limit of 10µg/m^3 is exceeded for the DM and DS scenarios with the background level in excess of this guideline level.

Table 16.21: Predicted Pollutant Concentrations Including Background Concentrations 2024

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
R01	DN	10.72	17.1	9.7	<1	344.4	0.41
	DS	10.72	17.2	9.8	<1	345.9	0.42
	DS – DN	0	0.1	0.1	0	1.5	0.01
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R02	DN	14.22	17.1	10.6	<2	380.9	0.46
	DS	14.22	17.2	10.6	<2	383.5	0.47
	DS – DN	0	0.1	0	0	2.6	0.01
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R03	DN	11.72	17.1	10	<1	367.9	0.45
	DS	11.92	17.2	10.1	<1	374.1	0.47
	DS – DN	0.2	0.1	0.1	0	6.2	0.02
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R04	DN	11.12	17.1	9.9	<1	365.1	0.44
	DS	11.42	17.2	10	<1	371.7	0.45
	DS – DN	0.3	0.1	0.1	0	6.6	0.01
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R05	DN	9.52	17.1	9.5	<1	336.7	0.4
	DS	9.72	17.2	9.6	<1	343.8	0.41
	DS – DN	0.2	0.1	0.1	0	7.1	0.01
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R06	DN	11.92	17.1	10.1	<1	376.6	0.45
	DS	12.82	17.5	10.5	<2	393.7	0.48
	DS – DN	0.9	0.4	0.4	1	17.1	0.03

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R07	DN	12.22	17.1	10.3	<2	369	0.44
	DS	13.32	17.4	10.6	<2	373.9	0.44
	DS – DN	1.1	0.3	0.3	0	4.9	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R08	DN	12.92	17.1	10.4	<2	368.5	0.44
	DS	13.22	17.2	10.5	<2	370.5	0.44
	DS – DN	0.3	0.1	0.1	0	2	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R09	DN	11.12	17.1	9.9	<1	365.1	0.44
	DS	11.42	17.2	10	<1	371.7	0.45
	DS – DN	0.3	0.1	0.1	0	6.6	0.01
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R10	DN	9.42	17.1	9.7	<1	335.5	0.4
	DS	10.72	17.5	10	<1	363.7	0.44
	DS – DN	1.3	0.4	0.3	0	28.2	0.04
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R11	DN	9.52	17.1	9.7	<1	336.4	0.4
	DS	11.82	17.8	10.3	<2	369.4	0.44
	DS – DN	2.3	0.7	0.6	0	33	0.04
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R12	DN	9.62	17.1	9.7	<1	338.1	0.41
	DS	12.22	18	10.5	<2	378.1	0.45
	DS – DN	2.6	0.9	0.8	0	40	0.04
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R13	DN	11.32	17.1	10.1	<1	384.5	0.46
	DS	11.92	17.3	10.3	<2	395.4	0.48
	DS – DN	0.6	0.2	0.2	0	10.9	0.02

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R14	DN	12.22	17.1	10.2	<2	377.5	0.46
	DS	14.02	17.7	10.7	<2	400.2	0.49
	DS – DN	1.8	0.6	0.5	0	22.7	0.03
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R15	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.22	17.9	10.2	<1	352.7	0.43
	DS – DN	1.9	0.8	0.7	0	19.7	0.03
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R16	DN	9.32	17.1	9.5	<1	333	0.4
	DS	13.92	18.9	11.1	<2	383	0.49
	DS – DN	4.6	1.8	1.6	0	50	0.09
	Impact Rating	Slight Adverse	Negligible	Negligible	n/a	n/a	n/a
R17	DN	9.32	17.1	9.5	<1	333	0.4
	DS	14.42	19.2	11.3	<3	387.2	0.48
	DS – DN	5.1	2.1	1.8	0	54.2	0.08
	Impact Rating	Slight Adverse	Negligible	Negligible	n/a	n/a	n/a
R18	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.22	17.7	10	<1	349.1	0.42
	DS – DN	1.9	0.6	0.5	0	16.1	0.02
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R19	DN	9.32	17.1	9.5	<1	333	0.4
	DS	10.32	17.4	9.7	<1	348.9	0.42
	DS – DN	1	0.3	0.2	0	15.9	0.02
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R20	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.22	17.7	10	<1	370.6	0.44
	DS – DN	1.9	0.6	0.5	0	37.6	0.04

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R21	DN	9.32	17.1	9.5	<1	333	0.4
	DS	10.52	17.4	9.7	<1	345.3	0.41
	DS – DN	1.2	0.3	0.2	0	12.3	0.01
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R22	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.92	19.1	10.1	<1	363.1	0.43
	DS – DN	2.6	2	0.6	0	30.1	0.03
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R23	DN	9.32	17.1	9.5	<1	333	0.4
	DS	10.92	17.5	9.8	<1	349.6	0.42
	DS – DN	1.6	0.4	0.3	0	16.6	0.02
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R24	DN	9.32	17.1	9.5	<1	333	0.4
	DS	10.92	17.5	9.8	<1	349.8	0.42
	DS – DN	1.6	0.4	0.3	0	16.8	0.02
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R25	DN	9.32	17.1	11.2	<1	333	0.4
	DS	11.12	17.6	11.6	<1	352.1	0.42
	DS – DN	1.8	0.5	0.4	0	19.1	0.02
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R26	DN	10.02	17.1	9.7	<1	338.1	0.4
	DS	10.12	17.1	9.7	<1	338.3	0.4
	DS – DN	0.1	0	0	0	0.2	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R27	DN	13.42	17.1	11.4	<3	371.9	0.46
	DS	13.52	17.2	11.4	<3	372.8	0.46
	DS – DN	0.1	0.1	0	0	1	0

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R28	DN	10.62	17.1	9.9	<1	342.3	0.41
	DS	10.72	17.2	10	<1	342.9	0.41
	DS – DN	0.1	0.1	0.1	0	0.6	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a

Design Year (2039)

Predicted concentrations (including background concentrations) for the 'DM', and 'DS' scenarios for the Opening Year 2039 are presented in **Table 16.22**. The receptor where the highest concentration of pollutants are predicted (including the background concentrations) as a result of the 'DS' scenario is Receptor 17 for NO_2, PM_{10}, $PM_{2.5}$, CO and Benzene (refer to **Figure 16.1.1**).

For this receptor, annual average concentrations of NO_2 are predicted to be 14.72µg/m³, which complies with the AQS of 40µg/m³; annual average concentrations of $PM_{2.5}$ are predicted to be 11.4µg/m³, which complies with the proposed limit value of 25µg/m³ and the annual average concentrations of PM_{10} are predicted to be 19.3µg/m³ which complies with the limit value of 40µg/m³. The number of annual days which PM_{10} levels is predicted to exceed the limit of 50µg/m³ is <3 days. This complies with the limit of 35 days. Annual average concentrations of Benzene are predicted to be 0.5µg/m³, which complies with the AQS of 5µg/m³ and 8 hour concentrations of CO are predicted to be 390.9µg/m³, which complies with the AQS of 10,000µg/m³.

From **Tables 16.4**, **16.5** and **16.6**, the predicted changes in concentration of all pollutants are rated as negligible or imperceptible impacts at all receptors except at receptors, R17 and R16 where an impact of slight adverse is predicted for NO_2. No impact rating is provided for benzene or CO in the TII Guidance. However, due to the small changes in concentrations and the easy compliance with limit values, a rating of negligible would be expected for all pollutants. The increase in magnitude of change in PM_{10} daily values is also considered negligible.

Under the 2039 DS scenario, all predicted pollutant concentrations comply with the relevant limit values at all receptors selected. Following guidance provided in LAQM.TG16[8], as all modelled results predict annual mean concentrations less than 60µg/m³, it is unlikely that this area would exceed the hourly mean NO_2 objective.

[8] Defra (2016) Local Air Quality Management Technical Guidance TG16

It should also be noted that predicted concentrations comply with the PM_{10} WHO guideline values at all locations.

The WHO $PM_{2.5}$ annual mean limit of 10µg/m^3 is exceeded for the DM and DS scenarios at some of the receptors with the background level of 9.5µg/m^3 close to this guideline level.

At the entrance and exit to the Lackagh Tunnel at Ch. 11+150, the closest residential receptors are approximately 470m from the eastern entrance and 480m from the western entrance. No significant air quality impacts are envisaged at these locations due to the separation from the tunnel openings to the nearest receptors.

At the entrance and exit to the tunnel at the Galway Racecourse, the closest sensitive receptors are approximately 80m from the eastern entrance and 350m from the western entrance. No significant air quality impacts are envisaged at these locations due to the separation from the tunnel openings to the nearest receptors.

Table 16.22: Predicted Pollutant Concentrations Including Background Concentrations – 2039

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
R01	DN	10.92	17.1	9.8	<1	345.6	0.5
	DS	11.02	17.2	9.8	<1	347.7	0.5
	DS- DN	0.1	0.1	0	0	2.1	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R02	DN	14.72	17.1	10.7	<2	382.3	0.5
	DS	14.52	17.1	10.7	<2	384.2	0.5
	DS- DN	-0.2	0	0	0	1.9	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R03	DN	11.92	17.1	10	<1	367.7	0.5
	DS	12.12	17.2	10.1	<1	374.8	0.5
	DS- DN	0.2	0.1	0.1	0	7.1	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R04	DN	11.42	17.1	10	<1	370.5	0.5
	DS	11.72	17.2	10.1	<1	378.2	0.5
	DS- DN	0.3	0.1	0.1	0	7.7	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R05	DN	9.52	17.1	9.5	<1	337.3	0.4
	DS	9.82	17.2	9.6	<1	344.8	0.5

Receptor	Scenario	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (Days > 50 µg/m³)	CO (µg/m³)	Benzene (µg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	DS- DN	0.3	0.1	0.1	0	7.5	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R06	DN	12.52	17.1	10.2	<2	382.5	0.5
	DS	13.02	17.5	10.5	<2	395.8	0.5
	DS- DN	0.5	0.4	0.3	0	13.3	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R07	DN	12.72	17.1	10.5	<2	371.3	0.5
	DS	12.82	17.1	10.5	<2	374.3	0.5
	DS- DN	0.1	0	0	0	3	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R08	DN	12.92	17.1	10.4	<2	368.6	0.5
	DS	13.32	17.2	10.5	<2	370.8	0.5
	DS- DN	0.4	0.1	0.1	0	2.2	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R09	DN	11.42	17.1	10	<1	370.5	0.5
	DS	11.72	17.2	10.1	<1	378.2	0.5
	DS- DN	0.3	0.1	0.1	0	7.7	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R10	DN	9.52	17.1	9.7	<1	335.9	0.4
	DS	11.02	19.05	10.1	<1	367.4	0.5
	DS- DN	1.5	1.95	0.4	0	31.5	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R11	DN	9.52	17.1	9.7	<1	336.5	0.4
	DS	12.22	17.9	10.4	<2	373.1	0.5
	DS- DN	2.7	0.8	0.7	0	36.6	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R12	DN	9.62	17.1	9.7	<1	338.3	0.4
	DS	12.92	18.2	10.7	<2	389.4	0.5
	DS- DN	3.3	1.1	1	0	51.1	0.1

Receptor	**Scenario**	**NO_2 (µg/m³)**	**PM_{10} (µg/m³)**	**$PM_{2.5}$ (µg/m³)**	**PM_{10} (Days > 50 µg/m³)**	**CO (µg/m³)**	**Benzene (µg/m³)**
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R13	DN	11.42	17.1	10.1	<2	386.6	0.5
	DS	12.12	17.3	10.3	<2	398.8	0.5
	DS- DN	0.7	0.2	0.2	0	12.2	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R14	DN	12.32	17.1	10.2	<1	378.1	0.5
	DS	14.62	17.9	10.9	<1	407	0.5
	DS- DN	2.3	0.8	0.7	0	28.9	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R15	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.42	17.7	10	<1	354.2	0.5
	DS- DN	2.1	0.6	0.5	0	21.2	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R16	DN	9.32	17.1	9.5	<1	333	0.4
	DS	14.32	19	11.2	<2	383	0.5
	DS- DN	5	1.9	1.7	0	50	0.1
	Impact Rating	Slight Adverse	Negligible	Negligible	n/a	n/a	n/a
R17	DN	9.32	17.1	9.5	<1	333	0.4
	DS	14.72	19.3	11.4	<3	390.9	0.5
	DS- DN	5.4	2.2	1.9	0	57.9	0.1
	Impact Rating	Slight Adverse	Negligible	Negligible	n/a	n/a	n/a
R18	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.42	17.8	10.1	<1	351.5	0.5
	DS- DN	2.1	0.7	0.6	0	18.5	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R19	DN	9.32	17.1	9.5	<1	333	0.4
	DS	10.42	17.4	9.7	<1	350	0.5
	DS- DN	1.1	0.3	0.2	0	17	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a

Receptor	Scenario	NO_2 (μg/m³)	PM_{10} (μg/m³)	$PM_{2.5}$ (μg/m³)	PM_{10} (Days > 50 μg/m³)	CO (μg/m³)	Benzene (μg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
R20	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.42	17.8	10	<1	375.6	0.5
	DS- DN	2.1	0.7	0.5	0	42.6	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R21	DN	9.32	17.1	9.5	<1	333	0.4
	DS	10.62	17.4	9.7	<1	346	0.5
	DS- DN	1.3	0.3	0.2	0	13	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R22	DN	9.32	17.1	9.5	<1	333	0.4
	DS	12.02	17.9	10.2	<2	364.7	0.5
	DS- DN	2.7	0.8	0.7	0	31.7	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R23	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.02	17.6	9.8	<1	350.5	0.5
	DS- DN	1.7	0.5	0.3	0	17.5	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R24	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.12	17.6	9.9	<1	352.8	0.5
	DS- DN	1.8	0.5	0.4	0	19.8	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R25	DN	9.32	17.1	9.5	<1	333	0.4
	DS	11.32	17.7	10	<1	355.6	0.5
	DS- DN	2	0.6	0.5	0	22.6	0.1
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R26	DN	10.22	17.1	9.8	<1	339.4	0.4
	DS	10.32	17.1	9.8	<1	339.7	0.4
	DS- DN	0.1	0	0	0	0.3	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R27	DN	13.82	17.1	11.6	<3	376.5	0.5
	DS	13.92	17.2	11.7	<3	377.5	0.5

Receptor	Scenario	NO_2 (μg/m³)	PM_{10} (μg/m³)	$PM_{2.5}$ (μg/m³)	PM_{10} (Days > 50 μg/m³)	CO (μg/m³)	Benzene (μg/m³)
	Limit Values	**40**	**40**	**25**	**35**	**10,000**	**5**
	DS- DN	0.1	0.1	0.1	0	1	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a
R28	DN	10.82	17.1	10	<1	343.2	0.5
	DS	10.92	17.2	10	<1	344.2	0.5
	DS- DN	0.1	0.1	0	0	1	0
	Impact Rating	Negligible	Negligible	Negligible	n/a	n/a	n/a

Ecologically Sensitive Areas

Lough Corrib cSAC

The following sections assess the potential for pollution due to the proposed road development under the headings of nitrogen compounds, VOC, metals/dust and ammonia at the Lough Corrib cSAC, at the River Corrib Bridge between Ch. 9+250 and Ch. 9+600, between Ch. 9+800 and Ch. 10+100 at Menlough, and Lackagh Tunnel between Ch. 10+450 and Ch. 11+450 during the operational phase, refer to **Figures 8.15.7** and **8.15.8**.

NOx

Table 16.23 presents the results from the air quality modelling using DMRB methodology based on traffic volumes for 2024 (Year of Opening) and 2039 (Design Year) for the Do-Minimum (without the proposed road development) and Do-Something (with the proposed road development) scenarios at the section of road at the Lough Corrib cSAC. The potential impact of NO_x concentration and deposition was assessed at various distances from the edge of the proposed road. The assessment was carried out in accordance with TII Guidelines using the DMRB Screening Model. Background concentrations are as outlined in **Table 16.19**.

Ambient NO_x concentrations predicted for the Opening and Design Years along a transect of up to 200m from the centre of the proposed road development are given in **Table 16.23** in accordance with TII guidance. The contribution of the proposed road development to NO_x deposition is also given and was calculated using the TII guidance methodology.

The annual average NO_x concentration at various distances from the centre of the road complies with the limit value of 30 μg/m^3 for the Do-Minimum scenario in 2024 and 2039, with NO_x concentrations reaching 37% of this limit in 2024 and 2039. For the Do-Something scenario, the limit values are complied with in 2024 at 80% of the limit value and complied with in 2039 with the predicted concentration at 83% of the limit value, including background concentrations at 10m from the edge of the proposed road.

The potential impact of the proposed road development results in a maximum increase in NO_x concentrations of a maximum of 13.64μg/m^3 at 10m from the proposed road edge. All predicted concentrations are in compliance with the Air Quality Standard for the protection of vegetation.

The proposed road development contribution to the NO_2 dry deposition rate along the 200m transect from the proposed road edge is also detailed in **Table 16.23**. The maximum increase in the NO_2 dry deposition rate is 1.03kg(N)/ha/yr in 2024 and 1.06kg(N)/ha/yr in 2039 for the Do-Something scenario. This is approximately 20% of the critical load for the lower boundary limit of inland and surface water habitats of 5-10kg(N)/ha/yr (TII 2011).

As outlined in **Section 16.3.2**, background nitrogen deposition levels are likely in the range of 1 to 2.5kg(N)/ha/yr. The addition of these background levels results in continued compliance with the critical load.

Table 16.23: Predicted Nitrogen Concentration including Background and Deposition at the Lough Corrib cSAC for 2024 and 2039

Distance to Proposed Road Development (m)	NOx Concentration (µg/m³) 2024				NOx Concentration (µg/m³) 2039			NO_2 Dry Deposition Rate Impact (kg(N)/ha/yr)	
	Background	Do-Minimum	Do-Something	Increase	Do-Minimum	Do-Something	Increase	2024	2039
10	11.2	11.2	23.97	12.77	11.2	24.84	13.64	1.03	1.06
20	11.2	11.2	21	9.8	11.2	21.67	10.47	0.95	0.97
30	11.2	11.2	18.83	7.63	11.2	19.35	8.15	0.88	0.89
40	11.2	11.2	17.19	5.99	11.2	17.6	6.4	0.82	0.84
50	11.2	11.2	15.92	4.72	11.2	16.25	5.05	0.78	0.79
60	11.2	11.2	14.92	3.72	11.2	15.18	3.98	0.74	0.75
70	11.2	11.2	14.13	2.93	11.2	14.33	3.13	0.71	0.72
80	11.2	11.2	13.49	2.29	11.2	13.65	2.45	0.69	0.69
90	11.2	11.2	12.99	1.79	11.2	13.11	1.91	0.67	0.67
100	11.2	11.2	12.6	1.4	11.2	12.69	1.49	0.65	0.65
110	11.2	11.2	12.29	1.09	11.2	12.36	1.16	0.64	0.64
120	11.2	11.2	12.06	0.86	11.2	12.12	0.92	0.63	0.63
130	11.2	11.2	11.9	0.7	11.2	11.94	0.74	0.62	0.62

Distance to Proposed Road Development (m)	NOx Concentration (μg/m³) 2024				NOx Concentration (μg/m³) 2039			NO_2 Dry Deposition Rate Impact (kg(N)/ha/yr)	
	Background	**Do-Minimum**	**Do-Something**	**Increase**	**Do-Minimum**	**Do-Something**	**Increase**	**2024**	**2039**
140	11.2	11.2	11.79	0.59	11.2	11.83	0.63	0.61	0.62
150	11.2	11.2	11.73	0.53	11.2	11.77	0.57	0.61	0.61
160	11.2	11.2	11.7	0.5	11.2	11.74	0.54	0.61	0.61
170	11.2	11.2	11.62	0.42	11.2	11.65	0.45	0.6	0.61
180	11.2	11.2	11.54	0.34	11.2	11.56	0.36	0.6	0.6
190	11.2	11.2	11.46	0.26	11.2	11.48	0.28	0.6	0.6
200	11.2	11.2	11.38	0.18	11.2	11.39	0.19	0.6	0.6
Standards	**30μg/m³**	**30μg/m³**	**30μg/m³**		**30μg/m³**	**30μg/m³**		**5-10kg(N)/ha/yr**	

<u>VOC</u>

No critical load limits exist for VOCs for the protection of vegetation.

An assessment of emissions of benzene was carried out for the proposed road development, in accordance with TII methodology using the DMRB modelling spreadsheet. Predicted concentrations were compared to the air quality standard of 5µg/m^3 for the protection of human health. The maximum predicted concentration for the Do-Something scenario was 10.2% of the standard including background concentrations of 5µg/m^3. As stated previously, these limits have been developed to protect the environment as a whole.

Benzene concentrations predicted for the Opening and Design Years along a transect of up to 200m from the proposed road development are given in **Table 16.24**.

Table 16.24: Predicted Benzene concentrations at the Lough Corrib cSAC including Background Concentrations for 2024 and 2039

Distance to Proposed Road Development (m)	Benzene Concentration (µg/m^3) 2024			Benzene Concentration (µg/m^3) 2039		
	Do-Minimum	Do-Something	Increase	Do-Minimum	Do-Something	Increase
10	0.4	0.49	0.09	0.4	0.51	0.11
20	0.4	0.47	0.07	0.4	0.48	0.08
30	0.4	0.46	0.06	0.4	0.46	0.06
40	0.4	0.44	0.04	0.4	0.45	0.05
50	0.4	0.43	0.03	0.4	0.44	0.04
60	0.4	0.43	0.03	0.4	0.43	0.03
70	0.4	0.42	0.02	0.4	0.42	0.02
80	0.4	0.42	0.02	0.4	0.42	0.02
90	0.4	0.41	0.01	0.4	0.42	0.02
100	0.4	0.41	0.01	0.4	0.41	0.01
110	0.4	0.41	0.01	0.4	0.41	0.01
120	0.4	0.41	0.01	0.4	0.41	0.01
130	0.4	0.4	0	0.4	0.41	0.01
140	0.4	0.4	0	0.4	0.4	0
150	0.4	0.4	0	0.4	0.4	0
160	0.4	0.4	0	0.4	0.4	0
170	0.4	0.4	0	0.4	0.4	0
180	0.4	0.4	0	0.4	0.4	0
190	0.4	0.4	0	0.4	0.4	0
200	0.4	0.4	0	0.4	0.4	0

Distance to Proposed Road Development (m)	**Benzene Concentration (µg/m³) 2024**			**Benzene Concentration (µg/m³) 2039**		
	Do-Minimum	**Do-Something**	**Increase**	**Do-Minimum**	**Do-Something**	**Increase**
Standards	**5µg/m³**	**5µg/m³**		**5µg/m³**	**5µg/m³**	

As outlined in **Section 16.2.5**, the Natural England report states that *levels of ethylene likely to be found in the vicinity of roads may be high enough to adversely affect sensitive species*. On this basis, comparisons of emission factors of VOCs (mg/vehicle/km) have been examined in order to estimate an appropriate ratio of ethylene to benzene. The five studies examined[9]; various types of vehicles, over a ten year period, across three countries. The highest ratio of ethylene to benzene determined was 3:1, for vehicles which were primarily diesel emissions. Increases in ethylene from the proposed road development have been predicted using this ratio and results presented in **Table 16.25**. No background data or relevant limit values are available for ethylene. At 10m from the proposed road edge a 0.28µg/m³ increase is predicted in 2024 and a 0.33µg/m³ increase in 2039.

Table 16.25: Predicted ethylene concentrations at the Lough Corrib cSAC for 2024 and 2039

Distance to Proposed Road Development (m)	**Ethylene Concentration (µg/m³) 2024**	**Ethylene Concentration (µg/m³) 2039**
	Increase	**Increase**
10	0.28	0.33
20	0.22	0.25
30	0.17	0.19
40	0.13	0.15
50	0.10	0.12
60	0.08	0.09
70	0.06	0.07
80	0.05	0.06
90	0.04	0.05
100	0.03	0.04
110	0.02	0.03
120	0.02	0.02
130	0.03	0.02
140	0.03	0.03
150	0.03	0.03

[9] Atmospheric Chemistry and Physics, 2009. *Vehicular emission of volatile organic compounds (VOCs) from a tunnel in Hong Kong*). Available at http://www.klacp.ac.cn/kycg/scilw/201506/W020150612344767439939.pdf

Distance to Proposed Road Development (m)	Ethylene Concentration (µg/m^3) 2024	Ethylene Concentration (µg/m^3) 2039
	Increase	Increase
160	0.03	0.03
170	0.03	0.03
180	0.03	0.03
190	0.03	0.03
200	0.03	0.03

Metals/Dust

No critical load limits exist for metals or dust for the protection of vegetation.

As outlined in the Environmental Protection Agency Air Quality in Ireland report 2015, high levels of heavy metals are usually observed in areas with a lot of heavy industry such as smelting and mining. Ireland as a country which has few heavy industries such as these, and as a consequence, the concentration of heavy metals is likely to remain low in the future. No reference is made to high levels of metals due to traffic emissions.

Heavy metals are continually monitored by the EPA for Zone C, at the heavily trafficked Bodkin Junction, Galway. Since 2015 measured heavy metals (Lead, Arsenic, Cadmium and Nickel) are all well below target values i.e. Lead 0.7%, Arsenic 15%, Cadmium 6%, Nickel 3% of the target values (Directive 2004/107/EC). These limits were developed to protect the environment as a whole.

PM_{10} concentrations predicted for the Opening and Design Years along a transect of up to 200m from the proposed road development are given in **Table 16.26**. Values include background concentrations of 17.1µg/m^3. All predicted concentrations are in compliance with the air quality standard for PM_{10} of 40µg/m^3. A maximum increase of 1.89µg/m^3 is predicted to occur in 2039 at 10m from the proposed road edge.

Table 16.26: Predicted PM_{10} concentrations at the Lough Corrib cSAC including Background Concentrations for 2024 and 2039

Distance to Proposed Road Development (m)	PM_{10} Concentration (µg/m^3) 2024			PM_{10} Concentration (µg/m^3) 2039		
	Do-Minimum	Do-Something	Increase	Do-Minimum	Do-Something	Increase
10	17.1	18.86	1.76	17.1	18.99	1.89
20	17.1	18.45	1.35	17.1	18.55	1.45
30	17.1	18.15	1.05	17.1	18.23	1.13
40	17.1	17.93	0.83	17.1	17.99	0.89
50	17.1	17.75	0.65	17.1	17.8	0.7
60	17.1	17.61	0.51	17.1	17.65	0.55

Distance to Proposed Road Development (m)	PM_{10} Concentration (µg/m³) 2024			PM_{10} Concentration (µg/m³) 2039		
	Do-Minimum	Do-Something	Increase	Do-Minimum	Do-Something	Increase
70	17.1	17.5	0.4	17.1	17.53	0.43
80	17.1	17.42	0.32	17.1	17.44	0.34
90	17.1	17.35	0.25	17.1	17.37	0.27
100	17.1	17.29	0.19	17.1	17.31	0.21
110	17.1	17.25	0.15	17.1	17.26	0.16
120	17.1	17.22	0.12	17.1	17.23	0.13
130	17.1	17.2	0.1	17.1	17.2	0.1
140	17.1	17.18	0.08	17.1	17.19	0.09
150	17.1	17.17	0.07	17.1	17.18	0.08
160	17.1	17.17	0.07	17.1	17.17	0.07
170	17.1	17.16	0.06	17.1	17.16	0.06
180	17.1	17.15	0.05	17.1	19.05	1.95
190	17.1	17.14	0.04	17.1	17.14	0.04
200	17.1	17.12	0.02	17.1	17.12	0.02
Standards	**40µg/m³**	**40µg/m³**	**40µg/m³**	**40µg/m³**	**40µg/m³**	**40µg/m³**

Ammonia

As outlined earlier, ammonia is emitted in small amounts by vehicles with catalytic converters and *roadside atmospheric concentrations are well below critical levels* for this pollutant. The Natural England report states that it is *unlikely to be a key issue, and effects on vegetation are more likely to arise from enhanced deposition of nitrogen to the soil environment*. The potential impact of nitrogen deposition on ecological sites has been assessed earlier in this Section.

River Corrib Bridge Crossing

The proposed road development crosses the River Corrib which is within the Lough Corrib cSAC on a bridge and embankment (between Ch. 9+500 and Ch. 9+600).

Noise barriers are proposed on both sides of the bridge structure. These will contain the majority of pollutants generated by traffic accessing the proposed road development. The elevated position of the proposed road development at this location will also result in good dispersion of pollution generated from traffic. This will have the effect of significantly lowering ground level concentrations. In addition, predicted concentrations of NO_x and nitrogen deposition levels are below relevant limits at this location even within 10m from the proposed road edge, refer to **Table 16.23**.

Predicted concentrations of VOCs and dust are in compliance with air quality standards for the protection of the environment as a whole.

Menlough – Ch. 9+800 to 10+100

To the east of the River Corrib the proposed road development continues east on embankment toward the Menlough Viaduct and traverses outside of the boundary of the Lough Corrib cSAC, overlapping it in places. The ecologically sensitive area where the qualifying interests of the Lough Corrib cSAC are located is to the southeast of this section of the proposed road development and comprises of an area of semi-natural Oak-Ash-Hazel woodlands, scrub, wet grassland and calcareous grassland; some of which correspond to Qualifying Interest (QI) Annex I habitats.

The elevated position of the proposed road development at this location will result in good dispersion of pollution generated from traffic. In addition, predicted concentrations of NO_x and nitrogen deposition levels are predicted to be below relevant limits at this location even within 10m of the proposed road edge.

Predicted concentrations of VOCs and dust are in compliance with air quality standards for the protection of the environment as a whole.

A windrose for Athenry meteorological station is provided in **Plate 16.3** (www.met.ie). This demonstrates that the prevailing wind in the area is from the south-west and west. The wind directions required to direct pollution towards this sensitive area are from the northwest and west. According to the windrose, wind from the northwest in 2016 was recorded for approximately 7% of the time in 2016. Therefore, the likelihood of pollution generated by road traffic interacting with the sensitive area is low due to northwest winds. Westerly winds were recorded for approximately 15% of the time in 2016. However, for approximately 10% of this time the wind speeds recorded are greater than 5 knots. This results in high dispersion of potential pollutants during this time, greatly reducing pollutant concentrations.

The separation between the edge of the proposed road development and the ecologically sensitive area is approximately 15m. As outlined in **Table 16.23**, the nitrogen deposition levels due to the proposed road development at such distances is predicted to be less than relevant limits.

Lackagh Tunnel

East of the Menlough Viaduct, the proposed road development enters a section of cut preceding Lackagh Tunnel immediately west of Lackagh Quarry and exits the tunnel in the disused quarry. The Lackagh Tunnel passes underneath Lough Corrib cSAC. The overlying habitats within the Lough Corrib cSAC at this location comprise a mosaic of Limestone pavement, and Calcareous grassland. All of these habitat types are Qualifying Interest (QI) habitats of the Lough Corrib cSAC.

As the proposed road development is in tunnel beneath the Lough Corrib cSAC at this location and the eastern approach is within Lackagh Quarry surrounded by quarry walls up to 40m in height, emissions generated here will not be physically able to interact with the designated areas. At the portals and at the western approach to the tunnel which runs adjacent (approximately 10m) to the Lough Corrib cSAC, there is the potential for air quality impacts. However, as outlined in **Table 16.23**, the nitrogen deposition levels due to the proposed road development at such distances is predicted to be less than relevant limits.

In addition, the dispersal of pollution at the eastern and western approach to the tunnel will be contained due to the effective barrier caused by the cutting along the Lough Corrib cSAC at this location.

Between Ch. 10+450 and Ch. 10+600 and between Ch. 10+750 and Ch. 10+900 there are short sections of embankment adjacent to the Lough Corrib cSAC. QI habitats are located c.75m from the first location (north of the proposed road development) and at the second location, c.45m from the northern edge of the proposed road development and c.15m from the southern edge of the proposed road development. At these distances of between 10 and 75m from the edge of the proposed road, NOx concentrations are predicted to be in compliance with the air quality standards for the protection of vegetation and the critical load for nitrogen deposition, refer to **Table 16.23**.

Predicted concentrations of VOCs and metals/dust are in compliance with air quality standards for the protection of the environment as a whole, refer to **Tables 16.24** and **16.25**.

Other ecological sensitive sites

Table 16.26 presents the results from the air quality modelling using DMRB methodology based on traffic volumes for 2024 (Opening Year) and 2039 (Design Year) for the Do-Minimum (without the proposed road development) and Do-Something (with the proposed road development) scenarios at the section of the proposed road development between N83 Tuam Road and N84 Headford (highest predicted traffic volumes). Lesser concentration and deposition values would be expected at all other sections of the proposed road development where lesser traffic volumes are predicted. The potential impact of NO_x concentration and deposition was assessed at various distances from the edge of the proposed road. The assessment was carried out in accordance with TII Guidelines using the DMRB Screening Model. Background concentrations are as outlined in **Table 16.19**.

The annual average NO_x concentration at various distances from the proposed road edge complies with the limit value of 30µg/m^3 for the Do-Minimum scenario in 2024 and 2039, with NO_x concentrations reaching 37% of this limit in 2024 and 2039. In the 2024 Do-Something scenario, the limit values are complied with at 86% of the limit value, this equates to a slight adverse impact. In the 2039 Do-Something scenario, the limit values are complied with at 92% of the limit value, this equates to a slight adverse impact.

Further away from the proposed road edge, all predicted concentrations comply.

The potential impact of the proposed road development results in a maximum increase in NO_x concentrations of a maximum of 16.53µg/m^3 at 10m from the proposed road edge.

The proposed road development contribution to the NO_2 dry deposition rate along the 200m transect from the proposed road edge is also detailed in **Table 16.27**. The maximum increase in the NO_2 dry deposition rate is predicted to be 1.22kg(N)/ha/yr in 2024 and 1.27kg(N)/ha/yr in 2039 for the Do-Something scenario. This is approximately 24.4% and 25.4% respectively of the critical load for the lower boundary limit of inland and surface water habitats of 5-10kg(N)/ha/yr (TII 2011).

Table 16.27: Predicted Nitrogen Concentration including background concentrations and Deposition at the section of the proposed road development with the highest AADT (between N83 and N84) for 2024 and 2039

Distance to Proposed Road Development (m)	NO_x Concentration (µg/m^3) 2024				NO_x Concentration (µg/m^3) 2039			NO_2 Dry Deposition Rate Impact (kg(N)/ha/yr)	
	Background	Do-Minimum	Do-Something	Increase	Do-Minimum	Do-Something	Increase	2024	2039
10	11.2	11.2	25.87	14.67	11.2	27.73	16.53	1.22	1.27
20	11.2	11.2	22.46	11.26	11.2	23.88	12.68	1.12	1.16
30	11.2	11.2	19.97	8.77	11.2	21.08	9.88	1.04	1.08
40	11.2	11.2	18.09	6.89	11.2	18.96	7.76	0.98	1.01
50	11.2	11.2	16.63	5.43	11.2	17.31	6.11	0.93	0.96
60	11.2	11.2	15.48	4.28	11.2	16.02	4.82	0.89	0.91
70	11.2	11.2	14.56	3.36	11.2	14.99	3.79	0.86	0.88
80	11.2	11.2	13.84	2.64	11.2	14.17	2.97	0.83	0.85
90	11.2	11.2	13.26	2.06	11.2	13.52	2.32	0.81	0.82
100	11.2	11.2	12.8	1.6	11.2	13.01	1.81	0.79	0.8
110	11.2	11.2	12.45	1.25	11.2	12.61	1.41	0.77	0.78
120	11.2	11.2	12.19	0.99	11.2	12.31	1.11	0.76	0.77
130	11.2	11.2	12	0.8	11.2	12.1	0.9	0.75	0.76
140	11.2	11.2	11.88	0.68	11.2	11.96	0.76	0.75	0.75

Distance to Proposed Road Development (m)	NO_x Concentration (μg/m^3) 2024				NO_x Concentration (μg/m^3) 2039			NO_2 Dry Deposition Rate Impact (kg(N)/ha/yr)	
	Background	Do-Minimum	Do-Something	Increase	Do-Minimum	Do-Something	Increase	2024	2039
150	11.2	11.2	11.81	0.61	11.2	11.89	0.69	0.74	0.75
160	11.2	11.2	11.78	0.58	11.2	11.85	0.65	0.74	0.75
170	11.2	11.2	11.69	0.49	11.2	11.75	0.55	0.74	0.74
180	11.2	11.2	11.59	0.39	11.2	11.64	0.44	0.73	0.74
190	11.2	11.2	11.5	0.3	11.2	11.54	0.34	0.73	0.73
200	11.2	11.2	11.4	0.2	11.2	11.3	0.1	0.72	0.72
Standards	**30μg/m^3**	**30μg/m^3**	**30μg/m^3**		**30μg/m^3**	**30μg/m^3**		**5-10kg(N)/ha/yr**	

Air Quality Improvements

Table 16.28 outlines locations where air quality will improve as a result of decreases in AADT. Light green areas represent scenarios where AADT flow values will decrease by 10%, the darkest green represents up to an 80% decrease.

The reduction in traffic will result in a localised improvement of air quality in these regions, which will be particularly evident where sensitive receptors are adjacent to roadways and traffic reductions are substantial.

Table 16.28: Locations of Improved Air Quality as a result of reduced AADT flows (refer to Figure 6.9 for location of link numbers)

Link number	Link location	2024	2039
		DS-DM	DS-DM
4	Existing N6 South of Briarhill	42%	40%
5	Existing N6 Near Ballybrit Business park	46%	39%
6	Existing N6 between N83 and R865	33%	30%
7	Existing N6 Between N84 and N83	50%	45%
9	Existing N6 - On Quincentenary Bridge	30%	30%
10	R338 at Westside Playing fields	50%	46%
11	Western Distributor Rd between Clybaun Rd and R338	35%	31%
12	Western Distributor Rd between Clybaun Rd and Ballymoneen Rd	21%	20%
13	R337 Kingston Road. Kingston	40%	40%
14	R336. Salthill Road Upper. Galway Golf Course	17%	18%
15	R336. Bearna Road. Bearna Woods	73%	73%
16	R336. Bearna Road. Bearna. Creagan bus stop	75%	77%
19	Boleybeg Road. Between Cappagh Road and Ballymoneen Road	67%	63%
21	N59. Thomas Hynes road. Between Hazel Park and Cherry Park	25%	21%
22	N59. Upper Newcastle Road. Between R338 and Corrib Village	18%	17%
23	N59. Barnacranny. Between Chesnut Lane and Circular Rd	19%	19%
29	R336. Tuam Road. Mervue Business Park	25%	24%
30	Wolfe Tone Bridge	20%	20%
32	Salmon Weir Bridge	15%	19%
34	Eglington Street	12%	15%
37	Cappagh Road - North of the proposed road development	52%	53%

16.5.4.2 Local air quality impacts based on ADMS model

NO_2

Annual mean NO_2 concentrations were predicted at the receptor locations for the future year when the proposed road development Opens (2024) and the Design Year (2039). It should be noted that this has been undertaken retaining vehicle emission factors and background pollutant concentrations at baseline levels (**Table 16.19**) to represent a worst case scenario.

Predicted annual mean NO_2 concentrations for the Do-Minimum (without the proposed road development) and Do-Something (with the proposed road development), the change in concentrations as a result of the proposed road development and the impact descriptor at each receptor are shown in **Table 16.29** and **Table 16.30** for the Opening Year (2024) and Design Year (2039), respectively. Results of modelling with the noise barriers in place area also included for the receptors, where relevant.

Table 16.29: Predicted concentrations of NO_2 (µg/m^3), 2024

Receptor	Do-Nothing (µg/m^3)	Without noise barriers			With noise barriers		
		Do-Something (µg/m^3)	Change in NO_2 (µg/m^3)	Impact	Do-Something (µg/m^3)	Change in NO_2 (µg/m^3)	Impact
R01	10	10.5	0.5	Negligible	-	-	-
R02	14.6	15.3	0.7	Negligible	-	-	-
R03	12	13	1	Negligible	-	-	-
R04	10.6	11.3	0.7	Negligible	11.3	0.7	Negligible
R05	8.9	9.2	0.3	Negligible	-	-	-
R06	12.1	15.2	3.1	Negligible	15.2	3.1	Negligible
R07	11.9	12.6	0.7	Negligible	-	-	-
R08	11.7	12.2	0.5	Negligible	-	-	-
R09	10.3	10.6	0.3	Negligible	-	-	-
R10	8.9	10.9	2	Negligible	-	-	-
R11	8.8	11.5	2.7	Negligible	11.1	2.3	Negligible
R12	9	10.8	1.8	Negligible	10.8	1.8	Negligible
R13	11.7	12.1	0.4	Negligible	-	-	-
R14	13.5	13.8	0.3	Negligible	-	-	-
R15	9.4	10.6	1.2	Negligible	10.6	1.2	Negligible
R16	9	16.4	7.4	Slight adverse	15	6	Slight adverse
R17	9.2	14.7	5.5	Slight adverse	13.5	4.3	Slight adverse
R18	9.2	10.2	1	Negligible	-	-	-
R19	8.8	10	1.2	Negligible	-	-	-
R20	8.8	12.6	3.8	Negligible	12.2	3.4	Negligible

Receptor	Do-Nothing (µg/m^3)	Without noise barriers			With noise barriers		
		Do-Something (µg/m^3)	Change in NO_2 (µg/m^3)	Impact	Do-Something (µg/m^3)	Change in NO_2 (µg/m^3)	Impact
R21	8.8	9.8	1	Negligible	9.8	1	Negligible
R22	8.8	11.3	2.5	Negligible	11	2.2	Negligible
R23	8.8	9.9	1.1	Negligible	9.9	1.1	Negligible
R24	8.7	9.7	1	Negligible	9.6	0.9	Negligible
R25	8.7	9.8	1.1	Negligible	9.7	1	Negligible
R26	9.8	9.8	0	Negligible	-	-	-
R27	13.4	13.7	0.3	Negligible	-	-	-
R28	10.7	10.8	0.1	Negligible	-	-	-

Predicted annual mean concentrations are all well below the limit value (40µg/m^3). The maximum concentration was predicted at R16 (16.4µg/m^3 in 2024), where the maximum change in concentration (7.4µg/m^3) was predicted. The predicted impact at R16 can be therefore described as slight adverse, refer to **Tables 16.4**, **16.5** and **16.6**. A slight adverse impact was also predicted at R17. A negligible impact was predicted at all other locations.

With the proposed noise barriers in place, lower concentrations are predicted at all of the nearby receptors, excluding R04, R06, R12, R15, R21 and R23, where the difference in predicted concentrations is <0.01µg/m^3. The trend for lower concentrations near to the proposed road development with the noise barrier in place is expected, but the impact will depend on the orientation of the noise barrier with respect to the wind direction. At all locations, the lower predicted change in concentrations with the noise barriers in place does not change the impact descriptor.

Following guidance provided in LAQM.TG16[10], as all modelled results predict annual mean concentrations less than 60µg/m^3, it is unlikely that this area would exceed the hourly mean NO_2 objective.

Table 16.30: Predicted concentrations of NO_2 (µg/m^3), 2039

Receptor	Do-Nothing (µg/m^3)	Without noise barriers)			With noise barriers		
		Do-Something (µg/m^3)	Change in NO_2 (µg/m^3)	Impact	Do-Something (µg/m^3)	Change in NO_2 (µg/m^3)	Impact
R01	10.7	11.9	1.2	Negligible	-	-	-
R02	15.9	16.6	0.7	Negligible	-	-	-
R03	12.9	14.3	1.4	Negligible	-	-	-
R04	11.7	12.5	0.8	Negligible	12.5	0.8	Negligible
R05	9.6	10	0.4	Negligible	-	-	-

[10] Defra (2016) Local Air Quality Management Technical Guidance TG16

Receptor	Do-Nothing (μg/m^3)	Without noise barriers)			With noise barriers		
		Do-Something (μg/m^3)	Change in NO_2 (μg/m^3)	Impact	Do-Something (μg/m^3)	Change in NO_2 (μg/m^3)	Impact
R06	13.4	15.4	2	Negligible	15.4	2	Negligible
R07	12.9	13.7	0.8	Negligible	-	-	-
R08	12.4	13.2	0.8	Negligible	-	-	-
R09	11.3	11.7	0.4	Negligible	-	-	-
R10	9.7	11.9	2.2	Negligible	-	-	-
R11	9.5	12.7	3.2	Negligible	12.2	2.7	Slight adverse
R12	9.7	11.9	2.2	Negligible	11.9	2.2	Slight adverse
R13	12.8	13.3	0.5	Negligible	-	-	-
R14	14.7	15.8	1.1	Negligible	-	-	-
R15	10.1	11.8	1.7	Negligible	11.8	1.7	Negligible
R16	9.7	18.2	8.5	Slight adverse	16.5	6.8	Moderate adverse
R17	10	16.6	6.6	Slight adverse	15.1	5.1	Moderate adverse
R18	9.9	11.2	1.3	Negligible	-	-	-
R19	9.5	10.9	1.4	Negligible	-	-	-
R20	9.5	14.1	4.6	Slight adverse	13.6	4.1	Slight adverse
R21	9.5	10.7	1.2	Negligible	10.6	1.1	Negligible
R22	9.5	12.5	3	Negligible	12.1	2.6	Slight adverse
R23	9.5	10.8	1.3	Negligible	10.8	1.3	Negligible
R24	9.4	10.6	1.2	Negligible	10.5	1.1	Negligible
R25	9.4	10.7	1.3	Negligible	10.6	1.2	Negligible
R26	10.9	11.1	0.2	Negligible	-	-	-
R27	15.7	16	0.3	Negligible	-	-	-
R28	12.1	12.4	0.3	Negligible	-	-	-

Predicted annual mean concentrations are all well below the limit value (40μg/m^3). The maximum concentration was predicted at R16 (18.2μg/m^3 in 2039), where the maximum change in concentration (8.5μg/m^3) was predicted. The predicted impact at R16 can be therefore described as slight adverse, refer to **Tables 16.4**, **16.5** and **16.6**. A slight adverse impact was also predicted at R17 and R20. A negligible impact was predicted at all other locations.

With the proposed noise barriers in place, lower concentrations are predicted at all of the nearby receptors, excluding R04, R06, R12, R15 and R23, where the difference in predicted concentrations is <0.01μg/m^3. The trend for lower concentrations near to the road with the noise barrier in place is expected, but the impact will depend on the orientation of the noise barrier with respect to the wind direction. At all locations, the lower predicted change in concentrations with the noise barriers in place does not change the impact descriptor.

Following guidance provided in LAQM.TG16[11], as all modelled results predict annual mean concentrations less than 60µg/m^3, it is unlikely that this area would exceed the hourly mean NO_2 objective.

PM_{10}

Annual mean PM_{10} concentrations were predicted at the assessed receptor locations for the future year when the proposed road development opens (2024) and the Design Year (2039). Although uncertainty regarding future year emission factors relates primarily to NOx emissions, it should be noted that the same approach of holding vehicle emission factors and background pollutant concentrations (**Table 16.19**) has been taken for PM_{10} and $PM_{2.5}$ concentrations.

Predicted annual mean PM_{10} concentrations for the do minimum and do something scenarios, the change in concentrations as a result of the proposed road development and the impact descriptor at each receptor are shown in **Table 16.31** and **Table 16.32**, for the Opening Year (2024) and Design Year (2039), respectively. Results of modelling with the noise barriers in place area also included for the receptors, where relevant.

Table 16.31: Predicted concentrations of PM_{10} (µg/m^3), 2024

Receptor	Do-Minimum (µg/m^3)	Without noise barriers)			With noise barriers		
		Do-Something (µg/m^3)	Change in PM_{10} (µg/m^3)	Impact	Do-Something (µg/m^3)	Change in PM_{10} (µg/m^3)	Impact
R01	17.8	17.9	0.1	Negligible	-	-	-
R02	18.6	18.7	0.1	Negligible	-	-	-
R03	18.1	18.4	0.3	Negligible	-	-	-
R04	17.9	18.1	0.2	Negligible	18.1	0.2	Negligible
R05	17.6	17.7	0.1	Negligible	-	-	-
R06	18.2	18.7	0.5	Negligible	18.7	0.5	Negligible
R07	18.2	18.4	0.2	Negligible	-	-	-
R08	18.2	18.2	0	Negligible	-	-	-
R09	17.9	17.9	0	Negligible	-	-	-
R10	17.6	18	0.4	Negligible	-	-	-
R11	17.6	18.1	0.5	Negligible	18.1	0.5	Negligible
R12	17.6	18	0.4	Negligible	18	0.4	Negligible
R13	18	18.1	0.1	Negligible	-	-	-
R14	18.4	18.5	0.1	Negligible	-	-	-

[11] Defra (2016) Local Air Quality Management Technical Guidance TG16

Receptor	Do-Minimum (µg/m³)	Without noise barriers)			With noise barriers		
		Do-Something (µg/m³)	Change in PM_{10} (µg/m³)	Impact	Do-Something (µg/m³)	Change in PM_{10} (µg/m³)	Impact
R15	17.7	18	0.3	Negligible	18	0.3	Negligible
R16	17.6	19	1.4	Negligible	18.7	1.1	Negligible
R17	17.7	18.7	1	Negligible	18.4	0.7	Negligible
R18	17.7	17.8	0.1	Negligible	-	-	-
R19	17.6	17.8	0.2	Negligible	-	-	-
R20	17.6	18.1	0.5	Negligible	18.1	0.5	Negligible
R21	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R22	17.6	18.1	0.5	Negligible	18	0.4	Negligible
R23	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R24	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R25	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R26	17.7	17.7	0	Negligible	-	-	-
R27	18	18	0	Negligible	-	-	-
R28	17.8	17.8	0	Negligible	-	-	-

Table 16.32: Predicted concentrations of PM_{10} (µg/m³), 2039

Receptor	Do-Minimum (µg/m³)	Without noise barriers)			With noise barriers		
		Do-Something (µg/m³)	Change in PM_{10} (µg/m³)	Impact	Do-Something (µg/m³)	Change in PM_{10} (µg/m³)	Impact
R01	17.8	18.1	0.3	Negligible	-	-	-
R02	18.7	18.8	0.1	Negligible	-	-	-
R03	18.2	18.4	0.2	Negligible	-	-	-
R04	18	18.1	0.1	Negligible	18.1	0.1	Negligible
R05	17.6	17.7	0.1	Negligible	-	-	-
R06	18.3	18.7	0.4	Negligible	18.7	0.4	Negligible
R07	18.3	18.4	0.1	Negligible	-	-	-
R08	18.2	18.3	0.1	Negligible	-	-	-
R09	17.9	18	0.1	Negligible	-	-	-
R10	17.6	18	0.4	Negligible	-	-	-
R11	17.6	18.2	0.6	Negligible	18.1	0.5	Negligible
R12	17.6	18	0.4	Negligible	18	0.4	Negligible
R13	18.1	18.2	0.1	Negligible	-	-	-
R14	18.4	18.7	0.3	Negligible	-	-	-
R15	17.7	18	0.3	Negligible	18	0.3	Negligible
R16	17.6	19.2	1.6	Negligible	18.9	1.3	Negligible

Receptor	Do-Minimum (μg/m³)	Without noise barriers)			With noise barriers		
		Do-Something (μg/m³)	Change in PM_{10} (μg/m³)	Impact	Do-Something (μg/m³)	Change in PM_{10} (μg/m³)	Impact
R17	17.7	18.9	1.2	Negligible	18.6	0.9	Negligible
R18	17.7	17.9	0.2	Negligible	-	-	-
R19	17.6	17.8	0.2	Negligible	-	-	-
R20	17.6	18.2	0.6	Negligible	18.2	0.6	Negligible
R21	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R22	17.6	18.2	0.6	Negligible	18.1	0.5	Negligible
R23	17.6	17.9	0.3	Negligible	17.9	0.3	Negligible
R24	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R25	17.6	17.8	0.2	Negligible	17.8	0.2	Negligible
R26	17.7	17.7	0	Negligible	-	-	-
R27	18.2	18.2	0	Negligible	-	-	-
R28	17.8	17.9	0.1	Negligible	-	-	-

Predicted annual mean concentrations are all well below the limit value (40μg/m³) at all locations in 2024 and 2039. The maximum concentration was predicted at R16 (19.2μg/m³ in 2039), where the maximum change in concentration (1.6μg/m³) was predicted. These levels were reduced following the inclusion of noise barriers. A negligible impact was predicted at all locations, refer to **Tables 16.4**, **16.5** and **16.6**.

The WHO guideline level is complied with at all receptor points.

$PM_{2.5}$

Annual mean $PM_{2.5}$ concentrations were predicted at the assessed receptor locations for the future year when the proposed road development opens (2024) and the Design Year (2039).

Predicted annual mean $PM_{2.5}$ concentrations for the Do-Minimum and Do-Something scenarios, the change in concentrations as a result of the proposed road development and the impact descriptor at each receptor are shown in **Table 16.33** and **Table 16.34**, for the Opening Year (2024) and Design Year (2039), respectively. Results of modelling with the noise barriers in place area also included for the receptors, where relevant.

Table 16.33: Predicted concentrations of $PM_{2.5}$ (μg/m³), 2024

Receptor	Do-Minimum (μg/m³)	Without noise barriers)			With noise barriers		
		Do-Something (μg/m³)	Change in $PM_{2.5}$ (μg/m³)	Impact	Do-Something (μg/m³)	Change in $PM_{2.5}$ (μg/m³)	Impact
R01	8.2	8.3	0.1	Negligible	-	-	-
R02	8.7	8.8	0.1	Negligible	-	-	-
R03	8.4	8.5	0.1	Negligible	-	-	-
R04	8.3	8.4	0.1	Negligible	8.4	0.1	Negligible
R05	8.1	8.1	0	Negligible	-	-	-
R06	8.5	8.8	0.3	Negligible	8.8	0.3	Negligible
R07	8.5	8.5	0	Negligible	-	-	-
R08	8.4	8.5	0.1	Negligible	-	-	-
R09	8.2	8.3	0.1	Negligible	-	-	-
R10	8.1	8.3	0.2	Negligible	-	-	-
R11	8.1	8.4	0.3	Negligible	8.4	0.3	Negligible
R12	8.1	8.3	0.2	Negligible	8.3	0.2	Negligible
R13	8.4	8.4	0	Negligible	-	-	-
R14	8.6	8.6	0	Negligible	-	-	-
R15	8.1	8.4	0.3	Negligible	8.4	0.3	Negligible
R16	8.1	9	0.9	Negligible	8.8	0.7	Negligible
R17	8.1	8.7	0.6	Negligible	8.6	0.5	Negligible
R18	8.1	8.2	0.1	Negligible	-	-	-
R19	8.1	8.2	0.1	Negligible	-	-	-
R20	8.1	8.4	0.3	Negligible	8.4	0.3	Negligible
R21	8.1	8.2	0.1	Negligible	8.2	0.1	Negligible
R22	8.1	8.4	0.3	Negligible	8.3	0.2	Negligible
R23	8.1	8.2	0.1	Negligible	8.2	0.1	Negligible
R24	8.1	8.2	0.1	Negligible	8.2	0.1	Negligible
R25	8.1	8.2	0.1	Negligible	8.2	0.1	Negligible
R26	8.1	8.1	0	Negligible	-	-	-
R27	8.4	8.4	0	Negligible	-	-	-
R28	8.2	8.2	0	Negligible	-	-	-

Table 16.34: Predicted concentrations of $PM_{2.5}$ (µg/m³), 2039

Receptor	Do-Minimum (µg/m³)	Without noise barriers			With noise barriers		
		Do-Something (µg/m³)	Change in $PM_{2.5}$ (µg/m³)	Impact	Do-Something (µg/m³)	Change in $PM_{2.5}$ (µg/m³)	Impact
R01	10.1	10.3	0.2	Negligible	-	-	-
R02	10.6	10.7	0.1	Negligible	-	-	-
R03	10.3	10.5	0.2	Negligible	-	-	-
R04	10.2	10.3	0.1	Negligible	10.3	0.1	Negligible
R05	10	10	0	Negligible	-	-	-
R06	10.4	10.6	0.2	Negligible	10.6	0.2	Negligible
R07	10.4	10.5	0.1	Negligible	-	-	-
R08	10.3	10.4	0.1	Negligible	-	-	-
R09	10.2	10.2	0	Negligible	-	-	-
R10	10	10.2	0.2	Negligible	-	-	-
R11	10	10.4	0.4	Negligible	10.3	0.3	Negligible
R12	10	10.3	0.3	Negligible	10.3	0.3	Negligible
R13	10.3	10.3	0	Negligible	-	-	-
R14	10.5	10.7	0.2	Negligible	-	-	-
R15	10	10.3	0.3	Negligible	10.3	0.3	Negligible
R16	10	11	1	Negligible	10.8	0.8	Negligible
R17	10	10.8	0.8	Negligible	10.6	0.6	Negligible
R18	10	10.2	0.2	Negligible	-	-	-
R19	10	10.1	0.1	Negligible	-	-	-
R20	10	10.4	0.4	Negligible	10.3	0.3	Negligible
R21	10	10.1	0.1	Negligible	10.1	0.1	Negligible
R22	10	10.3	0.3	Negligible	10.3	0.3	Negligible
R23	10	10.1	0.1	Negligible	10.1	0.1	Negligible
R24	10	10.1	0.1	Negligible	10.1	0.1	Negligible
R25	10	10.1	0.1	Negligible	10.1	0.1	Negligible
R26	10.1	10.1	0	Negligible	-	-	-
R27	10.4	10.4	0	Negligible	-	-	-
R28	10.1	10.2	0.1	Negligible	-	-	-

Predicted annual mean concentrations are all well below the limit value (20µg/m³) at all locations in 2024 and 2039. The maximum concentration was predicted at R16 (9µg/m³ in 2024), where the maximum change in concentration (0.9µg/m³) was predicted. A negligible impact was predicted at all locations, refer to **Tables 16.4**, **16.5** and **16.6**.

The WHO guideline level is exceeded at all receptor points, excluding R05 and R26 in 2024 and R05 in 2039. The exceedances are due to the contribution of background concentrations.

NOx

The proposed road development crosses the Lough Corrib cSAC. The concentration of NOx along four transects 200m from where the proposed road development crosses the Lough Corrib cSAC have been predicted. The background NOx concentration listed in **Table 16.19** (11.2µg/m³) has been added to the modelled results. Noise barriers are located alongside part of this section of the route and the results of modelling with the noise barriers in place have therefore also been included. The results and the change in concentrations for 2024 and 2039 are listed in **Table 16.35** and **Table 16.36** respectively for each of the four transects described in **Section 16.2.5.1**.

Table 16.35: Predicted NO_x concentrations (µg/m³) at Lough Corrib cSAC, 2024

Distance from proposed road (m)	Do-Minimum (µg/m³)	Without noise barriers			With noise barriers		
		Do-Something (µg/m³)	Change in NO_x (µg/m³)	Impact	Do-Something (µg/m³)	Change in NO_x (µg/m³)	Impact
Transect 1							
10	11.6	16.9	5.3	Slight adverse	16.9	5.3	Slight adverse
20	11.6	15.7	4.1	Slight adverse	15.7	4.1	Slight adverse
30	11.6	15	3.4	Slight adverse	15	3.4	Slight adverse
40	11.6	14.6	3	Slight adverse	14.6	3	Negligible
50	11.6	14.2	2.6	Negligible	14.2	2.6	Negligible
60	11.6	14	2.4	Negligible	14	2.4	Negligible
70	11.6	13.8	2.2	Negligible	13.8	2.2	Negligible
80	11.6	13.7	2.1	Negligible	13.7	2.1	Negligible
90	11.6	13.6	2	Negligible	13.6	2	Negligible
100	11.6	13.5	1.9	Negligible	13.5	1.9	Negligible
110	11.6	13.4	1.8	Negligible	13.4	1.8	Negligible
120	11.6	13.3	1.7	Negligible	13.3	1.7	Negligible
130	11.6	13.2	1.6	Negligible	13.2	1.6	Negligible
140	11.6	13.2	1.6	Negligible	13.2	1.6	Negligible
150	11.6	13.1	1.5	Negligible	13.1	1.5	Negligible
160	11.6	13.1	1.5	Negligible	13.1	1.5	Negligible
170	11.6	13	1.4	Negligible	13	1.4	Negligible
180	11.6	13	1.4	Negligible	13	1.4	Negligible
190	11.6	13	1.4	Negligible	13	1.4	Negligible

Distance from proposed road (m)	Do-Minimum (µg/m^3)	Without noise barriers			With noise barriers		
		Do-Something (µg/m^3)	Change in NO_x (µg/m^3)	Impact	Do-Something (µg/m^3)	Change in NO_x (µg/m^3)	Impact
200	11.6	12.9	1.3	Negligible	12.9	1.3	Negligible
Transect 2							
10	11.5	18.4	6.9	Slight adverse	18.4	6.9	Slight adverse
20	11.5	16.7	5.2	Slight adverse	16.7	5.2	Slight adverse
30	11.5	15.8	4.3	Slight adverse	15.8	4.3	Slight adverse
40	11.5	15.3	3.8	Slight adverse	15.3	3.8	Negligible
50	11.5	14.9	3.4	Negligible	14.9	3.4	Negligible
60	11.5	14.6	3.1	Negligible	14.6	3.1	Negligible
70	11.5	14.4	2.9	Negligible	14.4	2.9	Negligible
80	11.5	14.2	2.7	Negligible	14.3	2.8	Negligible
90	11.5	14.1	2.6	Negligible	14.1	2.6	Negligible
100	11.5	14	2.5	Negligible	14	2.5	Negligible
110	11.5	13.9	2.4	Negligible	13.9	2.4	Negligible
120	11.5	13.8	2.3	Negligible	13.8	2.3	Negligible
130	11.5	13.7	2.2	Negligible	13.7	2.2	Negligible
140	11.5	13.6	2.1	Negligible	13.6	2.1	Negligible
150	11.5	13.6	2.1	Negligible	13.6	2.1	Negligible
160	11.5	13.5	2	Negligible	13.5	2	Negligible
170	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
180	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
190	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
200	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
Transect 3							
10	11.5	17.4	5.9	Slight adverse	17.4	5.9	Slight adverse
20	11.5	16.1	4.6	Slight adverse	16.1	4.6	Slight adverse
30	11.5	15.3	3.8	Slight adverse	15.3	3.8	Slight adverse
40	11.5	14.8	3.3	Slight adverse	14.8	3.3	Negligible
50	11.5	14.5	3	Negligible	14.5	3	Negligible
60	11.5	14.2	2.7	Negligible	14.2	2.7	Negligible
70	11.5	14	2.5	Negligible	14	2.5	Negligible

Distance from proposed road (m)	Do-Minimum (µg/m³)	Without noise barriers			With noise barriers		
		Do-Something (µg/m³)	Change in NO_x (µg/m³)	Impact	Do-Something (µg/m³)	Change in NO_x (µg/m³)	Impact
80	11.5	13.8	2.3	Negligible	13.8	2.3	Negligible
90	11.5	13.7	2.2	Negligible	13.7	2.2	Negligible
100	11.5	13.5	2	Negligible	13.5	2	Negligible
110	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
120	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
130	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
140	11.5	13.2	1.7	Negligible	13.2	1.7	Negligible
150	11.5	13.2	1.7	Negligible	13.2	1.7	Negligible
160	11.5	13.1	1.6	Negligible	13.1	1.6	Negligible
170	11.5	13.1	1.6	Negligible	13.1	1.6	Negligible
180	11.5	13	1.5	Negligible	13	1.5	Negligible
190	11.5	13	1.5	Negligible	13	1.5	Negligible
200	11.5	12.9	1.4	Negligible	12.9	1.4	Negligible
Transect 4							
10	11.5	21.2	9.7	Slight adverse	18.4	6.9	Slight adverse
20	11.5	18.2	6.7	Slight adverse	16.9	5.4	Slight adverse
30	11.5	16.8	5.3	Slight adverse	16	4.5	Slight adverse
40	11.5	15.8	4.3	Slight adverse	15.3	3.8	Negligible
50	11.5	15.2	3.7	Negligible	14.9	3.4	Negligible
60	11.5	14.8	3.3	Negligible	14.5	3	Negligible
70	11.5	14.5	3	Negligible	14.3	2.8	Negligible
80	11.5	14.2	2.7	Negligible	14	2.5	Negligible
90	11.5	14	2.5	Negligible	13.8	2.3	Negligible
100	11.5	13.8	2.3	Negligible	13.7	2.2	Negligible
110	11.5	13.6	2.1	Negligible	13.5	2	Negligible
120	11.5	13.5	2	Negligible	13.4	1.9	Negligible
130	11.5	13.4	1.9	Negligible	13.3	1.8	Negligible
140	11.5	13.3	1.8	Negligible	13.2	1.7	Negligible
150	11.5	13.2	1.7	Negligible	13.1	1.6	Negligible
160	11.5	13.1	1.6	Negligible	13	1.5	Negligible
170	11.5	13	1.5	Negligible	13	1.5	Negligible
180	11.5	13	1.5	Negligible	12.9	1.4	Negligible

Distance from proposed road (m)	Do-Minimum (µg/m³)	Without noise barriers			With noise barriers		
		Do-Something (µg/m³)	Change in NO_x (µg/m³)	Impact	Do-Something (µg/m³)	Change in NO_x (µg/m³)	Impact
190	11.5	12.9	1.4	Negligible	12.9	1.4	Negligible
200	11.5	12.9	1.4	Negligible	12.9	1.4	Negligible

Table 16.36: Predicted NOx concentrations (µg/m³) at Lough Corrib SAC, 2039

Distance from propose d road (m)	Do-Minimum (µg/m³)	Without noise barriers			With noise barriers		
		Do-Something (µg/m³)	Change in NO_x (µg/m³)	Impact	Do-Something (µg/m³)	Change in NO_x (µg/m³)	Impact
Transect 1							
10	11.6	17.9	6.3	Slight adverse	17.9	6.3	Slight adverse
20	11.6	16.4	4.8	Slight adverse	16.4	4.8	Slight adverse
30	11.6	15.6	4	Slight adverse	15.6	4	Slight adverse
40	11.6	15.1	3.5	Slight adverse	15.1	3.5	Slight adverse
50	11.6	14.7	3.1	Slight adverse	14.7	3.1	Slight adverse
60	11.6	14.4	2.8	Negligible	14.4	2.8	Negligible
70	11.6	14.2	2.6	Negligible	14.2	2.6	Negligible
80	11.6	14	2.4	Negligible	14	2.4	Negligible
90	11.6	13.9	2.3	Negligible	13.9	2.3	Negligible
100	11.6	13.7	2.1	Negligible	13.7	2.1	Negligible
110	11.6	13.6	2	Negligible	13.6	2	Negligible
120	11.6	13.5	1.9	Negligible	13.5	1.9	Negligible
130	11.6	13.5	1.9	Negligible	13.5	1.9	Negligible
140	11.6	13.4	1.8	Negligible	13.4	1.8	Negligible
150	11.6	13.3	1.7	Negligible	13.3	1.7	Negligible
160	11.6	13.3	1.7	Negligible	13.3	1.7	Negligible
170	11.6	13.2	1.6	Negligible	13.2	1.6	Negligible
180	11.6	13.2	1.6	Negligible	13.2	1.6	Negligible
190	11.6	13.1	1.5	Negligible	13.1	1.5	Negligible
200	11.6	13.1	1.5	Negligible	13.1	1.5	Negligible
Transect 2							
10	11.5	19.4	7.9	Slight adverse	19.4	7.9	Slight adverse

Distance from propose d road (m)	Do-Minimum (μg/m³)	Without noise barriers			With noise barriers		
		Do-Something (μg/m³)	Change in NO_x (μg/m³)	Impact	Do-Something (μg/m³)	Change in NO_x (μg/m³)	Impact
20	11.5	17.4	5.9	Slight adverse	17.4	5.9	Slight adverse
30	11.5	16.3	4.8	Slight adverse	16.3	4.8	Slight adverse
40	11.5	15.6	4.1	Slight adverse	15.6	4.1	Slight adverse
50	11.5	15.2	3.7	Slight adverse	15.2	3.7	Slight adverse
60	11.5	14.8	3.3	Negligible	14.8	3.3	Negligible
70	11.5	14.6	3.1	Negligible	14.6	3.1	Negligible
80	11.5	14.4	2.9	Negligible	14.4	2.9	Negligible
90	11.5	14.2	2.7	Negligible	14.2	2.7	Negligible
100	11.5	14	2.5	Negligible	14	2.5	Negligible
110	11.5	13.9	2.4	Negligible	13.9	2.4	Negligible
120	11.5	13.8	2.3	Negligible	13.8	2.3	Negligible
130	11.5	13.7	2.2	Negligible	13.7	2.2	Negligible
140	11.5	13.6	2.1	Negligible	13.6	2.1	Negligible
150	11.5	13.6	2.1	Negligible	13.6	2.1	Negligible
160	11.5	13.5	2	Negligible	13.5	2	Negligible
170	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
180	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
190	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
200	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
Transect 3							
10	11.5	18.5	7	Slight adverse	18.5	7	Slight adverse
20	11.5	16.9	5.4	Slight adverse	16.9	5.4	Slight adverse
30	11.5	16	4.5	Slight adverse	16	4.5	Slight adverse
40	11.5	15.4	3.9	Slight adverse	15.4	3.9	Slight adverse
50	11.5	15	3.5	Slight adverse	15	3.5	Slight adverse
60	11.5	14.6	3.1	Negligible	14.6	3.1	Negligible
70	11.5	14.4	2.9	Negligible	14.4	2.9	Negligible
80	11.5	14.2	2.7	Negligible	14.2	2.7	Negligible
90	11.5	14	2.5	Negligible	14	2.5	Negligible

Distance from proposed road (m)	Do-Minimum (μg/m³)	Without noise barriers			With noise barriers		
		Do-Something (μg/m³)	Change in NO_x (μg/m³)	Impact	Do-Something (μg/m³)	Change in NO_x (μg/m³)	Impact
100	11.5	13.9	2.4	Negligible	13.9	2.4	Negligible
110	11.5	13.7	2.2	Negligible	13.7	2.2	Negligible
120	11.5	13.6	2.1	Negligible	13.6	2.1	Negligible
130	11.5	13.6	2.1	Negligible	13.6	2.1	Negligible
140	11.5	13.5	2	Negligible	13.5	2	Negligible
150	11.5	13.4	1.9	Negligible	13.4	1.9	Negligible
160	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
170	11.5	13.3	1.8	Negligible	13.3	1.8	Negligible
180	11.5	13.2	1.7	Negligible	13.2	1.7	Negligible
190	11.5	13.2	1.7	Negligible	13.2	1.7	Negligible
200	11.5	13.1	1.6	Negligible	13.1	1.6	Negligible
Transect 4							
10	11.6	23.2	11.6	Slight adverse	19.8	8.2	Slight adverse
20	11.6	19.7	8.1	Slight adverse	18	6.4	Slight adverse
30	11.6	17.9	6.3	Slight adverse	16.9	5.3	Slight adverse
40	11.6	16.7	5.1	Slight adverse	16.1	4.5	Slight adverse
50	11.6	16	4.4	Slight adverse	15.6	4	Slight adverse
60	11.6	15.5	3.9	Negligible	15.1	3.5	Negligible
70	11.6	15.1	3.5	Negligible	14.9	3.3	Negligible
80	11.6	14.8	3.2	Negligible	14.6	3	Negligible
90	11.6	14.5	2.9	Negligible	14.4	2.8	Negligible
100	11.6	14.3	2.7	Negligible	14.2	2.6	Negligible
110	11.6	14.1	2.5	Negligible	14	2.4	Negligible
120	11.6	13.9	2.3	Negligible	13.8	2.2	Negligible
130	11.6	13.8	2.2	Negligible	13.7	2.1	Negligible
140	11.6	13.7	2.1	Negligible	13.6	2	Negligible
150	11.6	13.5	1.9	Negligible	13.5	1.9	Negligible
160	11.6	13.4	1.8	Negligible	13.4	1.8	Negligible
170	11.6	13.4	1.8	Negligible	13.3	1.7	Negligible
180	11.6	13.3	1.7	Negligible	13.3	1.7	Negligible
190	11.6	13.2	1.6	Negligible	13.2	1.6	Negligible

Distance from proposed road (m)	Do-Minimum ($\mu g/m^3$)	Without noise barriers			With noise barriers		
		Do-Something ($\mu g/m^3$)	Change in NO_x ($\mu g/m^3$)	Impact	Do-Something ($\mu g/m^3$)	Change in NO_x ($\mu g/m^3$)	Impact
200	11.6	13.2	1.6	Negligible	13.2	1.6	Negligible

Predicted annual mean NO_x concentrations are all below the limit value (30µg/m^3). A maximum concentration of 23.2µg/m^3 was predicted at 10m from the proposed road development in 2039 (transect 4). A lower concentration of 19.8µg/m^3 was predicted with the noise barrier in place. In 2039, without the noise barriers in place, a slight adverse impact was predicted at distances from 10m to 50m with a negligible impact at further distances. With the noise barriers in place, the impact rating remains the same.

16.5.4.3 Regional air quality impacts

The DMRB regional approach was used to estimate total emissions from the existing road network. The assessment focuses on the change in emissions of nitrogen oxides, total hydrocarbons (THC) and particulate matter in the Opening and Design Years. **Table 16.37** presents the predicted pollutant emissions at regional level.

Table 16.37: Predicted NO_x, THC and PM_{10} Emissions at Regional Level for 2024 and 2039 (Tonnes per Annum)

	Scenario	NOx (t/a)	THC (t/a)	PM_{10} (t/a)
2024	DM	135	32	5.6
	DS	186	40	7.8
	DS - DM	51	8	2.2
2039	DM	171	38	7.0
	DS	242	50	9.9
	DS - DM	72	12	2.9
	% of change (2039) relative to Directive Limits	0.11%	0.02%*	n/a

*Note: * limit for VOC*

Nitrogen oxides are predicted to increase by 0.1% of the Directive 2016/2284 limit for NO_x in 2039. THC are predicted to increase by 0.02% of the Directive limit for VOC in 2030, refer to **Section 16.2.2.1**.

As there is no national reporting of particulate matter levels and no Directive limits exist, no comparison of annual particulate matter emissions can be made.

16.5.4.4 Potential Construction Impacts on Climate

Based on expected construction activities and methods, CO_2 values have been estimated during the construction phase, refer to **Table 16.38**.

Table 16.38: Total Estimated CO_2 Produced as a result of the Construction of the Proposed Road Development

	tonnes/year
Ireland's non-ETS CO_2 Commitment for 2020	38,000,000
Total CO_2 during construction phase Year 1 (maximum emissions)	150,000
Increase relative to CO_2 commitment per year	0.39%
Total CO_2 during construction phase	275,000

During the construction phase of the proposed road development, 150,000 tonnes per year of CO_2 are estimated to be generated, assuming a 36-month construction programme. Ireland has committed to achieve a 20% reduction in non-ETS greenhouse gas emissions by 2020 (relative to 2005 levels). The emissions predicted to be produced during the construction phase of the proposed road development constitutes 0.39% of Ireland's 2020 CO_2 limit under the EU Climate Change and Renewable Energy Package. These emissions will occur for the duration of the construction phase. Measures to mitigate these potential impacts are outlined in **Section 16.6**.

16.5.4.5 Potential Operational Impacts on Climate

Macro Climate

Table 16.39 describes the predicted CO_2 produced as a result of the proposed road development. The results include CO_2 levels based on Do-Minimum and Do-Something for both 2024 and 2039. Results are based on traffic data for the proposed road development and include the design speed for each existing and proposed road, refer to **Chapter 6, Traffic Assessment and Route Cross-section**. Ireland has committed to achieve a 20% reduction in non-ETS greenhouse gas emissions by 2020 (relative to 2005 levels). Predicted changes in levels of CO_2 due to the proposed road development are compared to Ireland's non-ETS commitments under the EU Climate Change and Renewable Energy Package. The projected increase of CO_2 in 2039 is 0.094% of Ireland's non-ETS commitment.

Table 16.39: Total Estimated CO_2 Produced as a result of the Operation of the Proposed Road Development

Scenario	**Tonnes/year**
Ireland's non-ETS CO_2 Commitment for 2020	38,000,000
Total CO_2 as a result of scheme 2024 (DM-DS) [1]	26,059
Change relative to CO_2 commitment	0.069%
Total CO_2 as a result of scheme 2039 (DM-DS) [1]	35,776
Change relative to CO_2 commitment	0.094%

Note:[1] Total C converted to total CO_2 using a factor of 44/12

It should be noted that the calculations include for a worst-case scenario which considers traffic within the city centre travelling at speed limits. In reality, these speeds are likely to be significantly slower particularly during peak times.

In order to replicate the existing congestion in Galway City, an assessment of the Do-Minimum scenarios for both 2024 and 2039 were undertaken using slower speeds than the design speeds for city centre link roads.

Traffic speeds were reduced by 50% and 75% for internal City link roads for the Do-Minimum scenarios in order to determine the potential change in CO_2 emissions.

- For a 50% reduction in traffic speeds for the Do-Minimum scenario, CO_2 emissions (DS-DM) for 2024 decrease from 26,059 tonnes per year to 17,233 tonnes per year; a 34% decrease compared to emissions at the speed limits. For 2039, CO_2 emissions for 2039 decrease from 35,776 tonnes per year to 26,129 tonnes per year; a 27% decrease compared to emissions at speed limits
- For a 75% reduction in traffic speeds for the Do-Minimum scenario, CO_2 emissions (DS-DM) for 2024 decrease from 26,059 tonnes per year to 8,686 tonnes per year; a 67% decrease compared to emissions at speed limits. For 2039, CO_2 emissions for 2039 decrease from 35,776 tonnes per year to 16,672 tonnes per year; a 53% decrease compared to emissions at speed limits
- When a congested (75% of design speed) Do-Minimum scenario is assessed against the Do-Something scenario, this predicted to result in a change of 0.023% of the EU Ireland's non-ETS CO2 Commitment for 2020 and 0.044% in 2039

Micro-Climate

The proposed road development will result in changes to the shape of the existing terrain. Such changes may modify airflow and temperature profiles in the area. These modifications will not be significant from a climatic perspective and are unlikely to result in any adverse impact on local flora and fauna and residential populations.

16.6 Mitigation Measures

16.6.1 Introduction

A description of the proposed air quality and climate mitigation measures to be implemented during the construction and operational phases are described below.

16.6.2 Construction Phase

16.6.2.1 Air quality

Emissions to air during earthmoving and construction will occur, although the prevailing weather, the size of the site and its distance from sensitive receptors will assist in facilitating the management of any effects. The focus of the control procedures will therefore be to reduce the generation of airborne material.

The assessment of potential construction impacts contained in **Section 16.5.3** includes the implementation of 'standard mitigation', as stated in the TII Guidelines. This shall include the following measures:

- Spraying of exposed earthwork activities and site haul roads during dry weather
- Provision of wheel washes at exit points
- Control of vehicle speeds and speed restrictions. It is proposed that site traffic is restricted to 20km/hr. This will help to minimise the occurrence of dust re-suspension
- Sweeping of hard surface roads

In addition, the following measures will be implemented. These measures are based on best practice as outlined in the British Research Establishment (BRE) document 'Controlling particles, vapour and noise pollution from construction sites' and the Institute of Air Quality Management (IAQM) 'Guidance on the assessment of dust from demolition and construction', 2016.

- A public communication strategy will be implemented by the Contractor which will outline procedures to inform members of the community on activities that may be disruptive, further details are contained in **Appendix A.7.5 Construction Environmental Management Plan**. This appendix also includes details of a complaints register which will be implemented during the construction phase
- Exhaust emissions from vehicles operating within the site, including trucks, excavators, diesel generators or other plant equipment, will be controlled by the contractor through regular servicing of machinery
- During dry periods when dust generation is likely or during windy periods, construction areas and vehicles delivering material with dust forming potential will also be sprayed with water, as appropriate
- Areas where materials will be handled and stockpiled will be positioned away from main site access roads. These areas will also be designed to minimise their exposure to wind – all stockpiles shall be kept to the minimum practicable height with gentle slopes
- There shall be no long-term stockpiling on site and storage time will be minimised
- Material drop heights from plant to plant or from plant to stockpile will be minimised
- Water suppression will be used during the demolition of buildings
- Crushing and concrete batching plant will be located as far from sensitive receptors as is reasonably practicable. All storage bins and transfer points will be covered. Silos will be fitted with reverse jet air filters

Dust screens will be implemented at locations where there is the potential for air quality impacts during the construction phase as outlined in **Section 16.5.3**, i.e. at locations where sensitive receptors are located within 100m of the works. In addition, a 2m dust screen will be provided at the locations at the locations in the areas of the overlap of the proposed road development and the Lough Corrib cSAC and the area of the proposed road development adjacent to Moycullen Bogs NHA.

Employee awareness is also a most important way that dust may be controlled on any site. Staff training and the vigilant management of operations ensure that all dust suppression methods are implemented and continuously inspected. Further details on employee training are provided in the Construction Environmental Management Plan (CEMP) in **Appendix A.7.5**.

Dust deposition monitoring will be conducted at a number of locations in the vicinity of the proposed road development. At a minimum, monitoring will be carried out at the two nearest sensitive receptors at locations where works of a ‘major’ scale is proposed while works are taking place in proximity, refer to **Section 16.5.3.1**. Monitoring will be carried out using the Bergerhoff method, i.e. analysis of dust collecting jars left on-site (German Standard VDI 2119, 1972). Results will be compared to the TA Luft guidelines. Should an exceedance of the TA Luft limit occur during the construction phase or a complaint be received in relation to dust levels, additional mitigation measures, for example more regular spraying of water, will be implemented. At least one month of dust deposition monitoring will be carried out in advance of the commencement of works to determine a baseline.

In addition, it is proposed to carry out particulate monitoring (PM_{10} and $PM_{2.5}$) at the nearest sensitive receptors upwind and downwind of the construction works where sensitive receptors have been identified within 25m of the works, refer to **Section 16.5.3.1**. This monitoring programme will take place when works likely to generate dust are being carried out. The monitoring will allow direct comparison with the PM_{10} and $PM_{2.5}$ air quality standards on a daily basis.

The particulate and dust deposition limits will be used to determine potential occurrences of dust nuisance associated with the proposed construction works. Should the limit values be approaching an exceedance during the construction works, the levels will be recorded by the contractor. An investigation will subsequently be carried out to determine potential causes and the options available to reduce the level of dust.

All potential causes for the high levels will be analysed. These will include the construction works taking place, potential off site sources and meteorological conditions. Should the construction works taking place be identified as the primary cause of the high level, the contractor will ensure that the mitigation measures listed above are improved upon. Should high dust levels continue to occur following these improvements, the contractor will provide alternative mitigation measures and/or will modify the construction works taking place.

16.6.2.2 Climate

The following mitigation measures will be implemented during the construction phase of the development so as to minimise CO_2 emissions:

- Materials required for the construction works will be sourced locally where possible. There are operational quarries located in proximity to the proposed road development. Rock crushing will be undertaken on site where possible, to reduce the requirement to import crushed stone to site
- The Construction Traffic Management Plan outlined in the CEMP in **Appendix A.7.5** will be implemented in full. This will minimise congestion and encourage car sharing and the use of public transport
- Materials will be handled efficiently on site to minimise the waiting time for loading and unloading, thereby reducing potential emissions
- Engines will be turned off when machinery is not in use
- The regular maintenance of plant and equipment will be carried out
- Materials with a reduced environmental impact will be used where available, such as:
    - Ground Granulated Blast Furnace Slag (GGBS) and Pulverished Fly Ash (PFA) will be used as replacements for Portland cements
    - Recycled steel

The Contractor will be required to implement an Energy Management System for the duration of the works. This will include the following at a minimum:

- Use of thermostatic controls on all heating systems in site buildings
- The use of insulated temporary building structures
- The use of low energy equipment and power saving functions on all computer systems
- The use of low flow tap fittings and showers

The use of solar/thermal power to heat water for the on-site welfare facilities including sinks and showers.

16.6.3 Operational Phase

16.6.3.1 Air Quality

As it is predicted that all air quality standards for the protection of human health and vegetation will be complied with, no specific mitigation measures are required.

At a National / European level, improvements in air quality are likely over the next few years as a result of the on-going comprehensive vehicle inspection and maintenance program, fiscal measures to encourage the use of alternatively fuelled vehicles and the introduction of cleaner fuels.

16.6.3.2 Climate

The *Transport Infrastructure Ireland Environmental Impact Assessment of National Road Schemes – A Practical Guide* notes that climate change issues are largely outside the scope of an EIAR for individual road schemes as the issues and mitigation measures are the subject of specific policies and strategies set out by government.

However, it is anticipated that the proposed road development will assist with the removal of traffic congestion from within Galway City and its environs by transferring existing and future traffic from the existing road network to the new road infrastructure. Therefore, journey times will reduce and journey time certainty will increase for both public transport and private vehicle users. The reduction in traffic congestion will reallocate the space for cyclists, pedestrians and reconfigure the public transport network. This will result in reducing the number of short commuter journeys by car by facilitating journeys by bicycle/on foot. The positive impact of this modal shift is difficult to quantify in terms of carbon emissions however, it will help to reduce emissions.

Improvements to the Galway bus network have been identified as necessary to better cater for existing and future travel patterns in Galway City. The reallocation of road space for public transport will assist with the delivery of an improved bus network resulting in carbon emission reductions.

In addition, the provision of improved public transport, traffic management measures, cycling and walking facilities and the introduction of the 'Cross-city Link' by the GTS will encourage a modal shift in line with Smarter Travel - A Sustainable Transport Future, A New Transport Policy for Ireland 2009 – 2020. This shift has the potential to reduce greenhouse gas emissions associated with the proposed road development in the future.

CO_2 emissions for the average new car fleet were reduced to 120g/km by 2012 through EU legislation on improvements in vehicle motor technology and by an increased use of biofuels.

The National Mitigation Plan outlines a number of existing mitigation measures and future possible mitigation measures under consideration relating to road transport, as follows:

Existing:

- Taxation system where a lesser road tax is paid where CO_2 emissions are within lower bands
- Grants provided by Sustainable Energy Authority Ireland (SEAI) to incentivise the purchase of electric vehicles
- Deploy natural gas refuelling stations and gas injection facilities
- Using intelligent transport systems (ITS) to enhance the efficiency of infrastructure and fuel use in a transport network

Under consideration:

- Further measures to accelerate the take-up of low carbon technologies
- Increase in carbon tax on transport fuel
- The motor tax and VRT system could be further amended in line with improvements to energy efficiency and emissions reductions in cars and vans

to additionally incentivise or maintain the advantages of purchasing of the lowest emitting vehicles

- encourage the take-up of alternatively fuelled vehicles, removing or reducing supports or preferential treatment for petrol and diesel fuelled vehicles
- Reduce maximum speed limits on motorways to 110km/hr in order to reduce emissions. It is noted that the design speed for the proposed road development at 100km/hr is less than the 120km/hr that usually applies to motorway schemes

16.7 Residual Impacts

16.7.1 Introduction

Residual impacts are assessed for the construction and operational phases of the proposed road development.

16.7.2 Construction Phase

The residual impact on air quality as a result of the proposed road development will not be significant following the implementation of mitigation measures outlined above. Dust deposition and $PM_{10}/PM_{2.5}$ monitoring shall be carried out to confirm the effectiveness of the mitigation measures.

16.7.3 Operational Phase

As it is predicted that all air quality standards for the protection of human health and vegetation will be complied with, no residual impacts are envisaged. See **Chapter 18, Human Beings, Population and Human Health** for an appraisal of potential health impacts.

It is expected that potential carbon emissions generated by the proposed road development can be offset by measures outlined in the Galway Transport Strategy, removing congestion in Galway City and measures outlined in the National Mitigation Plan.

16.7.4 Cumulative Impacts

The traffic data used in the assessment for future years, considers development proposed for the Galway area listed below, and incorporates the cumulative impacts of these projects into the 'Do-Minimum' traffic data used in this EIAR.

- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)

- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Transport Strategy (GTS), which includes the following:
    - Investigation of prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Galway to Oughterard (part of the Galway to Clifden) Greenway
    - Galway City to Oranmore (part of the Galway to Dublin) Cycleway

No major construction works are envisaged to take place in such proximity to the proposed road development which would significantly impact on dust levels.

The cumulative impacts are considered by incorporating background concentrations into predicted values and existing traffic volumes and are described in the impact assessment sections above.

The main aim of the Galway Transport Strategy is to address the current and future transport requirements of Galway City and its environs.

This includes the provision of new transport infrastructure, as follows:

- Public transport: the introduction of a 'Cross City Link' to increase the amount of people able to access the heart of the city by public transport
- Walking and cycling: ensuring that a network of cycle and walking routes is developed across the city and its environs
- Road network: Providing improved access and movement across and within Galway City and its environs

The proposed road development has been assessed with reference to the objectives of the Galway Transport Strategy. Negative significant cumulative impacts on air quality will not arise.

16.8 Summary

The potential air quality and climate impact of the proposed road development has been assessed during the construction and operational phases. During the operational phase, all air quality standards are predicted to be complied with and a worst-case impact of slight adverse is expected. Following the implementation of mitigation measures, no significant residual air quality and climate impacts are envisaged. During the construction phase, particulate monitoring and dust deposition monitoring will be carried out to ensure the effectiveness of the mitigation measures and compliance with air quality standards.

16.9 References

Transport Infrastructure Ireland. (2011) *Guidelines for the Treatment of Air Quality during the Planning and Construction of National Roads Schemes* TII. Dublin Ireland.

Air Quality Standards Regulations, 2011 (S.I. No. 180 of 2011). The Stationery Office, Dublin, Ireland.

European Parliament and European Council. *(2008) EC Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe*. Strasbourg, France.

TA Luft. (2002) *Technical Instructions on Air Quality Control*.

Smarter Travel - *A Sustainable Transport Future, A New Transport Policy for Ireland 2009 – 2020*

Department of Transport, Tourism and Sport. *Issues Paper for Consultation on the Preparation of Low-Carbon Roadmap for Transport*.

Department of Communications, Climate Action and Environment, *National Mitigation Plan*, July 2017.

Department of Environment, Community and Local Government, National Climate Change Adaptation Framework (NCCAF), December 2012.

Environmental Protection Agency. (EPA). (2006) *Environmental Management in the Extractive Industry (Non-Scheduled Minerals)*. EPA, Johnstown Castle Estate, Wexford, Ireland.

Environmental Protection Agency. (EPA). State of the Environment Report, 2016 – An Assessment, 2016.

European Parliament and European Council. *(2001) Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants.* Strasbourg, France.

Directive (EU) 2016/2284, of the European Parliament and of the Council on the *reduction of national emissions of certain atmospheric pollutants*.

(2015) *Climate Action and Low Carbon Development Act.*

Defra. (2016) Local Air Quality Management Technical Guidance TG16.

DMRB. (2007) *Screening Method (Version 1.03c) spreadsheet*.

UK DMRB*, Volume 11, Section 3, Annex F, 2007.*

EPA. (2017) *Air Quality in Ireland 2016 –Key Indicators of Ambient Air Quality*. Johnstown Castle Estate, Wexford, IrelandEPA. (2016) *Air Quality in Ireland 2015 –Key Indicators of Ambient Air Quality*. Johnstown Castle Estate, Wexford, Ireland.

EPA. (2015*) Air Quality in Ireland 2014 –Key Indicators of Ambient Air Quality*. Johnstown Castle Estate, Wexford, Ireland.

EPA. Draft 2017, Guidelines on the information to be contained in environmental impact assessment reports.

EPA. Draft 2015, *Revised Guidelines on the Information to be Contained in Environmental Impact Statements*.

EPA. Draft 2015, *Advice Notes for Preparing Environmental Impact Statements*.

EPA 2002, *Guidelines on the Information to be contained in Environmental Impact Statements.*

EPA 2003, *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements*.

German Standard. (1972) *VDI 2119*.

Natural England, *the Ecological Effects of Air Pollution from Road Transport*, 2004, 2016 update.

WHO. *Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide*, Global update 2005.

UK Critical Levels Advisory Group, *Critical levels of air pollutants for the UK, UK Department of the environmental air quality division, 1996.*

UK Environment Agency, *Construction Carbon Calculator*, July 2012.

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