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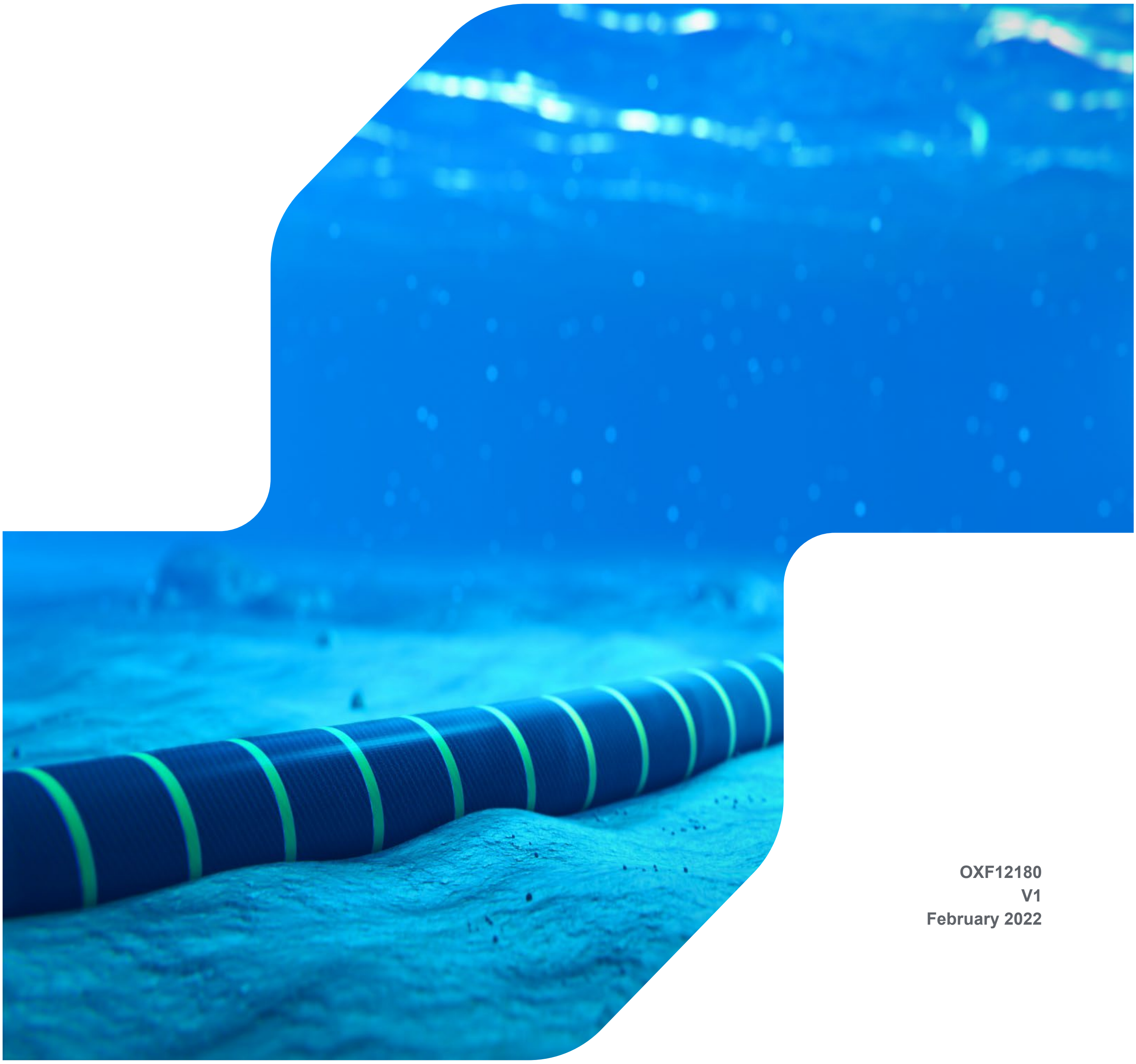
Appendix 13.2 – Atmospheric Dispersion Modelling Methodology



OXF12180
V1
February 2022

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
0	Draft	ACD	JT	MB	09/02/2022

Approval for issue

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Atmospheric Dispersion Modelling Methodology

Summary of Key Pollutants Considered

1.1 For the operational phase of the Project, the main pollutants from road traffic with potential for local air quality impacts are nitrogen oxides (NOx) and particulate matter (PM_{10}). Emissions of total NO_X from combustion sources comprise of nitric oxide (NO) and NO_2. The NO oxidises in the atmosphere to form NO_2. The assessment of operational impacts therefore focuses on changes in NO_2 and PM_{10} concentrations. The impact from fine particulate matter, known as $PM_{2.5}$ (a subset of PM_{10}) concentrations has also been considered.

Source: European Environment Agency (2016) Explaining Road Transport Emissions: A Non-technical Guide

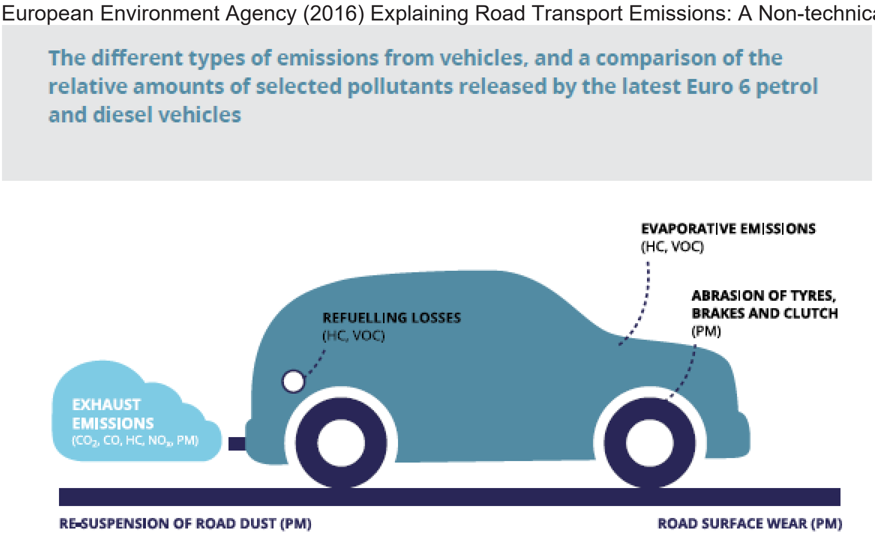

Figure 1: Types of Vehicle Emissions

Atmospheric Dispersion Modelling of Pollutant Concentrations

1.2 In urban areas, pollutant concentrations are primarily determined by the balance between pollutant emissions that increase concentrations, and the ability of the atmosphere to reduce and remove pollutants by dispersion, advection, reaction and deposition. An atmospheric dispersion model is used as a practical way to simulate these complex processes; such a model requires a range of input data, which can include emissions rates, meteorological data and local topographical information. The model used and the input data relevant to this assessment are described in the following sub-sections.

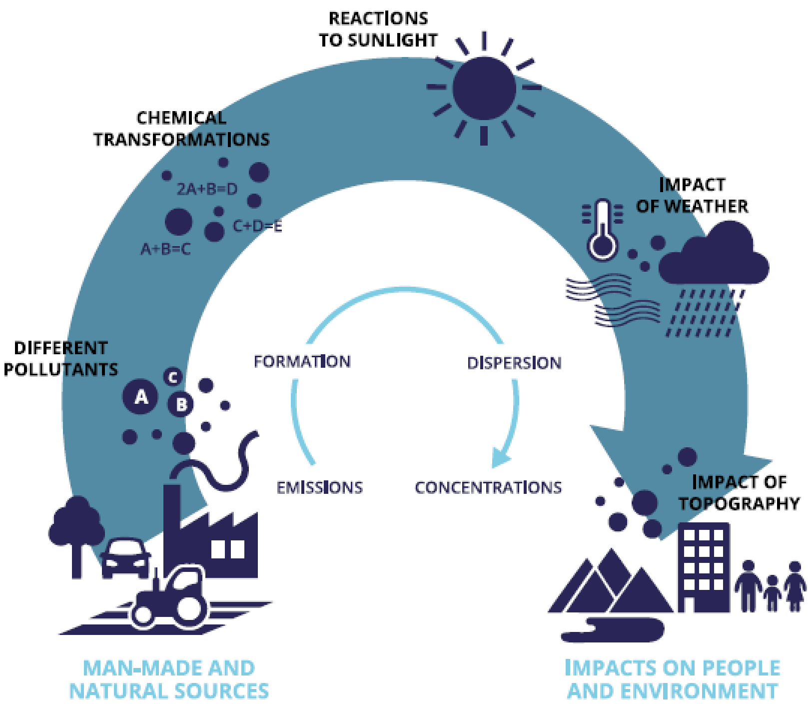

Figure 2: Air Pollution: From Emissions to Exposure

Source: European Environment Agency (2016) Explaining Road Transport Emissions: A Non-technical Guide

1.3 The atmospheric pollutant concentrations in an urban area depend not only on local sources at a street scale, but also on the background pollutant level made up of the local urban-wide background, together with regional pollution and pollution from more remote sources brought in on the incoming air mass. This background contribution needs to be added to the fraction from the modelled sources and is usually obtained from measurements or estimates of urban background concentrations for the area in locations that are not directly affected by local emissions sources.

1.4 The ADMS-Roads model has been used in this assessment to predict the air quality impacts from changes in traffic on the local road network. This is a version of the Atmospheric Dispersion Modelling System (ADMS), a formally validated model developed in the UK by Cambridge Environmental Research Consultants Ltd (CERC) and widely used in the UK and internationally for regulatory purposes.

Model Input Data

Meteorological Data

1.5 ADMS-Roads requires detailed meteorological data as an input. Prestwick meteorological station is considered the most representative observing station for the region of the study area that supplies all the data in the required format.

1.6 Prestwick meteorological station is approximately 30 km southeast of the Project Site. It is located approximately 2.5 km from the coast and has an elevation of 20 m. The Project Site and Prestwick meteorological station are at similar distances from the coast and are at similar elevations.

1.7 Meteorological data from Prestwick collated in 2021 have been used within the dispersion model. The wind rose is presented in Figure 2.

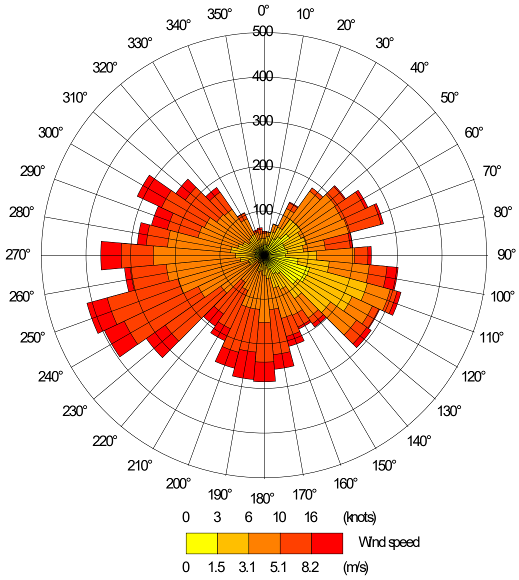

Figure 3: Wind Rose - Prestwick, 2021

1.8 At the request of North Ayrshire Council, a sensitivity test of the meteorological data has been carried out using meteorological data collated at Drumalbin in 2020 met data. The sensitivity test is provided in Appendix 13.4.

Traffic Data

1.9 Traffic data used in the assessment have been provided by the project's transport consultants. The traffic flow data used for the operational assessment are summarised in Table 1 and include the roads where the EPS & RTPIS threshold criteria are exceeded.

Table 1: Traffic Data Used Within the Assessment

Road ID	Without Development Traffic		With Development Traffic		Speed (km.h^{-1})
	24-hr Annual Average Daily Traffic flow	%HGV	24-hr Annual Average Daily Traffic flow	%HGV	
1a	10,148	4.1	10,820	4.3	48
1b					112
2a	10,186	5.0	10,857	5.1	48
2b					112
3	14,173	3.2	14,800	3.4	112

1.10 The average speed on each road has been reduced by 10 km.hr^{-1} to take into account the possibility of slow-moving traffic near junctions and at roundabouts in accordance with LAQM.TG16 (Defra, 2018a).

1.11 The modelled road links are illustrated in Figure 13.1 of the EIA Report.

Vehicle Emission Factors

1.12 The modelling has been undertaken using Defra's 2021 emission factor toolkit (version 11.0) which draws on emissions generated by the European Environment Agency (EEA) COPERT 5.3 emission calculation tool.

Receptors

1.13 The air quality assessment predicts the impacts at locations that could be sensitive to any changes. For assessing human-health impacts, such sensitive receptors should be selected where the public is regularly present and likely to be exposed over the averaging period of the objective. LAQM.TG16 provides examples of exposure locations, and these are summarised in Table 2.

Table 2: Examples of Where Air Quality Objectives Apply

Averaging Period	Objectives should apply at:	Objectives should generally not apply at:
Annual-mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building's façades), or any other location where public exposure is expected to be short-term.

Averaging Period	Objectives should apply at:	Objectives should generally not apply at:
Daily-mean	All locations where the annual-mean objective would apply, together with hotels. Gardens of residential properties.	Kerbside sites (as opposed to locations at the building's façade), or any other location where public exposure is expected to be short-term.
Hourly-mean	All locations where the annual and 24 hour mean would apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations to which the public might reasonably be expected to spend 1-hour or longer.	Kerbside sites where the public would not be expected to have regular access.

1.14 Representative sensitive receptors for this assessment have been selected at properties where pollutant concentrations and/or changes in pollutant concentrations are anticipated to be greatest, as listed in Chapter 13 (Air Quality), Table 13.1 of the EIA Report. The approaches used to predict the concentrations for these different averaging periods are described below.

Long-Term Pollutant Predictions

1.15 Annual-mean NO_x and PM_{10} concentrations have been predicted at representative sensitive receptors using ADMS-Roads, then added to relevant background concentrations. Primary NO in the NO_X emissions is converted to NO_2 to a degree determined by the availability of atmospheric oxidants locally and the strength of sunlight. For road traffic sources, annual-mean NO_2 concentrations have been derived from the modelled road-related annual-mean NO_X concentration using Defra's calculator (Defra, 2020).

Short-Term Pollutant Predictions

1.16 In order to predict the likelihood of exceedances of the hourly-mean AQS objectives for NO_2 and the daily-mean AQS objective for PM_{10}, the following relationships between the short-term and the annual-mean values at each receptor have been considered.

Hourly-Mean AQS Objective for NO_2

1.17 Research undertaken in support of LAQM.TG16 has indicated that the hourly-mean limit value and objective for NO_2 is unlikely to be exceeded at a roadside location where the annual-mean NO_2 concentration is less than 60 µg.m^{-3}. The threshold of 60 µg.m^{-3} NO_2 has been used as the guideline for considering a likely exceedance of the hourly-mean nitrogen dioxide objective.

Daily Mean AQS Objective for PM_{10}

1.18 The number of exceedances of the daily-mean AQS objective for PM_{10} of 50 µg.m^{-3} may be estimated using the relationship set out in LAQM.TG16:

*Number of Exceedances of Daily Mean of 50 µg.m^{-3} = -18.5 + 0.00145 * (Predicted Annual-mean PM_{10})^3 + 206 / (Predicted Annual-mean PM_{10} Concentration)*

1.19 This relationship indicates that the daily-mean AQS objective for PM_{10} is likely to be met if the predicted annual-mean PM_{10} concentration is 22.4 µg.m^{-3} or less.

1.20 The daily mean objective is therefore not considered further within this assessment if the annual-mean PM_{10} concentration is predicted to be less than 22.4 $\mu g.m^{-3}$.

Fugitive PM_{10} Emissions

1.21 Transport PM_{10} emissions arise from both the tailpipe exhausts and from fugitive sources such as brake and tyre wear and re-suspended road dust. Improvements in vehicle technologies are reducing PM_{10} exhaust emissions; therefore, the relative importance of fugitive PM_{10} emissions is increasing. Current official vehicle emission factors for particulate matter include brake dust and tyre wear which studies suggest may account for approximately one-third of the total particulate emissions from road transport; but not re-suspended road dust (which remains unquantified.)