FIVE ESTUARIES OFFSHORE WIND FARM

PRELIMINARY ENVIRONMENTAL INFORMATION REPORT

VOLUME 5, ANNEX 10.4: ROAD TRAFFIC DISPERSION MODELLING METHODOLOGY

Document Reference	004685573-01
Revision	A
Date	January 2023

Project	Five Estuaries Offshore Wind Farm
Sub-Project or Package	Preliminary Environmental Information Report
Document Title	Volume 5, Annex 10.4: Road Traffic Dispersion Modelling Methodology
Document Reference	004685573-01
Revision	A

Revision	Date	Status/Reason for Issue	Originator	Checked	Approved
A	Jan-23	Final for PEIR	SLR	GoBe	VE OWFL

FIVE ESTUARIES OFFSHORE WIND FARM

Preliminary Environmental Information Report

Annex 10.4 of Volume 3, Chapter 10: Road Traffic Dispersion Modelling

Prepared for: Five Estuaries Wind Farm Ltd

SLR Ref: 404.V05356.00010
Version No: v1.0
January 2023

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CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

DEFINITION OF ABBREVIATIONS AND ACRONYMS

Term	Definition
AADT	Annual Average Daily Traffic
APIS	Air Pollution Information System
AQMA	Air Quality Management Area
ASNW	Ancient Semi-Natural Woodland
DfT	Department for Transport
EFT	Emission Factor Toolkit
HDV	Heavy Duty Vehicle
LAQM	Local Air Quality Management
LDV	Light Duty Vehicle
LWS	Local Wildlife Site
NGET	National Grid Electricity Transmission
PEIR	Preliminary Environmental Information Report
VE	Five Estuaries Offshore Windfarm

1.0 Road Traffic Dispersion Modelling Methodology

1. In order to appropriately assess road traffic impacts associated with the construction phase of the onshore elements of VE on sensitive receptors, detailed dispersion modelling has been undertaken using the CERC ADMS-Roads v5 dispersion model, focussing on concentrations of NO_2, PM_{10} and $PM_{2.5}$ for the following scenarios:

- 2019 BC – Base flows for the year (2019);
- 2027 DM – Future baseline flows for the earliest potential year construction will commence (2027), inclusive of any other relevant committed development flows; and
- 2027 DS – 2027 DM flows, plus peak road traffic flows generated by Five Estuaries Offshore Windfarm (VE) construction activities.

2. For the above future year scenarios (2027), concurrent emission factors and background (projected) pollutant concentrations have been used – representing the earliest date of potential construction.

3. To ensure potential air quality impacts that may arise throughout the construction phase are understood, 2027 has been adopted for the purposes of dispersion modelling (i.e. earliest date of potential construction). Use of 2027 is believed to be conservative, given the forecasted reductions in vehicle emission factors and background pollutant concentrations (following the introduction of legislative and policy initiatives, alongside low emission technologies/ fuels), likely to exaggerate resultant concentrations and effects relative to what may occur in reality.

1.1 Traffic Inputs

4. Traffic data inputs used in support of the construction phase assessment has been informed by analysis undertaken and presented within Volume 3, Chapter 8: Traffic and Transport. Data has been supplemented from the Department for Transport (DfT) traffic count website[1] (where relevant) and adjusted accordingly - in line with the analysis undertaken as part of the transport assessment within Volume 3, Chapter 8: Traffic and Transport.

5. Construction road traffic flows have been calculated using the maximum consecutive 12 months (representing annual) flow (HDVs and employees (LDVs) separately) across the 18-month construction programme[2]. This Annual Average Daily Traffic (AADT) flow ensures the highest average period of construction has been captured for each section of the road network. This approach is considered appropriate in comparison to averaging out road traffic values across the full onshore construction period to derive AADT flows, which would dilute the predicted datasets. This approach assumes that the maximum consecutive 12 month vehicle flows generated throughout the whole construction phase occur under worst case air quality conditions (2027 vehicle emission factors and background pollutant concentrations) projected for the full construction period. This is considered conservative.

6. Traffic speeds were modelled at the relevant speed limit for each road as outlined in Table 1.1. However, where appropriate, the speeds have been reduced to simulate queues at junctions, traffic lights and other locations where queues or slower traffic are known to be an issue, in accordance with LAQM.TG(22). Traffic speeds have been assumed to be consistent across all the modelled scenarios.

[1] DfT, Road Traffic Statistics website. https://roadtraffic.dft.gov.uk/ [accessed November 2022].
[2] The OnSS construction programme is 27 months long. The cable construction programme runs concurrently for the first 18 months. Therefore assessment of the 18 months represents the maximum generation of construction trips.

7. The latest version of the Emission Factor Toolkit (EFT) version 11.0 developed by Defra[3] has been used to determine vehicle emission factors for input into the ADMS-Roads dispersion model, supporting each of the above scenarios.

8. To initially inform the spatial extent of the model, changes in traffic volumes on the local road network were compared to ecological and human screening thresholds (See Section 10.5 - Volume 3 Chapter 10: Air Quality). Where relevant, neighbouring links were also included within the dispersion model to facilitate a robust assessment, rather than rely on their individual contributions being represented within the appropriate background datasets. As such, the spatial extent of the dispersion model is greater than the affected road network – as includes road links which may experience insignificant vehicle volumes.

9. The traffic flows used for the future modelled assessment years (2027 DM and 2027 DS) includes vehicle movements associated with relevant committed developments in the assessment area (see Volume 3, Chapter 8).

10. As agreed within the Traffic and Transport ETG, assessment of cumulative effects (associated with live projects/ plans) was not considered for the purposes of the PEIR Traffic and Transport assessment. This was based on the availability of information (see Volume 3, Chapter 8: Traffic and Transport). However, to facilitate an indicative cumulative modelled assessment for the purposes of PEIR, trips associated with North Falls OWF have been considered within the dispersion modelling assessment. North Falls trips have conservatively been considered to equal the VE trips on each modelled road link. As such, the dispersion modelling exercise and associated outcomes are inherently cumulative in nature.

11. The dispersion modelling assessment did not consider road traffic volumes associated with the National Grid electricity transmission (NGET) EACN substation based upon the unavailability of information (see Volume 3, Chapter 8: Traffic and Transport). NGET will be considered within the ES Traffic and Transport assessment. However, based upon initial analysis, trips generated by NGET are likely to impact the A12, A120 and northern access routes only. A complete cumulative assessment will be undertaken for the ES in consideration of all relevant live project/ plans.

12. Details of the traffic flows used in this assessment are provided in Table 1.1, whilst the modelled roads in relation to the PEIR onshore red line boundary are presented in Volume 3, Chapter 10: Air Quality Figure 10.2.

Table 1.1
Traffic Data Used Within the Assessment

Link	2019 BC		2027 DM		2027 DS		Speed (kph) (A)
	AADT	% HDV	AADT	% HDV	AADT	% HDV	
A12 north of A120	60,190	9.5	66,200	10.6	66,637	10.8	112
A12 south of A120	70,063	8.3	76,625	9.3	77,062	9.5	112
A120 between A12 and A133	44,278	6.1	49,981	6.8	50,854	7.4	112
A120 between the A133 and Harwich Road	12,248	11.4	13,745	12.5	14,091	13.5	80/112
A120 between Harwich Road and Bentley Road	12,248	11.4	13,745	12.5	13,999	13.3	80

[3] Defra, EFT v11.0 (2021). https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html [accessed November 2022].

Link	2019 BC		2027 DM		2027 DS		Speed (kph) (A)
	AADT	% HDV	AADT	% HDV	AADT	% HDV	
A120 between Bentley Road and B1035	12,561	12.7	13,852	13.4	14,116	14.2	80
A120 east of B1035	14,178	9.4	14,971	9.4	14,971	9.4	96
A133 between A120 and B1033 Colchester Road	21,773	3.5	26,035	4.3	26,563	5.0	96/112
A133 between B1033 and B1027	21,760	3.2	24,762	3.4	24,927	3.6	96
B1033 Colchester Road between A133 and B1441 Weeley Bypass	12,360	13.2	16,446	12.1	16,808	12.6	48/96
B1441 Weeley Bypass/ Clacton Road/ Weeley Road	4,914	16.4	6,029	15.5	6,149	15.6	96
B1033 Colchester Road between B1441 Weeley Bypass and Tendring Road	8,285	15.6	9,963	15.7	10,205	16.3	48
B1035 south of A120	5,100	14.4	5,722	14.8	5,800	15.2	96
B1035 north of A120	6,925	15.7	7,706	16.0	7,788	16.3	96
Bentley Road	780	20.2	1,246	23.9	1431	28.3	96
Weeley/Colchester Rd/B1033 RBT	12,780	14.6	16,219	13.8	16,581	14.3	48
A12 Main Carriageway	39,913	12.4	42,144	12.4	42,144	12.4	112
Ipswich Road	21,007	2.8	22,788	2.8	22,788	2.8	48/96
A12 Slip Road NB	9,630	7.1	10,168	7.1	10,387	7.9	112
A12 Slip Road SB	13,736	6.9	14,504	6.9	14,722	7.4	112
A12 Slip Road WB	19,698	6.1	20,799	6.1	21,018	6.5	80/112
A12 Slip Road EB	17,310	5.6	18,278	5.6	18,496	6.0	80

Note:
(A) Speeds based upon National Speed Limits. Traffic speeds have been adjusted to take into account queues and congestion in accordance with LAQM.TG(22).

1.2 Meteorological Data

13. The nearest synoptic meteorological station relative to the Preliminary Environmental Impact Report (PEIR) onshore red line boundary (RLB) and modelled road network is Wattisham (>17 km away). The Wattisham meteorological station is located further inland, relative to the PEIR onshore RLB and modelled road network, which may experience a difference in meteorological conditions. The nearest relevant (coastal) synoptic meteorological station relative to the PEIR onshore RLB and modelled road network is Shoeburyness Landwick (>35 km away). The meteorological vendor recommends that synoptic meteorological data may only be considered relevant for locations within 20 km of the dispersion site. It was therefore determined that there is no clear representative meteorological station within a suitable distance to the PEIR onshore RLB and modelled road network which could representatively reflect local meteorological conditions.

14. In recognition of the above, numerical weather prediction (NWP) meteorological data was consequently utilised for the assessment, centred on the model domain, relating to 2019. NWP meteorological data is considered an appropriate source of data in coastal locations where there is an unavailability of synoptic meteorological stations, as will better represent the local atmospheric

stability. NWP meteorological data was provided by an accredited 3rd party vendor. A wind rose of the 2019 NWP data is presented in Volume 3, Chapter 10: Air Quality Figure 1.1.

15. A surface roughness value of 0.2 m has used to represent the dispersion site. A surface roughness value of 0.2 m was also used for the meteorological measurement. The use of a variable surface roughness file will be considered at the ES stage to take into account variation in land uses across the modelled domain to refine model performance.

16. A minimum Monin-Obukhov Length value of 10 has been used for both the dispersion site and for the meteorological measurement.

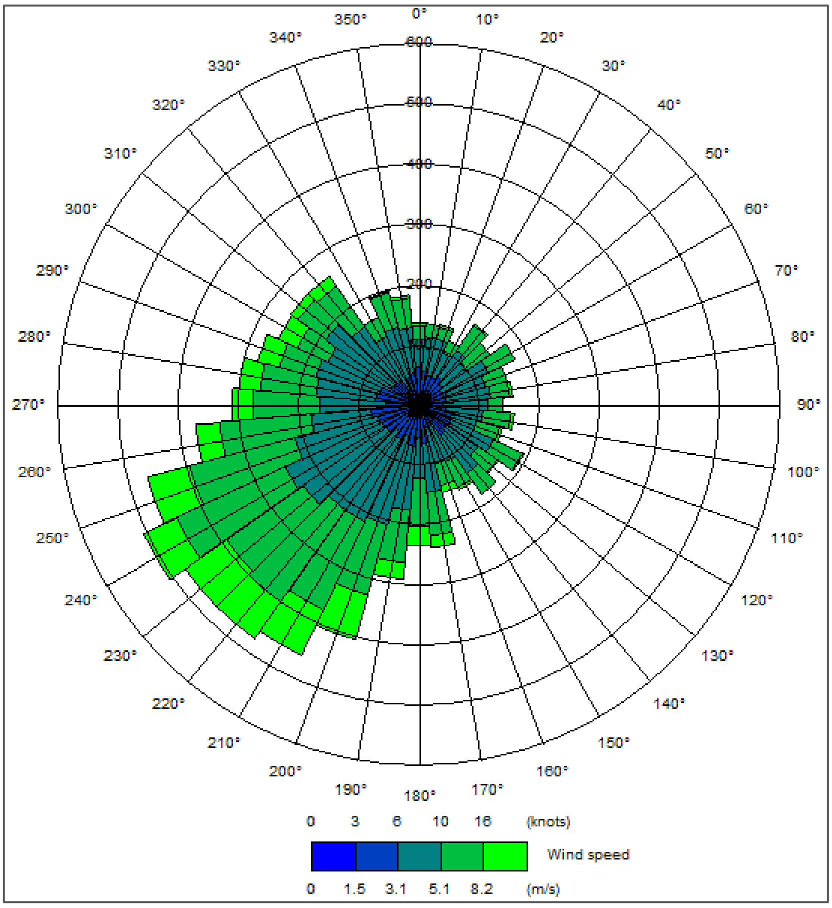

Figure 1.1
Wind Rose for NWP Data (2019)

1.3 Sensitive Receptors

1.3.1 Human Receptors

17. Human receptors considered in the assessment of emissions from peak construction phase road traffic volumes generated by VE are shown Table . Their locations are illustrated in Volume 3, Chapter 10: Air Quality Figure 10.2. Receptors are representative of worst-case exposure locations at existing residential properties relative to the extent of the affected road network.

18. All receptors were considered in relation to exposure at breathing height relative to the adjacent road, at ground level, i.e. 1.5 m or 3.5 m height. Receptor locations represent relevant exposure – in accordance with LAQM.TG(22).

19. As discussed in Section 3.1, the model has been split into two separate verification domains in order to provide more confidence in the model predictions. Details of the corresponding verification zone assigned to each sensitive receptor are presented in Table .

Table 1.2
Human Receptor Locations Considered

Receptor	X	Y	Height (m)	Verification Domain
R1	614197	222477	1.5	B
R2	614124	222455	1.5	B
R3	613548	222572	1.5	B
R4	612972	222760	1.5	B
R5	611024	223481	1.5	B
R6	610797	223482	1.5	B
R7	609569	225073	1.5	B
R8	610771	225501	1.5	B
R9	611302	226513	1.5	B
R10	611274	226562	1.5	B
R11	611141	226674	1.5	B
R12	611506	226873	1.5	B
R13	612341	227368	1.5	B
R14	608778	225128	1.5	B
R15	608768	225016	1.5	B
R16	608203	225102	1.5	B
R17	604619	227055	1.5	B
R18	603135	227962	1.5	B
R19	602211	229440	1.5	B
R20	602421	229740	1.5	B
R21	603024	230763	1.5	B
R22	603414	231908	1.5	B
R23	598918	228907	3.5	B
R24	598571	228813	1.5	B
R25	596015	225338	3.5	B
R26	596016	225284	1.5	B
R27	595058	225171	1.5	A
R28	594956	225162	1.5	A
R29	595127	225133	1.5	A
R30	605495	235360	1.5	B

1.3.2 Ecological Receptors

20. As documented in Volume 3, Chapter 10: Air Quality, Table details the extent of ecological designations (with sensitive qualifying features) located within 200 m of road links projected to experience developmental-generated vehicle movements requiring detailed assessment. These comprise ancient semi-natural woodland (ASNW)s and local wildlife sites (LWSs).

21. Details of the corresponding verification zone assigned to each sensitive receptor are presented in Table . Their locations are illustrated in Volume 3, Chapter 10: Air Quality Figure 10.4.

Table 1.3
Sensitive Ecological Designations Considered Within the Modelling Assessment

ID	Name	Designation	Verification Domain
ER4	Walls Wood	ASNW	B
ER6	4830	ASNW	B
ER14	Ardleigh RW	LoWS	B
ER15	Walls Wood	LoWS	B

22. All receptors have assumed a height of 0 m and represented in the model using gridded and polygon boundary receptors (within 200 m of the affected road) to identify the maximum modelled impact.

23. Details of baseline conditions for the above designations is provided in Section 2.0.

1.4 Background Datasets

1.4.1 Ambient Concentrations

24. In the absence of locally representative background monitoring sites, annual mean background concentrations used for the purposes of the assessment have been obtained from the Defra supplied background maps (2018 reference year), based on the 1 km grid squares which cover the dispersion model domain as presented in Table . Preference was to utilise the Defra supplied background concentration estimates for the purposes of the ecological road traffic modelling assessment rather than the air pollution information systems (APIS) datasets – in order to maintain consistency with the verification procedure.

25. To avoid double counting of potential background sources already contained within the ADMS-Roads dispersion model, relevant sources were removed from the appropriate background map grid square. This was limited to the removal of 'Trunk A Road In' for the assessment study area for the future year scenarios. For details on the model verification approach, see Section 3.1.

26. As the relationship between NO_2 and NO_x is not linear, the NO_2 Adjustment for NO_x Sector Removal Tool[4] has been used – in accordance with LAQM.TG(22).

[4] Defra NO_2 Adjustment for NO_x Sector Removal Tool (v8.0)

Table 1.4
Defra Mapped Background Pollutant Concentrations

Grid Square (X,Y)	Year	Annual Mean Concentration (µg/m^3)			
		NO_x	NO_2	PM_{10}	$PM_{2.5}$
614500, 222500	2019	10.7	8.3	15.0	9.8
	2027	8.3	6.5	13.9	8.3
613500, 222500	2019	12.0	9.2	15.4	9.7
	2027	8.9	7.0	14.3	8.5
612500, 222500	2019	11.4	8.8	15.8	9.9
	2027	8.6	6.7	14.6	8.5
611500, 223500	2019	12.0	9.2	16.5	10.2
	2027	9.0	7.0	15.3	8.8
610500, 223500	2019	12.6	9.6	17.1	11.0
	2027	9.3	7.3	15.9	9.0
609500, 225500	2019	14.8	11.2	16.9	9.6
	2027	10.4	8.0	15.7	9.0
610500, 225500	2019	12.1	9.3	16.3	9.7
	2027	9.0	7.0	15.2	8.8
611500, 226500	2019	11.4	8.8	16.0	10.9
	2027	8.6	6.8	14.8	8.7
612500, 227500	2019	11.3	8.7	16.6	9.5
	2027	8.6	6.7	15.5	8.8
608500, 225500	2019	14.2	10.8	15.7	9.6
	2027	10.1	7.8	14.6	8.7
604500, 227500	2019	15.0	11.3	16.4	9.8
	2027	10.8	8.4	15.2	9.1
603500, 227500	2019	16.6	12.4	15.5	9.8
	2027	11.7	9.0	14.3	9.0
602500, 229500	2019	20.9	15.3	17.2	9.5
	2027	14.1	10.7	16.0	9.8
603500, 230500	2019	15.0	11.4	16.0	9.5
	2027	10.8	8.3	14.8	9.0
603500, 231500	2019	17.1	12.8	17.7	9.4
	2027	11.7	9.0	16.5	9.6
598500, 228500	2019	19.2	14.2	17.9	9.6
	2027	13.0	9.9	16.7	9.9
596500, 225500	2019	26.9	19.2	18.0	9.3

Grid Square (X,Y)	Year	Annual Mean Concentration (µg/m^3)			
		NO_x	NO_2	PM_{10}	$PM_{2.5}$
	2027	17.0	12.7	16.8	10.3
595500, 225500	2019	20.3	14.9	17.4	9.4
	2027	13.6	10.3	16.1	9.9
594500, 225500	2019	20.6	15.1	18.0	9.6
	2027	13.6	10.3	16.8	10.1
605500, 235500	2019	15.3	11.5	16.6	10.1
	2027	10.6	8.2	15.5	9.2

1.4.2 Deposition Fluxes

27. Habitat specific background deposition rates have been obtained from the APIS website, based on the 1 km grid squares which cover the modelled area. Further detail on these datasets can be found in Section 2.0.

1.5 Model Outputs

1.5.1 Ambient Concentrations

28. The background pollutant values have been used in conjunction with the concentrations predicted by the ADMS-Roads model to calculate predicted total annual mean concentrations of NO_2, PM_{10} and $PM_{2.5}$ for each respective scenario.

29. For the prediction of annual mean NO_2 concentrations for all modelled scenarios at receptor locations, the road NO_x contributions (adjusted as per Section 1.4.1) have been converted to total NO_2 following the methodology in LAQM.TG(22) using the latest version of Defra's NO_x to NO_2 conversion tool (v8.1)[5]. The modelled NO_2 road contribution was then added to the appropriate NO_2 background concentration value to obtain an overall total annual mean NO_2 concentration.

30. For the prediction of short-term NO_2 impacts, LAQM.TG(22) advises that it is valid to assume that exceedances of the 1-hour mean AQAL for NO_2 are unlikely to occur where the annual mean NO_2 concentration is <60µg/m^3. This approach has thus been adopted for the purposes of this assessment, at relevant receptor locations with an applicable exposure period.

31. For the prediction of short-term PM_{10}, LAQM.TG(22) provides an empirical relationship between the annual mean and the number of exceedances of the 24-hour mean AQAL for PM_{10} that can be calculated as follows:

$$\text{No. 24-hour mean exceedances} = -18.5 + 0.00145 \times \text{annual mean}^3 + (206/\text{annual mean})$$

32. This relationship has thus been adopted to determine whether exceedances of the short-term PM_{10} AQAL are likely in this assessment.

33. Verification of the ADMS-Roads assessment has been undertaken as per Section 2.0. All results presented in the assessment are those calculated following the process of model verification, using an

[5] Defra NO_x to NO_2 Calculator v8.1 (2020), available at https://laqm.defra.gov.uk/air-quality/air-quality-assessment/no2-adjustment-for-nox-sector-removal-tool/ [accessed November 2022].

adjustment factor of 2.197 for verification domain A (human receptors R27, R28 and R29) and an adjustment factor of 2.652 for all other receptors (verification domain B).

1.5.2 Deposition Rates

34. Road dry deposition fluxes were calculated from the adjusted road-NO_2 using empirical methods provided within the EA's AQTAG06[6], which are subsequently recommended within the IAQM's ecological guidance.

35. In recognition of the NO_x to NO_2 non-linear relationship (facilitated by the NO_x to NO_2 conversion tool), the road NO_2 contribution used for screening was derived through subtraction of the total NO_2 modelled concentration from the scenarios discussed in Section 1.0, as it is not considered appropriate to process individual contributions of NO_2 from different development aspects.

36. Road dry deposition fluxes were calculated using the following equation:

Dry deposition flux (µg/m^2/s) = ground level concentration (µg/m^3) x deposition velocity (m/s)

37. The applied deposition velocities for the relevant chemical species are provided in Table 1.5. These velocities vary, dependant on land use. For the purposes of this assessment, all habitats were assumed to be 'Woodland'.

Table 1.5
Applied Deposition Velocities

Chemical Species	Recommended Deposition Velocity (m/s)	
NO_2	Grassland	0.0015
	Woodland	0.0300

Critical Loads – Nutrient Nitrogen

38. For the assessment of nutrient nitrogen, the predicted road deposition rates were converted from µg/m^2/s to units of kgN/ha/year using a standard conversion factor of 95.9.

Critical Loads – Acidification

39. For the assessment of acidification, the predicted road deposition rates were converted to units of equivalents (keq/ha/year), which is a measure of how acidifying the chemical species can be, by multiplying the dry deposition flux (µg/m^2/s) by the standard conversion factor of 6.84.

40. The calculation of the process contribution of nitrogen to the critical load function has been carried out according to the guidance on APIS[7], to determine which compound is the primary contributor to acidity in the local setting, as evidenced in Figure 1.2, where:

- CLmaxS — the maximum critical load of sulphur, above which the deposition of sulphur alone would be considered to lead to an exceedance;
- CLminN — a measure of the ability of a system to "consume" deposited nitrogen (e.g. via immobilisation and uptake of the deposited nitrogen); and
- CLmaxN — the maximum critical load of acidifying nitrogen, above which the deposition of nitrogen alone would be considered to lead to an exceedance.

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[6] AQTAG06 – Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air. Environment Agency, March 2014 version.
[7] http://www.apis.ac.uk/clf-guidance [accessed November 2022].

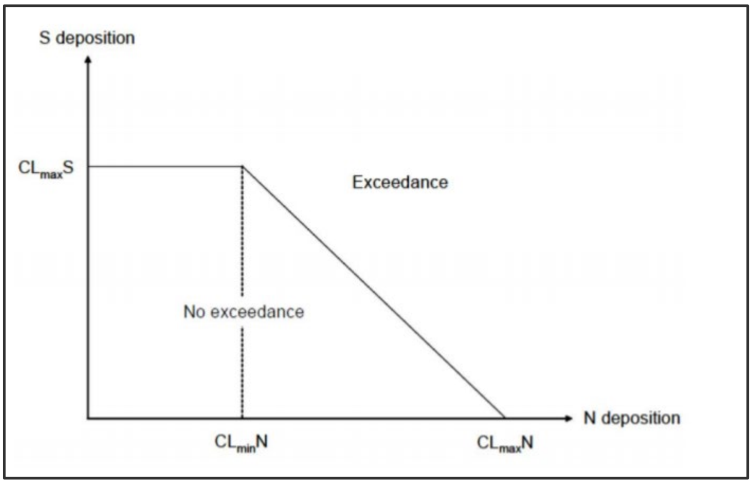

Figure 1.2
Acidification Critical Load Function

41. Given that sulphur vehicular emissions have not been calculated within this assessment (as standard practice for UK assessments – given the use of low sulphur fuels), the above acid critical load function has only considered inputs of nitrogen solely relative to '$CL_{max}N$'.

1.6 Uncertainty

42. Dispersion modelling is inherently uncertain and is principally reliant on the accuracy and representativity of its inputs. In acknowledgement of this, the ADMS-Roads dispersion model has been verified with the latest representative publicly available local monitoring data – as collected by Tendring District Council and Colchester Borough Council.

43. Following verification, all model output statistical parameters (used to evaluate model performance and uncertainty) are within LAQM.TG(22) prescribed ideal tolerances (Section 3.1).

44. In addition, there is a widely acknowledged disparity between emission factors and ambient monitoring data . To help minimise any associated uncertainty when forming conclusions from the results, this assessment has utilised the latest EFT version 11.0 utilising COPERT 5.3 emission factors, and associated tools/ datasets published by Defra.

45. Furthermore, 2027 has been adopted for the purposes of assessing peak road traffic movements generated across the whole construction phase. This approach assumes that the maximum consecutive 12 month vehicle flows generated throughout the whole construction phase occur under worst case air quality conditions (2027 vehicle emission factors and background pollutant concentrations) projected for the full construction period. This is in recognition of the forecasted reductions in vehicle emission factors and background pollutant concentrations (following the introduction of legislative and policy initiatives, alongside low emission technologies/ vehicles). Use of these variables in combination is considered conservative – as will likely exaggerate resultant concentrations and effects relative to what may occur in reality.

2.0 Ecological Baseline Conditions

46. Critical loads and background conditions vary at each ecological designation (based upon geography, sensitivity and interest features). APIS has been used to provide details of baseline conditions at the assessed ecological designations requiring detailed assessment. APIS is a support tool for the assessment of potential effects of air pollutants on habitats and species, developed in partnership by the UK conservation agencies and regulatory agencies and the Centre for Ecology and Hydrology.

47. APIS provides baseline conditions for international and national ecological designations. Details of the applied assessed primary habitat type present at each designation were provided by the project Ecologist based upon information provided by the Essex Wildlife Trust Biological Records Centre and professional judgement

48. Critical Loads/ deposition rates were obtained via the 'search by location' function via APIS. Where variables spatially vary (i.e. reported as 1 km grid squares), the worst case values reported across the whole assessed designation have been used (i.e. min Critical Loads/ max background values). This approach assumes that the location of maximum impact coincides at the location of greatest sensitivity to facilitate a conservative assessment. Further detail is provided below.

2.1 Critical Levels

49. Table 2.1 details the applied baseline annual mean NO_X Critical Level conditions at each assessed ecological designation. The maximum background concentration for each designation has been reported.

Table 2.1
Baseline Annual Mean NO_X Critical Level Conditions at Ecological Receptors

Site	NOx Annual Mean Concentration (µg/m^3)	
	Critical Level	APIS Max Background
ER4	30	16.8
ER6	30	19.1
ER14	30	16.8
ER15	30	14.7

2.2 Critical Loads

2.2.1 Nutrient Nitrogen

50. Table 2.2 details the applied baseline nutrient nitrogen Critical Load conditions at each assessed ecological designation. The maximum background dataset for each designation has been reported.

51. Nutrient nitrogen critical loads are habitat/species specific (derived from a range of experimental studies) available via APIS. Given that critical loads are often reported in ranges in relation to eutrophication, representing the upper and lower bounds where impacts are perceptible, those values which facilitate a worst-case assessment have been used (i.e. minimum critical load for nutrient nitrogen deposition).

Table 2.2
Baseline Nutrient Nitrogen Critical Load Conditions at Ecological Receptors

Site	Habitat	Critical Load Range (Min – Max)	Critical Load Adopted	Max Background
		(kgN/ha/yr)		
ER4	Broadleaved, Mixed and Yew Woodland	10 – 20	10	28.6
ER6	Broadleaved, Mixed and Yew Woodland	10 – 20	10	28.6
ER14	Broadleaved, Mixed and Yew Woodland	10 – 20	10	28.6
ER15	Broadleaved, Mixed and Yew Woodland	10 – 20	10	28.6

2.2.2 Acidification

52. Table 2.3 details the applied baseline acidification Critical Load conditions at each assessed ecological designation. The maximum background dataset for each designation has been reported.

53. Acidification Critical Load are dependent on soil chemistry, as well as habitat type. In the UK, empirical Critical Load have been assigned at a 1 km grid square resolution based upon the mineralogy and chemistry of the dominant soil series present in the grid square, as provided on APIS. Where there is spatial variation in these Critical Loads across an ecological designation, the minimum values have been reported.

Table 2.3
Baseline Acidification Critical Load Conditions at Ecological Receptors

Site	Habitat	Critical Load (Min)			Max Background		Sensitivity
		CLminN	CLmaxS	CLmaxN	N	S	
		(keq/ha/yr)					
ER4	Broadleaved, Mixed and Yew Woodland	0.142	1.541	1.683	2.04	0.17	N
ER6	Broadleaved, Mixed and Yew Woodland	0.142	1.543	1.685	2.04	0.17	N
ER14	Broadleaved, Mixed and Yew Woodland	0.142	1.541	1.683	2.04	0.17	N
ER15	Broadleaved, Mixed and Yew Woodland	0.142	1.568	1.710	2.02	0.16	N

3.0 Model Verification

54. The ADMS-Roads dispersion model has been widely validated for this type of assessment and is specifically listed in LAQM.TG(22) guidance as an accepted dispersion model.

55. Model validation undertaken by the software developer (CERC) will not have included validation in the vicinity of the modelled domain. It is therefore necessary to perform a comparison of modelled results with local monitoring data at relevant locations. This process of verification attempts to minimise modelling uncertainty and systematic error by correcting modelled results by an adjustment factor to gain greater confidence in the final results.

56. Prior to undertaking model verification, model setup parameters and input data were reviewed to maximise the performance of the dispersion model in relation to the real-world conditions.

57. Consistent with advice provided by Defra to local authorities across England, 2019 has been used for the purposes of model verification as this relates to the most recent year of monitoring data available which has not been impacted by the COVID-19 pandemic. Use of monitoring data recorded in 2020 for the purposes of model verification introduces an element of uncertainty into the final adjusted modelled predictions, as monitoring conditions experienced for the majority of 2020 are not deemed to be representative of long-term baseline conditions and could lead to a systematic underprediction at modelled receptor locations.

3.1 NO_x/ NO_2 Verification

58. NO_x/ NO_2 verification relates to the comparison and adjustment of modelled road-NO_x (as output from the ADMS-Roads dispersion model), relative to monitored road-NO_x.

59. For NO_x/ NO_2 model verification, 2019 LAQM CBC and TDC monitoring data has been used for those roadside locations situated adjacent to a modelled link i.e. where traffic data exists (Table 3.1).

Table 3.1
Local Monitoring Data Used for Model Verification

Site ID	X	Y	2019 Monitored NO_2 Concentration (µg/m^3)	2019 Data Capture (%)
CBC131	595025	225166	39.8	100.0
CBC132	595106	225123	32.5	100.0
DT14,15,16 (triplicate)	616062	218517	31.6*	100.0
DT19	613924	227789	23.2	100.0
DT20	612619	227395	20.7	100.0

Table Notes
*Represents a calculated mean 2019 concentration (given the triplicate location).

60. As NO_2 concentrations are solely reported using diffusion tubes, NO_x was back calculated using the latest version of Defra's NO_x to NO_2 Calculator (v8.1). The NO_x to NO_2 Calculator was also used to facilitate the conversion of modelled road-NO_x (as output from the ADMS-Roads dispersion model) into road-NO_2.

61. Verification was completed using the 2019 Defra background mapped concentrations (2018 reference year) for the relevant 1 km grid squares (i.e. those within which the model verification sites are located), with those already modelled sources removed, to avoid duplication. This was limited to removal of 'Trunk A Road In' for the CBC verification sites and 'Trunk A Road In' and 'Primary A Road In' for the TDC sites for the verification assessment.

62. Initial comparison of the modelled vs. monitored road NO_x contribution at all relevant verification locations outlined in Table 3.1 is provided in Table 3.2. An initial adjustment factor of 2.343 has been derived, based on a linear regression forced through zero, as shown in Figure 3.1

Table 3.2
NO_x/ NO_2 Model Verification – Initial (2.343)

Site ID	Monitored Road NO_x (µg/m³)	Modelled Road NO_x (µg/m³)	Ratio (Monitored vs. Modelled Road NO_x)	Adjustment Factor	Adjusted Modelled Total NO_2 (µg/m³)	Monitored Total NO_2 (µg/m³)	% Difference (Adjusted Modelled NO_2 vs Monitored NO_2)
CBC131	57.5	25.2	2.3	2.343	40.4	39.8	1.5
CBC132	41.2	20.0	2.1		35.1	32.5	8.1
DT14,15,16	46.0	18.5	2.5		30.5	31.6	-3.7
DT19	28.7	9.2	3.1		19.6	23.2	-15.3
DT20	23.2	7.8	3.0		18.1	20.7	-12.5

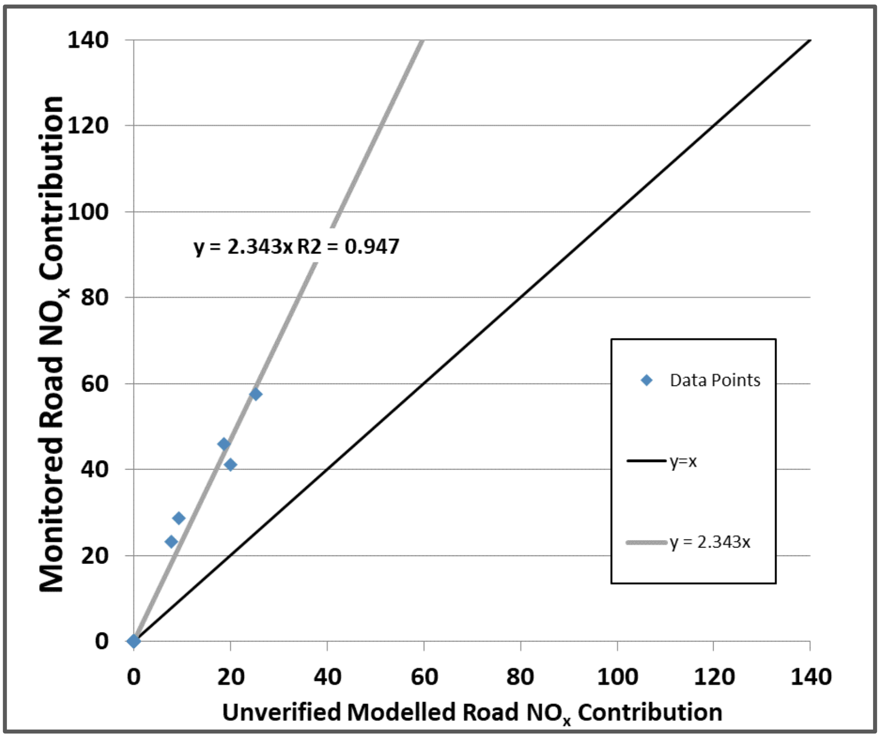

Figure 3.1
Comparison of Modelled vs. Monitored Road NOx Contribution - Initial (2.343)

63. LAQM.TG(22) states that:

"In order to provide more confidence in the model predictions and the decisions based on these, the majority of results should be within 25% of the monitored concentrations as a minimum, preferably within 10%".

64. The difference between modelled vs. monitored NO_2 concentrations was inside the 25% recommended tolerance at all locations, however within the 10% ideal tolerance at three locations. Although modelled concentrations were within the LAQM.TG(22) recommended tolerances at all verification locations – there was a clear difference in model performance. For instance, following adjustment with the initial factor (2.343), there is an overprediction in modelled NO_2 concentrations at CBC's diffusion tubes, and conversely an underprediction at TDC's diffusion tubes. A review of the monitoring locations (and surrounding modelled environments) was undertaken.

65. CBC131 and CBC132 are located adjacent to the A12, within/ adjacent to the CBC AQMA no.4 Lucy Lane North, Stanway – an area of sensitivity, declared for the exceedences of annual mean NO_2 concentrations. Both monitoring locations are also located on the periphery of Colchester's urban conurbation.

66. All other monitoring locations (TDC) are similarly located adjacent to the arterial roads, however in rural locations (outside of air quality management areas (AQMAs)).

67. Due to the differences in local environments and subsequent model performance, the model has been split into two verification domains in order to provide more confidence in the model predictions, as illustrated in Volume 3, Chapter 10: Air Quality Figure 10.2:

- Domain A – The location within and immediately adjacent to the CBC AQMA no.4 Lucy Lane North, Stanway (CBC131 and CBC132), to recognition of local sensitivities; and
- Domain B – The entirety of the modelled domain outside Domain A.

3.1.1 Domain A

68. Comparison of the modelled vs. monitored road NO_x contributions for those verification locations located within Domain A is provided in Table 3.3. An adjustment factor of 2.197 has been derived, based on a linear regression forced through zero, as shown in Figure 3.2. No further improvement to the ADMS-Roads dispersion model could be achieved.

Table 3.3
NO_x/ NO_2 Model Verification – Domain A (2.197)

Site ID	Monitored Road NO_x (µg/m^3)	Modelled Road NO_x (µg/m^3)	Ratio (Monitored vs. Modelled Road NO_x)	Adjustment Factor	Adjusted Modelled Total NO_2 (µg/m^3)	Monitored Total NO_2 (µg/m^3)	% Difference (Adjusted Modelled NO_2 vs Monitored NO_2)
CBC131	57.5	25.2	2.3	2.197	38.8	39.8	-2.5
CBC132	41.2	20.0	2.1		33.8	32.5	4.0

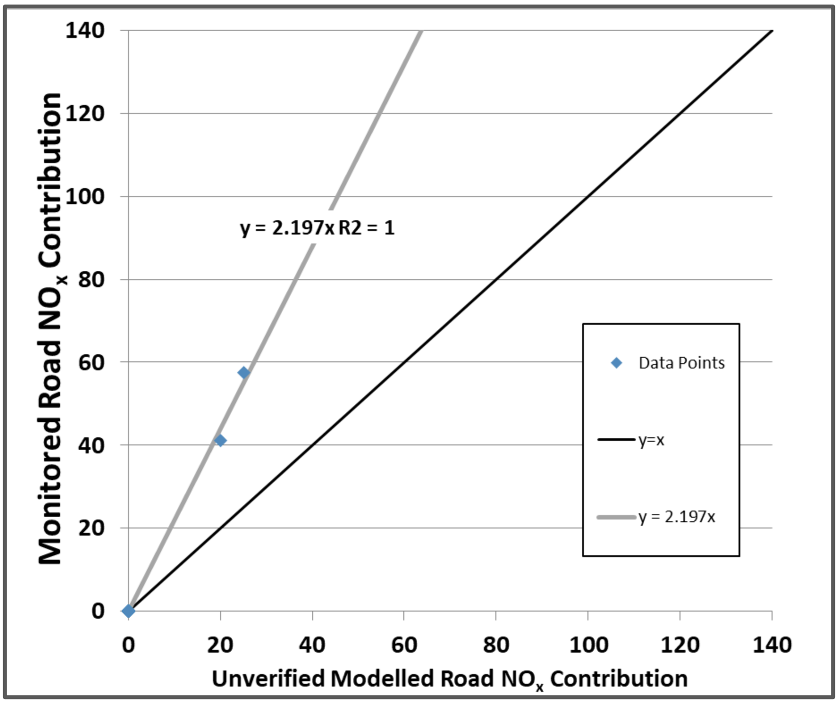

Figure 3.2
Comparison of Modelled vs. Monitored Road NOx Contribution – Domain A (2.197)

69. As noted in Table 3.3, the difference between the adjusted modelled NO_2 and monitored NO_2 is within ±10% at all verification locations within Domain A and therefore within the ideal LAQM.TG(22) prescribed limit. In addition, a verification factor of 2.197 reduces the Root Mean Square Error (RMSE) from a value of 12.8µg/m^3 to 1.2µg/m^3 – within the ideal LAQM.TG(22) prescribed limit (10% of the annual mean AQAL). On this basis, the derived verification factor (2.197) was considered acceptable and was subsequently applied to all road-NO_x concentrations predicted within Domain A (as output of the ADMS Roads dispersion model). This is limited to R27, R28 and R29.

3.1.2 Domain B

70. Comparison of the modelled vs. monitored road NO_x contributions for those verification locations located within Domain B is provided in Table 3.4. An adjustment factor of 2.652 has been derived, based on a linear regression forced through zero, as shown in Figure 3.3. No further improvement to the ADMS-Roads dispersion model could be achieved.

Table 3.4
NO_x/ NO_2 Model Verification – Domain B (2.652)

Site ID	Monitored Road NO_x (µg/m^3)	Modelled Road NO_x (µg/m^3)	Ratio (Monitored vs. Modelled Road NO_x)	Adjustment Factor	Adjusted Modelled Total NO_2 (µg/m^3)	Monitored Total NO_2 (µg/m^3)	% Difference (Adjusted Modelled NO_2 vs Monitored NO_2)
DT14,15,16	46.0	18.5	2.5	2.652	33.1	31.6	4.6
DT19	28.7	9.2	3.1		21.1	23.2	-9.1
DT20	23.2	7.8	3.0		19.3	20.7	-6.6

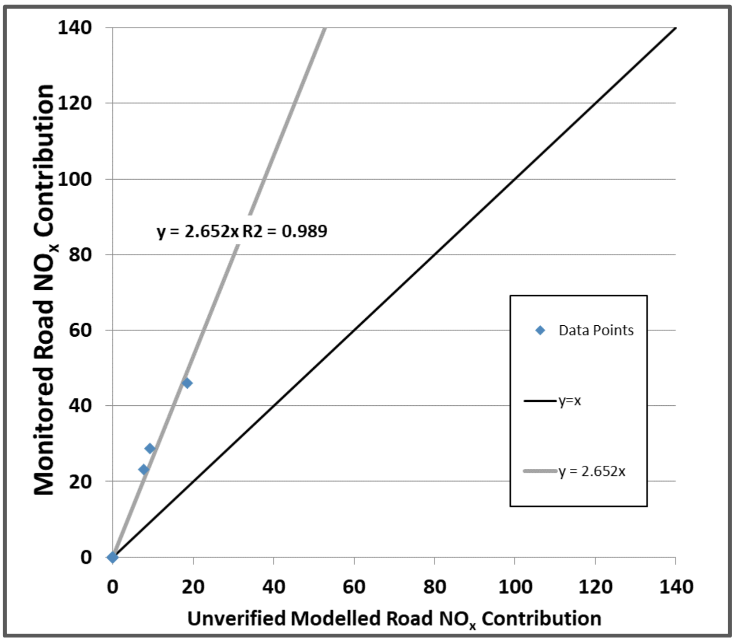

Figure 3.3
Comparison of Modelled vs. Monitored Road NOx Contribution – Domain B (2.652)

71. As noted in Table 3.4, the difference between the adjusted modelled NO_2 and monitored NO_2 is within ±10% at all verification locations and therefore within the ideal LAQM.TG(22) prescribed limit. In addition, a verification factor of 2.652 reduces the RMSE from a value of 10.8µg/m^3 to 1.7µg/m^3 – within the ideal LAQM.TG(22) prescribed limit (10% of the annual mean AQAL). On this basis, the derived verification factor (2.652) was considered acceptable and was subsequently applied to all road-NO_x concentrations predicted within Domain B (as output of the ADMS Roads dispersion model). All receptors (excluding R27, R28 and R29).

3.2 PM_{10}/ $PM_{2.5}$ Verification

72. The adjustment factors of 2.197 and 2.652 has also been applied to road-PM_{10} and $PM_{2.5}$ concentrations (as output of the ADMS Roads dispersion model) at the relevant receptor locations within zone A and zone B as detailed in Section 3.1, following the recommendations of LAQM.TG(22), in the absence of local particulate monitoring.

4.0 Modelling Results

4.1 Human Receptors

4.1.1 NO_2 Modelling Results

73. Table presents the annual mean NO_2 concentrations predicted at all assessed receptor locations of relevant exposure for the 2019 BC, 2027 DM and 2027 DS scenarios.

Table 4.1
Predicted Annual Mean NO2 Concentrations – 2027 Planned Construction Year

Receptor	Predicted Annual Mean NO_2 Concentration (µg/m^3)			% Change of AQAL	% of 2027 DS Relative to AQAL	EPUK & IAQM Impact Descriptor
	2019 BC	2027 DM	2027 DS			
R1	13.8	9.1	9.1	0.2	22.8	Negligible
R2	15.3	9.9	9.9	0.2	24.8	Negligible
R3	19.0	11.8	11.9	0.2	29.8	Negligible
R4	16.2	10.4	10.5	0.2	26.3	Negligible
R5	22.9	13.9	14.0	0.3	35.0	Negligible
R6	18.8	11.8	11.9	0.2	29.8	Negligible
R7	17.9	11.1	11.1	0.2	27.8	Negligible
R8	15.3	9.7	9.8	0.1	24.5	Negligible
R9	15.0	9.6	9.6	0.2	24.0	Negligible
R10	13.5	8.9	9.0	0.2	22.5	Negligible
R11	10.3	7.5	7.6	0.2	19.0	Negligible
R12	14.2	9.1	9.2	0.1	23.0	Negligible
R13	16.0	9.9	10.0	0.1	25.0	Negligible
R14	25.0	14.3	14.4	0.3	36.0	Negligible
R15	18.9	11.4	11.5	0.2	28.8	Negligible
R16	20.3	12.1	12.1	0.2	30.3	Negligible
R17	27.3	15.7	15.9	0.3	39.8	Negligible
R18	28.2	16.3	16.4	0.3	41.0	Negligible
R19	30.7	17.2	17.3	0.2	43.3	Negligible
R20	34.8	19.3	19.4	0.2	48.5	Negligible
R21	42.9	23.0	23.0	0.2	57.5	Negligible
R22	28.5	15.9	15.9	<0.1	39.8	Negligible
R23	35.3	19.4	19.4	0.1	48.5	Negligible
R24	33.0	18.2	18.2	0.1	45.5	Negligible
R25	36.5	20.0	20.1	0.1	50.3	Negligible
R26	47.8	25.7	25.8	0.2	64.5	Negligible
R27	41.4	22.4	22.5	0.2	56.3	Negligible

Receptor	Predicted Annual Mean NO_2 Concentration (µg/m³)			% Change of AQAL	% of 2027 DS Relative to AQAL	EPUK & IAQM Impact Descriptor
	2019 BC	2027 DM	2027 DS			
R28	37.0	20.1	20.1	0.1	50.3	Negligible
R29	42.5	23.1	23.1	0.2	57.8	Negligible
R30	39.5	21.0	21.1	0.2	52.8	Negligible

4.1.2 PM_{10} Modelling Results

74. Table presents the annual mean PM_{10} concentrations predicted at all assessed receptor locations of relevant exposure for the 2019 BC, 2027 DM and 2027 DS scenarios.

Table 4.2
Predicted Annual Mean PM10 Concentrations – 2027 Planned Construction Year

Receptor	Predicted Annual Mean PM_{10} Concentration (µg/m³)			% Change of AQAL	% of 2027 DS Relative to AQAL	EPUK & IAQM Impact Descriptor
	2019 BC	2027 DM	2027 DS			
R1	16.0	15.0	15.0	<0.1	37.5	Negligible
R2	16.3	15.4	15.5	0.1	38.8	Negligible
R3	16.4	15.4	15.4	0.1	38.5	Negligible
R4	16.5	15.4	15.5	<0.1	38.8	Negligible
R5	17.9	16.8	16.9	0.1	42.3	Negligible
R6	18.0	16.9	17.0	<0.1	42.5	Negligible
R7	17.7	16.6	16.6	<0.1	41.5	Negligible
R8	17.1	16.0	16.1	<0.1	40.3	Negligible
R9	16.9	15.7	15.8	<0.1	39.5	Negligible
R10	16.7	15.6	15.7	0.2	39.3	Negligible
R11	16.3	15.2	15.3	0.1	38.3	Negligible
R12	16.8	15.6	15.7	<0.1	39.3	Negligible
R13	17.6	16.4	16.5	<0.1	41.3	Negligible
R14	17.2	16.0	16.1	0.1	40.3	Negligible
R15	16.6	15.5	15.5	<0.1	38.8	Negligible
R16	16.7	15.6	15.6	<0.1	39.0	Negligible
R17	18.0	16.8	16.8	0.1	42.0	Negligible
R18	17.1	15.9	16.0	0.1	40.0	Negligible
R19	19.1	17.8	17.8	<0.1	44.5	Negligible
R20	19.6	18.3	18.3	<0.1	45.8	Negligible
R21	19.4	18.2	18.2	0.1	45.5	Negligible
R22	19.5	18.3	18.3	<0.1	45.8	Negligible
R23	20.4	19.1	19.1	<0.1	47.8	Negligible
R24	20.1	18.8	18.9	<0.1	47.3	Negligible

Receptor	Predicted Annual Mean PM_{10} Concentration (µg/m³)			% Change of AQAL	% of 2027 DS Relative to AQAL	EPUK & IAQM Impact Descriptor
	2019 BC	2027 DM	2027 DS			
R25	20.4	19.1	19.2	<0.1	48.0	Negligible
R26	21.7	20.4	20.5	<0.1	51.3	Negligible
R27	20.4	19.1	19.1	<0.1	47.8	Negligible
R28	20.6	19.3	19.3	<0.1	48.3	Negligible
R29	20.5	19.2	19.3	<0.1	48.3	Negligible
R30	19.8	18.6	18.6	<0.1	46.5	Negligible

4.1.3 $PM_{2.5}$ Modelling Results

75. Table presents the annual mean $PM_{2.5}$ concentrations predicted at all assessed receptor locations of relevant exposure for the 2019 BC, 2027 DM and 2027 DS scenarios.

Table 4.3
Predicted Annual Mean PM2.5 Concentrations – 2027 Planned Construction Year

Receptor	Predicted Annual Mean $PM_{2.5}$ Concentration (µg/m³)			% Change of AQAL	% of 2027 DS Relative to AQAL	EPUK & IAQM Impact Descriptor
	2019 BC	2027 DM	2027 DS			
R1	10.3	8.9	8.9	<0.1	35.6	Negligible
R2	10.5	9.2	9.2	0.1	36.8	Negligible
R3	10.4	9.1	9.2	<0.1	36.8	Negligible
R4	10.5	9.0	9.0	<0.1	36.0	Negligible
R5	11.2	9.7	9.7	0.1	38.8	Negligible
R6	11.6	9.6	9.6	<0.1	38.4	Negligible
R7	10.2	9.6	9.6	<0.1	38.4	Negligible
R8	10.2	9.3	9.4	<0.1	37.6	Negligible
R9	11.4	9.2	9.2	<0.1	36.8	Negligible
R10	11.3	9.1	9.2	0.1	36.8	Negligible
R11	11.0	8.9	8.9	0.1	35.6	Negligible
R12	11.4	9.1	9.2	<0.1	36.8	Negligible
R13	10.2	9.4	9.4	<0.1	37.6	Negligible
R14	10.6	9.6	9.6	0.1	38.4	Negligible
R15	10.2	9.3	9.3	<0.1	37.2	Negligible
R16	10.3	9.3	9.3	<0.1	37.2	Negligible
R17	10.9	10.0	10.1	0.1	40.4	Negligible
R18	10.9	10.0	10.0	0.1	40.0	Negligible
R19	10.8	11.0	11.0	<0.1	44.0	Negligible
R20	11.1	11.3	11.3	<0.1	45.2	Negligible
R21	11.8	11.1	11.1	<0.1	44.4	Negligible

Receptor	Predicted Annual Mean $PM_{2.5}$ Concentration (µg/m³)			% Change of AQAL	% of 2027 DS Relative to AQAL	EPUK & IAQM Impact Descriptor
	2019 BC	2027 DM	2027 DS			
R22	10.7	10.7	10.7	<0.1	42.8	Negligible
R23	11.3	11.4	11.4	<0.1	45.6	Negligible
R24	11.1	11.2	11.3	<0.1	45.2	Negligible
R25	11.0	11.8	11.8	<0.1	47.2	Negligible
R26	11.9	12.6	12.6	<0.1	50.4	Negligible
R27	11.5	11.7	11.8	<0.1	47.2	Negligible
R28	11.4	11.6	11.6	<0.1	46.4	Negligible
R29	11.6	11.8	11.9	<0.1	47.6	Negligible
R30	12.3	11.1	11.1	<0.1	44.4	Negligible

4.2 Ecological Receptors

76. Results presented herein relate to the maximum modelled impact of each individual ecological designation requiring detailed assessment (i.e. where impacts cannot be screened out), and as such, represents a conservative outlook.

4.2.1 NOX Critical Level Modelling Results

77. Table presents the maximum modelled 2027 annual mean NO_X Critical Level (30µg/m³) impacts as a result of VE at all applicable ecological receptor locations for initial screening.

Table 4.4
Maximum Predicted Annual Mean NO_X Impacts – 2027 Planned Construction Year

ID	Site	Designation	Maximum Modelled Contribution	
			µg/m³	% of Critical Level
ER4	Walls Wood	AW	0.6	1.9
ER6	4830	AW	0.1	0.2
ER14	Ardleigh RW	LoWS	0.1	0.3
ER15	Walls Wood	LoWS	0.6	1.9

4.2.2 Nutrient Nitrogen Critical Load Modelling Results

78. Table presents the maximum modelled 2027 nutrient nitrogen Critical Load impacts as a result of VE at all applicable ecological receptor locations for initial screening.

Table 4.5
Maximum Predicted Nutrient Nitrogen Impacts – 2027 Earliest Potential Construction Year

ID	Site	Designation	Critical Load Min – Max (Kg N/ha/yr)	Maximum Modelled Contribution	
				Kg N/ha/yr	% of Min Critical Load
ER4	Walls Wood	AW	10 - 20	0.1	0.8
ER6	4830	AW	10 - 20	0.0	0.1
ER14	Ardleigh RW	LoWS	10 - 20	0.0	0.2
ER15	Walls Wood	LoWS	10 - 20	0.1	0.8

4.2.3 Acidification Critical Load Modelling Results

79. Table presents the maximum modelled 2027 acidification Critical Load impacts as a result of VE at all applicable ecological receptor locations for initial screening.

Table 4.6
Maximum Predicted Acidification Impacts – 2027 Earliest Potential Construction Year

ID	Site	Designation	MaxN Critical Load (keq/ha/yr)	Maximum Modelled Contribution	
				Keq/ha/yr	% of MaxN Critical Load
ER4	Walls Wood	AW	1.683	0.006	0.3
ER6	4830	AW	1.710	0.001	0.0
ER14	Ardleigh RW	LoWS	1.685	0.001	0.1
ER15	Walls Wood	LoWS	1.683	0.006	0.3

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