West Winch Housing Access Road

Environmental Statement, Chapter 6: Air Quality, Appendix 2: Operational Phase Methodology

Author: WSP

Document Reference: NCC/3.06.02

Version Number: 001

Date: November 2023

Contents

Tables

Figures

1 Operational Phase: Methodology

1.1 Introduction

1.1.1 Table 1-1 outlines specific inputs included in the ADMS dispersion model.

Table 1-1 Dispersion Model Input

Item	**Notes**
Dispersion model software	CERC ADMS-Roads Version 5.0.0.1
Setup	Coordinate system: OSGB 1936 British National Grid (epsq:27700) Dry deposition option used
Source	Road sources NO_x, PM_{10} and $PM_{2.5}$ emissions calculated for traffic data (**Appendix 6-1**) using Defra Emissions Factors Toolkit (EFT) version 11.0: • Area: England (Not London) • Year: 2019, 2027 and 2030 • Traffic Format: Basic Split • Road Type: Rural (Not London) and Urban (Not London) • Output: Air Quality Modelling (g/km/s) NH_3 emissions calculated for traffic data (**Appendix 6-1**) using Air Quality Consultants Ltd Calculator for Road Emissions of Ammonia (CREAM) version V1A • Area: England (Not London) • Year: 2019, 2027 and 2030 • Traffic Format: Basic Split • Road Type: Rural (Not London) and Urban (Not London) • Output: Air Quality Modelling (g/km/s) 'NH_3_Grassland' added to pollutant pallet with a deposition velocity of 0.02m/s, and 'NH_3_Forest' added to pollutant pallet with a deposition velocity of 0.03m/s (Note: deposition velocities taken from AQTAG06, Grassland = short vegetation, Forest = tall vegetation)
Meteorology	Marham 2019 Site latitude 52.75° Dispersion site surface roughness 0.4m Dispersion site minimum Monin-Obukhov length 30m Meteorological measurement site surface roughness 0.2m Meteorological measurement site minimum Monin-Obukhov length 10m Surface albedo 0.23 Priestley Taylor parameter 1 Height of wind measurement 10m Wind data in sectors of 10 degrees Meteorological data are hourly sequential
Background pollutant data	Not input to model but incorporated in the post-processing of model outputs to give predictions of total pollutant concentrations. Defra background data (2018 reference year) for annual mean concentrations of NOx, NO_2, PM_{10} and $PM_{2.5}$ for 2019, 2027 and 2030 were used. The future year background predictions assume that emissions reduce over time in line with Government forecasts. Before use, the background data were adjusted to remove in-grid square 'Motorway', 'Trunk A Road' and 'Primary A Road' components as these were modelled explicity using ADMS-Roads and would otherwise be double counted. The background NO_x and NO_2 data were adjusted using Defra's 'NO2 Adjustment for NO_x Sector Removal Tool' (version 8.0) to remove as these were modelled explicitly. Background data for NH_3 and nitrogen deposition for 2019 were taken from the Air Pollution Information System (APIS). Unlike the Defra background data, the data from APIS require manipulation to predict background concentrations in future years; this was done with reference to the Joint Nature Conservation Committee's Nitrogen Futures publication. For the assessment, the Nitrogen Futures 'business as usual' scenario was adopted whereby NH_3 background concentrations increase by approximately 0.08% year on year, and Nitrogen deposition (which depends on NOx and NH_3 levels) decreases by approximately -1.04% year on year. The data for 2030 were assumed to be representative of the 2042 design year. Background data for human receptors are included in **Table A-6-2-1**. Background data for ecological receptors are included in **Appendix 6-4**.
Grids	Specified points (discrete receptors)

Item	Notes
Output	Long-term concentrations (µg/m^3) NO_x, PM_{10}, $PM_{2.5}$, 'NH_3_Grassland' and 'NH_3_Forest' (Note: Grassland = short vegetation, Forest = tall vegetation)
Post-processing of model outputs	Model outputs (i.e. modelled road source contributed) NO_x, PM_{10} and $PM_{2.5}$ were adjusted following model verification (discussed later in this appendix), in accordance with LAQM.TG(22) guidance. Total annual mean NO_x (µg/m^3) = adjusted modelled road source contributed NO_x (µg/m^3) + background NO_x (µg/m^3) Total annual mean PM_{10} (µg/m^3) = adjusted modelled road source contributed PM_{10} (µg/m^3) + background PM_{10} (µg/m^3) Total annual mean $PM_{2.5}$ (µg/m^3) = adjusted modelled road source contributed $PM_{2.5}$ (µg/m^3) + background $PM_{2.5}$ (µg/m^3) Defra NO_x to NO_2 calculator version 8.1 was used to determine road source contributed NO_2 and total annual mean NO_2 from adjusted modelled road source contributed NO_x and background NO_2. To indicate compliance with the 24-hour mean PM_{10} standard, LAQM.TG(22) gives the following equation that relates the annual mean concentration to the number of exceedances of the 50µg/m^3 threshold, where up to 35 exceedances are allowed: *Number of 24-hour mean PM_{10} exceedances of 50µg/m^3 = -18.5 + 0.00145 x annual mean^3 + (206 ÷ annual mean)* Note: where the annual mean PM_{10} concentration is less than 16.5µg/m^3 then the number of exceedances of the 24-hour mean objective can be assumed to be zero (the relationship is invalid for annual mean concentrations less than 14.8µg/m^3). To indicate compliance with the 1-hour mean NO_2 standard, LAQM.TG(22) advises that compliance is likely if the annual mean concentration is less than 60µg/m^3. For NH_3, no adjustment was undertaken as there were no appropriate monitoring data to allow model verification for this pollutant. Total annual mean NH_3 (µg/m^3) = modelled road source contributed NH_3 (µg/m^3) + background NH_3 (µg/m^3) Calculation of Nitrogen Deposition *Step 1 – calculate dry deposition fluxes* Dry NO_2 deposition flux (µg/m^2/s) = road source contributed NO_2 (µg/m^3) * dry NO_2 deposition velocity for short vegetation (0.0015m/s) or tall vegetation (0.003m/s) Dry NH_3 deposition flux (µg/m^2/s) = road source contributed NH_3 (µg/m^3) * dry NH_3 deposition velocity for short vegetation (0.02m/s) or tall vegetation (0.03m/s) *Step 2 – convert dry deposition fluxes to dry deposition rates* Dry nitrogen deposition due to NO_2 (kg/ha/yr) = dry NO_2 deposition flux (µg/m^2/s) * 96 Dry nitrogen deposition due to NH_3 (kg/ha/yr) = dry NH_3 deposition flux (µg/m^2/s) * 259.7 *Step 3 – calculate total dry deposition rate* Total dry nitrogen deposition (kg/ha/yr) = dry nitrogen deposition due to NO_2 (kg/ha/yr) + dry nitrogen deposition due to NH_3 (kg/ha/yr) + background nitrogen deposition for short or tall vegetation (kg/ha/yr)

Table 1-2 Background pollutant concentrations (μg/m³)

Background grid square X,Y	NO_2 2019	PM_{10} 2019	$PM_{2.5}$ 2019	NO_2 2027	PM_{10} 2027	$PM_{2.5}$ 2027	NO_2 2030	PM_{10} 2030	$PM_{2.5}$ 2030
565500, 324500	7.9	14.0	8.9	6.3	12.8	7.9	6.0	12.8	7.9
566500, 324500	7.9	15.2	9.1	6.2	14.1	8.2	6.0	14.1	8.2
567500, 324500	8.2	15.1	9.1	6.3	14.0	8.2	6.0	14.0	8.2
565500, 323500	8.2	14.0	8.9	6.5	12.9	8.0	6.2	12.9	8.0
566500, 323500	8.6	17.2	9.7	6.6	16.0	8.8	6.3	16.0	8.8
567500, 323500	8.5	17.2	9.7	6.5	16.0	8.8	6.2	16.0	8.7
565500, 322500	9.6	15.3	9.6	7.4	14.2	8.6	7.0	14.1	8.6
566500, 322500	9.7	17.4	10.0	7.3	16.3	9.0	6.9	16.3	9.0
567500, 322500	8.1	15.4	9.2	6.3	14.3	8.3	6.1	14.3	8.3
564500, 321500	10.0	15.3	9.7	7.9	14.1	8.8	7.5	14.1	8.7
565500, 321500	9.3	15.6	9.5	7.2	14.4	8.6	6.9	14.4	8.6
566500, 321500	8.8	16.4	9.6	6.9	15.3	8.6	6.6	15.2	8.6
564500, 320500	10.9	15.0	9.7	8.5	13.8	8.8	8.1	13.8	8.7
565500, 320500	11.0	16.5	9.9	8.4	15.4	8.9	8.0	15.3	8.9
566500, 320500	8.6	16.3	9.5	6.8	15.2	8.6	6.5	15.2	8.6

Background grid square X,Y	**NO_2 2019**	**PM_{10} 2019**	**$PM_{2.5}$ 2019**	**NO_2 2027**	**PM_{10} 2027**	**$PM_{2.5}$ 2027**	**NO_2 2030**	**PM_{10} 2030**	**$PM_{2.5}$ 2030**
561500, 319500	10.7	15.4	9.7	8.5	14.2	8.7	8.1	14.2	8.7
562500, 319500	13.0	16.0	10.2	10.0	14.8	9.3	9.6	14.8	9.2
563500, 319500	12.6	15.5	9.8	10.2	14.3	8.9	9.8	14.3	8.9
564500, 319500	10.7	16.7	10.2	8.2	15.5	9.3	7.8	15.5	9.3
565500, 319500	9.2	16.2	9.8	7.2	15.0	8.8	6.9	15.0	8.8
560500, 318500	10.8	16.4	10.0	8.1	15.3	9.0	7.6	15.2	9.0
561500, 318500	13.0	16.5	10.4	9.8	15.3	9.4	9.2	15.3	9.4
562500, 318500	13.1	16.4	10.1	9.8	15.2	9.2	9.2	15.2	9.1
563500, 318500	14.5	17.7	10.6	10.8	16.5	9.6	10.2	16.5	9.6
564500, 318500	9.6	17.2	9.9	7.4	16.0	9.0	7.1	16.0	9.0
565500, 318500	8.2	16.6	9.6	6.4	15.5	8.7	6.2	15.4	8.7
560500, 317500	9.7	15.3	9.3	7.9	14.1	8.4	7.7	14.1	8.4
561500, 317500	10.6	15.6	9.4	8.8	14.4	8.5	8.5	14.4	8.5
562500, 317500	10.8	16.3	9.7	8.7	15.1	8.7	8.4	15.1	8.7
563500, 317500	10.1	16.2	9.8	7.7	15.1	8.9	7.3	15.0	8.9
564500, 317500	8.6	17.5	9.9	6.7	16.3	9.0	6.4	16.3	9.0

Background grid square X,Y	NO_2 2019	PM_{10} 2019	$PM_{2.5}$ 2019	NO_2 2027	PM_{10} 2027	$PM_{2.5}$ 2027	NO_2 2030	PM_{10} 2030	$PM_{2.5}$ 2030
565500, 317500	7.9	16.0	9.4	6.2	14.9	8.5	6.0	14.8	8.5
561500, 316500	8.0	17.0	9.7	6.4	15.8	8.7	6.2	15.8	8.7
562500, 316500	8.0	15.9	9.4	6.4	14.8	8.5	6.1	14.8	8.5
563500, 316500	8.6	15.9	9.6	6.7	14.8	8.6	6.4	14.8	8.6
564500, 316500	8.4	16.5	9.7	6.5	15.3	8.7	6.2	15.3	8.7
565500, 316500	8.3	15.5	9.4	6.4	14.3	8.5	6.1	14.3	8.5
563500, 315500	8.4	15.8	9.5	6.5	14.6	8.6	6.2	14.6	8.6
564500, 315500	7.7	15.3	9.2	6.1	14.1	8.3	5.8	14.1	8.3
563500, 314500	8.0	16.1	9.6	6.2	15.0	8.7	5.9	15.0	8.7
564500, 314500	7.4	16.5	9.5	5.8	15.3	8.6	5.6	15.3	8.6
563500, 313500	8.2	16.6	9.7	6.5	15.4	8.7	6.2	15.4	8.7
564500, 313500	7.2	16.2	9.4	5.8	15.0	8.5	5.6	15.0	8.5
563500, 312500	7.9	16.0	9.5	6.1	14.9	8.6	5.9	14.8	8.6

1.2 Model verification

1.2.1 Model verification was undertaken in accordance with Defra technical guidance LAQM.TG(22).

1.2.2 All the monitoring sites included in the model verification were taken from BCKLWN's 2023 Annual Status Report.

1.2.3 Diffusion tubes at monitoring locations 62, 94, 95 and 96 were not included in the verification as these locations did not have sufficient traffic data within 200m to accurately model. All other monitoring locations reported by the local authority were not roadside to the affected road network. These locations were also mainly within the nearby Railway Road AQMA, and so were not representative of the more rural study area.

1.2.4 Ideally, verification is undertaken using ratified monitoring data from roadside continuous monitoring locations, which are set back the kerb at between 1 and 10m (typically) and are reasonably representative of the receptor locations of interest. However, all monitoring sites that are adjacent to the affected road network are NO_2 diffusion tubes, which are less accurate than well maintained continuous monitoring instruments.

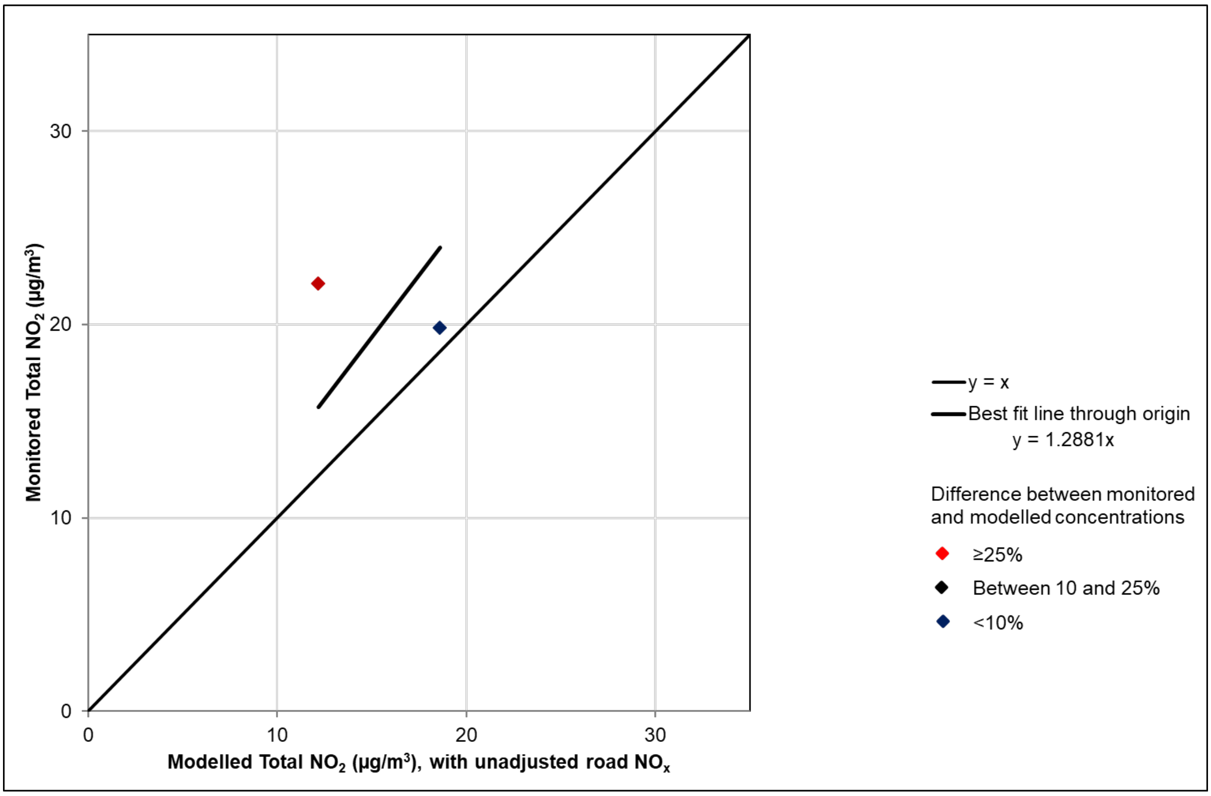
1.2.5 The following tables and graphs set out the model verification that was undertaken.

1.2.6 Comparison of monitored and modelled total annual mean NO_2 concentrations (μg/m^3) before any adjustment.

Table 1-3 Comparison of monitored and modelled total annual mean NO_2 concentrations (µg/m³) before any adjustment

Site ID	Background Annual Mean NO_2	Total Monitored Annual Mean NO_2 (A)	Total Modelled Annual Mean NO_2 (B)	B – A (C)	C/A (%)
73	8.35	22.10	12.20	-9.9	-45%
76	13.12	19.80	18.62	-1.2	-6%

Figure 1-1 Comparison of monitored to modelled total annual mean NO_2 concentration before adjustment



Best fit line before adjustment

Equation y = 1.2881x

Slope 1.2881

Differences between monitored and modelled concentrations

Within +10%	1
Within -10%	0
Within ±10%	**1**
Within +10 to +25%	0
Within -10 to -25%	0
Within ±10 to ±25%	**0**
Over +25%	1
Under -25%	0
Greater ±25%	**1**
Within ±25%	**1**

Uncertainty Statistics

Model tends to underestimate concentrations

1.2.7 One of the results are within ±10% of the standard for annual mean NO_2 of 40µg/m^3. One of the results is greater than ±25% of the standard for annual mean NO_2 of 40µg/m^3.

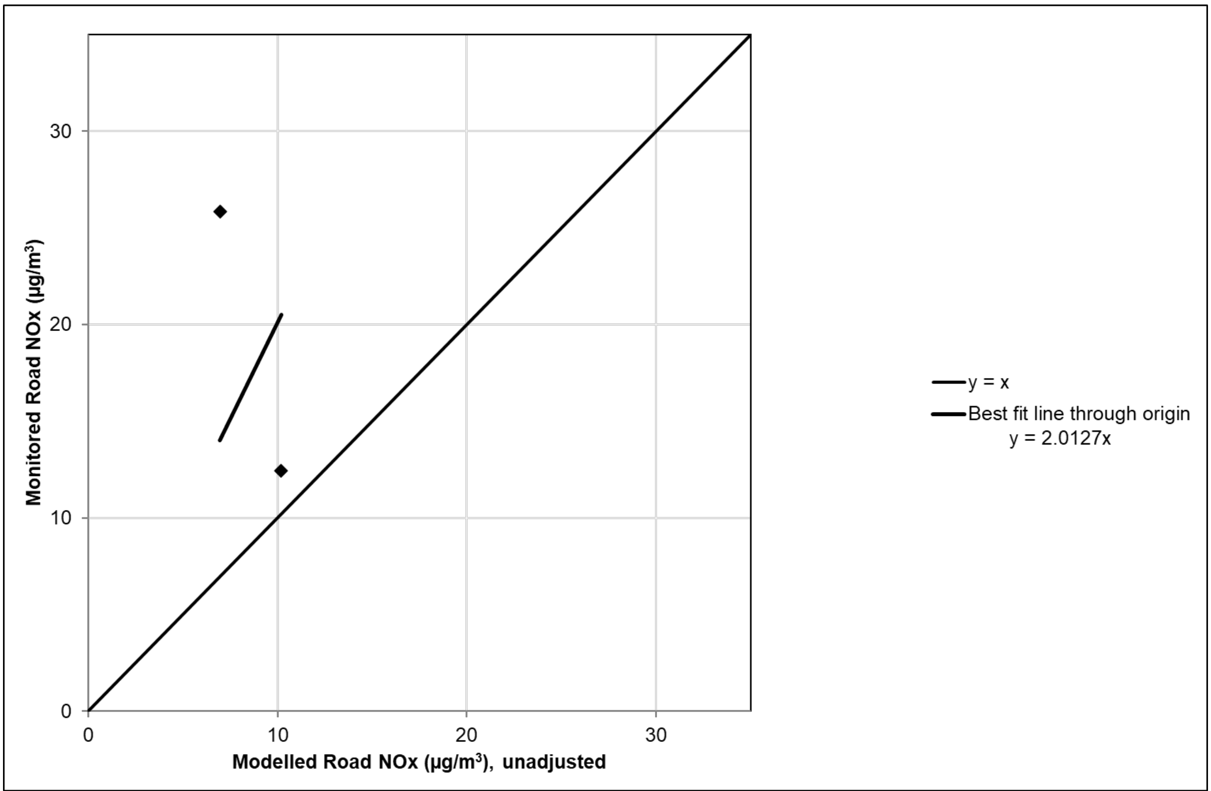
1.2.8 The ideal values for the RMSE and FB are both 0. Defra recommends that where the RMSE is more than 25% of the standard then model inputs and verification should be revisited to make improvements. As there are only two suitable monitoring locations, the RMSE and fractional bias cannot be reasonably determined.

1.2.9 Comparison of monitored and modelled road contributed annual mean NOx concentrations (µg/m^3) and determination of adjustment factor for modelled road contributed NOx

Table 1-4 Comparison of monitored and modelled road contributed annual mean NOx concentrations (µg/m³) and determination of adjustment factor for modelled road contributed NOx

Site ID	Monitored Road NOx (B)	Modelled Road NOx (C)	B/C	Adjusted Modelled Road NOx
73	25.86	6.96	3.71	14.02
76	12.44	10.20	1.22	20.53

Figure 1-2 Comparison of measured road-NOx with unadjusted modelled road-NOx



Best fit line

Equation y = 2.0127x

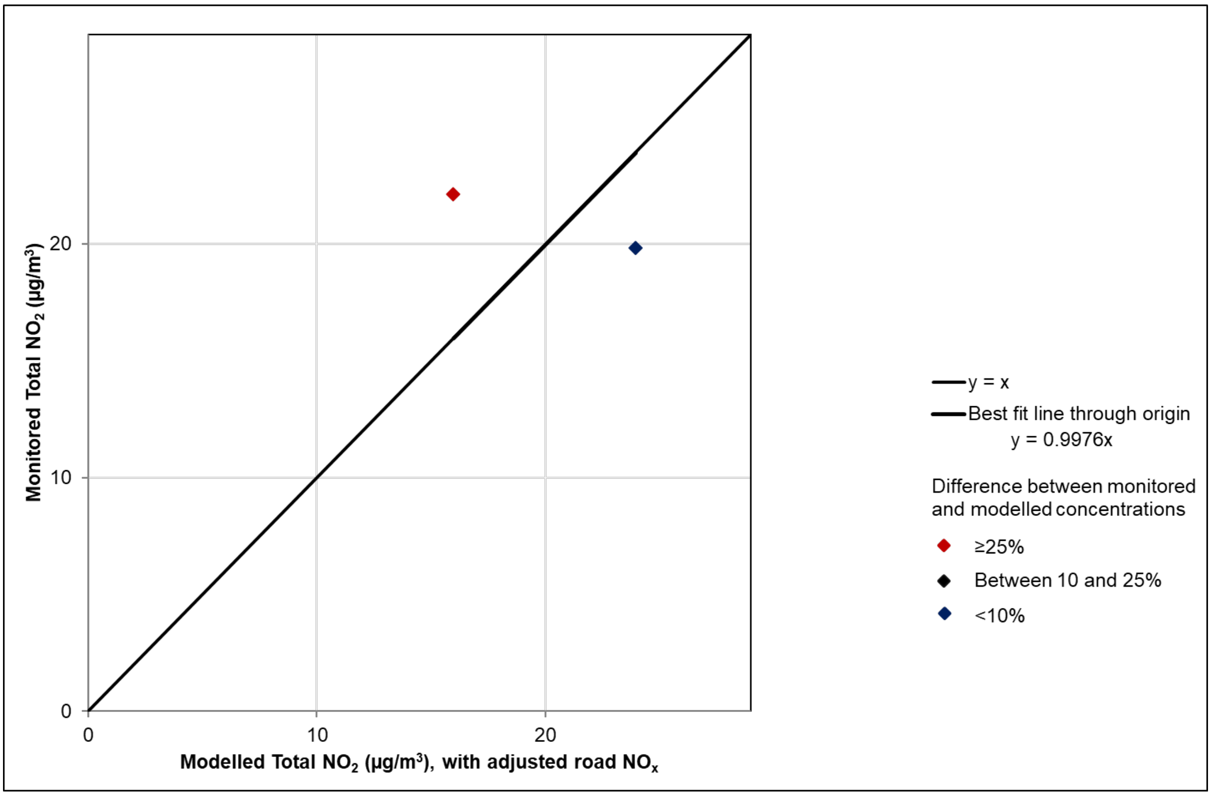
Slope 2.0127 (adjustment factor)

1.2.10 Comparison of monitored and modelled total annual mean NO_2 concentrations (µg/m³) after adjustment of modelled road contributed NO_x

Table 1-5 Comparison of monitored and modelled total annual mean NO_2 concentrations (µg/m^3) after adjustment of modelled road contributed NOx

Site ID	Background Annual Mean NO_2	Total Monitored Annual Mean NO_2 (A)	Total Modelled Annual Mean NO_2 (B)	B – A (C)	C/A (%)
73	8.35	22.10	15.99	-6.11	-0.28
76	13.12	19.80	23.96	4.16	0.21

Figure 1-3 Monitored and modelled total annual mean NO_2 concentration after adjustment



Best fit line after adjustment

Equation y = 0.9976x

Slope 0.9976

Differences between modelled and monitored concentrations

Within +10%	0
Within -10%	0
Within ±10%	**0**
Within +10 to +25%	0
Within -10 to -25%	1
Within ±10 to ±25%	**1**
Over +25%	1
Under -25%	0
Greater ±25%	**1**
Within ±25%	**1**

1.2.11 One result is within ±25% of the standard for annual mean NO_2 of 40µg/m^3. One result is greater than ±25% of the standard for annual mean NO_2 of 40µg/m^3. Again, as there are only two suitable monitoring locations, the RMSE and fractional bias are not reported. It cannot be confirmed if adjustment has helped with providing more accurate results, but adjustment provides a reasonably conservative calculation for the model results.

1.2.12 In the absence of any suitable monitoring locations for PM_{10} and $PM_{2.5}$, the model adjustment factor for modelled road contributed NOx has also been applied to modelled road contributions of PM_{10} and $PM_{2.5}$. Although this is not ideal, it is in line with LAQM.TG(22) procedure where suitable PM monitoring is absent.