APPENDIX 11.4

11.4 Modelling Methodology

Background Concentrations

11.4.1 The background concentrations across the study area have been defined using the national pollution maps published by Defra (Ref 11.20). These cover the whole country on a 1x1 km grid and are published for each year from 2010 until 2025. The maps include the influence of emissions from a range of different sources; one of which is road traffic. As noted in the main air quality chapter, there are some concerns that Defra may have over-predicted the rate at which road traffic emissions of nitrogen oxides will fall in the future. The maps currently in use were verified against measurements made during 2010 at a large number of automatic monitoring stations and so there can be reasonable confidence that the maps are representative of conditions during 2010. Similarly, there is reasonable confidence that the reductions which Defra predicts from other sectors (e.g. rail) will be achieved.

11.4.2 In order to calculate background nitrogen dioxide and nitrogen oxides concentrations in 2011, it is assumed that there was no reduction in the road traffic component of backgrounds between 2010[1] and 2011. This has been done using the source-specific background nitrogen oxides maps provided by Defra (Ref 11.20). For each grid square, the road traffic component has been held constant at 2010 levels, while 2011 values have been taken for the other components. Nitrogen dioxide concentrations have then been calculated using the background nitrogen dioxide calculator which Defra (Ref 11.20) publishes to accompany the maps. The result is a set of 'adjusted 2011 background' concentrations.

11.4.3 Two separate sets of 2016 background nitrogen dioxide and nitrogen oxides concentrations have been used for the future-year assessment. The 2016 background 'without emissions reduction' has been calculated using the same approach as described for the 2011 data: the road traffic component of background nitrogen oxides has been held constant at 2010 values, while 2016 data are taken for the other components. Nitrogen dioxide has then been calculated using Defra's background nitrogen dioxide calculator. The 2016 background 'with emissions reduction' assumes that Defra's revised predicted reductions occur from 2011 onward. This dataset has been derived first by calculating the ratio of the unadjusted mapped value for 2016 to the unadjusted mapped value for 2011. This ratio has then been applied to the adjusted calibrated 2016 value (as derived in Paragraph 11.4.2).

11.4.4 For PM_{10} and $PM_{2.5}$, there is no strong evidence that Defra's predictions are unrealistic and so the year-specific mapped concentrations have been used in this assessment

[1] This approach assumes that has been no reduction in emissions per vehicle but also that traffic volumes have remained constant. This is not the same as the assumption made for dispersion modelling, in which emissions per vehicle are held constant while traffic volumes are assumed to change year on year. Overall, this discrepancy is unlikely to influence the overall conclusions of the assessment.

Model inputs

11.4.5 Predictions have been carried out using the ADMS-Roads dispersion model (v3.1). The model requires the user to provide various input data, including emissions from each section of road, and the road characteristics (including road width). Vehicle emissions have been calculated based on vehicle flow, fleet composition and speed data using the Emission Factor Toolkit (Version 5.2c) published by Defra (Ref 11.20). For nitrogen dioxide future-year concentrations have been predicted once using year-specific emission factors from the EFT and once using emission factors for 2011[2] which is the year for which the model has been verified.

11.4.6 The model has been run using 2011 meteorological data from the monitoring station located at Bedford, which is considered suitable for this area.

11.4.7 AADT flows and %HGV data have been provided by Pell Frischmann. Base year data was provided for 2013, but this data has been conservatively applied to the year 2011. In reality, flows are likely to be very similar between the two years. Future year data has been provided for 2026, but this has been applied to the year 2016 to ensure a worst-case assessment. Traffic speeds were based on the speed limit of the road, reduced to 20 km/h at junctions. The traffic data used in this assessment are summarised in Table A11.0.1.

Table A11.0.1: Summary of Traffic Data used in the Assessment

Road Link	2011		2016 Without Scheme		2016 With Scheme	
	AADT	% HDV	AADT	% HDV	AADT	% HDV
Stoke Rd	8,705	3.3	11,852	3.1	15,278	2.7
Bletchley Rd S of Whaddon Rd	1,580	5.2	2,315	5.0	3,041	4.5
Bletchley Rd N of Whaddon Rd	7,042	0.7	9,984	5.0	13,005	5.0
Whaddon Rd S site access	5,434	5.4	7,199	11.0	9,211	6.7
Whaddon Rd N site access	5,409	5.4	7,202	12.0	6,151	11.0
A421 W of Coddimoor Ln	24,061	10.6	33,112	10.6	16,991	0.0
A421 W of Bottle Dump Rdbt	23,794	11.0	32,771	10.9	33,883	11.0
A421 E of Bottle Dump Rdbt	22,139	10.3	29,995	12.0	29,668	9.5
A421 E site access	22,998	4.3	31,118	11.9	31,457	9.9
A421 E Snelshall St	21,563	10.0	27,748	10.0	37,200	8.1
A421 E Windmill Hill Rdbt	26,064	8.2	33,289	10.9	39,642	9.2
A421 E Fulmer St	36,063	6.2	44,705	8.5	49,192	8.0
Coddimoor Ln	10,321	1.4	14,245	1.4	15,778	1.8

[2] i.e. combining current-year emission factors with future-year traffic data.

Road Link	2011		2016 Without Scheme		2016 With Scheme	
	AADT	% HDV	AADT	% HDV	AADT	% HDV
Whaddon Rd	7,132	1.6	9,829	1.5	10,029	2.5
Buckingham Rd W site access	9,780	2.8	12,485	7.1	24,051	4.6
Buckingham Rd E site access	9,780	2.8	12,485	7.1	24,051	4.6
Buckingham Rd W Church Green Rd	17,242	1.9	21,300	2.6	23,684	2.6
Buckingham Rd E Church Green Rd	21,090	1.8	26,429	5.5	28,432	5.5
Church Green Rd	6,984	0.7	8,834	4.5	8,667	5.0
Snelshall St S Holborn Crescentt	7,232	0.0	8,309	4.8	9,797	4.3
Snelshall St N Holborn Crescent	7,077	0.0	8,736	10.8	9,298	0.0
Snelshall St N Chaffron Way	5,094	0.5	6,261	6.7	6,654	6.3
Chaffron Way W Snelshall St	10,116	4.1	12,835	5.7	13,451	5.3
Chaffron Way E Snelshall St	8,615	5.0	10,917	11.9	11,882	9.9
Tattenhoe N A421	9,533	0.2	10,989	8.0	14,550	7.0
Tattenhoe S A421	6,306	0.2	7,827	9.0	9,456	8.0
Fulmer St	9,103	0.3	11,255	8.8	10,444	0.4
Shenley Rd	15,155	0.1	18,810	3.0	16,825	3.0

11.4.8 Diurnal flow profiles for the traffic have been derived from the national diurnal profiles published by DfT (Ref 11.29). Figure A4.2 shows the road network included within the model and defines the study area.

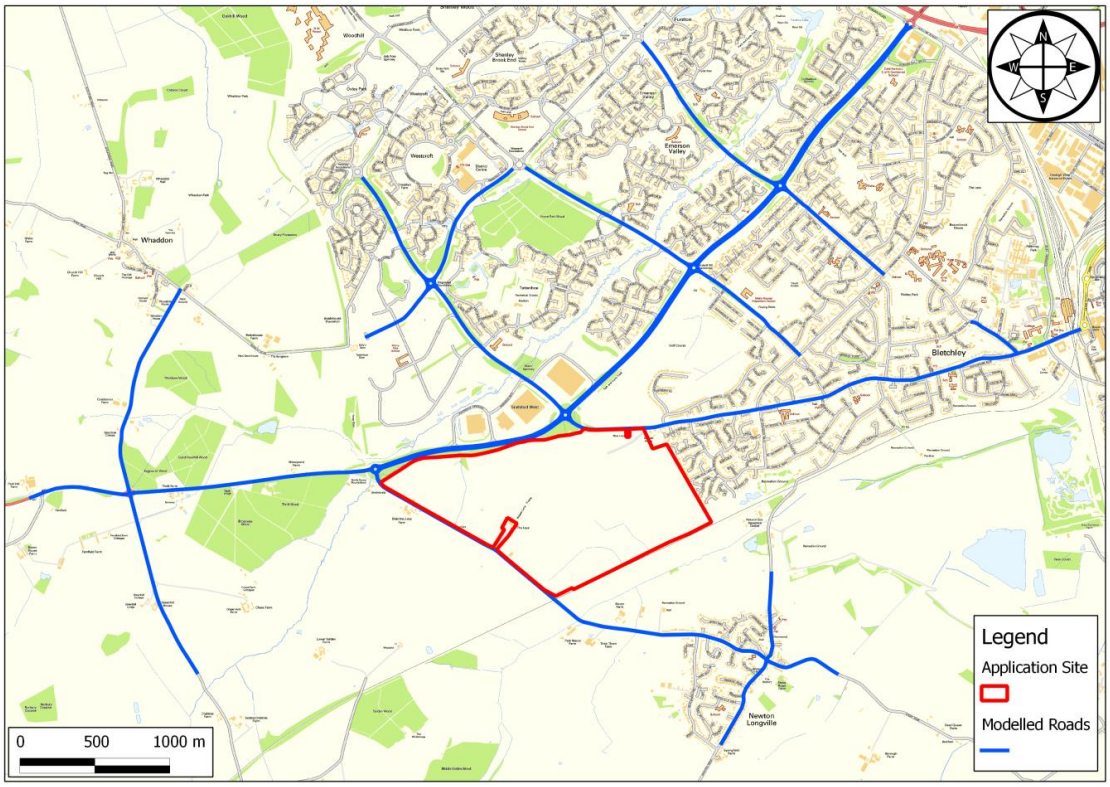

Figure A11.0.1: Modelled Road Network

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Model Verification

11.4.9 In order to ensure that ADMS-Roads accurately predicts local concentrations, it is necessary to verify the model against local measurements. The verification methodology is described below.

11.4.10 The 2011 background nitrogen dioxide concentration for the 18 Wheatcroft Close diffusion tube site, which was the only nearby site for which traffic data for the adjacent roads were available, have been derived from the national maps and were calculated using the same approach as described for the 2011 data (see Paragraph 11.4.2). The road traffic component of background nitrogen oxides is held constant at 2010, while 2011 data are taken for the other components. Nitrogen dioxide is then calculated using Defra's background nitrogen dioxide calculator. The background concentration for the diffusion tube location is presented in Table A4.2.

Table A11.0.2: Background NO_2 Concentration (µg/m^3) used in the Verification for 2011

Location	Grid Square Coordinates	NO_2
18 Wheatcroft Close	486500,236500	20.0

11.4.11 AADT flows, and the proportions of HDVs, for Grafton Street and Dansteed Way have been determined from the interactive web-based map provided by the Department for Transport

(Ref 11.30). Traffic speeds were estimated based upon the speed limit and the proximity to a junction. Traffic data used in the model verification are presented in Table A4.3.

Table A11.0.3: AADT Traffic Data used in the Model Verification

Road Link	2011
Grafton Street	17,469
Standing Way west of Grafton Street	26,629
Standing Way east of Grafton Street	23,488

11.4.12 Most nitrogen dioxide (NO_2) is produced in the atmosphere by the reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides (NOx = NO + NO_2). The model has been run to predict the annual mean NOx concentrations during 2011 at the 18 Wheatcroft Close diffusion tube monitoring site.

11.4.13 The model output of road-NOx (i.e. the component of total NOx coming from road traffic) has been compared with the 'measured' road-NOx. Measured road-NOx was calculated from the measured NO2 concentration and the predicted background NO2 concentration using the NOx from NO2 calculator available on the Defra LAQM Support website (Ref 11.20).

11.4.14 An adjustment factor was determined as the ratio of the 'measured' road contribution and the model derived road contribution. The data used to calculate the adjustment factor are provided below:

- Measured NO_2 : 21.9 µg/m^3
- Background NO_2 : 20.0 µg/m^3
- 'Measured' road-NOx (from NOx to NO_2 calculator): 3.9 µg/m^3
- Modelled road-NOx = 4.6 µg/m^3
- Road-NOx adjustment factor: 3.9/4.6 = **0.862**

11.4.15 The factor implies that the unadjusted model is over-predicting the road-NOx contribution. Professional experience suggests that applying this factor may lead to an under-prediction of concentrations at the development site, and therefore this factor was not applied to the modelled road-NOx concentration. It was determined to be worst-case not to adjust the model output. The total nitrogen dioxide concentrations were then determined by combining the modelled road-NOx concentrations with the predicted background NO_2 concentration within the NOx from NO_2 calculator (Ref 11.20).

PM_{10} and $PM_{2.5}$

11.4.16 There are no local PM_{10} or $PM_{2.5}$ monitoring data with which the model could be verified. In this situation the model outputs of road-PM_{10} and road-$PM_{2.5}$ would usually be adjusted by the same factor as for road NO_x, but with this factor being below one, it has not been applied, in order for the assessment to be worst-case. The model outputs of road-PM_{10} and road-$PM_{2.5}$ have, therefore, not been adjusted.

Model Post-processing

Nitrogen oxides and nitrogen dioxide

11.4.17 The model predicts road-NOx concentrations at each receptor location. These concentrations have then been adjusted using the primary adjustment factor, which, along with the background NO_2, is processed through the NOx from NO_2 calculator available on the Defra LAQM Support website (Defra, 2012). The traffic mix within the calculator was set to "All UK traffic". The calculator predicts the component of NO_2 based on the adjusted road-NOx and the background NO_2. This is then adjusted by the secondary adjustment factor to provide the final predicted concentrations.

PM_{10} and $PM_{2.5}$

11.4.18 The number of exceedences of 50 µg/m^3 as a 24-hour mean PM_{10} concentration has been calculated from the adjusted-modelled total annual mean concentration following the relationship advised by (Ref 11.1):

$$A = -18.5 + 0.00145\ B^3 + 206/B$$

where A is the number of exceedences of 50 µg/m^3 as a 24-hour mean PM_{10} concentration and B is the annual mean PM_{10} concentration. The relationship is only applied to annual mean concentrations greater than 16.5 µg/m^3, below this concentration, the number of 24-hour exceedences is assumed to be zero.