Environmental Statement – Chapter 7: Air Quality
Appendix 7.2: Dispersion Model Inputs, Verification and Performance

Dispersion Model Inputs

Traffic Emission Factors and Sensitivity Assessment

Defra provides an Emission Factor Toolkit (EfT) in order to calculate emissions from a given length of road based on the traffic composition (number of vehicles of each type) and speed data. Emission factors improve with time as new vehicles registered in the UK have to meet progressively tighter European type approval emissions categories, referred to as "Euro" standards. As the proportion of vehicles in the fleet meeting a particular Euro standard increases, the vehicle emissions from the fleet theoretically improve. In order to reflect this, the EfT provides projected emission factors for future years.

Emission factors were determined for each scenario using the latest EfT (v8.0.1).

Modelled traffic exhaust concentrations of oxides of nitrogen (NOx) have been subject to verification in accordance with LAQM.TG(16) and annual mean NO_2 concentrations calculated using the latest DEFRA 'NOx-NO_2 Calculator' (v6.1). The traffic mix within the calculator has been set to "All other UK traffic" for a 2028 year (i.e. the complete development opening year). Welwyn Hatfield was selected as the local authority.

In summary, the assessment has utilised the following inputs:

- 2028 emission factors from v8.0.1 of the EFT; and
- 2028 mapped background concentrations sourced from the DEFRA mapping study.

Recent evidence indicates a disparity between the emission factors and ambient monitoring data[1]. To address this uncertainty, an additional modelling scenario has been assessed in which it has been assumed there is no improvement in vehicle emissions from the verified 2017 baseline year, and no improvement in backgrounds from the 2015 DEFRA mapping study base year. Reference should be made to Appendix 7.3 for presentation of the sensitivity modelling scenario. These modelling assumptions and sensitivity on the dispersion modelling inputs are in accordance with principles of the IAQM's Position Statement on Dealing with Uncertainty in Vehicle NOx Emissions within Air Quality Assessments[2].

Meteorological Data

To calculate pollutant concentrations at identified sensitive receptor locations the dispersion model uses sequential hourly meteorological data, including wind direction, wind speed, temperature, cloud cover and stability, which exert significant influence over atmospheric dispersion.

The dispersion modelling has been undertaken using 2017 data from Luton Airport. This Site is located approximately 13km to the north-west of the Proposed Development site. It is also the closest meteorological station that records all of the parameters necessary for dispersion modelling.

[1] Carslaw, et al. (2011). Trends in NOx and NO_2 emissions and ambient measurements in the UK.

[2] http://www.iaqm.co.uk/text/position_statements/vehicle_NOx_emission_factors.pdf - accessed October 2018.

The meteorological dataset used in this assessment was provided by ADM Ltd. A windrose is presented in Figure 7.3.

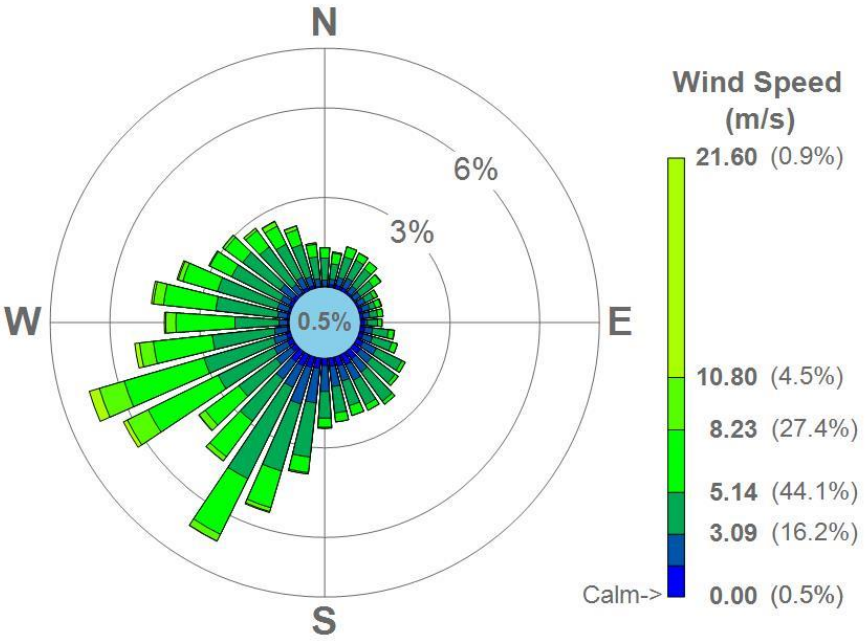

Figure 7.3: Wind Rose for Luton Airport Meteorological Station (2017)

Dispersion Model Input Summary

The modelling input parameters are summarized in Table Error*! No text of specified style in document.*.***1***.

Table Error! No text of specified style in document.**.1: Land West of Hatfield AQIA – Summary of Modelling Inputs**

Parameter	Description	Input Variable
Surface Roughness	Surface roughness of the modelling domain as a function of land use	A roughness length z0 of 0.5m was used within the assessment area of this dispersion modelling study. This value is for 'open suburbia' and therefore considered appropriate for the surface roughness of the dispersion modelling assessment area
Road Source Emissions	Source of the emission factors used	EFT v.8.0.1
Emission Year	Modelling year used to factor the traffic emissions	2017 verification year and 2028 development opening year. A further sensitivity scenario was assessed which considered 2017 emission factors for the development opening year.
Road Type	Road type within the EFT emission database	Urban (not London)
Elevation of Road	Height of the road link above ground level	Flat – roads are at ground level
Road Width	Width of the road link	Road width obtained from OS map
Road Speed	Road speed in km/h	Variable based on posted limit and adjustment for road geometry in line with LAQM.TG(16)
Time Varied	Daily, weekly or monthly	None – AADT modelled to determine annual mean impacts

Parameter	Description	Input Variable
Emissions	variations in emissions applied to road sources	
Meteorology	Representative hourly sequential meteorological data	Luton Airport 2017
Background	Background pollutant concentration considered during the modelling	DEFRA Mapped backgrounds (2015 base year) projected to 2028 for 2028 development opening year. A further sensitivity scenario was assessed which considered 2015 DEFRA mapped background base year concentrations for the development opening year.
Output	Output as gridded or specified points	Specific points
Pollutant Output	Pollutants modelled and averaging time	NO_2 and PM_{10} annual mean, calculated 1-hour mean NO_2 and 24-hour mean PM_{10}

Traffic Data

Road traffic data entered into the assessment was obtained from Vectos, transport consultants to the applicant. A summary of the traffic data considered within then assessment is presented in Table Error*! No text of specified style in document.**.2***, Table Error*! No text of specified style in document.**.3*** and Table Error*! No text of specified style in document.**.4*** based upon the LDV AADT flow, the HDV AADT flow and the modelled vehicle speed, respectively.

Reference should be made to Chapter 12 Transport, for further details on the transport assessment and traffic data considered for the scheme. Reference should be made to Application Site and surrounding area.

Table Error! No text of specified style in document.**.2: Traffic Data used within the Dispersion Modelling Assessment – LDV AADT Flow**

Link	Road Name	24-hour AADT – LDVs		
		2017 Baseline / Verification	2028 Do-Minimum	2028 Do-Something
1a	A1057	14,047	16,100	16,399
1b	A1057 (between Ellenbrook Lane and A1001)	14,683	16,831	18,037
1c	A1057 (between Mosquito Way and A1001)	14,683	16,831	17,278
2	Coopers Green Lane (North of Hatfield Avenue)	11,308	12,961	13,618
3	Coopers Green Lane (South of Hatfield Avenue)	11,317	12,972	13,629
4	A1001 (South of Cavendish Way Roundabout)	21,748	24,928	26,155
5	A1001 SB (North of Cavenish Way Roundabout)	10,997	12,605	12,724
6	A1001 NB (North of Cavenish Way	12,087	13,854	13,942

Link	Road Name	24-hour AADT – LDVs		
		2017 Baseline / Verification	2028 Do-Minimum	2028 Do-Something
	Roundabout)			
7a	Hatfield Avenue	6,852	7,854	8,555
7b	Hatfield Avenue (between Frobisher Way and Hatfield	6,852	7,854	8,555
7c	Hatfield Avenue (between Hatfield Bus. Park and Gypsy Moth Avenue)	6,852	7,854	8,370
7d	Hatfield Avenue (between Gypsy Moth Avenue and Mosquito Way)	6,852	7,854	8,351
7e	Hatfield Avenue (between Mosquito Way and A1001)	6,852	7,854	8,761
10a	Mosquito Way North of Albatross Way	9,929	11,380	13,060
10b	Mosquito Way (between Dragon Road and Gypsy Moth Lane)	9,090	10,419	10,835
10c	Mosquito Way (between Gypsy Moth Lane and Hatfield Avenue)	9,090	10,419	10,829
11	Mosquito Way South of Albatross Way	9,929	11,380	13,060
12	Albatross Way	1,586	1,818	4,306
13	A1001 Comet Way	19,486	22,335	22,335
R1	Comet Way / Hatfield Avenue roundabout	12,808	14,681	15,676
R2	Comet Way / A1057 roundabout	15,809	18,121	18,719

Table Error! No text of specified style in document.**.3: Traffic Data used within the Dispersion Modelling Assessment– HDV AADT Flow**

Link	Road Name	24-hour AADT – HDVs		
		2017 Baseline / Verification	2028 Do-Minimum	2028 Do-Something
1a	A1057	618	708	708
1b	A1057 (between Ellenbrook Lane and A1001)	646	740	759
1c	A1057 (between Mosquito Way and A1001)	646	740	740
2	Coopers Green Lane (North of Hatfield Avenue)	217	249	249
3	Coopers Green Lane (South of Hatfield Avenue)	174	199	199
4	A1001 (South of Cavendish Way Roundabout)	2,526	2,896	2,917
5	A1001 SB (North of Cavenish Way	1,277	1,464	1,464

Link	Road Name	24-hour AADT – HDVs		
		2017 Baseline / Verification	2028 Do-Minimum	2028 Do-Something
	Roundabout)			
6	A1001 NB (North of Cavenish Way Roundabout)	1,404	1,609	1,609
7a	Hatfield Avenue	203	232	232
7b	Hatfield Avenue (between Frobisher Way and Hatfield	203	232	232
7c	Hatfield Avenue (between Hatfield Bus. Park and Gypsy Moth Avenue)	203	232	232
7d	Hatfield Avenue (between Gypsy Moth Avenue and Mosquito Way)	203	232	232
7e	Hatfield Avenue (between Mosquito Way and A1001)	203	232	232
10a	Mosquito Way North of Albatross Way	405	464	464
10b	Mosquito Way (between Dragon Road and Gypsy Moth Lane)	405	464	464
10c	Mosquito Way (between Gypsy Moth Lane and Hatfield Avenue)	405	464	464
11	Mosquito Way South of Albatross Way	386	442	463
12	Albatross Way	198	227	248
13	A1001 Comet Way	823	943	943
R1	Comet Way / Hatfield Avenue roundabout	810	928	928
R2	Comet Way / A1057 roundabout	1,483	1,700	1,707

Table Error! No text of specified style in document.**.4: Traffic Data used within the Dispersion Modelling Assessment– Modelled Speed**

Link	Road Name	Vehicle Speed (km/h) [A]		
		2017 Baseline / Verification	2028 Do-Minimum	2028 Do-Something
1a	A1057		64	
1b	A1057 (between Ellenbrook Lane and A1001)		64	
1c	A1057 (between Mosquito Way and A1001)		64	
2	Coopers Green Lane (North of Hatfield Avenue)		96	
3	Coopers Green Lane (South of Hatfield Avenue)		96	
4	A1001 (South of Cavendish Way		80	

Link	Road Name	Vehicle Speed (km/h) [A]		
		2017 Baseline / Verification	2028 Do-Minimum	2028 Do-Something
	Roundabout)			
5	A1001 SB (North of Cavenish Way Roundabout)		80	
6	A1001 NB (North of Cavenish Way Roundabout)		80	
7a	Hatfield Avenue		48	
7b	Hatfield Avenue (between Frobisher Way and Hatfield		48	
7c	Hatfield Avenue (between Hatfield Bus. Park and Gypsy Moth Avenue)		48	
7d	Hatfield Avenue (between Gypsy Moth Avenue and Mosquito Way)		48	
7e	Hatfield Avenue (between Mosquito Way and A1001)		48	
10a	Mosquito Way North of Albatross Way		48	
10b	Mosquito Way (between Dragon Road and Gypsy Moth Lane)		48	
10c	Mosquito Way (between Gypsy Moth Lane and Hatfield Avenue)		48	
11	Mosquito Way South of Albatross Way		48	
12	Albatross Way		48	
13	A1001 Comet Way		48	
R1	Comet Way / Hatfield Avenue roundabout		48	
R2	Comet Way / A1057 roundabout		20	

Note:

(A) Links were modelled with a 20km/h corresponding 'slow-down' phase prior to all roundabouts and junctions, in accordance with guidance presented within LAQM.TG(16).

Dispersion Model Verification

Calculation of Correction Factors

The model output of road-NOx (i.e. the component of total NOx coming from road traffic exhaust emissions) has been compared with the 'calculated' road-NOx concentration. For this calculation, the following assessment inputs were used, which are considered to be representative of the development locale:

- DEFRA's NOx to NO2 calculator version 6.1;
- 'Welwyn Hatfield' was selected as the 'Local Authority';

- 2017 NO_2 diffusion tube monitoring locations WH7, WH19, WH22, WH25, WH26 from the WHC monitoring network; and
- 2017 DEFRA mapped background for the grid square containing the above diffusion tubes (20.9µg/m^3 for NGR: x521500, y208500 for monitoring location WH7; 19.1µg/m^3 for NGR: x522500, y209500 for monitoring location WH19; and 17.1µg/m^3 for NGR: x521500, y209500 for monitoring locations WH22, WH25 and WH26).

Calculated NOx data versus modelled NOx data is shown in Table Error*! No text of specified style in document.*.***5*** below with the applied primary adjustment factors.

Table Error! No text of specified style in document.**.5: Verification Data 2017, Initial Step**

Monitoring Location	Modelled NOx Road Contribution (µg/m^3)	Calculated NOx Road Contribution (µg/m^3)	Ratio of Modelled : Calculated NOx	Monitored NO_2 Concentration (µg/m^3)	Adjusted Modelled NO_2 Concentration (µg/m^3)	Difference (%)
WH7	10.4	18.2	1.74	30	42.8	+42.6
WH19	10.3	65.9	6.41	49	40.9	-16.6
WH22	9.52	55.3	5.81	43	37.6	-12.6
WH25	15.1	62.8	4.16	46	47.8	+3.98
WH26	9.30	45.8	4.92	39	37.2	-4.72
		***m*-regression factor**	4.4666			

In accordance with LAQM.TG(16), the ratio of 'Calculated Road Contribution' to 'Modelled NOx Road Contribution' has been calculated and reviewed. This average relationship is a minimum of 1:1.74 (monitoring location WH7) and a maximum of 1:6.41 (monitoring location WH19). It is considered that these ratios illustrate that the dispersion modelling and verification is performing differently across the modelling domain. Therefore, as a precautionary approach monitoring location WH7 has been removed from the verification study, as this ultimately calculates a higher *m*-regression verification factor.

Calculated NOx data versus modelled NOx data is shown in Table Error*! No text of specified style in document.*.***6*** below, based upon the removal of monitoring location WH7 from the verification study, with the applied primary adjustment factors. The final verification results are graphed in Figure 7.4.

Table Error! No text of specified style in document.**.6: Verification Data 2017, Secondary Step**

Monitoring Location	Modelled NOx Road Contribution (µg/m^3)	Calculated NOx Road Contribution (µg/m^3)	Ratio of Modelled : Calculated NOx	Monitored NO_2 Concentration (µg/m^3)	Adjusted Modelled NO_2 Concentration (µg/m^3)	Difference (%)
WH19	10.3	65.9	6.41	49	-11.5%	-11.5
WH22	9.52	55.3	5.81	43	-7.05%	-7.05
WH25	15.1	62.8	4.16	46	11.3%	+11.3
WH26	9.30	45.8	4.92	39	1.28%	+1.28
		***m*-regression**	5.049			

Monitoring Location	Modelled NOx Road Contribution (µg/m³)	Calculated NOx Road Contribution (µg/m³)	Ratio of Modelled : Calculated NOx	Monitored NO_2 Concentration (µg/m³)	Adjusted Modelled NO_2 Concentration (µg/m³)	Difference (%)
		factor				

As stated in Table Error*! No text of specified style in document.*.**6**, modelled NOx concentrations have therefore been verified using a factor of 5.049**.** Modelled PM_{10} concentrations have further been verified using a factor of 5.049, following the recommendations of LAQM.TG(16) guidance.

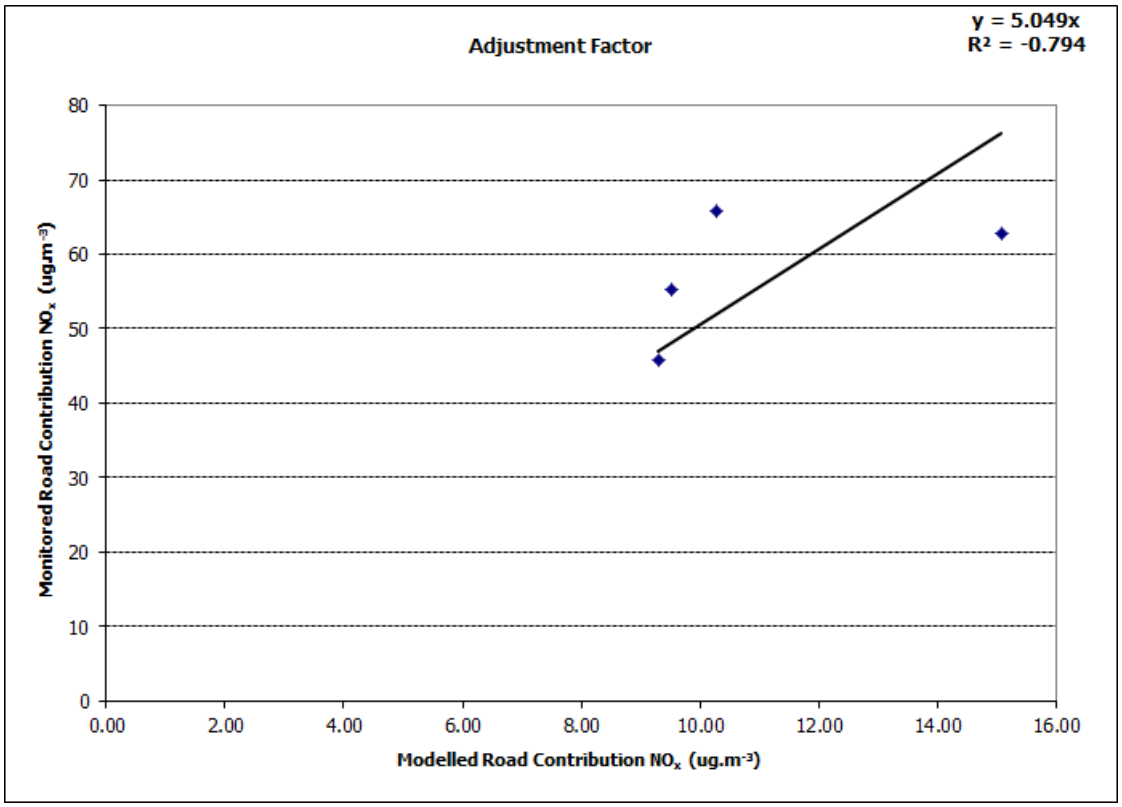

Figure 7.4: Final Verification and Adjustment

Model Performance

An evaluation of model performance has been undertaken to establish confidence levels in model results. LAQM.TG(16) identifies a number of statistical procedures that are appropriate to evaluate model performance and assess uncertainty. The statistical parameters used in this assessment are:

- Root mean square error (RMSE); and
- Fractional bias (FB).

A brief for explanation of each statistic is provided in Table Error*! No text of specified style in document.*.**7**, and further details can be found in LAQM.TG(16).

Table Error! No text of specified style in document**..7: Dispersion Model Performance Checks**

Parameter	Comments	Value
Root Mean Square Error	RMSE is used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared If the RMSE values are higher than ±25% of the objective being assessed, it is recommended that the model inputs and verification should be revisited in order to make improvements. For example, if the model predictions are for the annual mean NO_2 AQO of 40µg/m^3, if an RMSE of 10µg/m^3 or above is determined for a model, the local authority would be advised to revisit the model parameters and model verification. Ideally an RMSE within 10% of the AQO would be derived, which equates to 4µg/m^3 for the annual mean NO_2 AQO.	4.13µg/m^3 (i.e. 10.3% of the NO_2 annual mean AQO)
Fractional Bias	It is used to identify if the model shows a systematic tendency to over or under predict. FB values vary between +2 and -2 and has an ideal value of zero. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.	+0.017

As indicated in Table Error*! No text of specified style in document.**.7***, the RMSE value is calculated to be 4.13µg/m^3 / 10.3% d therefore within ±25% of the NO_2 annual mean AQO based upon the average factor m-regression factor derived from monitoring locations WH19, WH22, WH25 and WH26 considered within the verification assessment. Furthermore, the FB is calculated to be +0.0017 and within the required +2 and -2 range.

Therefore, model performance and uncertainty is considered to be satisfactory and monitoring locations WH19, WH22, WH25 and WH26 have been retained within the verification study.