A1 Birtley to Coal House

Scheme Number: TR010031

6.3 Environmental Statement – Appendix 5.7 Model Verification

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A1 Birtley to Coal House

Development Consent Order 20[xx]

Environmental Statement - Appendix

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MODEL VERIFICATION

1.1.1. The comparison of modelled concentrations with local monitored concentrations is a process termed 'verification'. Model verification investigates the discrepancies between modelled and measured concentrations, which can arise due to the presence of inaccuracies and/or uncertainties in model input data, modelling and monitoring data assumptions. The following are examples of potential causes of such discrepancy:

- Estimates of background pollutant concentrations
- Uncertainty in monitored pollutant concentrations
- Meteorological data uncertainties
- Traffic data uncertainties
- Model input parameters, such as 'roughness length'
- Overall limitations of the dispersion model

1.1.2. Most nitrogen dioxide 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 the primary pollutant emissions of nitrogen oxides (NO_x = NO + NO_2), in line with the guidance provided within Chapter 7 of LAQM.TG(16).

1.1.3. For the Scheme, the dispersion model has been run to predict the 2017 annual mean road-NO_x contribution at various groups of monitoring locations, which represent existing receptor locations using Interim Advice Note (IAN) 185 Speed Banded emissions. The model output of road-NOx has been compared with the 2017 'measured' road-NOx, which was determined from the nitrogen dioxide concentration measured at monitoring sites, utilising the NOx from NO_2 calculator provided by DEFRA, and the NOx background concentration (from the DEFRA 1km x 1km background mapping). Monitored NO_2 data has been taken from local authority monitoring and Highways England project specific monitoring (Appendix A.6).

1.1.4. Details of the data used in the verification processes are presented below. The data were limited to the zone within which the traffic model was well validated.

1.1.5. For the Scheme, three verification factors have been derived, relating to the following zones:

- A692 Bus Lane – applied at modelled receptors located alongside the bus lane which was not modelled
- A1 junction 77-78 East – applied at all modelled to the east of the A1 between junctions 77 and 78.
- All other locations

Table 7-1 – Monitored and modelled road NO_x, including sector removed background, for each verification zone

Monitoring Site	Background NOx (Sector Removed)	Monitored NO_2	Monitored Road Contribution to NOx	Modelled Road Contribution to NOx	Ratio Monitored to Modelled
Verification Zone: A692 Bus Lane					
S7_007_0315	19.53	29.46	30.38	13.16	2.309
S8_008_0315	19.53	36.62	46.28	19.90	2.326
Verification factor:					**2.321**
Verification Zone: A1 J77-78 East					
A1SNB_004	17.42	21.69	17.08	8.42	2.029
A1SNB_08_Trip	17.51	28.34	30.63	11.31	2.708
A1SNB_033	19.86	24.84	20.17	12.60	1.601
Verification factor					**2.082**
Verification Zone: Other					
A1	18.25	25.00	31.75	29.71	1.069
G4	19.01	20.60	12.80	10.34	1.238
G12	19.53	20.40	11.83	14.54	0.813
G31	20.01	21.10	12.63	11.24	1.123
G88	24.40	23.90	12.99	15.51	0.837
G89	20.01	22.00	14.41	19.40	0.743
G90	19.53	22.80	16.59	10.46	1.586
G91	20.01	25.70	21.90	27.14	0.807
G95	19.53	18.00	7.17	6.81	1.052

Monitoring Site	Background NOx (Sector Removed)	Monitored NO_2	Monitored Road Contribution to NOx	Modelled Road Contribution to NOx	Ratio Monitored to Modelled
A1BC_026_0815	20.01	28.37	27.46	26.74	1.027
S1_001_0315	18.25	29.59	32.26	25.34	1.273
S3_003_0315	18.25	24.42	21.42	12.59	1.701
S4_004_0315	20.01	24.13	18.69	12.59	1.484
S5_005_0315	18.25	28.33	29.57	28.28	1.046
S6_006_0315_Trip	20.01	29.42	29.70	26.82	1.107
S9_009_0315	19.53	22.19	15.37	16.44	0.935
S10_010_0315	19.36	23.59	18.57	14.74	1.260
S11_011_0315	18.43	36.17	46.70	36.09	1.294
S12_012_0315	19.01	22.95	17.48	11.59	1.509
S13_013_0315	19.01	24.86	21.35	15.53	1.375
S14_014_0315	27.40	21.70	5.00	5.88	0.851
S15_015_0315	21.84	26.37	20.93	14.63	1.430
62.00	18.57	36.00	46.19	23.90	1.933
A1SNB_002	17.42	19.40	12.55	9.88	1.270
A1SNB_003	17.42	21.20	16.10	10.16	1.585
A1SNB_006	17.42	19.63	13.01	11.70	1.112
A1SNB_007	17.42	17.58	9.02	6.13	1.472
A1SNB_010	19.86	24.35	19.17	16.44	1.166
A1SNB_011	18.20	24.01	20.62	15.79	1.306
A1SNB_12_Trip	18.20	24.56	21.74	15.59	1.394

Monitoring Site	Background NOx (Sector Removed)	Monitored NO_2	Monitored Road Contribution to NOx	Modelled Road Contribution to NOx	Ratio Monitored to Modelled
A1SNB_013	19.86	23.61	17.67	15.34	1.152
A1SNB_016	18.31	27.48	27.80	25.89	1.074
A1SNB_017	18.31	24.56	21.74	10.26	2.119
A1SNB_018	18.57	25.88	24.07	18.12	1.329
A1SNB_019	18.57	23.97	20.14	15.07	1.336
A1SNB_020	18.57	30.11	33.05	27.65	1.195
A1SNB_022	18.57	26.31	24.96	20.28	1.231
A1SNB_024	18.04	28.27	29.88	19.02	1.571
A1SNB_025	18.57	46.55	71.85	47.12	1.525
A1SNB_026	18.57	27.55	27.56	20.81	1.324
A1SNB_27_Trip	18.57	28.14	28.82	20.85	1.383
A1SNB_034	19.86	24.06	18.57	13.12	1.415
A1SNB_035	18.57	28.09	28.71	28.92	0.993
A1SNB_037	18.57	26.07	24.47	18.54	1.320
A1SNB_038	18.57	29.85	32.48	22.22	1.462
A1SNB_039	18.57	29.41	31.54	19.92	1.584
A1SNB_040	18.57	33.36	40.20	36.85	1.091
S16_016_0315_Trip	18.75	24.79	21.51	15.03	1.431
S18_018_0315	19.35	27.13	25.56	19.20	1.331
A1SNB_001	15.71	26.11	28.33	19.53	1.451
Verification factor:					**1.255**

1.1.6. The verification factor for each zone represents the linear fit, through zero, to the selected monitored/modelled road contribution to annual mean NOx data points (red lines in Figures A.1 – A.3). Monitored concentrations were eliminated from the verification process for various reasons, but primarily where the monitoring locations were on relatively busy roads not included in the modelling or where the monitoring were at odds with neighbouring/similar sites.

1.1.7. It was noted during the verification that receptors A1SNB_004, A1SNB_08_trip and A1SNB_033 on the eastern side of the A1 between junctions 77 and 78 had measured concentrations much greater than those modelled (Figure A.1). This was likely due to the exclusion of local minor roads from the traffic model (and sources of pollution from the verification process) in the vicinity of these receptors. As a result, a separate verification factor has been applied to these receptors.

1.1.8. Monitored concentrations at receptors S7_007 and S8_008 were also much greater than those modelled, due to the fact the bus lane was not captured in the model, therefore this area was also given its own verification factor (Figure A.2).

1.1.9. After verification, the monitored and modelled total nitrogen dioxide concentrations are compared (Figure A.3). This showed a good fit to the data and no secondary verification factor was required.

Figure 7-1 – Verification graph showing modelled versus monitored road NO_X for the zone 1 domain

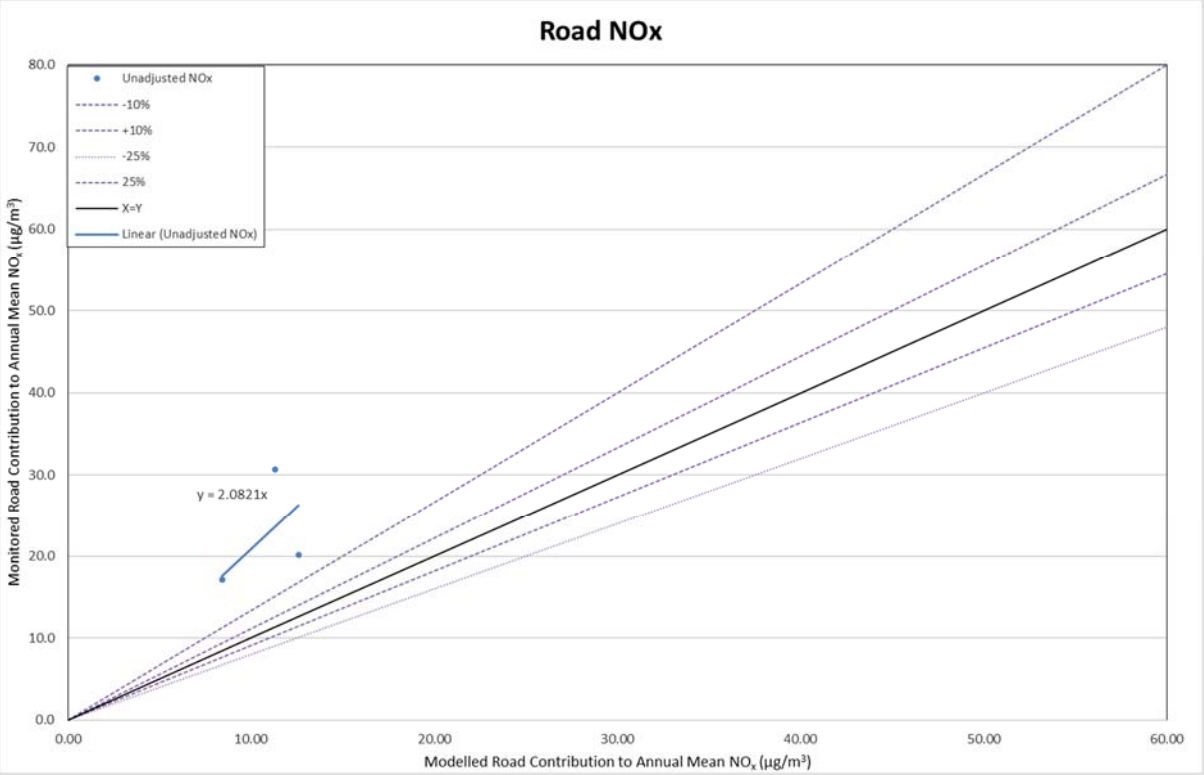


Figure 7-2 – Verification graph showing modelled versus monitored road NO_X for the zone 2 domain

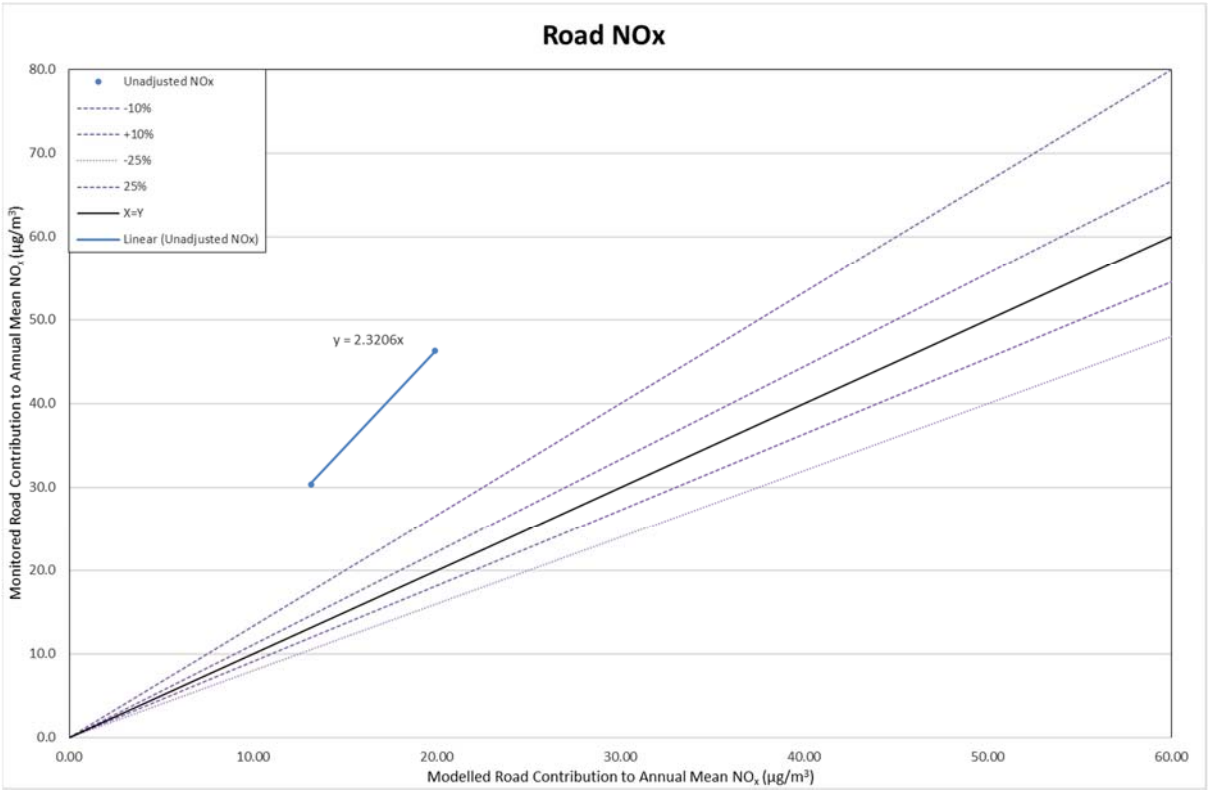
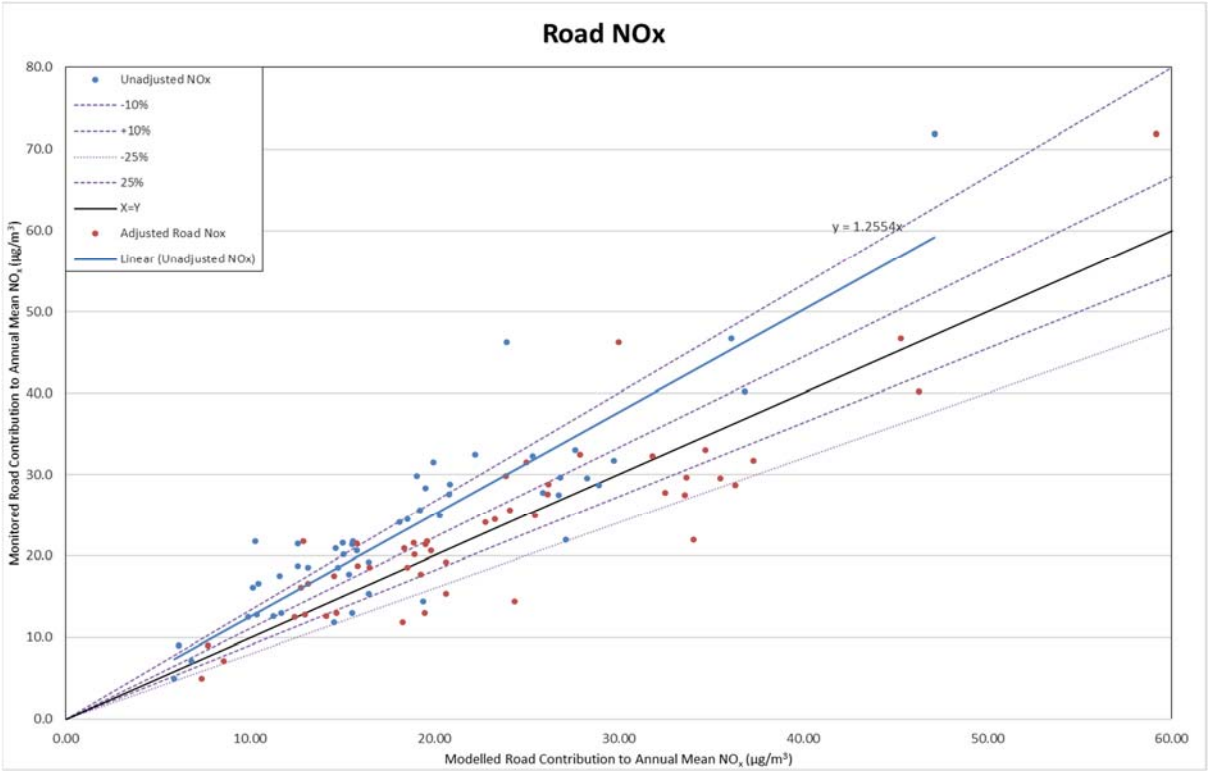


Figure 7-3 – Verification graph showing modelled versus monitored road NO_X for the zone 3 domain



1.1.10. **Table 7-2** presents statistical parameters for describing model uncertainty. The Root Mean Square Error (RMSE) is used to define the average error or uncertainty of the model. The results of the RMSE calculation in this case are concentrations of NO_2 measured in units of micrograms per metre cubed.

1.1.11. Fractional Bias (FB) is used to identify if the model shows a tendency to over or under predict and values can vary between +2 and -2 and have an ideal value of 0. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.

1.1.12. After adjustment the model uncertainty is well within the desired 10% of the relevant objective, with a slight tendency to over-predict in Zone 3 and under-predict in Zone 2.

Table 7-2 - Description of model uncertainty after adjustment

Statistical Parameter	Zone 1	Zone 2	Zone 3	Ideal Value
RMSE	0.05	2.6	2.6	0
Fractional Bias	0.000	0.003	-0.001	0

Note: Values shown to multiple decimal places to show value is not 0, as a value of 0 means the model outputs are perfectly representing monitored concentrations.

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