

A303 Sparkford to Ilchester Dualling Scheme TR010036

6.3 Environmental Statement Appendix 5.3 Model Verification

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Forms and Procedure) Regulations 2009
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Infrastructure Planning

Planning Act 2008

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(Applications: Prescribed Forms
and Procedure) Regulations
2009**

**A303 Sparkford to Ilchester Dualling
Scheme**

Development Consent Order 201[X]

**6.3 Environmental Statement
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Table of Contents

1	Model Verification	1
1.1	Overview	1
1.2	Results	2

1 Model Verification

1.1 Overview

- 1.1.1 Model verification is a process by which checks are carried out to determine the performance of a dispersion model at a local level, primarily by comparison of modelled results with monitoring data. The verification process benefits an assessment by investigating uncertainties and minimising them either through informed refinement of model input parameters or adjustment of the model output if it is deemed necessary.
- 1.1.2 Guidance produced by the Department for Environment Food and Rural Affairs (Defra)¹ provides a methodology for model verification including calculation methods and directions on the suitability of monitoring data.
- 1.1.3 Verification of modelled 2016 annual mean NO₂ concentrations has been undertaken utilising monitoring results from relevant diffusion tube sites within the study area.
- 1.1.4 Background concentrations used in the model verification have been taken from Defra and, following comparison with background air quality monitoring sites, have been uplifted using the factors discussed in section 5.7.32 of Chapter 5 Air Quality (Volume 6.1) and are presented in Table 1.1 below.

Table 1.1: Adjusted Defra background pollutant map data for verification

Grid Square	2016	
	NO _x (µg/m ³)	NO ₂ (µg/m ³)
349500, 120500	10.8	8.5
352500, 123500	11.3	8.8
354500, 123500	13.4	10.2
354500, 125500	10.8	8.4
356500, 124500	11.2	8.7
357500, 125500	10.3	8.0
357500, 126500	8.2	6.5
358500, 125500	10.3	8.1
360500, 126500	12.0	9.3
363500, 126500	10.2	8.0

Note: Background concentrations have been uplifted by a factor of 1.21 (NO_x) and 1.22 (NO₂)

- 1.1.5 Data from South Somerset District Council and the scheme monitoring survey was reviewed (see Appendix 5.2, Volume 6.2 for more details) and only areas representative of receptors used within the assessment have been included in the verification process. No South Somerset District Council sites met this criterion as all the monitoring sites were greater than 7 kilometres from the

¹ Defra (2018) Local Air Quality Management Technical Guidance (TG16) [online] available at: <https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf> (last accessed March 2018).

affected road network (ARN) and therefore were not considered representative of the receptors within the assessment. Therefore, only sites from the scheme specific monitoring survey were used. The exact location of each of the sites selected has been confirmed using street photography and photos taken by the personnel that undertook the surveys.

- 1.1.6 Twelve scheme specific monitoring sites were used for verification. Diffusion tube 007 was excluded from verification as it is not representative of the location of receptors used in the assessment. Diffusion tube 012 was also excluded as the tube was located on a bridge above the existing A303 (greater than 5 metres) and therefore is not considered a representative roadside location.
- 1.1.7 The locations of the monitoring sites used in model verification are indicated in Figure 5.5 contained in Volume 6.3. The scheme monitoring sites were annualised and bias adjusted in accordance with Defra guidance, as described in Appendix 5.4, Volume 6.3. Table 1.2 presents the monitoring data used within the model verification.

Table 1.2: Monitoring data used within model verification

Site ID	OS Grid reference		2016 Annual Mean (NO ₂) µg/m ³
	X	Y	
A303SPAR_001_1215	363096	126330	13.3
A303SPAR_002_1215	360781	126516	11.7
A303SPAR_003_1215	360913	126904	13.3
A303SPAR_004_1215	360471	126423	18.7
A303SPAR_005_1215	358967	125551	19.7
A303SPAR_006_1215	357851	125391	19.8
A303SPAR_008_1215	357724	125321	25.6
A303SPAR_009_1215	357074	125029	28.6
A303SPAR_010_1215	356760	124922	29.7
A303SPAR_011_1215	354621	125071	14.4
A303SPAR_013_1215	354326	123937	13.7
A303SPAR_014_1215	352190	123964	20.8
A303SPAR_015_1215	349768	120271	13.7

1.2 Results

- 1.2.1 Table 1.3 presents a comparison of the monitored and modelled concentrations of NO_x and NO₂ at the diffusion tube sites for the year 2016. There appears to be systematic under prediction of NO₂ concentrations at all locations; model underprediction ranges from 0.7 to 42.7%.

Table 1.3: Unadjusted model verification results

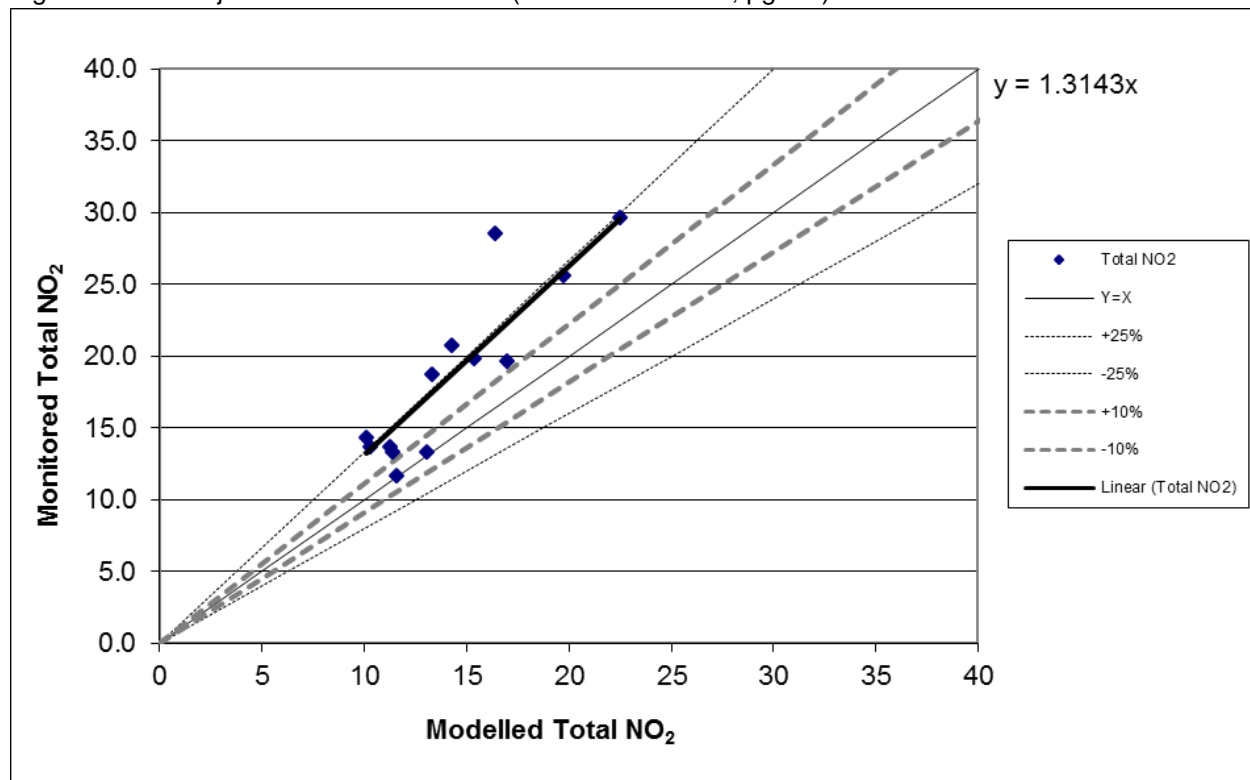
Site ID	Monitored road NO _x (µg/m ³)	Modelled road NO _x (µg/m ³)	Monitored total NO ₂ (µg/m ³)	Modelled total NO ₂ (µg/m ³)	Total NO ₂ % difference
A303SPAR_001_12 15	9.7	6.1	13.3	11.4	-14.5
A303SPAR_002_12 15	4.3	4.1	11.7	11.6	-0.7
A303SPAR_003_12 15	7.4	6.7	13.3	13.0	-2.4
A303SPAR_004_12 15	17.6	7.3	18.7	13.3	-28.8
A303SPAR_005_12 15	21.7	16.4	19.7	16.9	-13.8
A303SPAR_006_12 15	22.1	13.5	19.8	15.4	-22.5
A303SPAR_008_12 15	33.8	21.8	25.6	19.7	-23.1
A303SPAR_009_12 15	40.0	15.4	28.6	16.4	-42.7
A303SPAR_010_12 15	41.1	26.2	29.7	22.5	-24.2
A303SPAR_011_12 15	10.9	3.0	14.4	10.1	-29.7
A303SPAR_013_12 15	6.4	1.8	13.7	11.3	-18.1
A303SPAR_014_12 15	22.6	10.0	20.8	14.3	-31.4
A303SPAR_015_12 15	9.6	3.3	13.7	10.3	-25.0

1.2.2 Table 1.3 and Figure 1.1 present a comparison of the monitored and modelled concentrations of NO_x and NO₂ at the verification sites. Following Defra guidance, modelled and measured road traffic concentrations have been compared to derive a verification factor to apply to the modelled results. As diffusion tubes only measure total NO₂, the road traffic NO_x concentration measured by the diffusion tube was estimated following Defra TG16². Monitored road traffic NO_x was estimated using Version 6.1 of the NO_x to NO₂ calculator³, based on the Defra predicted background NO₂.

1.2.3 Following Defra guidance, a model adjustment factor of 1.71 has been calculated when comparing modelled and monitored road traffic NO_x.

² Defra (2018) Local Air Quality Management Technical Guidance (TG16) [online] available at: <https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf> (last accessed March 2018).

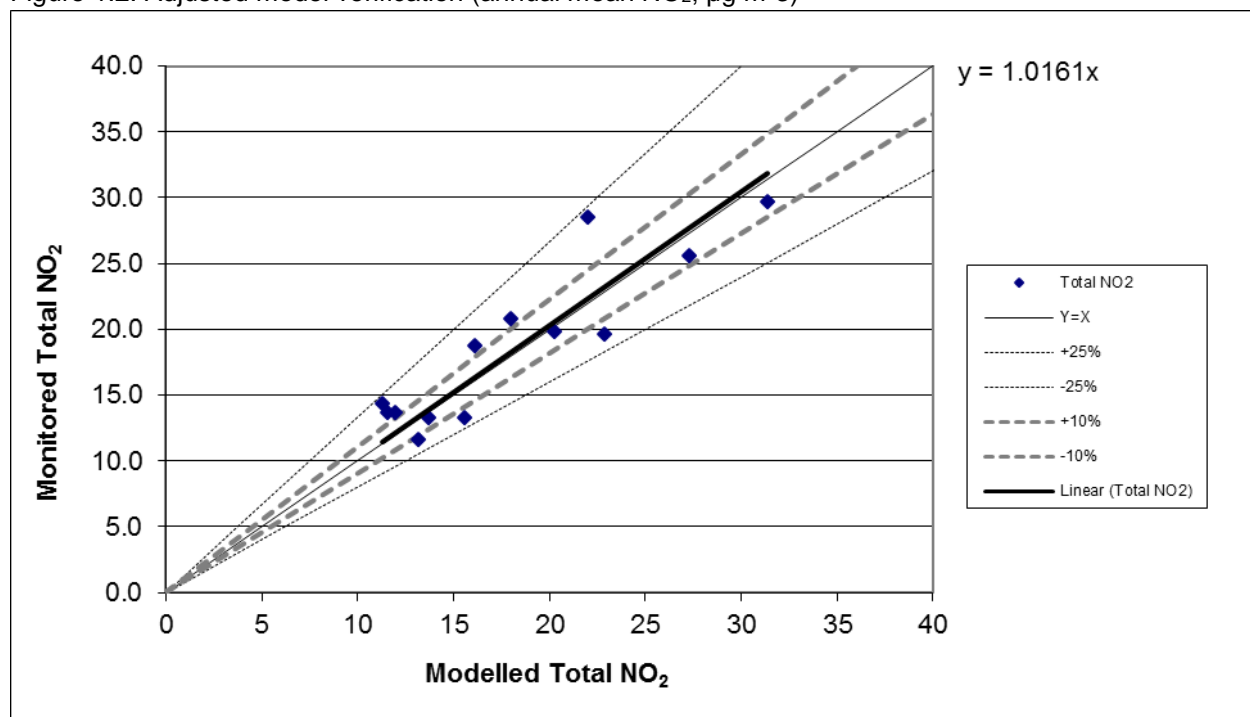
³ Defra (2017) NO_x to NO₂ Calculator, Version 6.1 [online] available at: <https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc> (last accessed March 2018).

Figure 1.1: Unadjusted model verification (annual mean NO₂; µg/m³)

1.2.4 Table 1.4 and Figure 1.2 present the adjusted modelled NO₂ with monitored NO₂ at the verification sites. The model predicts NO₂ concentrations within 10% of the monitored concentrations at four of the 13 sites and predicts NO₂ concentrations within 25% of the monitored concentrations at all sites. The model is therefore performing adequately at these locations following adjustment.

Table 1.4: Adjusted model verification results

Site ID	Monitored total NO ₂ (µg/m ³)	Modelled total NO ₂ (µg/m ³)	% difference
A303SPAR_001_1215	13.3	13.7	3.0
A303SPAR_002_1215	11.7	13.2	12.8
A303SPAR_003_1215	13.3	15.6	16.8
A303SPAR_004_1215	18.7	16.1	-14.0
A303SPAR_005_1215	19.7	22.9	16.3
A303SPAR_006_1215	19.8	20.3	2.4
A303SPAR_008_1215	25.6	27.3	6.6
A303SPAR_009_1215	28.6	22.0	-23.1
A303SPAR_010_1215	29.7	31.4	5.7
A303SPAR_011_1215	14.4	11.3	-21.5
A303SPAR_013_1215	13.7	12.0	-12.8
A303SPAR_014_1215	20.8	18.0	-13.6
A303SPAR_015_1215	13.7	11.6	-15.8

Figure 1.2: Adjusted model verification (annual mean NO₂; µg m⁻³)

- 1.2.5 Table 1.5 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 NO₂ measured in units of micrograms per metre cubed. Table 1.5 shows that before adjustment the model uncertainty was $\pm 5.4 \mu\text{g}/\text{m}^3$ or 13.5% of the annual mean NO₂ objective. After adjustment the model uncertainty is reduced to $\pm 2.8 \mu\text{g}/\text{m}^3$ or 7.0% of the annual mean NO₂ objective. After adjustment the model uncertainty is within the desired 10% of the relevant objective, as recommended by Defra guidance.
- 1.2.6 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. Table 1.5 shows that before adjustment the model is under-predicting annual mean NO₂ concentrations. Following adjustment the model is very close to the desired FB value of 0 with a slight tendency to over-predict.
- 1.2.7 The correlation coefficient (R) is used to measure the linear relationship between modelled and measured data. A value of zero means no relationship and a value of 1 means absolute relationship. The value of R increases slightly from 0.89 to 0.90 following model adjustment.

Table 1.5: Description of model uncertainty

Statistical parameter	Before adjustment	After adjustment	Ideal value
Root mean square Error	5.37	2.77	0
Fractional bias	0.27	0.03	0
Correlation coefficient	0.89	0.90	1

- 1.2.8 The statistical analysis above demonstrates that the model performs adequately versus monitoring data, following adjustment. An adjustment factor of 1.71 has therefore been applied to modelled road NO_x contributions at all receptors.