Appendix H-2 – Modelling Methodology

Introduction

Annual mean concentrations of nitrogen oxides (NO_X) and particulate matter smaller than 10 microns (um) in aerodynamic diameter were predicted using the ADMS-Roads dispersion model (version 4.1). The model uses detailed information regarding traffic flows on the local road network together with meteorological data to predict pollutant concentrations at specific locations identified by the user.

This Appendix presents in detail the modelling methodology applied for the assessment of traffic generated by the Scheme during the construction phase, including discussions on model set up, traffic data and model verification.

Traffic Data

Data on the annual average daily flows, annual average vehicular speeds and proportion of Heavy Goods Vehicles (HGVs) on roads surrounding the scheme were obtained from the 2016 Oxfordshire County Council traffic survey and from DfT monitoring locations, and were elaborated by CH2M traffic engineers. The survey covered 11 roads that are routes for construction traffic.

Estimates of the number construction vehicles that will be operated during the construction phase of the Scheme, expressed as daily HGV movements, were provided for each construction area. HGV movements were also applied to the access tracks to the construction site. **Figure 1** provides an overview of the HGV additions applied to the ARN in the model.

Further information on the traffic data used for the assessment is outlined in the Transport Assessment chapter.

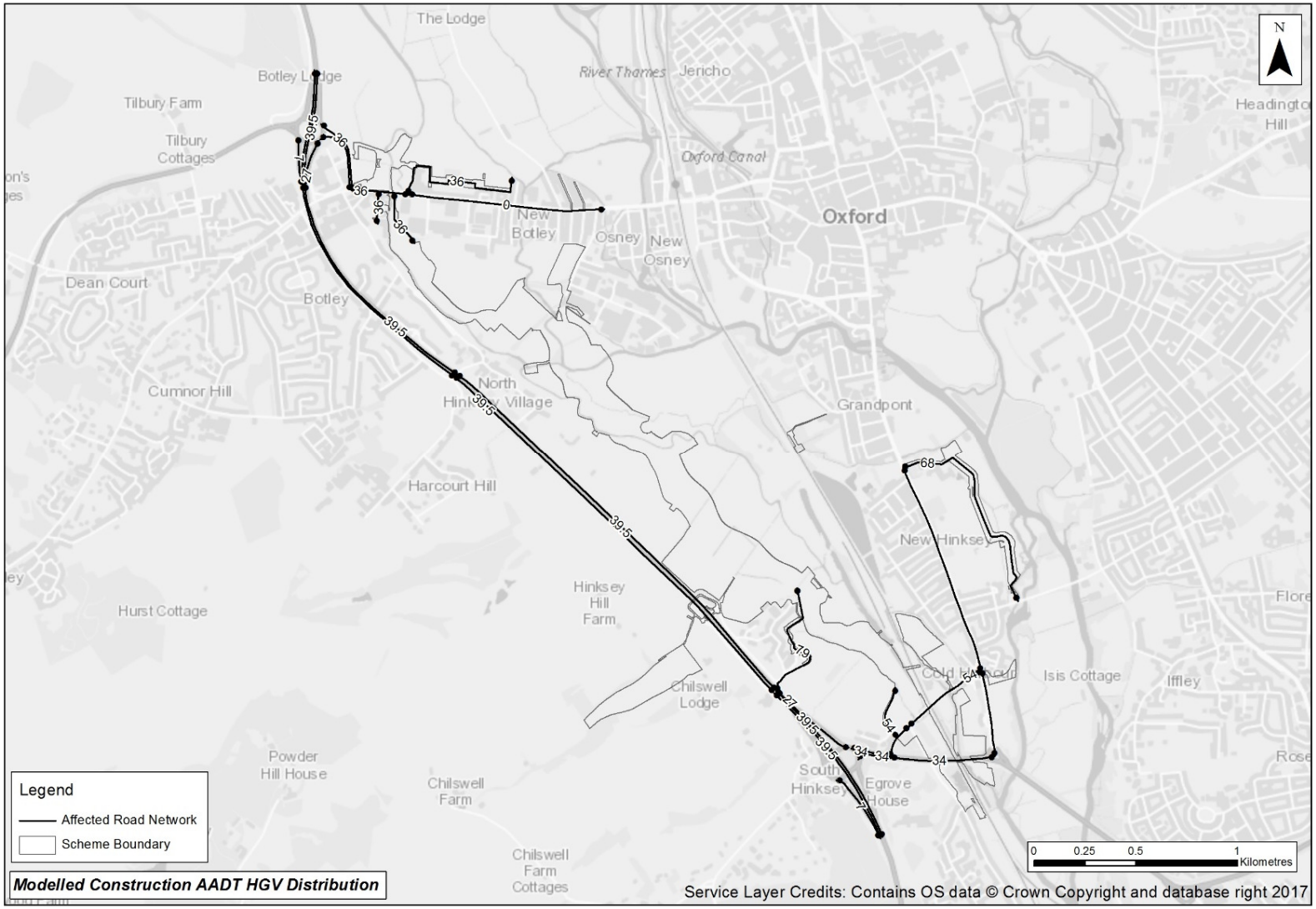

Figure 1: HGV additions to Road Network

Meteorological Data

The model was run using a full year of hourly sequential metrological data for 2016 from the meteorological station at Brize Norton airfield, located 20 km west of the Scheme. Data from the station is representative of the meteorological conditions across the study area, as it is upwind from the scheme with relatively few obstructions. The 2016 wind rose for the area is shown in **Figure 2.** The dominant wind direction was from the west-southwest. A uniform surface roughness length of 0.5 m (representative of urban land use) was assumed across the study area and the meteorological measurement site.

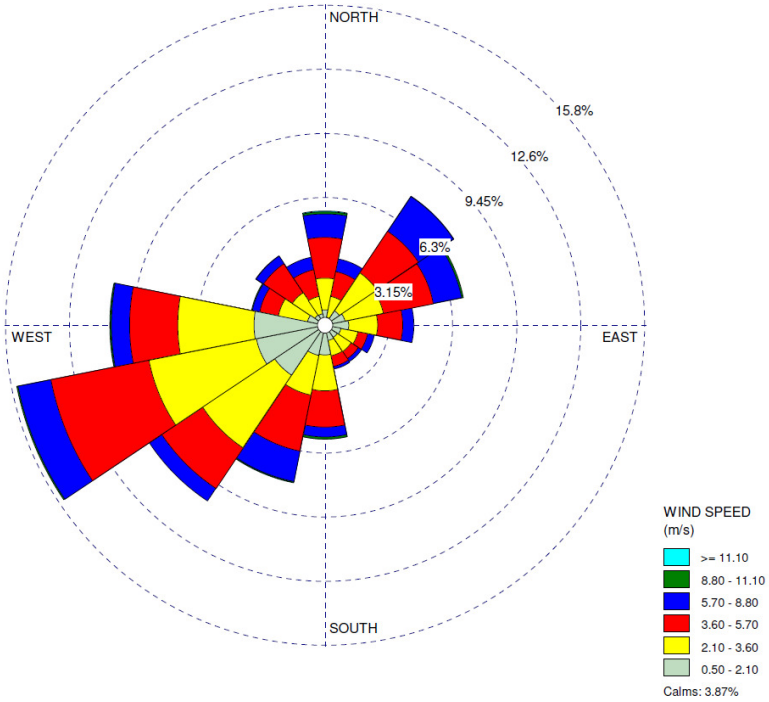

Figure 2: Wind rose representative of the site conditions. Data obtained from Brize Norton airfield for 2016

Modelling Scenarios

For the operational local air quality assessment, the following scenarios were considered:

- Base Case (year 2016)
- Do-Minimum (future baseline, ***without*** the construction phase of any sub-scheme)
- Do-Something (future baseline ***with*** construction phases of each sub-scheme)

The Do-Something scenario, instead of covering the operation of the scheme (which is anticipated to have no significant impacts on local air quality), covers the impacts on local air quality from construction HGV movements on local roads, and impacts associated with the closure of Old Abingdon Road and the consequential redistribution of traffic to other local roads. Construction HGVs have been treated differently from the rest of the traffic. Emissions from construction HGVs have been estimated using the

'Euro User' advanced option of the Defra's latest Emissions Factor Toolkit (EFT version 8, November 2017), which allows the user to define the proportion of each Euro standard for each category of vehicle. Following Oxford City Council recommendations, construction HGVs have been all Euro V. This was deemed conservative as it is likely that HGVs operating during the construction phase will be all Euro VI, resulting in the higher contributions of road NO_X and PM_{10} during the construction phase of the scheme.

Emission Factors

The EFT provides emission rates for 2015 through to 2030 based on national road fleet composition estimates from the National Atmospheric Emissions Inventory (NAEI). EFT emission factors are taken from the European Environment Agency's COPERT 5 emissions model, which accounts for more up-to-date, real-world emission performance of Euro 5 and 6 vehicles.

Background Concentrations

Background pollutant concentrations are spatially and temporally variable throughout the UK. Background NO_2 and PM_{10} concentrations have been used for the base and year (2016) scenario. Background pollutant concentrations were obtained from Defra Local Air Quality Management Website (https://uk-air.defra.gov.uk/data/laqm-background-home), which provide modelled predictions based on a grid at a resolution of 1 km^2 across the UK.

Defra Technical Guidance (TG16) recommends the use of the national background mapping and a comparison with background monitoring data if available. Background monitoring sites from Oxford City Council (OCC) and Vale of White Horse District Council (VWHDC) were compared to Defra mapped background mapped data. Only three background monitoring sites were available in OCC: CM1 – St. Aldate's (Oxford Centre AURN), CM2 – High Street, and CM3 – St. Ebbe's. All sites are located within Oxford city centre, and are therefore unrepresentative of the OFAS study area. Defra background mapping data were used instead as suitable background concentrations.

The background concentrations used in this assessment were based on projected 2016 Defra backgrounds as a conservative approach. Major road contributions were subtracted from the total background NO_X concentration to avoid double counting (using the Defra NO_2 Adjustment for NO_X Sector Removal Tool v6.0, 2017). In-square motorway, trunk A-road, and primary A-road sector contributions were subtracted from the total background PM_{10} for consistency.

NO_X to NO_2 Conversion Factors

Modelled road-traffic NO_X was converted to NO_2 using Version 6.1 of the Defra NO_X to NO_2 calculator. The calculator considers the difference between vehicular and background NO_X, the concentration of ozone (O_3) (to oxidise NO to NO_2), and the different proportions of primary (directly emitted) NO_2 in different years.

Model Verification

Prior to assessing the operational local air quality impacts at worst-case identified receptors, a verification process was carried out for the Base Case scenario to validate the model predictions against available monitoring data within the study area. Following Defra TG16 guidance, the verification process for this study takes into account a comparison of predicted and measured road-traffic contributions to NO_X and NO_2 concentrations in an attempt to assess and evaluate the performance of the model.

A total of eight monitoring locations, consisting of both automatic and diffusion tube sites, were considered within this verification process. The ADMS model was used to predict the contribution of road-traffic to NO_X concentrations at these eight locations. The monitoring sites used in this verification process have been sifted down following Defra TG16 guidance, based on their site location (with only roadside sites being considered appropriate for the model validation). Initial modelled versus monitored results for total NO_2 concentrations are presented in **Table 1**.

Due to the large geographic extent of the affected road network assessed for the Scheme, and the spatial variability of pollutant concentrations in and around Oxford, the verification process was split up into four areas. The four verification areas included:

- Verification Zone 1: Northern A34 Corridor;
- Verification Area 2: Southern A34 Corridor;
- Verification Area 3: Botley Road, and;
- Verification Area 4: A4144, A423, and Abingdon Road.

Table 1: Unadjusted Annual Mean Modelled and Monitored Total NO_2 Concentrations ($\mu g\ m^{-3}$) at Monitoring Sites in Study Area

Site Id	Council	Verification Section	Monitored NO_2	Unadjusted Modelled NO_2	% Difference Model vs Measured
S1	VWHDC	Zone 2	30.3	28.2	-6.9
S2	VWHDC	Zone 1	28.8	23.3	-19.1
S3	VWHDC	Zone 1	**57.4**	32.6	-43.2
S4	VWHDC	Zone 1	35.2	24.2	-31.3
DT2	OCC	Zone 4	34.0	22.5	-33.8
DT3	OCC	Zone 4	38.0	28.9	-23.9
DT36	OCC	Zone 3	35.0	18.5	-47.1
DT37	OCC	Zone 3	22.0	21.0	-4.5
*Exceedances with the Annual mean NO_2 objective of 40 $\mu g\ m^{-3}$ are shown in **bold**.*					

Figure 2 presents a map of the extent of each verification area, and the monitoring sites included in the verification process for each area. The A34 was divided into north and southern sections by the junction for North Hinksey Lane for consistency with the Oxfordshire County Council and DfT traffic surveys.

After reviewing monitoring sites, site DT2 was excluded from the verification process. The site was found to be kerbside, which according the Defra TG(16) guidance is not suitable for verification. In addition, DT2 is located along Weirs Lane, which is not included the road network that has been modelled.

In the following sub-sections, modelled versus measured road NO_x concentrations have been used to obtain a model verification factor for each verification area. The gradient for the line of best fit through an intercept of zero is the verification factor for each area, which was applied to the Road-NO_X contribution output from the ADMS model.

The adjusted modelled Road-NO_X was then converted back to road-NO_2 (using the NO_X-to-NO_2 calculator v5.1) and added to the background contribution to obtain a total modelled NO_2 concentration. The final comparison between the total modelled and monitored NO_2 concentration indicates whether the verification process was sufficient to adjust the modelled NO_2 concentrations. Based on Defra TG16

guidance, the verification should ideally produce modelled concentrations within ± 25% of monitored concentrations and ideally within ± 10% for monitors exceeding the AQS Objective.

Following Defra TG16, the verification factor derived in each section for road traffic NO_X was also applied to road traffic PM_{10} concentrations as there were no monitoring sites to verify PM_{10} concentrations in the study area. This was considered a conservative approach for verifying PM_{10} results. The discussion of the verification process for each area is described in the sub-sections below.

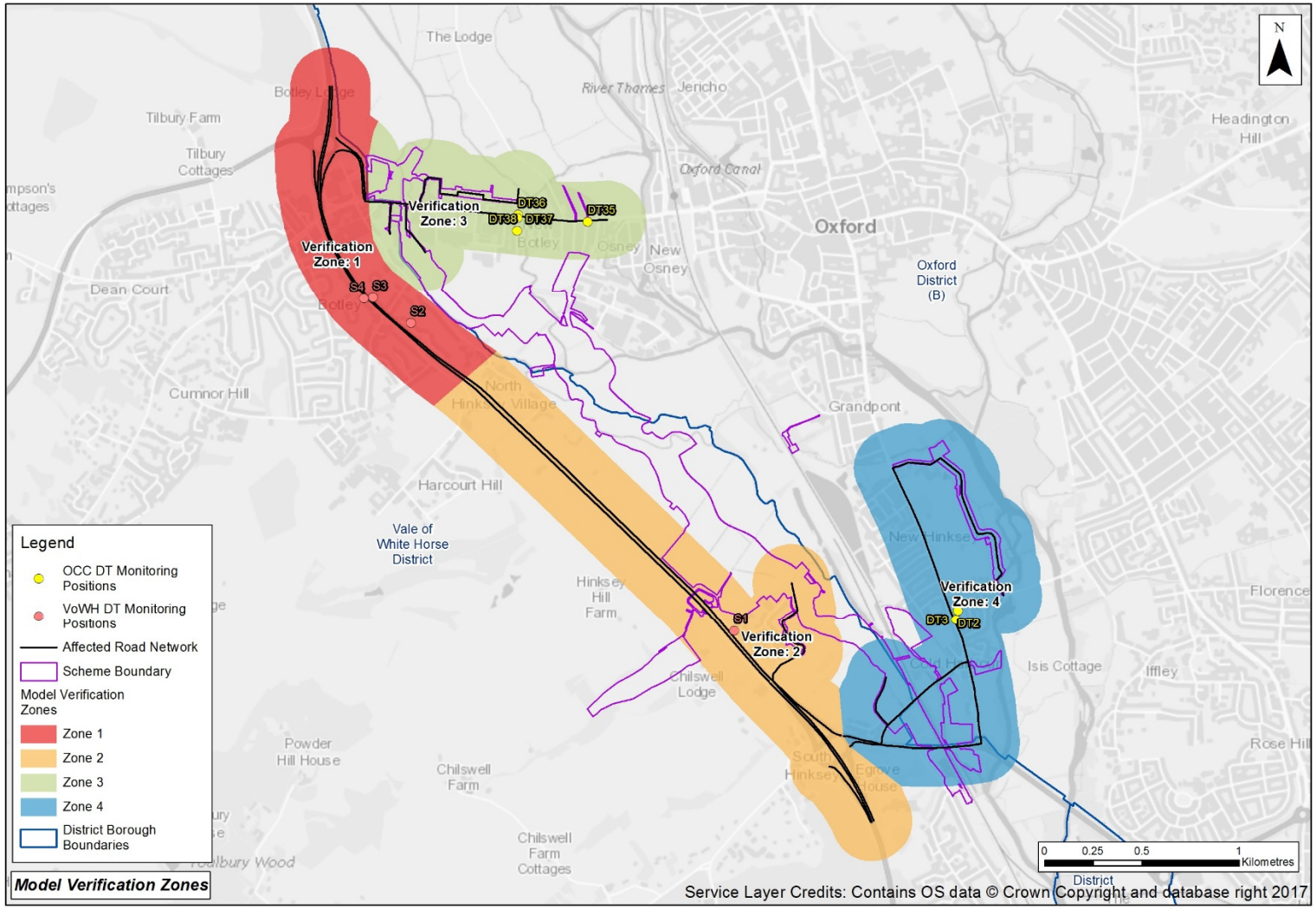

Figure 2: Map of the geographic extent of each verification zone and the associated monitoring sites for the Oxford Flood Alleviation Scheme.

Verification Zone 1: Northern A34 Corridor

Unadjusted monitored and modelled Road-NO_X for sites in the A3024 Corridor area are plotted in **Figure 3** below. The model underpredicted the Road-NO_X contribution for all three sites by more than 25% due to the number of road sources with traffic data availability. The verification factor applied to the sites in the northern A34 Corridor area is presented in below, as **2.19**.

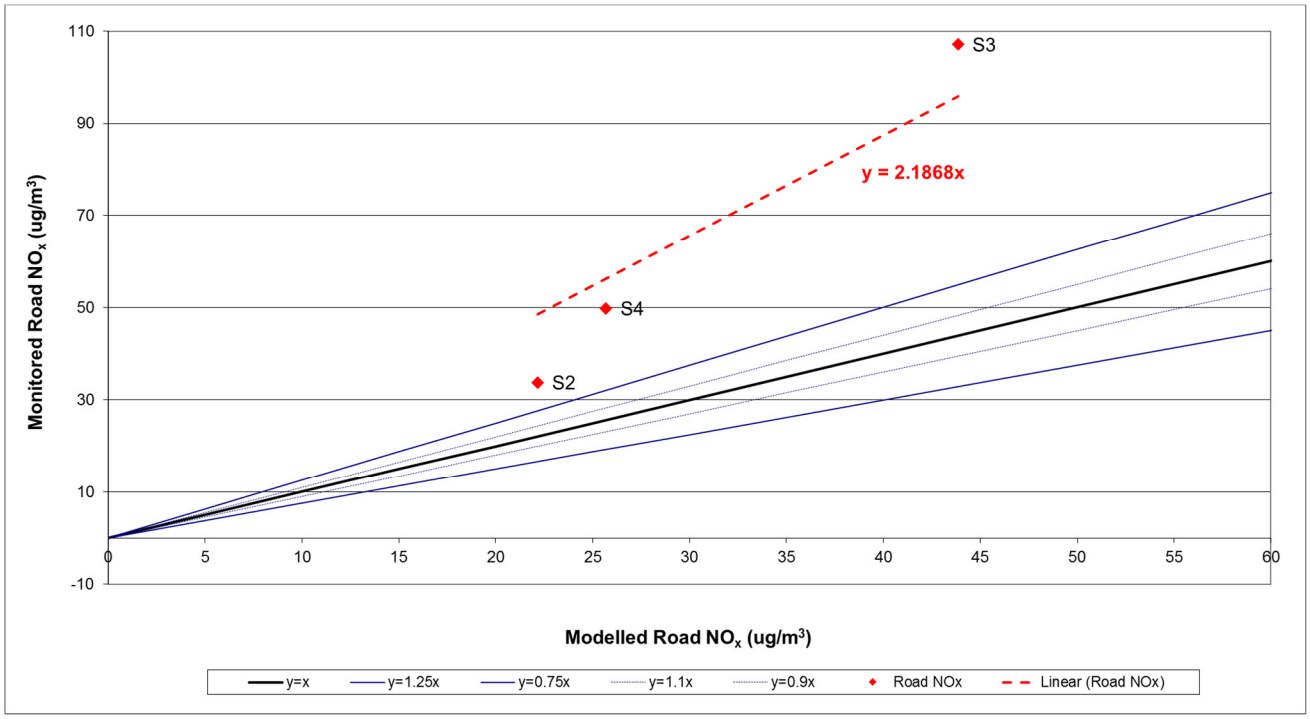

Figure 3: Modelled versus Monitored Road NOx Concentrations (µg/m³) in the A3024 corridor section

The conversion of the adjusted (verified) Road-NO_X concentration to Road-NO_2 was added to the background NO_2 to obtain the total adjusted-modelled NO_2 concentration. The adjusted modelled versus monitored total NO_2 concentrations are shown in **Table 2** and are plotted in **Figure 4**.

Table 2: Adjusted Annual Mean Modelled and Monitored Total NO_2 Concentrations (µg m^{-3}) at Monitoring Sites in the A34 Corridor

Site Id	Council	Monitored NO_2	Adjusted Modelled NO_2	% Difference Model vs Measured
S2	VWHDC	28.8	35.4	22.9%
S3	VWHDC	57.4	53.4	-7.0%
S4	VWHDC	35.2	37.9	7.8%

All the adjusted modelled results are within ± 25% of the monitored concentrations, with the majority within ± 10%, with the exception of site S2, which is overpredicting by approximately 23%.

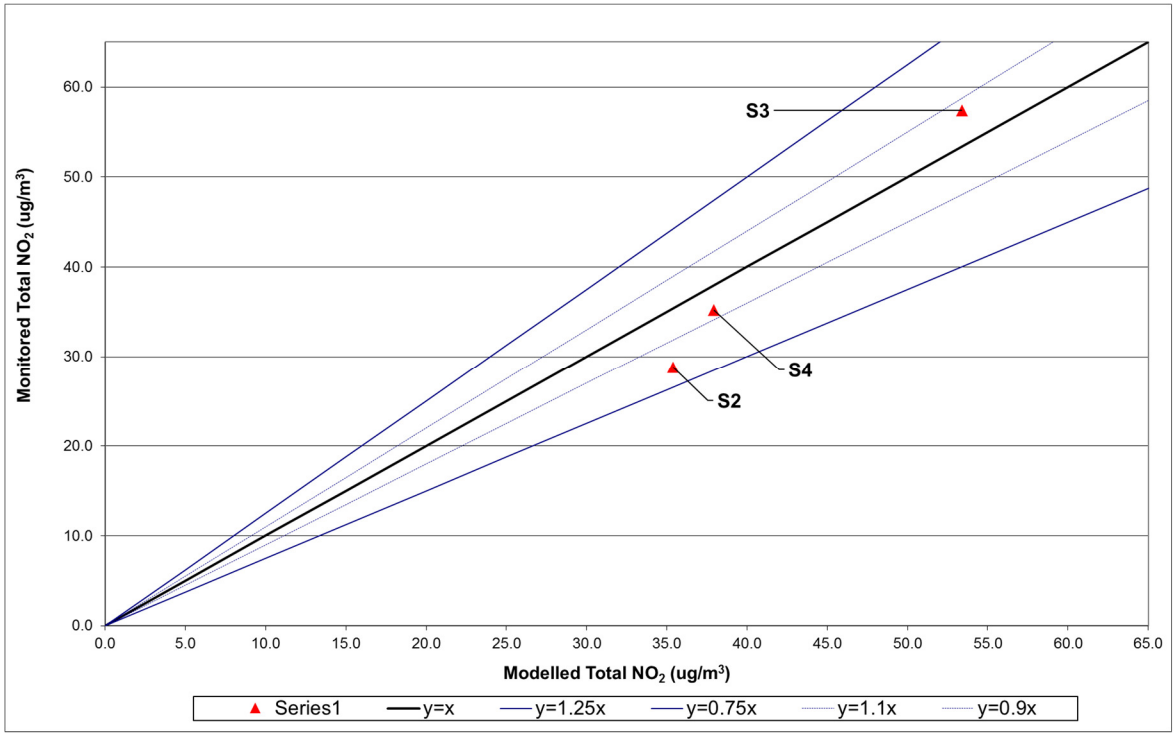

*Figure 4: **Adjusted Modelled versus Monitored Total NO_2 Concentrations ($\mu g/m^3$) in the A34 Corridor area***

Verification Area 2: Southern A34 Corridor

Figure 5 presents the unadjusted modelled versus measured Road-NO_X for site S1 within the southern A34 Corridor zone. The model slightly underpredicted the Road-NO_X contribution at S1 by roughly 12%. The verification factor applied to the Southampton city centre section is presented in below, as **1.14**.

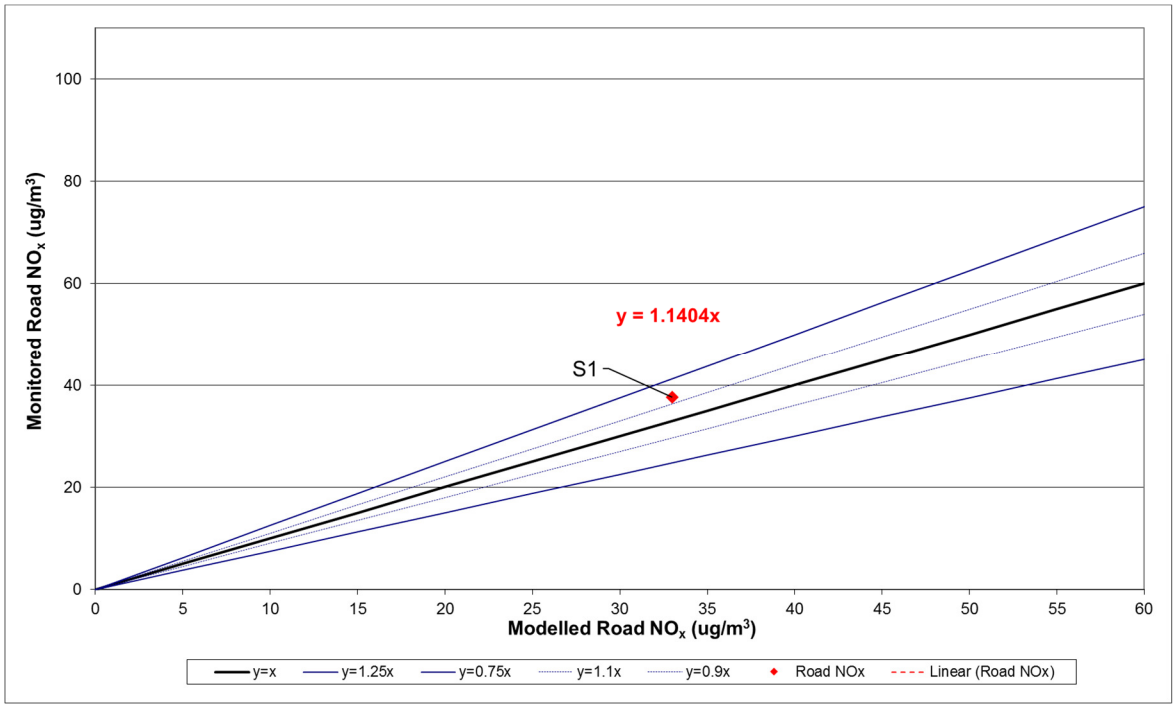

Figure 5: Modelled versus Monitored Road NO_X Concentrations ($\mu g/m^3$) in the Southampton city centre section

The conversion of the adjusted (verified) Road-NO_x concentration to Road-NO_2 was added to the background NO_2 to obtain the total adjusted-modelled NO_2 concentration. Post-verification, the adjusted-modelled and measured (monitored) total NO_2 concentrations were equivalent.

Verification Area 3: Botley Road

Figure 6 shows that the ADMS model underpredicted Road-NO_X at all sites along Botley Road. The modelled value at DT37 was within 25% of the measured value, however at DT36 underpredicted well under 25%. The verification factor applied to account for the underprediction is presented below as **2.07**.

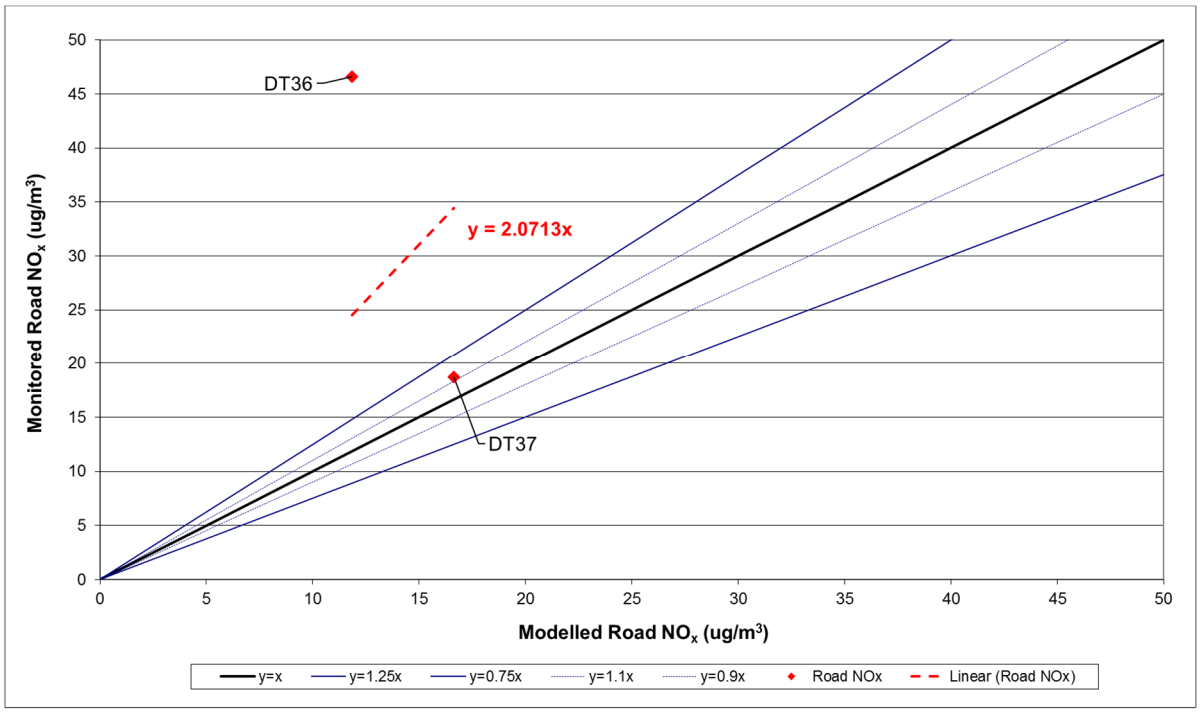

Figure 6: Modelled versus Monitored Road NO_X Concentrations ($\mu g/m^3$) in the Onslow Road section

The conversion of the adjusted (verified) Road-NO_X concentration to Road-NO_2 is added to the background NO_2 to obtain the total adjusted-modelled NO_2 concentration. The adjusted modelled versus monitored total NO_2 concentrations are shown in **Table 3** and are plotted in **Figure 7**.

Table 3: Adjusted Annual Mean Modelled and Monitored Total NO_2 Concentrations ($\mu g\ m^{-3}$) at Monitoring Sites in the Onslow Road section

Site Id	Council	Monitored NO_2	Adjusted Modelled NO_2	% Difference Model vs Measured
DT36	OCC	35.0	24.8	-29.0%
DT37	OCC	22.0	29.5	34.3%

All the adjusted modelled results are outside ± 25% of the monitored NO_2 concentrations. Post-verification, the modelled total NO_2 concentration at DT37 is roughly 34% greater than the monitored value due to the over-compensation of the adjustment of the large concentration underprediction at DT36. DT36 still underpredicted by roughly 30% after adjustment.

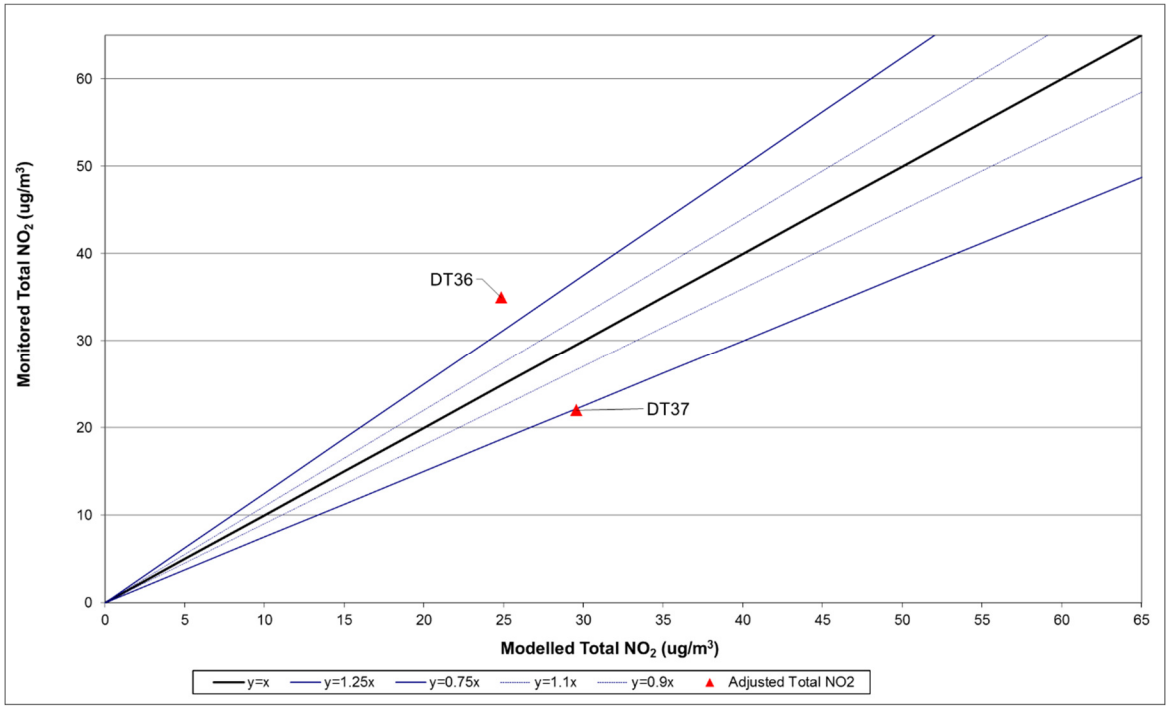

Figure 7: Adjusted Modelled versus Monitored Total NO_2 Concentrations ($\mu g/m^3$) in the Onslow Road area

Verification Area 4: A4144, A423 and Abingdon Road

One site was available for verification in the A4144, A423 and Abingdon Road Zone. Site DT3 underpredicted the Road-NO_X concentration by over 40%. The unadjusted modelled versus measured Road-NO_x for DT3 is presented in **Figure 8** below. The verification factor applied to this zone is **1.76**.

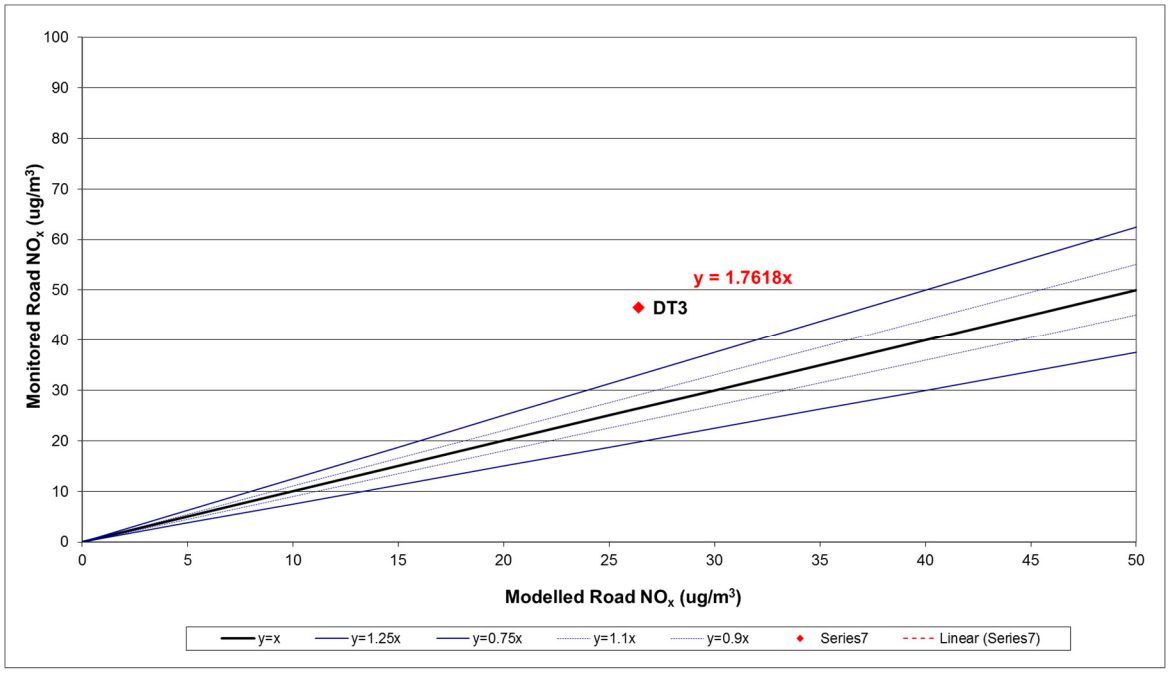

Figure 8: Modelled versus Monitored Road NOx Concentrations ($\mu g/m^3$) in the A33 Corridor section

The conversion of the adjusted (verified) Road-NO_X concentration to Road-NO_2 was added to the background NO_2 to obtain the total adjusted-modelled NO_2 concentration. Post-verification, the adjusted-modelled and measured (monitored) total NO_2 concentrations were equivalent.