Detailed Assessment of Air Quality at Bushey High Street and Shenley Road for Hertsmere Borough Council

June 2015

Experts in air quality management & assessment

Document Control

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Job Number	J2235

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Document Status and Review Schedule

Report No.	Date	Status	Reviewed by
J2235/1/F1	23 June 2015	Final	Prof. Duncan Laxen (Managing Director)

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Contents

Hertsmere Borough Council confirms that it accepts the recommendations made in this report.

1 Introduction

1.1 Air Quality Consultants Ltd has been commissioned by Hertsmere Borough Council to undertake a Detailed Assessment of air quality within two areas of Hertsmere. In 2012, Hertsmere Borough Council completed an air quality Updating and Screening Assessment, which concluded that a Detailed Assessment was required as a result of measured exceedences of the nitrogen dioxide annual mean objective along Bushey High Street, Bushey and Shenley Road, Borehamwood.

1.2 The aim of this Detailed Assessment is to determine whether the annual mean nitrogen dioxide objective continues to be exceeded at relevant locations and, if so, the extent of exceedences and thus the boundary of the Air Quality Management Area (AQMA) required.

Background

1.3 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Defra, 2007) sets out a framework for air quality management, which includes a number of air quality objectives. National and international measures are expected to achieve these objectives in most locations, but where areas of poor air quality remain, air quality management at a local scale has a particularly important role to play. Part IV of the Environment Act 1995 requires local authorities to periodically review and assess air quality in their areas. The role of this process is to identify areas where it is unlikely that the air quality objectives will be achieved. These locations must be designated as AQMAs and a subsequent Air Quality Action Plan (AQAP) developed in order to reduce pollutant emissions in pursuit of the objectives.

1.4 Review and Assessment is a long-term, ongoing process, structured as a series of 'rounds'. Local Authorities in England, Scotland and Wales have now completed the first, second, third and fourth rounds of Review and Assessment, with the fifth round well underway.

1.5 Technical Guidance for Local Air Quality Management (LAQM.TG(09)) (Defra, 2009) sets out a phased approach to the Review and Assessment process. This prescribes an initial Updating and Screening Assessment (USA), which all local authorities must undertake. It is based on a checklist to identify any matters that have changed since the previous round. If the USA, or subsequent Progress Reports, identify any areas where there is a risk that the objectives may be exceeded, which were not identified in the previous round, then the Local Authority should progress to a Detailed Assessment.

1.6 The purpose of the Detailed Assessment is to determine whether an exceedence of an air quality objective is likely and the geographical extent of that exceedence. If the outcome of the Detailed Assessment is that one or more of the air quality objectives are likely to be exceeded, then an Air Quality Management Area (AQMA) must be declared.

1.7 This report represents a Detailed Assessment in the fifth round of Review and Assessment. It follows the findings of monitoring in 2012, which concluded that there were measured concentrations that exceeded the annual mean nitrogen dioxide objective value of 40 μg/m^3, along Bushey High Street, Bushey and Shenley Road, Borehamwood.

The Air Quality Objectives

1.8 The Government's Air Quality Strategy (Defra, 2007) provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment. The 'standards' are set as concentrations below which health effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of a particular pollutant. The 'objectives' set out the extent to which the Government expects the standards to be achieved by a certain date. They take account of the costs, benefits, feasibility and practicality of achieving the standards. It also sets out how the different sectors: industry, transport and local government, can contribute to achieving the air quality objectives. The objectives are prescribed within The Air Quality (England) Regulations 2000 (Stationery Office, 2000) and The Air Quality (England) (Amendment) Regulations 2002 (Stationery Office, 2002).

1.9 Table 1 summarises the objectives which are relevant to this report. Appendix 1 provides a brief summary of the health effects of nitrogen dioxide.

Table 1: Air Quality Objectives for Nitrogen Dioxide

Pollutant	Time Period	Objective
Nitrogen Dioxide	1-hour mean	200 μg/m^3 not to be exceeded more than 18 times a year
	Annual mean	40 μg/m^3

1.10 The air quality objectives only apply where members of the public are likely to be regularly present for the averaging time of the objective (i.e. where people will be exposed to pollutants). For annual mean objectives, relevant exposure is limited to residential properties, schools and hospitals. The 1-hour objective applies at these locations as well as at any outdoor location where a member of the public might reasonably be expected to stay for 1 hour or more, such as shopping streets, parks and sports grounds, as well as bus stations and railway stations that are not fully enclosed.

1.11 Measurements across the UK have shown that the 1-hour nitrogen dioxide objective is unlikely to be exceeded unless the annual mean nitrogen dioxide concentration is greater than 60 μg/m^3 (Defra, 2009). Thus exceedences of 60 μg/m^3 as an annual mean nitrogen dioxide concentration are used as an indicator of potential exceedences of the 1-hour nitrogen dioxide objective.

2 Assessment Methodology

Monitoring

2.1 Nitrogen dioxide monitoring was carried out in the study areas by Hertsmere Borough Council using two automatic monitoring sites and a number of passive diffusion tube sites in 2014. The monitoring sites within the study areas are shown in Figure 1 and Figure 2 and concentrations are presented in Table 2.

2.2 The urban background automatic monitor at Hertswood School, Borehamwood operated for all of 2014 whilst the nearby Hertsmere Borehamwood Roadside monitor only commenced operation in September 2014. As such, the data from Borehamwood Roadside monitor have been annualised to provide an annual mean equivalent value, in accordance with the guidance set out in Box 3.2 of LAQM.TG(09). Details are provided in Appendix A3.

2.3 Diffusion tubes were prepared and analysed by Gradko International Ltd using the 20% TEA in water method. It is necessary to adjust diffusion tube data to account for laboratory bias. In its Review and Assessment reports between 2010 and 2013, Hertsmere Borough Council has consistently adjusted its diffusion tube results using national bias-adjustment factors. The national bias adjustment factor for 2014, based on 16 studies, from the database of national factors provided on the Review and Assessment Helpdesk website (spreadsheet version 03/15) was 0.91. This has been applied to the raw 2014 diffusion tube data to provide the adjusted data presented in Table 2.

2.4 A triplicate co-location study was carried out in 2014 at the Hertswood School, Borehamwood automatic monitor. The locally derived bias-adjustment factor for this study was found to be 0.92. Given the historical use of the national bias-adjustment factor and the good agreement between the national and local bias-adjustment factors, it is considered appropriate to apply the national bias-adjustment factor for 2014.

Modelling

2.5 Annual mean nitrogen dioxide concentrations have been predicted using detailed dispersion modelling (ADMS-Roads v3.4). The model outputs have been verified against the monitoring data described above and shown in Table 2, in Section 3. Details of the modelling methodology and verification are provided in Appendix A2.

2.6 Concentrations have been predicted at specific address point receptors within both study areas. In addition, concentrations have been predicted for a grid of receptors around the Shenley Road study area to allow concentration isopleths to be plotted.

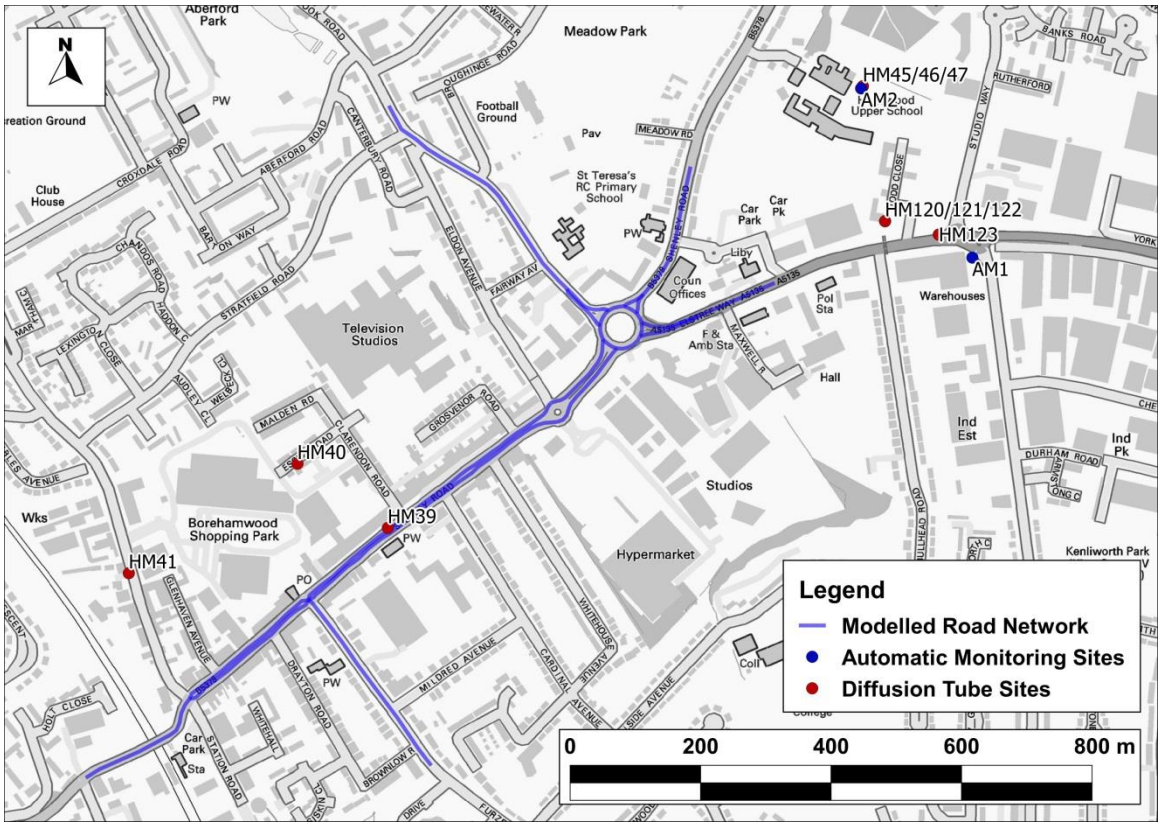

Figure 1: Detailed Assessment Monitoring Locations and Modelled Roads in the Shenley Road Study Area

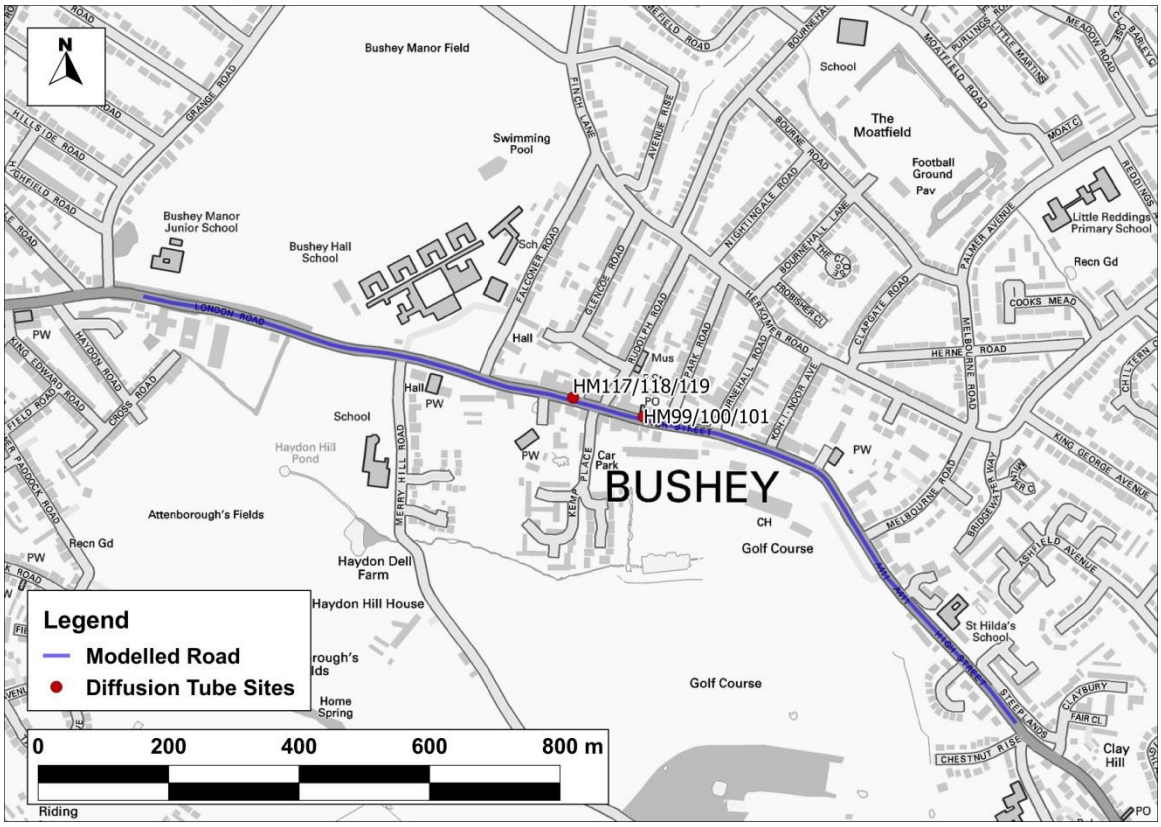

Figure 2: Detailed Assessment Monitoring Locations and Modelled Roads in the Bushey High Street Study Area

National Background Pollution Maps

2.7 The background concentrations across the study area have been defined using the national pollution maps published by Defra (2014). The derivation of background concentrations is described in Appendix A2.1. The background concentrations are all well below the objectives.

Table 1: Estimated Annual Mean Background Pollutant Concentrations in the Study Areas for 2014 (µg/m^3)

Year	NO_2
Shenley Road Study Area	20.8
Bushey High Street Study Area	19.3
Objectives	**40**

3 Results

Monitoring

3.1 Monitoring data for the period 2010 to 2014 for sites within the study areas (Figure 1 and Figure 2) are summarised in Table 2. The two automatic monitors and HM39–41, HM45/46/47, HM120/121/122 and HM123/124/125 diffusion tube monitoring sites are situated within the Shenley Road study area. The HM99/100/101 and HM117/118/119 diffusion tube sites are within the Bushey High Street study area. Concentrations recorded at these diffusion tube monitoring sites in 2014 have been adjusted using a national bias-adjustment factor of 0.91.

Table 2: Summary of Nitrogen Dioxide (NO_2) Monitoring (2010-2014) [a]

Site No.	Site Type	Location	2010	2011	2012	2013	2014
Automatic Monitors - Annual Mean (µg/m^3)							
AM1	Roadside	Hertsmere Borehamwood Roadside	-	-	-	-	**42.7** [b]
AM2	Urban Background	Hertswood School, Borehamwood	-	-	-	-	25.2
Objective			**40**				
Automatic Monitors - No. of Hours > 200 µg/m^3							
AM1	Roadside	Hertsmere Borehamwood Roadside	-	-	-	-	1 (166)
AM2	Urban Background	Hertswood School, Borehamwood	-	-	-	-	0
Objective			**18 (200 – 99.79th Percentile if low data capture)** [c]				
Diffusion Tubes - Annual Mean (µg/m^3) [d]							
HM39	Roadside	117 Shenley Road Borehamwood	**57**	**47**	**55**	**52**	**51.8**
HM40	Roadside	17 Essex Road Borehamwood	28	25	29	27	26.1
HM41	Roadside	39 Theobald Street Borehamwood	36	33	37	36	35.4
HM45/46/47	Urban Background	AQMS 1/2/3	26	24	25	27	25.2 [e]
HM99/100/101	Roadside	84 High Street 1/2/3, Bushey	**49**	**46**	**50**	**56**	**43.2** [e]

Site No.	Site Type	Location	2010	2011	2012	2013	2014
HM117/118/119	Roadside	44 High Street, Bushey 1/2/3	**45**	**40**	**46**	**50**	**44.5** [e]
HM120/121/122	Roadside	Mills Court, Todd Close 1/2/3	-	-	-	29	31.6 [e]
HM123/124/125	Roadside	Studio Plaza, Elstree Way 1/2/3	-	-	-	**46**	**47.1** [e]
Objective			**40**				

[a] Exceedences of the objectives are shown in bold.

[b] Monitoring at this site started on 15th September 2014, so data has been annualised in accordance with the guidance set out in Box 3.2 of LAQM.TG(09). Further details are provided in Appendix A3. Based on such a short period, the value should be treated as indicative.

[c] Values in brackets are 99.79th percentiles, which are presented where data capture is <75%.

[d] 2010 – 2013 data have been taken from the 2014 Progress Report (Hertsmere Borough Council, 2014).

[e] Average of triplicate diffusion tubes.

3.2 The annual mean objective has consistently been exceeded at both of the triplicate diffusion tube sites within the Bushey High Street study area between 2010 and 2014. These sites are both roadside sites situated on posts within an urban street canyon. Due to the design of the street, some building façades within the street canyon are closer to the road than these monitoring sites. As sensitive receptors within the street canyon are at the first floor level, it is not immediately clear whether exceedences would be expected at sites with relevant exposure. Neither of these sites has measured concentrations exceeding 60 µg/m^3 between 2010 and 2014, and thus exceedences of the 1-hour objective are unlikely.

3.3 Within the Shenley Road study area, exceedences of the annual mean nitrogen dioxide objective have consistently been recorded at the HM39 roadside diffusion tube monitoring site. This tube is situated along the busy high street section of Shenley Road, and it is therefore likely that concentrations of nitrogen dioxide will exceed the objective at ground-floor façades along this section of Shenley Road. Whilst there is no relevant exposure at ground level along this section of Shenley Road, concentrations may be exceeded at the first-floor level at the façades of residential properties.

3.4 Concentrations at the roadside diffusion tube site HM41 on Theobald Street, situated off Shenley Road, have remained below 40 µg/m^3 and as such it is considered that concentrations at the façades of properties along Theobald Street are unlikely to exceed the objective value.

3.5 Monitoring sites in background locations within the Shenley Road study area, including AM2 and HM45/46/47, or along roads with lower traffic flows, including HM40 and HM120/121/122, have consistently remained below the objective. The roadside automatic monitoring site AM1 and

diffusion tube HM123/124/125 along Elstree Way are both near to a double roundabout with significant traffic flows, and as such have recorded concentrations above the objective value. None of the monitoring sites within the Shenley Road study area have measured concentrations exceeding 60 µg/m^3.

Modelling

Bushey High Street

3.6 Annual mean nitrogen dioxide concentrations have been predicted in 2014 at each of the receptor locations along Bushey High Street shown in Figure 3 and Figure 4, at heights of 1.5 m and 4.5 m, representing exposure at the ground and first floors respectively. Predicted concentrations exceed the annual mean objective at a number of receptors within the street canyon along Bushey High Street at ground-floor level, where the two monitoring sites are located. The corresponding predicted concentrations at the first floor level all remain below the objective.

3.7 The highest modelled annual mean nitrogen dioxide concentration at ground level is 47.0 µg/m^3, whilst that at first-floor level is 36.4 µg/m^3, for a property that is near to the HM99/100/101 diffusion tube monitoring site outside 84 Bushey High Street. There are no predicted annual mean concentrations greater than 60 µg/m^3, and thus exceedences of the 1-hour objective are unlikely.

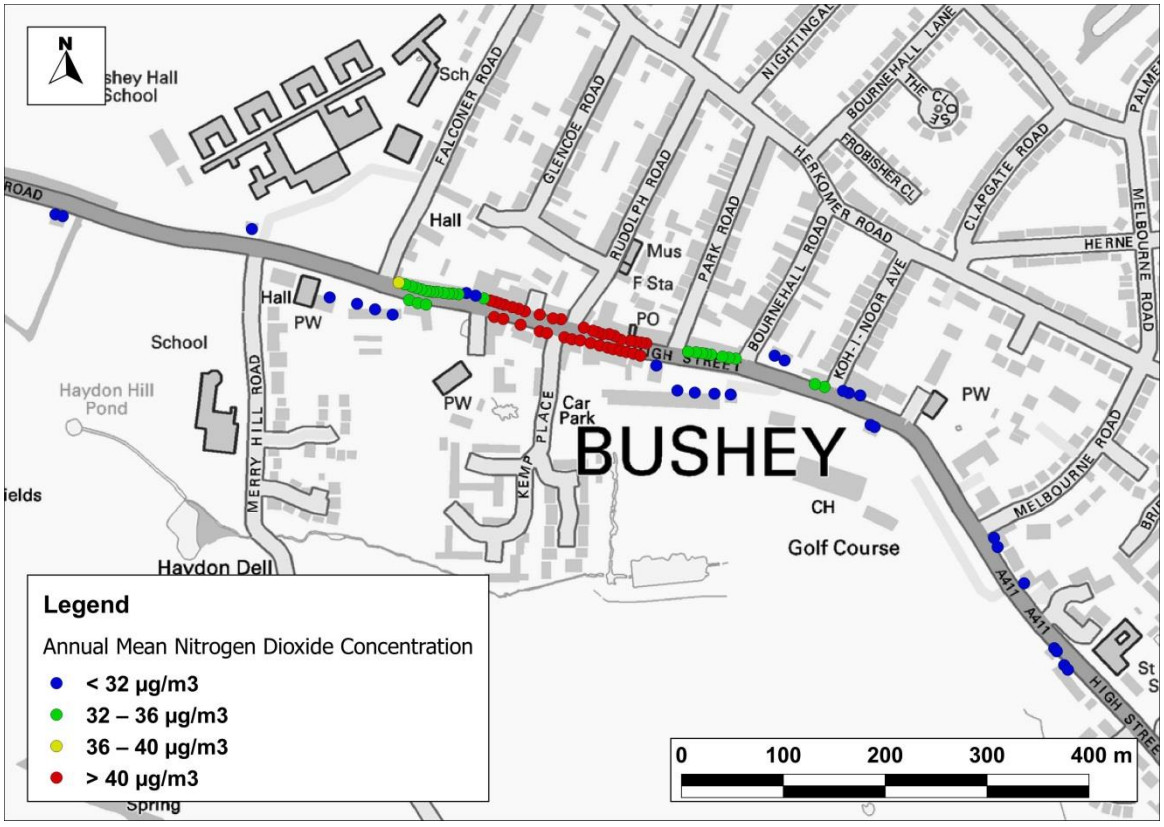

Figure 3: Modelled Annual Mean Nitrogen Dioxide Concentrations (µg/m^3) in 2014 at Ground-Floor Receptors on Bushey High Street

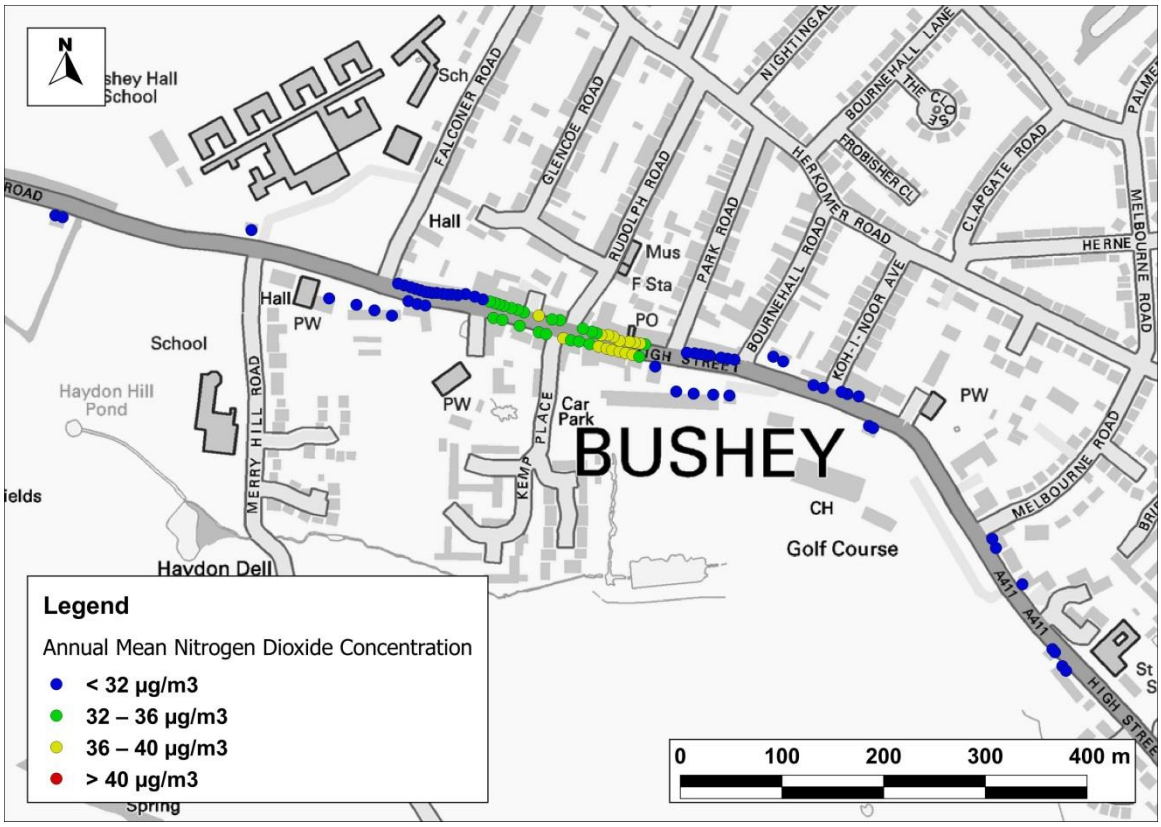

Figure 4: Modelled Annual Mean Nitrogen Dioxide Concentrations (µg/m^3) in 2014 at First-Floor Receptors on Bushey High Street

3.8 There is no relevant exposure at ground-floor level along Bushey High Street at locations where exceedences are predicted in the modelling results and concentrations at receptors with relevant exposure are predicted to be below the objective.

3.9 Concentrations recorded in 2014 at the HM99/100/101 and HM117/118/119 diffusion tube monitoring sites, with which the modelling has been verified, were lower than most of the previous four years. If concentrations at these sites were to increase again into the future, it is likely that exceedences of the objective would be expected at locations with relevant exposure along Bushey High Street.

Shenley Road

3.10 Annual mean nitrogen dioxide concentrations in 2014 have also been predicted at each of the receptor locations around Shenley Road shown in Figure 5 and Figure 6, at heights of 1.5 m and 4.5 m, representing exposure at the ground and first floors respectively. Predicted concentrations exceed the annual mean objective at many receptors along Shenley Road at ground-floor level, and a number of receptors at first-floor level.

3.11 The highest modelled annual mean nitrogen dioxide concentration at ground level is 57.6 µg/m^3, whilst that at first floor level is 43.3 µg/m^3, predicted at the junction of Shenley Road and Furzehill Road. There are no predicted annual mean concentrations greater than 60 µg/m^3, and thus exceedences of the 1-hour objective are unlikely.

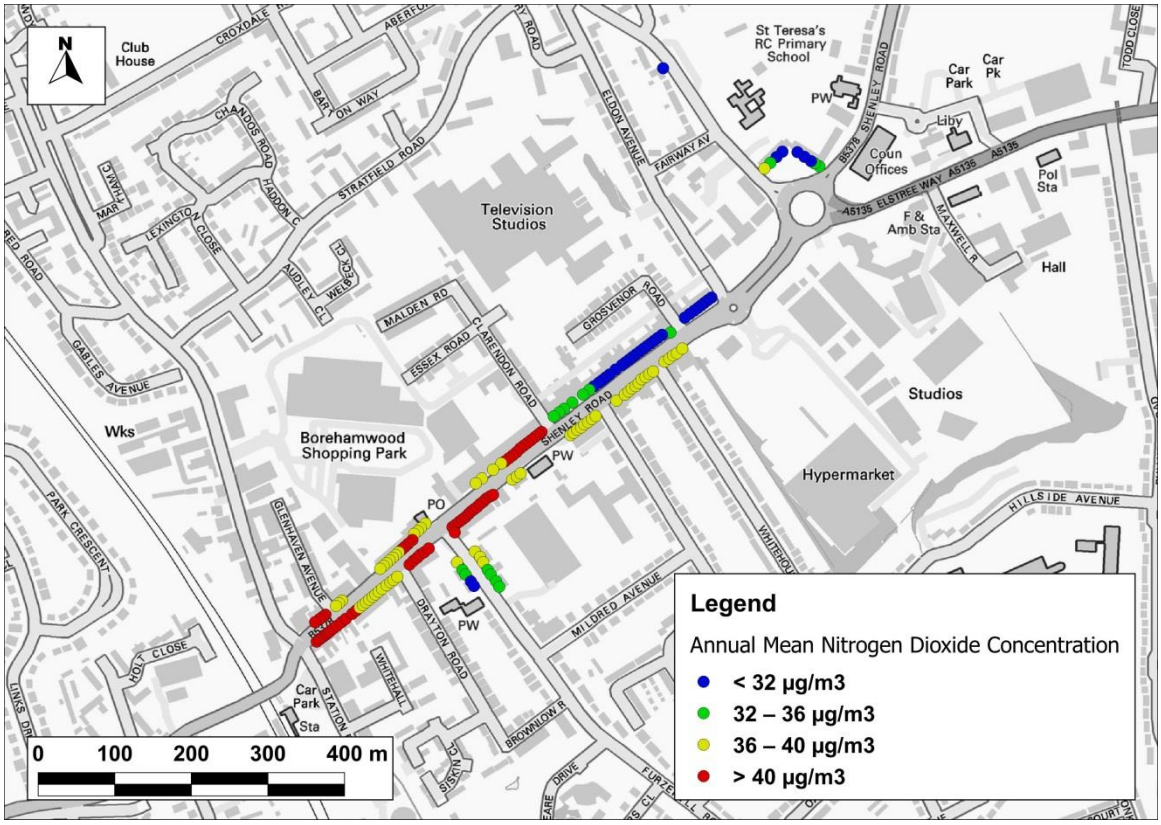

Figure 5: Modelled Annual Mean Nitrogen Dioxide Concentrations (µg/m^3) in 2014 at Ground-Floor Receptors on Shenley Road

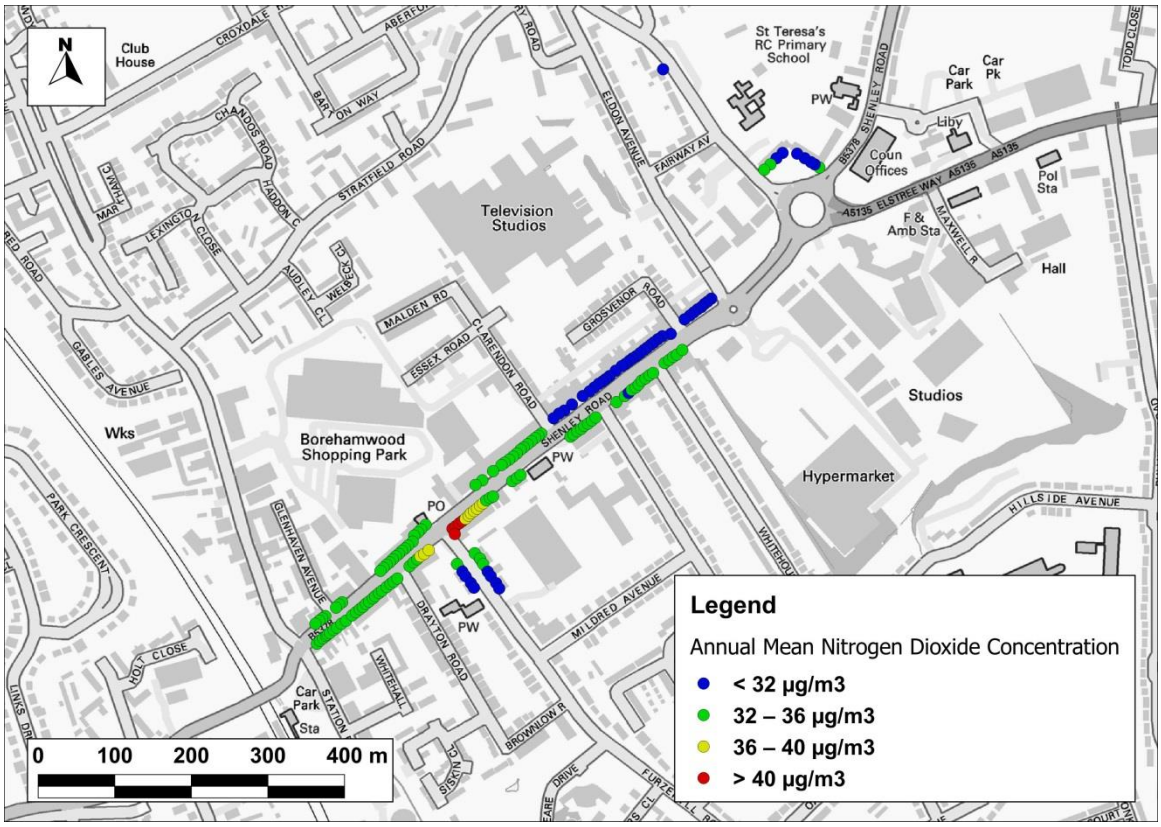

Figure 6: Modelled Annual Mean Nitrogen Dioxide Concentrations (µg/m^3) in 2014 at First-Floor Receptors on Shenley Road

3.12 There are no exceedences predicted on the ground floor along Shenley Road at receptors where relevant exposure exists. Exceedences are however predicted at receptors with relevant exposure at a number of first floor locations.

3.13 Isopleth maps of the modelled annual mean nitrogen dioxide concentrations at ground-floor and first-floor levels are presented in Figure 7 and Figure 8. These show that annual mean nitrogen dioxide concentrations are predicted to be high along much of Shenley road at ground-level, but that exceedences of the objective, where relevant exposure exists, are only predicted to occur around the junction of Shenley Road and Furzehill Road.

3.14 The isopleths show the 40 µg/m^3 contour in red, as well as the 36 µg/m^3 contour in yellow. There is some uncertainty surrounding both the measured and modelled concentrations. It is therefore recommended that an AQMA is declared to include, as a minimum, those residential properties which lie within the 36 µg/m^3 contour, in order to be precautionary and avoid having to re-declare areas in the near future.

3.15 No exceedences of 60 µg/m^3 as an annual mean nitrogen dioxide concentration have been identified, and thus exceedences of the 1-hour objective are unlikely.

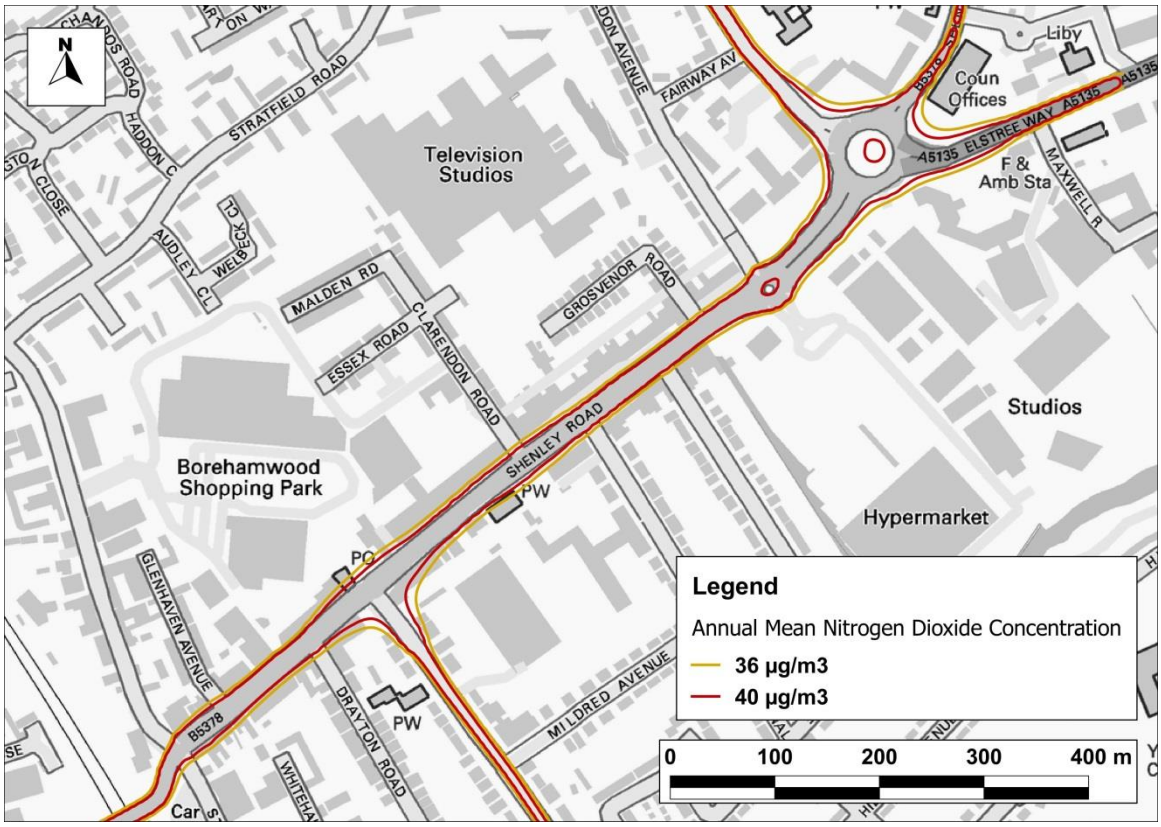

Figure 7: Contour of Annual Mean Nitrogen Dioxide Concentrations (µg/m^3) in 2014 at Ground-Floor Level around Shenley Road

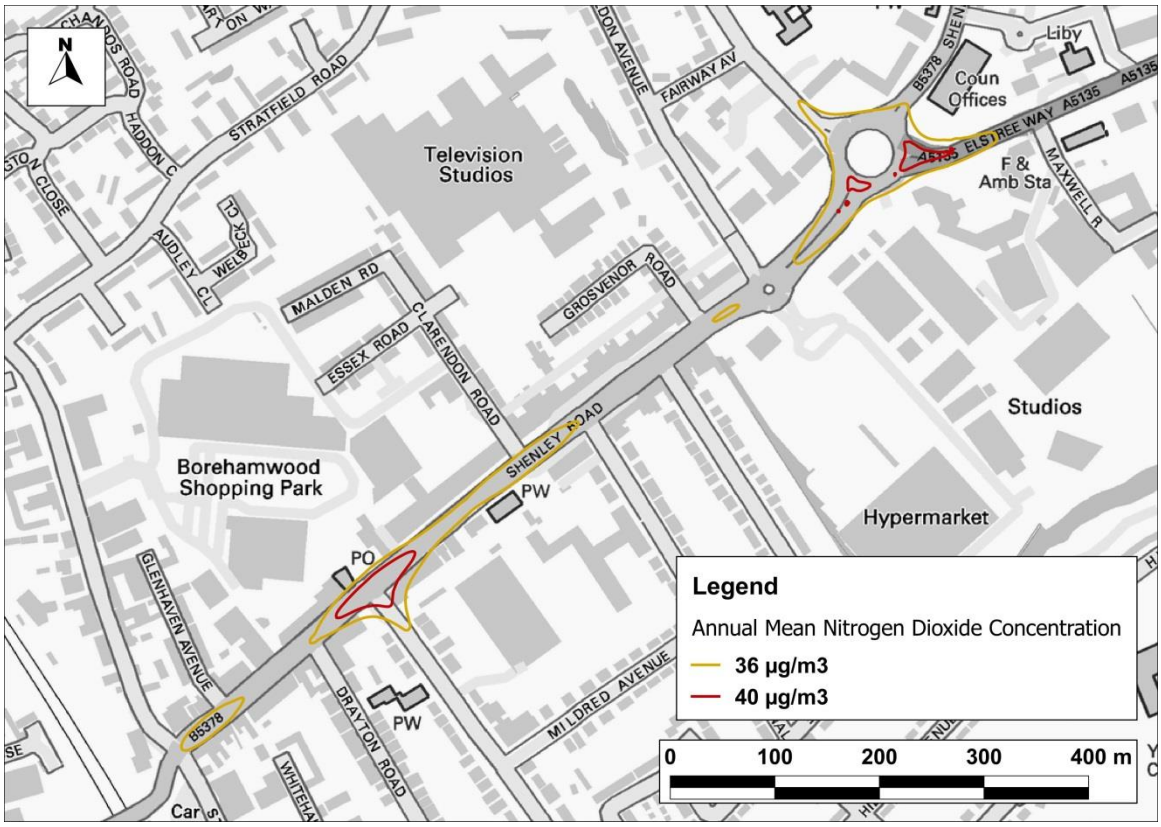

Figure 8: Contour of Annual Mean Nitrogen Dioxide Concentrations (µg/m^3) in 2014 at First-Floor Level around Shenley Road

Population Exposure

3.16 Objective exceedences are predicted at around 5 residential properties along Shenley Road. Assuming that each property has on average two occupants, this equates to approximately 10 residents.

Air Quality Improvements Required

3.17 The degree of improvement needed in order for the annual mean nitrogen dioxide objective to be achieved is defined by the difference between the highest measured or predicted concentration and the objective level (40 µg/m^3). The highest nitrogen dioxide concentration was predicted at the first floor of 1 Furzehill Parade (R110) (43.3 µg/m^3), requiring a reduction of 3.3 µg/m^3 in order for the objective to be achieved.

3.18 In terms of describing the reduction in emissions required, it is more useful to consider nitrogen oxides (NO_x). The required reduction in local nitrogen oxides emission has been calculated in line with guidance presented in LAQM.TG(09) (Defra, 2009). Table 3 sets out the reduction in local emissions of NO_x that would be required at each of the worst-case receptor locations where an exceedence is predicted, in order for the annual mean objective to be achieved.

3.19 Table 3 shows that close to 1 Furzehill Parade (at the junction of Shenley Road and Furzehill Road) a reduction of up to approximately 16% in local road traffic emissions would be required in order to achieve the objective.

Table 3: Improvement in Annual Mean Nitrogen Dioxide Concentrations and Nitrogen Oxides Concentration Required in 2014 to Meet the Objective

Receptor	Required reduction in annual mean nitrogen dioxide concentration (µg/m3)	Required reduction in emissions of oxides of nitrogen from local roads (%)
R110	3.3	16.4
R111	2.0	10.6
R112	0.9	5.0
R113	0.2	0.9
R155	1.4	7.6

4 Conclusions and Recommendations

4.1 A Detailed Assessment has been carried out for nitrogen dioxide in two areas within Hertsmere. These areas were identified as being at risk of exceeding the annual mean air quality objective for nitrogen dioxide, based on monitoring, in Hertsmere Borough Council's 2012 USA.

4.2 The Detailed Assessment has been carried out using a combination of 2014 monitoring data and modelled concentrations. Concentrations of nitrogen dioxide have been modelled for 2014 using the ADMS-Roads dispersion model. The model has been verified against measurements made at the two nitrogen dioxide diffusion tube monitoring locations in Bushey and a single tube on Shenley Road which lie adjacent to the road network included in the model.

4.3 For the Bushey High Street area, the assessment has identified that the annual mean nitrogen dioxide objective is not being exceeded at locations of relevant exposure. No exceedences of 60 $\mu g/m^3$ as an annual mean nitrogen dioxide concentration have been identified at locations of relevant exposure, and thus exceedences of the 1-hour objective are unlikely.

4.4 It is therefore recommended that an AQMA need not be declared along Bushey High Street, but that Hertsmere Borough Council should continue monitoring at the current worst-case locations (diffusion tube sites HM99/100/101 and HM117/118/119). If annual mean concentrations at these sites increase in future years then it is recommended that the council should remodel this location. It is also recommended that consideration be given to locating a monitoring site or sites at first-floor level, to provide a better indication of concentrations where there is relevant exposure.

4.5 For the Shenley Road area, the assessment has identified exceedences of the annual mean nitrogen dioxide objective at locations with relevant exposure. No exceedences of 60 $\mu g/m^3$ as an annual mean nitrogen dioxide concentration have been identified at locations of relevant exposure, and thus exceedences of the 1-hour objective are unlikely.

4.6 It is therefore recommended that an AQMA should be declared to include the whole of Shenley Road between the roundabout with Eldon Avenue (eastern extent) and the junction with Theobald Street (western extent). There is some uncertainty surrounding both the measured and modelled concentrations. It is therefore recommended that an AQMA is declared to include all residential properties that front onto this section of Shenley Road, in order to be precautionary.

4.7 It is also recommended that Hertsmere Borough Council continues monitoring nitrogen dioxide at the existing monitoring locations around Shenley Road, and expand the network where possible, particularly into areas which are 'canyon' like. Additionally, it is recommended that a diffusion tube monitoring site should be installed on the ground floor of the south western corner of Brook Court along Brook Road, as modelling results predict concentrations approaching the objective at ground-floor level. It is also recommended that consideration be given to locating a monitoring site

or sites at first-floor level, to provide a better indication of concentrations where there is relevant exposure.

4.8 It is recommended that Hertsmere Borough Council continues to monitor nitrogen dioxide at the existing monitoring locations. The monitoring results can then be used to inform future Review and Assessment Reports and Air Quality Action Planning.

5 References

Defra (2009) *Review & Assessment: Technical Guidance LAQM.TG(09)*, Defra.

Defra (2014) *Defra Air Quality Website*, [Online], Available: http://www.defra.gov.uk/environment/quality/air/airquality/.

Defra (2015) *Defra Air Quality Website*, [Online], Available: http://laqm.defra.gov.uk/.

DfT (2009) *Road Traffic Forecasts (AF09) Results from the Department for Transport's National Transport Model* .

DfT (2011) *TEMPRO (Version 6.2) System*, [Online], Available: www.tempro.org.uk.

DfT (2015) *Annual Average Daily Flows*, [Online], Available: http://www.dft.gov.uk/matrix/.

Hertfordshire County Council (2015) *Traffic Counts Map*, [Online], Available: http://webmaps.hertsdirect.org/generic/index.htm?layers=19,20&title=Traffic%20Counts%20Map.

Hertsmere Borough Council (2014) *2014 Air Quality Progress Report for Hertsmere Borough Council*.

6 Glossary

AADT	Annual Average Daily Traffic
ADMS-Roads	Atmospheric Dispersion Modelling System model for Roads
AQC	Air Quality Consultants
AQMA	Air Quality Management Area
AURN	Automatic Urban and Rural Network
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
Exceedence	A period of time when the concentration of a pollutant is greater than the appropriate air quality objective. This applies to specified locations with relevant exposure
HDV	Heavy Duty Vehicles (> 3.5 tonnes)
IAQM	Institute of Air Quality Management
LAQM	Local Air Quality Management
µg/m^3	Microgrammes per cubic metre
NO	Nitric oxide
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides (taken to be NO_2 + NO)
Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides
Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal
TEA	Triethanolamine – used to absorb nitrogen dioxide

7 Appendices

A1 Summary of Health Effects of Nitrogen Dioxide

Table A1.1: Summary of Health Effects of Nitrogen Dioxide

Pollutant	Main Health Effects
Nitrogen Dioxide	Short-term exposure to high concentrations may cause inflammation of respiratory airways. Long term exposure may affect lung function and enhance responses to allergens in sensitised individuals. Asthmatics will be particularly at risk (Defra, 2007).

A2 Modelling Methodology

Background Concentrations

A2.1 The background concentrations across the study area have been defined using the national pollution maps published by Defra (2014). These cover the whole country on a 1x1 km grid and are published for each year from 2011 until 2030. The maps include the influence of emissions from a range of different sources; one of which is road traffic.

A2.2 In order to calculate background nitrogen dioxide and nitrogen oxides concentrations in 2014, it is assumed that there was no reduction in the road traffic component of backgrounds between 2011[1] and 2014. This has been done using the source-specific background nitrogen oxides maps provided by Defra (2015). For each grid square, the road traffic component has been held constant at 2011 levels, while 2014 values have been taken for the other components. Nitrogen dioxide concentrations have then been calculated using the background nitrogen dioxide calculator which Defra (2015) publishes to accompany the maps. The result is a set of 'adjusted 2014 background' concentrations.

Model Inputs

Road Traffic

A2.3 Predictions have been carried out using the ADMS-Roads dispersion model (v3.4). The model requires the user to provide various input data, including emissions from each section of road, and the road characteristics (including road width and street canyon height, where applicable). Vehicle emissions have been calculated based on vehicle flow, composition and speed data using the Emission Factor Toolkit (Version 6.0.1) published by Defra (2015).

A2.4 The model has been run using the full year of meteorological data that corresponds to the most recent set of nitrogen dioxide monitoring data (2014). The meteorological data have been taken from the monitoring station located at Northolt, which is considered suitable for this area.

A2.5 For the purposes of modelling, it has been assumed that the modelled receptors along Bushey High Street around and between the two diffusion tube monitoring sites are within a street canyon formed by the buildings along this section. This road has a number of canyon-like features, which reduce dispersion of traffic emissions, and can therefore lead to concentrations of pollutants being higher here than they would be in areas with greater dispersion.

[1] This approach assumes that there has been no reduction in emissions per vehicle, but 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. This discrepancy is unlikely to influence the overall conclusions of the assessment.

A2.6 AADT flows, diurnal flow profiles, speeds, and vehicle fleet composition data have been provided by Hertfordshire County Council.

A2.7 AADT flows for Bushey High Street and Brook Road have been derived from weekday counts, which may over-predict annual average flows. The proportions of HDVs for these links have been determined from the interactive web-based map provided by the Department for Transport (DfT, 2015).

A2.8 AADT flows for Shenley Road, Furzehill Road and Elstree Way have been derived from AAWT flows provided on the Councils' website (Hertfordshire County Council, 2015). These flows have been factored forwards to the assessment year of 2014 using growth factors derived from the National Transport Model and associated guidance (DfT, 2009), adjusted to local conditions using the TEMPRO System v6.2 (DfT, 2011). The proportions of HDVs for these links have been determined from the interactive web-based map provided by the Department for Transport (DfT, 2015). Traffic speeds have been estimated based on professional judgement, taking account of the road layout, speed limits and the proximity to a junction. The traffic data used in this assessment are summarised in Table A2.1.

Table A2.1: Summary of Traffic Data used in the Assessment (AADT) [a]

Road Link	2014	
	AADT	%HDV
Bushey High Street		
Bushey High Street	16,339	3.2
Shenley Road		
Shenley Road	15,876	3.6
Furzehill Road	10,085	3.6
Elstree Way	15,094	3.6
Brook Road	14,811	3.6

[a] This is just a summary of the data entered into the model, which have been input as hourly average flows of motorcycles, cars, buses, Light Goods Vehicles and Heavy Goods Vehicles, as well as diurnal flow profiles for these vehicles.

A2.9 Diurnal flow profiles for the traffic on Bushey High Street and around Shenley Road have been derived from hourly automatic traffic count data in each area provided by Hertfordshire County Council.

A2.10 Figure 1 shows the road network included within the model for Shenley Road and Figure 2 shows the modelled roads for Bushey High Street.

Model Verification

A2.11 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.

Nitrogen Dioxide (Bushey High Street Site)

A2.12 Most nitrogen dioxide (NO_2) is produced in the atmosphere by 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 2014 at the HM99/100/101 and HM117/118/119 diffusion tube monitoring sites. Concentrations have been modelled at 2.1 m and 2.0 m respectively, the heights of the monitors.

A2.13 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 has been calculated from the measured NO_2 concentrations and the predicted background NO_2 concentration using the NOx from NO_2 calculator (Version 4.1) available on the Defra LAQM Support website (Defra, 2015).

A2.14 A primary adjustment factor has been determined as the slope of the best-fit line between the 'measured' road contribution and the model derived road contribution, forced through zero (Figure A2.1). This factor has then been applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations. The total nitrogen dioxide concentrations have then been determined by combining the adjusted modelled road-NOx concentrations with the predicted background NO_2 concentration within the NOx to NO_2 calculator. A secondary adjustment factor has finally been calculated as the slope of the best-fit line applied to the adjusted data and forced through zero (Figure A2.2).

A2.15 The following primary and secondary adjustment factors have been applied to all modelled nitrogen dioxide data:

- Primary adjustment factor : 2.686
- Secondary adjustment factor: 1.001

A2.16 The results imply that the model has under predicted the road-NOx contribution. This is a common experience with this and most other models.

A2.17 Figure A2.3 compares final adjusted modelled total NO_2 at each of the monitoring sites, to measured total NO_2, and shows a 1:1 relationship.

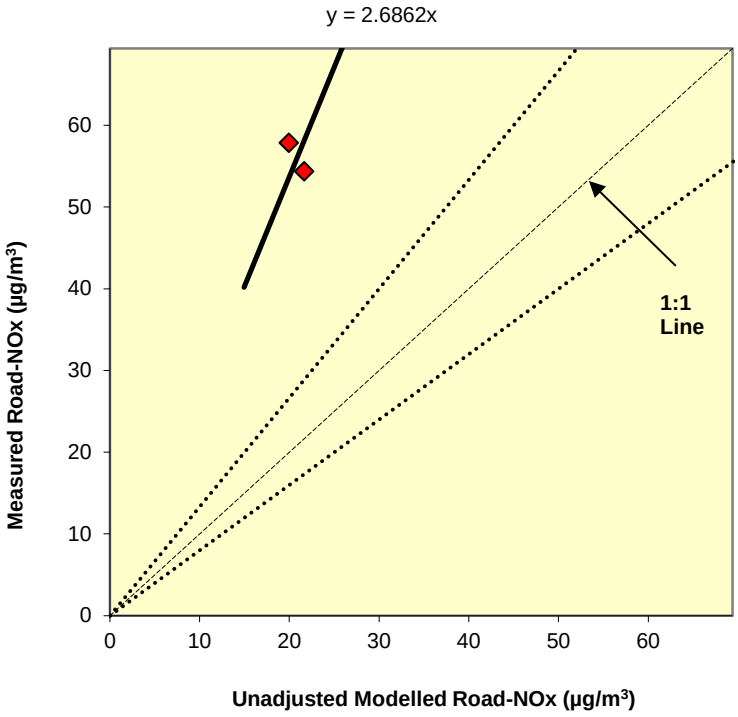

Figure A2.1: Comparison of Measured Road NOx to Unadjusted Modelled Road NOx Concentrations. The dashed lines show ± 25%.

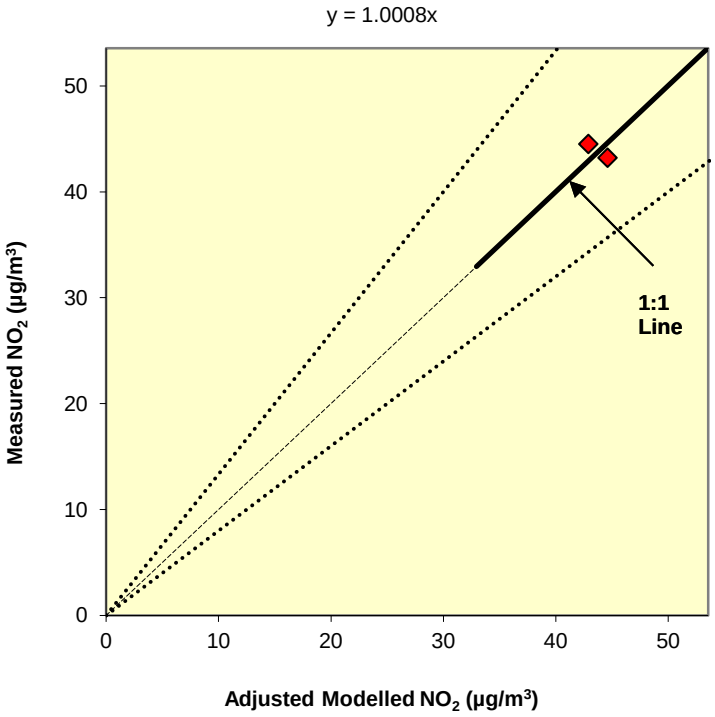

Figure A2.2: Comparison of Measured Total NO_2 to Primary Adjusted Modelled Total NO_2 Concentrations. The dashed lines show ± 25%.

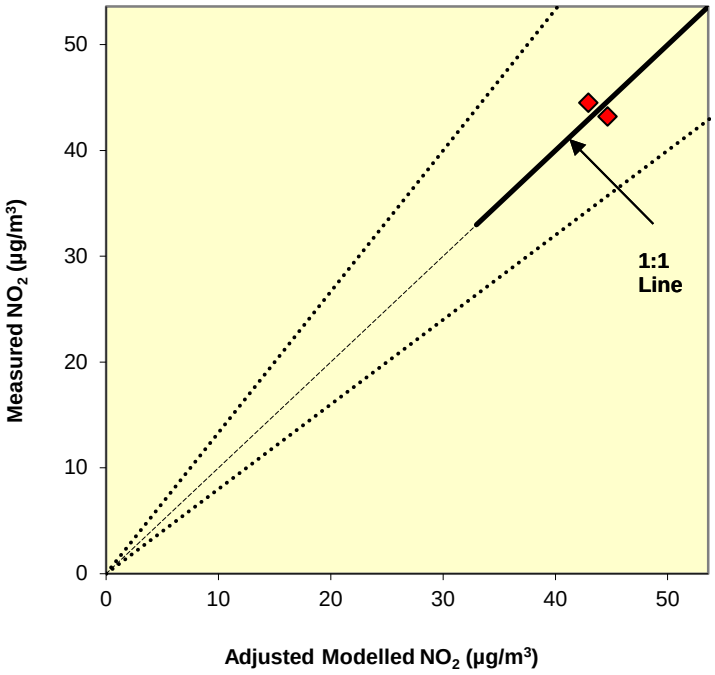

Figure A2.3: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations. The dashed lines show ± 25%.

Nitrogen Dioxide (Shenley Road Site)

A2.18 Most nitrogen dioxide (NO_2) is produced in the atmosphere by 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 2014 at the HM39 diffusion tube monitoring site. Concentrations have been modelled at 2.1 m, the height of the monitor.

A2.19 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 has been calculated from the measured NO_2 concentration and the predicted background NO_2 concentration using the NOx from NO_2 calculator (Version 4.1) available on the Defra LAQM Support website (Defra, 2015).

A2.20 An adjustment factor has been determined as the ratio of the 'measured' road contribution and the model derived road contribution. This factor has then been applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations. The total nitrogen dioxide concentrations have then been determined by combining the adjusted modelled road-NOx concentrations with the predicted background NO_2 concentration within the NOx to NO_2 calculator (Defra, 2015).

A2.21 The data used to calculate the adjustment factor are provided below:

- Measured NO_2 : 51.8 µg/m^3
- Background NO_2 : 20.8 µg/m^3
- 'Measured' road-NOx (from NOx to NO_2 calculator): 74.9 µg/m^3
- Modelled road-NOx = 21.4 µg/m^3
- Road-NOx adjustment factor: 74.9/21.4 = **3.506**

A2.22 The factor implies that the unadjusted model is under-predicting the road-NOx contribution. This is a common experience with this and most other models.

Model Post-processing

Road Traffic

A2.23 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 to NO_2 calculator available on the Defra LAQM Support website (Defra, 2015). The traffic mix within the calculator has been set to "All other urban UK traffic", which is considered suitable for the study area. 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.

A3 Adjustment of Short-Term Data to Annual Mean

A3.1 The Hertsmere Borehamwood Roadside automatic monitoring site was established on the roadside adjacent to the roundabout with Shenley Road and Elstree Way in September 2014. As such, the available data for 2014 do not represent a full calendar year. In accordance with the guidance set out in Box 3.2 of LAQM.TG(09), the data have been adjusted to an annual mean, based on the ratio of concentrations during the short-term monitoring period (4 months; September – December 2014) to those over the 2014 calendar year at three background sites operated as part of the Automatic Urban and Rural Network (AURN) where long-term data are available.

A3.2 The annual mean nitrogen dioxide concentrations and the period means for each of the three monitoring sites from which adjustment factors have been calculated are presented in Table A3.1, along with the Overall Factor.

Table A3.1: Data used to Adjust Short-term Monitoring Data at the Borehamwood Roadside site to 2014 Annual Mean (µg/m^3)

Site	Site Type	Annual Mean	Period Mean (September to December)	Ratio (Am/Pm)
Camden – Bloomsbury	Urban Background	44.6	51.0	0.87
Harrow – Stanmore	Urban Background	24.7	30.1	0.82
Kensington and Chelsea – North Kensington	Urban Background	33.0	37.7	0.87
			Average	**0.86**