Further Assessment of Air Quality in the Hertford AQMA – East Herts District Council

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Experts in air quality management & assessment

Document Control

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Contents

1 Introduction

1.1 This report is the Further Assessment of nitrogen dioxide concentrations within the Gascoyne Way Air Quality Management Area (AQMA), Hertford. The report is one of a series produced by, and on behalf of, East Herts District Council, which periodically review and assess air quality within the District. East Herts District Council accepts the conclusions of this report and intends to implement all recommendations.

The Air Pollutant of Concern

1.2 Nitrogen dioxide is associated with adverse effects on human health. At high levels nitrogen dioxide causes inflammation of the airways. Long-term exposure may affect lung function and respiratory symptoms. Nitrogen dioxide also enhances the response to allergens in sensitive individuals (Defra, 2007).

The Air Quality Objectives

1.3 The Government has established a set of air quality standards and objectives to protect human health. The 'standards' are set as concentrations below which 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 an individual 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 economic efficiency, practicability, technical feasibility and timescale. The objectives for use by local authorities are prescribed within the Air Quality Regulations, 2000 (Stationery Office, 2000) and the Air Quality (England) (Amendment) Regulations 2002, (Stationery Office, 2002). The relevant objectives for this assessment are provided in Table 1.

Table 1: Relevant Air Quality Objectives

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

1.4 The objectives for nitrogen dioxide were to be achieved by 2005, and continue to apply in all future years thereafter. 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 the annual mean objective, relevant exposure is mainly 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.

1.5 Measurements across the UK have shown that the 1-hour nitrogen dioxide objective is unlikely to be exceeded where the annual mean concentration is below 60 $\mu g/m^3$ (Defra, 2009). Therefore, 1-hour nitrogen dioxide concentrations will only be considered if the annual mean concentration is above this level.

1.6 The European Union has also set limit values for nitrogen dioxide. Achievement of these values is a national obligation rather than a local one. The limit values for nitrogen dioxide are the same levels as the UK objectives, and are to be achieved by 2010 (Stationery Office, 2007). The objectives are the same as, or more stringent than, the limit values, thus it is appropriate to focus on the objectives.

Introduction to Review and Assessment

1.7 The Air Quality Strategy (Defra, 2007) provides the policy framework for air quality management and assessment in the UK. As well as providing the air quality objectives listed above, it also sets out how the different sectors: industry, transport and local government can contribute to achieving the air quality objectives. Local authorities are seen to play a particularly important role. The strategy describes the Local Air Quality Management (LAQM) regime that has been established, whereby every authority has to carry out regular Reviews and Assessments of air quality in its area to identify whether the objectives have been, or will be, achieved at relevant locations, by the applicable date.

1.8 Review and Assessment is carried out as a series of rounds. Local Air Quality Management Technical Guidance (LAQM.TG(09)) (Defra, 2009) sets out a phased approach to the current round of Review and Assessment. This prescribes an initial Updating and Screening Assessment (USA), which all authorities must undertake. It is based on a checklist to identify any matters that have changed since the previous round. If the USA identifies 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.

1.9 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. Subsequent to the declaration of an AQMA, a Further Assessment should be carried out, 1) to confirm that the AQMA declaration is justified and that the appropriate area has been declared, 2) to ascertain the sources contributing to the exceedence, and 3) to calculate the magnitude of reduction in emissions required to achieve the objective. This information can be used to inform an Air Quality Action Plan, which will identify measures to improve local air quality.

Key Findings of Previous Review and Assessment Reports

1.10 In July 2009 a Detailed Assessment was undertaken for the Gascoyne Way area of Hertford due to monitored exceedences of the annual mean objective for nitrogen dioxide. Following this, an AQMA was designated in May 2010.

1.11 In May 2010 a Progress Report was prepared. The report concluded that East Herts District Council was correct in its designation of the Air Quality Management Area. However, the report identified that the boundary of the current AQMA may need to be amended to incorporate properties on Old Cross and Ware Road due to monitored exceedences of the annual mean objective for nitrogen dioxide (East Herts District Council, 2010).

1.12 The Air Quality Action Plan is currently being drafted. The conclusions of this Further Assessment will be fully taken into account in the final document.

Scope

1.13 Guidance within LAQM.TG(09) (Defra, 2009) explains that a Further Assessment report allows authorities to:

- confirm their original assessment, and thus ensure they were correct to designate an AQMA in the first place;
- calculate more accurately what improvement in air quality, and corresponding reduction in emissions, would be required to attain the air quality objectives within the AQMA;
- refine their knowledge of sources of pollution, so that the air quality Action Plan may be appropriately targeted;
- take account of any new guidance issued by Defra and the Devolved Administrations, or any new policy developments that may have come to light since declaration of the AQMA;
- take account of any new local developments that were not fully considered within the earlier Review and Assessment work. This might, for example, include the implications of new transport schemes, commercial or major housing developments etc, that were not committed or known of at the time of preparing the Detailed Assessment;
- carry out additional monitoring to support the conclusion to declare the AQMA;
- corroborate the assumptions on which the AQMA has been based, and to check that the original designation is still valid, and does not need amending in any way; and
- respond to any comments made by statutory consultees in respect of the Detailed Assessment.

2 Study Area and AQMA Location

2.1 The Hertord AQMA encompasses properties along Gascoyne Way, from Church Street to Hertingfordbury Road (Figure 1). The majority of properties along Gascoyne Way are commercial, but with relevant exposure for the annual mean objective in the residential units at first floor level. There are no locations additional to those relevant for the annual objective that are relevant for the 1-hour objective.

2.2 In addition to the AQMA location, a number of additional roads have been assessed, these include Old Cross and Ware Road where monitored exceedences of the annual mean objective for nitrogen dioxide have been measured.

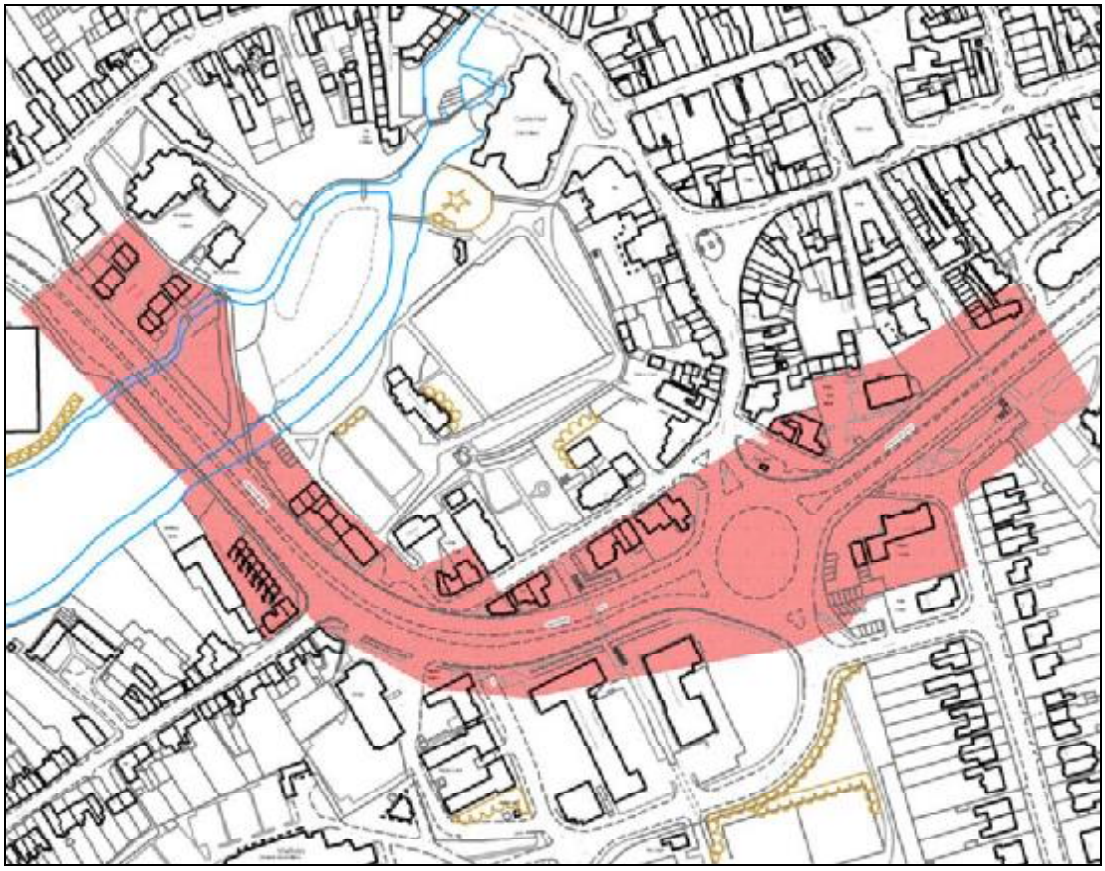

Figure 1: Hertford AQMA (provided by East Herts District Council)

3 Local Developments since Declaration of the AQMA

New and Proposed Local Developments

3.1 There have been no new roads or housing developments close to the AQMA since the Detailed Assessment was carried out. Planning permission has been granted for a mixed-use development including housing and supermarket near Old Cross, Hertford. The Air Quality assessment submitted as part of the application predicted an insignificant increase in air pollution.

National Developments

3.2 The latest guidance from Defra in LAQM.TG(09) (Defra, 2009) has been followed regarding NOx to NO_2 relationships. All the latest tools associated with the release of LAQM.TG(09) (Defra, 2009) have been used for this assessment.

4 New Monitoring and Modelling Data

New Monitoring

4.1 The Council maintains two automatic air quality monitoring sites within its district and 19 diffusion tube sites. There are no real-time analysers situated within the Hertford study area, and this assessment therefore relies on diffusion tube monitoring.

Bias Adjustment of Diffusion Tubes

4.2 Diffusion tube measurements may exhibit substantial bias compared to the reference method (real-time chemiluminescent analyser) for measuring nitrogen dioxide. As a result, LAQM.TG(09) recommends that Local Authorities should apply a 'bias adjustment factor', which is calculated by undertaking a co-location study with a real time analyser. If this cannot be undertaken within the local authority area, then a default factor made available within a spreadsheet on the Review and Assessment helpdesk website should be used (Defra, 2011a). The Council uses Gradko for analysis of diffusion tubes (20% TEA in Water). For this study, the 2010 data have been adjusted using the national factor provided on the Review and Assessment Helpdesk website (0.95; spreadsheet version 03/11).

Diffusion Tube Data

4.3 The diffusion tube monitoring locations in close proximity to the Hertford AQMA are shown in Figure 2. A number of the diffusion tube sites have triplicate tubes in order to increase the confidence in the results.

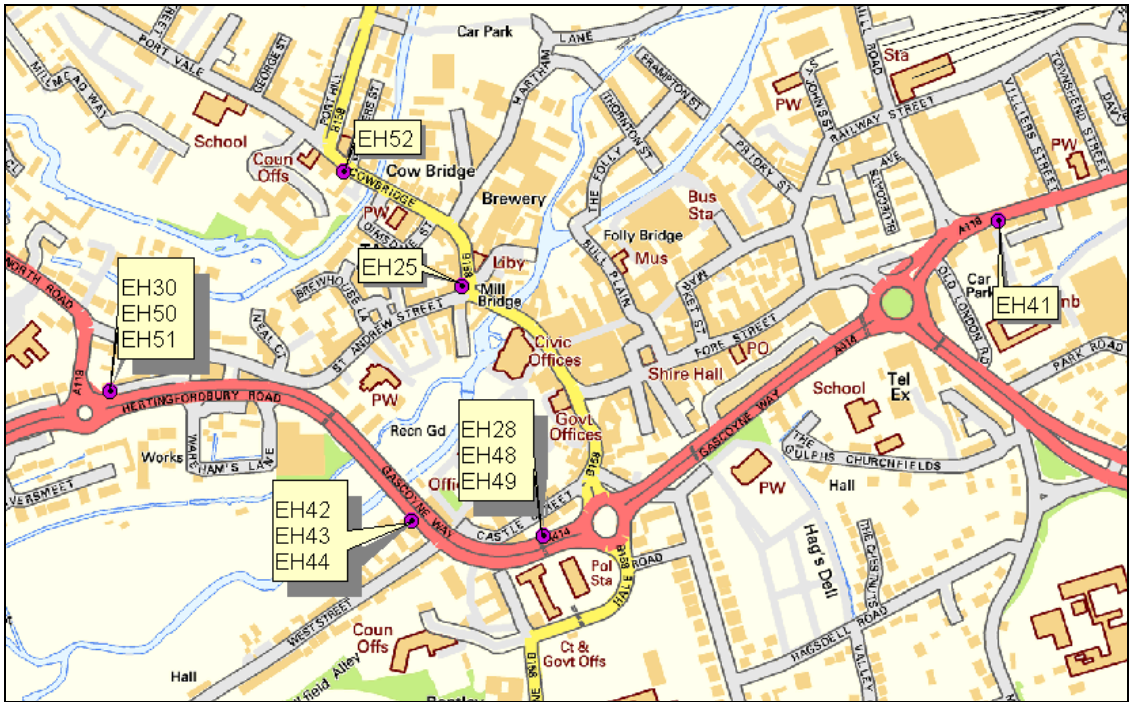

Figure 2: Monitoring locations in close proximity to the Hertford AQMA.

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4.4 In April 2009 East Herts Council changed diffusion tube suppliers from Lambeth to Gradko. As an annual mean calculated from diffusion tubes analysed by two different laboratories is not practicable, the Council did not include the first three months of monitoring for diffusion tube EH25 – EH41. The remaining nine months were annualised. In 2009 six diffusion tubes were already being supplied and analysed by Gradko (EH42 – EH47), therefore 12 months data from one supplier was available. EH48 – EH52 were first installed in April 2009 and their results were also annualised to provide an annual mean (East Herts District Council, 2010). Monitoring data for 2009 and 2010 are presented in Table 2.

Table 2: Diffusion Tube Data within the Study Area[a]

Name	No.	Within AQMA	OS Grid Coordinates		Annual mean nitrogen dioxide (µg/m^3)	
			X	Y	2009[b]	2010[c]
Old Cross (triplicate)	EH25	N	532449	212675	**42[d]**	**40.9**
Castle Street	EH28, EH48 EH49	Y	532542	212370	**45**	39.8
Downey Cottage, Hertingfordbury Road (triplicate)	EH30 EH50 EH51	N	532023	212550	**45**	**40.1**
Ware Road	EH41	N	533101	212755	**49**	**43.8**
West Street (triplicate)	EH42 EH43 EH44	Y	532389	212394	**67**	**54.4**
Cowbridge	EH52	N	532389	212394	35	30.9

[a] Values in bold are exceedences of the objective.

[b] As reported in East Herts District Council's 2010 Progress Report (East Herts District Council, 2010)

[c] Bias adjusted using the national factor of 0.95 (using national factors in version 03/11 of the spreadsheet available at laqm.defra.gov.uk/bias-adjustment-factors/national-bias.html, which includes East Herts District Council's local bias adjustment factor).

[d] Low data capture (67%)

4.5 There are four monitoring sites which measured an exceedence of the annual mean objective within the study area in 2010. The majority of the diffusion tubes are attached to lamp posts or sign posts on the pavements and are therefore expected to measure higher concentrations than at the façades of the properties. There is relevant residential exposure at ground-floor level near to a number of the diffusion tube sites. In 2009 the West Street monitoring site measured concentrations of nitrogen dioxide exceeding 60 µg/m^3, the Technical Guidance TG(09), issued by the Department for Environment Food and Rural Affairs (DEFRA), regards this as being indicative of a potential failure of the 1-hour objective. Traffic flows are lower on Cowbridge and therefore the results are lower, as would be expected.

4.6 Measured concentrations at Old Cross and Ware Road exceeded the objective in 2009 and 2010, confirming the findings of the Progress Report that the AQMA needs to be extended to include this area.

New Modelling

4.7 Annual mean concentrations of nitrogen dioxide from road sources in 2010 have been modelled within the study area using ADMS Roads (version 3). Further details of the dispersion modelling methodology and details of the input parameters are set out below and in Appendix 1.

Road Traffic Impacts

4.8 The contribution of emissions from road traffic to the annual mean concentrations of nitrogen dioxide within each study area has been modelled using ADMS Roads (version 3). The following input data were used:

- Hertfordshire County Council provided AADT flows, split into a number of vehicle classes. There will be uncertainty associated with these traffic data, however, the conclusions of the assessment are unlikely to be particularly sensitive to this uncertainty. All of the traffic flows used in this assessment have been assumed to have the national diurnal flow profiles published by the Department for Transport (DfT, 2009).
- Detailed fleet composition data were provided, and therefore the emissions from each vehicle class were calculated using ADMS Roads (version 3) for each vehicle class individually. This enabled detailed source apportionment;
- Speeds are based on the speed limit, but also take into account the proximity to a junction and traffic speeds observed during the site visit;
- The locations of roads and buildings (including road width) were obtained using Ordnance Survey mapping information;
- Meteorological data from Stansted have been used. Complete wind and temperature data were available, however, cloud cover was missing for 14% of the time and this was provided by data from Luton and then Northolt.

4.9 The model has been verified by comparing the predicted results with local measurements (within the study area), and the model output adjusted accordingly. Details of model verification are presented in Appendix 1.

Modelling Uncertainty

4.10 Uncertainty is inherent in all measured and modelled data. All values presented in this report are the best possible estimates, but uncertainties in the results might cause over- or under-predictions. All of the measured concentrations presented have an intrinsic margin of error. Defra (2011a) suggests that this is of the order of plus or minus 20% for diffusion tube data and plus or minus 10% for automatic measurements. The model results rely on traffic data provided by Hertfordshire County Council and any uncertainties inherent in these data will carry into this assessment. There will be additional uncertainties introduced because the modelling has simplified real-world processes into a series of algorithms. For example: it has been assumed that wind conditions

measured at Stansted during 2010 will have occurred throughout the study areas during 2010; and it has been assumed that the dispersion of emitted pollutants will conform to a Gaussian distribution over flat terrain. An important step in the assessment is verifying the dispersion model against the measured data. By comparing the model results with measurements, and correcting for the apparent under-prediction of the model, the uncertainties can be reduced.

4.11 The limitations to the assessment should be borne in mind when considering the results set out in the following sections. While the model should give an overall accurate picture, i.e. one without bias, there will be uncertainties for individual receptors. The results are 'best estimates' and have been treated as such in the discussion.

Concentrations at Specific Receptors

4.12 Locations representing worst-case residential exposure along the roads within the study area were selected for modelling. In total thirty-one residential receptor locations were selected.

4.13 Receptor locations are shown in Figure 4. Annual mean nitrogen dioxide concentrations predicted for each of these receptors are presented in Table 3. The highest predicted concentration in 2010 is 58.7 µg/m^3, at Receptor 24. Concentrations are also predicted to exceed the annual mean objective at Receptors 4, 5, 9, 12, 14, 23, 25, 29 and Receptor 30. There are no predicted annual mean concentrations greater than 60 µg/m^3.

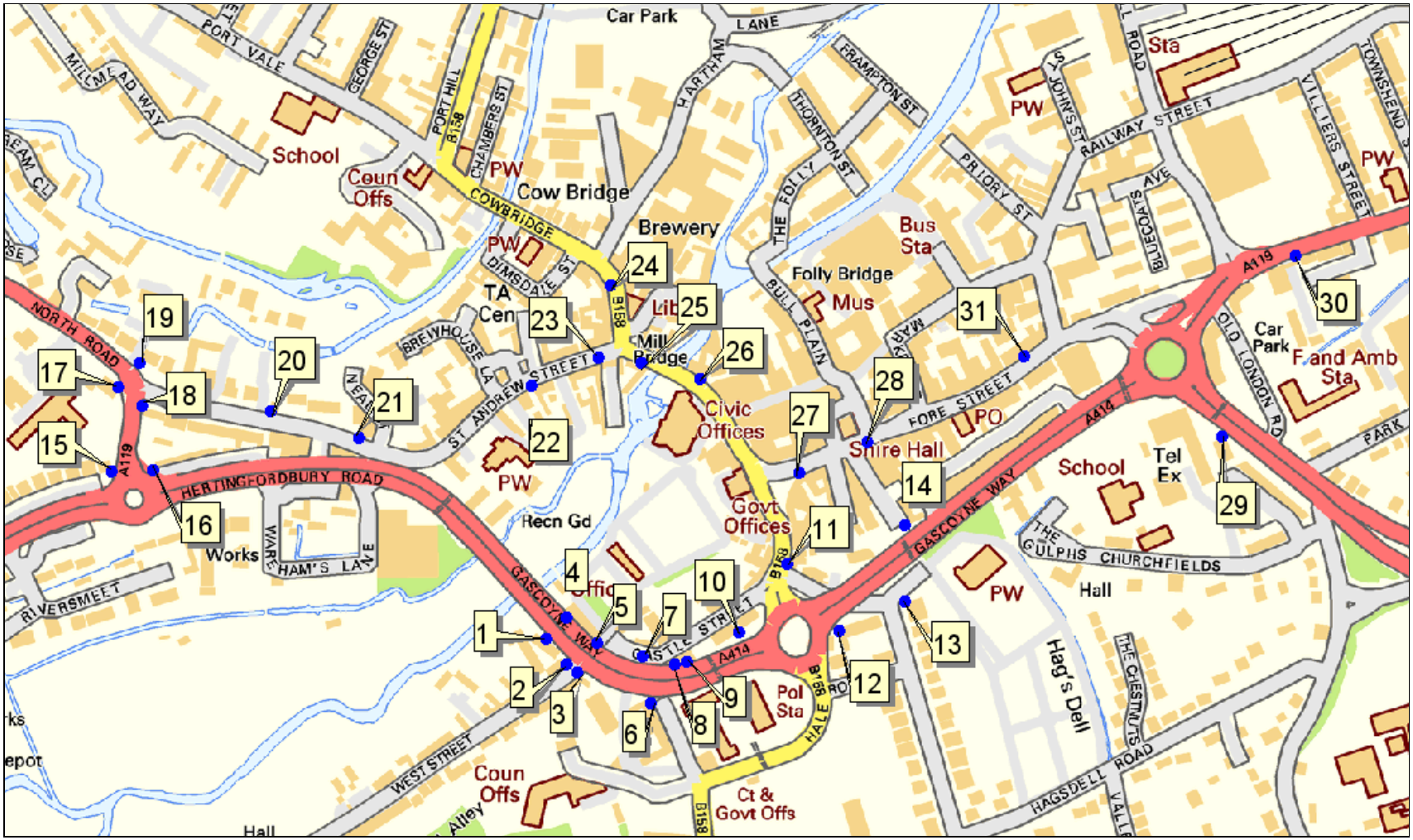

Figure 4: Receptor Locations.

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Table 3: Predicted Annual Mean Concentrations of Nitrogen Dioxide (µg/m^3) in 2010[a]

Receptor	Location	Height (m)	Annual Mean (µg/m^3)
1	Maltings Mews	1.5	39.6
2	Old Maltings, West Street	1.5	35.8
3	1 West Street	1.5	36.6
4	Closest property on Castle Street to Gascoyne Way	1.5	**51.2**
5	Closest property on Castle Street to pedestrian crossing	1.5	**46.4**
6	Closest property on Peg's Lane to Gascoyne Way	1.5	37.4
7	40 Castle Street	1.5	38.8
8	The White Horse, Castle Street	1.5	37.3
9	29 Castle Street	4.5	**44.4**
10	21 Castle Street	1.5	39.8
11	17 Queens Road	1.5	35.1
12	Hale Court	5	**55.6**
13	Closest property on Queens Road to Gascoyne Way	1.5	39.3
14	Closest property on Church Street to Gascoyne Way	4.5	**41.1**
15	52 Hertingfordbury	1.5	32.5
16	36 Hertingfordbury	1.5	40.0
17	The Old Rectory	4.5	29.9
18	41 North Road	1.5	38.7
19	10c North Road	1.5	29.2
20	6 North Road	1.5	31.0
21	Ebeneezer Court	1.5	36.6
22	25 St Andrew Street	1.5	37.5
23	1 St Andrews Street	1.5	**46.2**
24	23 Cowbridge	1.5	**58.7**
25	3 Town Mill Mews	3.5	**47.7**
26	18 Mill Bridge	1.5	25.6
27	2 Fore Street	1.5	31.2
28	32 Fore Street	3.5	26.2
29	15-26 London Road	1.5	**50.1**
30	4 Ware Road	1.5	**48.5**
31	97 Fore Street	1.5	36.7
Objective		**40**	**A1**

[a] Values in bold are predicted exceedences of the objective.

4.14 Concentrations have also been predicted for a grid of receptors to enable the extent of the exceedence area to be to be determined (Figure 5). These confirm that there are relevant locations outside of the current AQMA at which concentrations are likely to have exceeded the annual mean nitrogen dioxide objective in 2010.

4.15 The AQMA boundary should therefore be amended to include, as a minimum, those relevant locations where exceedences have been predicted alongside Mill Bridge, Old Cross and St Andrews Street, and also alongside London Road and Ware Road. Due to uncertainties associated with the modelling it is advised that the entire area within the 36 $\mu g/m^3$ contour should be included in the amended AQMA. Outside the study area there are unlikely to be any exceedences as the properties are located further away from the road.

4.16 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.

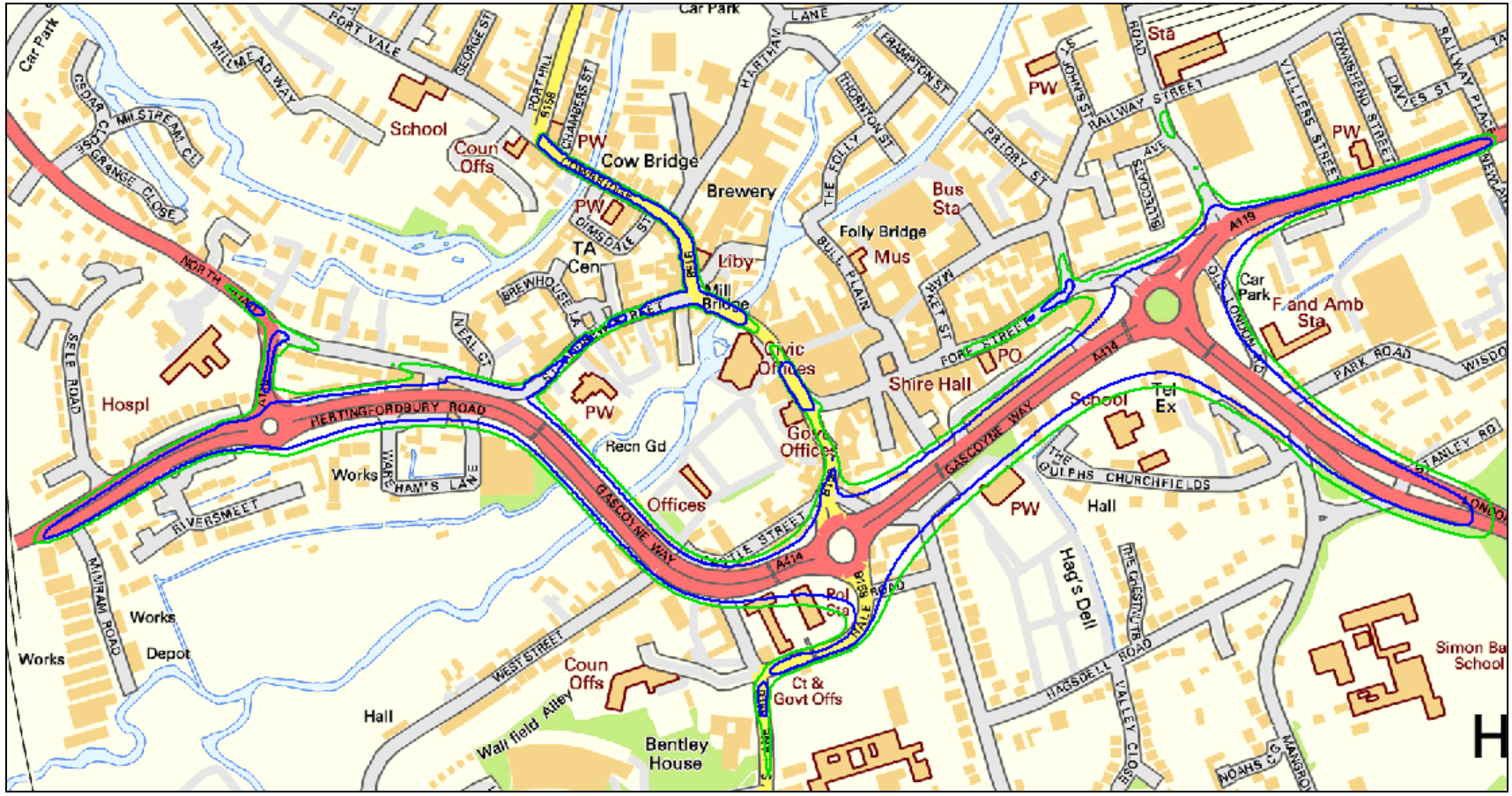

Figure 5: Extent of the Modelled 40µg/m^3 Contour (blue line) and 36 µg/m^3 Contour (green line) of Annual Mean Nitrogen Dioxide Concentrations in 2010 (modelled at 1.5 m).

5 Source Apportionment

5.1 In order to develop an appropriate action plan it is necessary to identify the sources contributing to the objective exceedences within the AQMA. The data presented here can be used to inform future traffic management decisions, and have been calculated in line with guidance provided in LAQM.TG(09) (Defra, 2009).

5.2 Figure 6 and Table 4 set out the relative contributions of traffic emissions. The following categories have been included in the source apportionment:

- Ambient Background (Bkgd);
- Motorcycle (MCL);
- Cars;
- Light Goods Vehicles (LGV);
- Bus;
- Heavy Goods Vehicles (HGV);

5.3 Ten receptor locations identified previously as exceeding the objective have been used to provide an overview of source contributions. Table 4 and Figure 6 show, the most significant component at all receptors is the ambient background concentration, except at Receptor 24, where the most significant component is from cars. At Receptors 23, 25 and 30 a significant component is from buses. In most cases, emissions from cars and HGVs together are the main local contributors to the overall concentration.

Table 4: Predicted Annual Mean (2010) Nitrogen Dioxide Concentrations and the Contribution of Each Source Type to the Total

Receptor	Annual Mean Concentration (µg/m^3)						
	Bkgd	MCL	Car	LGV	Bus	HGV	Total
4	18.1	0.2	14.3	5.7	1.3	11.6	51.2
5	18.1	0.1	12.3	4.9	1.2	9.9	46.4
9	18.1	0.1	11.2	4.4	1.2	9.3	44.4
12	18.1	0.1	12.5	4.9	4.1	15.9	55.6
14	18.1	0.1	7.8	3.3	2.4	9.4	41.1
23	18.1	0.1	9.6	3.2	9.4	5.7	46.2
24	18.1	0.2	18.3	5.6	4.7	11.9	58.7
25	18.1	0.1	10.1	3.5	9.2	6.8	47.7
29	18.2	0.1	9.2	4.0	3.9	14.8	50.1
30	18.2	0.1	9.9	4.0	8.2	8.1	48.5
	% Contribution to Total						
	Bkgd	MCL	Car	LGV	Bus	HGV	Total
4	35.3	0.3	28.0	11.2	2.6	22.7	100.0
5	38.9	0.3	26.4	10.5	2.5	21.4	100.0
9	40.7	0.3	25.3	9.9	2.8	21.0	100.0
12	32.5	0.1	22.4	8.9	7.4	28.7	100.0
14	44.0	0.2	19.1	8.0	5.8	23.0	100.0
23	39.2	0.2	20.9	7.0	20.4	12.4	100.0
24	30.8	0.3	31.2	9.6	8.0	20.2	100.0
25	37.9	0.2	21.2	7.4	19.2	14.2	100.0
29	36.2	0.1	18.4	8.0	7.8	29.5	100.0
30	37.5	0.1	20.5	8.2	17.0	16.7	100.0

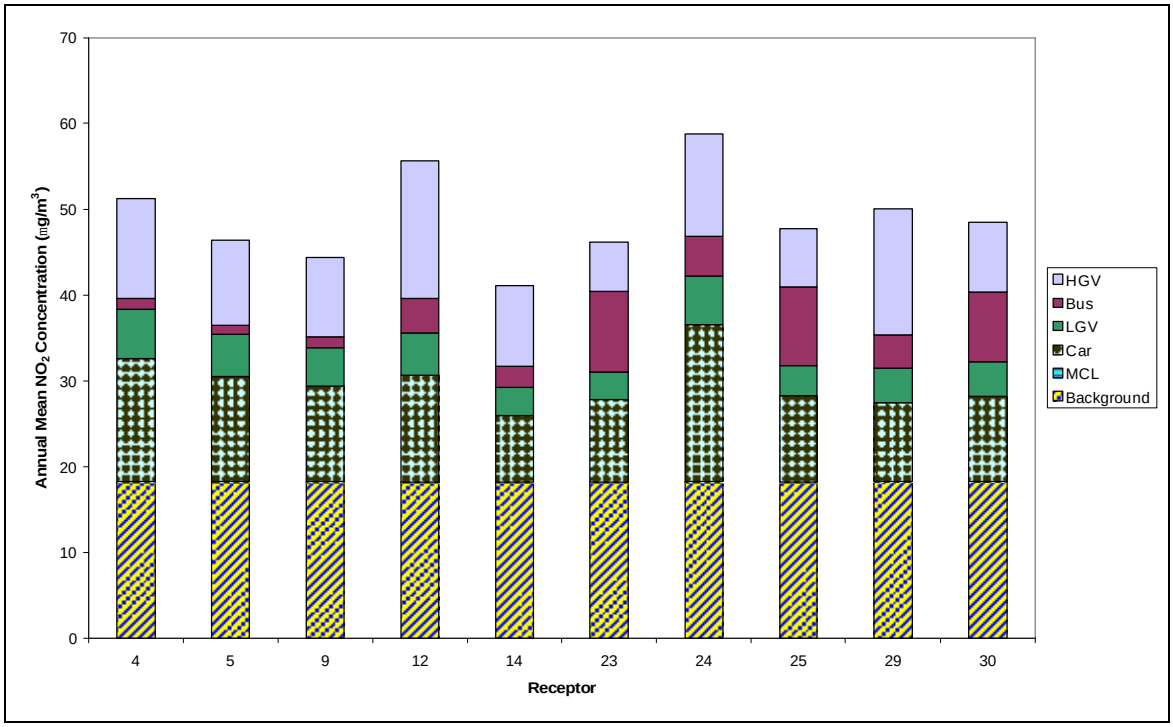

Figure 6: Relative Contribution of Each Source Type to the Total Predicted Annual Mean Nitrogen Dioxide Concentration (µg/m^3) at Receptor Locations.

6 Air Quality Improvements Required

6.1 The degree of improvement needed in order for the annual mean objective for nitrogen dioxide to be achieved is defined by the difference between the highest measured or predicted concentration and the objective level (40 µg/m^3).

6.2 The highest nitrogen dioxide concentration is that measured at Receptor 24 (58.7 µg/m^3), requiring a reduction of 18.7 µg/m^3 in order for the objective to be achieved.

6.3 In terms of describing the reduction in emissions required, it is more useful to consider nitrogen oxides (NOx). The required reduction in local nitrogen oxides emissions has been calculated in line with guidance presented in LAQM.TG(09) (Defra, 2009). Table 5 sets out the required reduction in local emissions of NOx that would be required at each of the Receptors where an exceedence was predicted in 2010, in order for the annual mean objective to have been achieved. At Receptor 24, local emissions would need to have been 53.8% lower in order to meet the objective.

Table 5: Improvement in Annual Mean Nitrogen Dioxide Concentrations and in Emissions of Oxides of Nitrogen at Receptors in 2010.

Receptor	Required reduction in annual mean nitrogen dioxide concentration (µg/m^3)	Required reduction in emissions of oxides of nitrogen from local roads (%)
4	11.2	39.7
5	6.4	26.7
9	4.4	19.5
12	15.6	48.6
14	1.1	5.6
23	6.2	25.7
24	18.7	53.8
25	7.7	30.5
29	10.1	37.1
30	8.5	32.8

7 Summary and Conclusions

7.1 Nitrogen dioxide concentrations within and around the Hertford AQMA have been assessed through diffusion tube monitoring and detailed dispersion modelling. The results indicate that the annual mean nitrogen dioxide objective was exceeded in 2010 within the AQMA, and also at locations of relevant exposure outside of the AQMA.

7.2 It is therefore recommended that:

- The AQMA should be extended to include, as a minimum, the area alongside Mill Bridge, Old Cross and St Andrews Street, and also alongside London Road and Ware Road, and monitoring should continue.

7.3 Source apportionment of the local traffic emissions has been undertaken. This shows, in the majority of cases, ambient background concentrations contribute the largest proportion to the overall concentration, followed by emissions from cars and HGVs on the local roads. In a number of cases, emissions from buses also contribute a significant proportion to the overall concentration. This highlights the importance of keeping all sources under consideration when contemplating measures to include within the action plan.

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9 Glossary

Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal.
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, taking into account costs, benefits, feasibility and practicality. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides.
Exceedence	A period of time where the concentration of a pollutant is greater than the appropriate air quality objective.
AQMA	Air Quality Management Area
ADMS Roads	Atmospheric Dispersion Modelling System for Roads.
NOx	Nitrogen oxides
NO_2	Nitrogen dioxide.
mg/m^3	Microgrammes per cubic metre.
Roadside	A site sampling between 1 m of the kerbside of a busy road and the back of the pavement. Typically this will be within 5 m of the road, but could be up to 15 m (Defra, 2009).
HGV	Heavy Goods Vehicle
LGV	Light Goods Vehicle
MCL	Motorcycles
TEA	Triethanolamine – used to absorb nitrogen dioxide

A1 Appendix 1: Dispersion Modelling Methodology

A1.1 Annual mean concentrations of nitrogen dioxide during 2010 have been modelled using the Atmospheric Dispersion Modelling System (ADMS). ADMS is one of the dispersion models accepted for modelling within LAQM.TG(09) (Defra, 2009). Road sources were modelled using ADMS Roads (version 3).

Traffic Data:

A1.2 Traffic data were provided by Hertfordshire County Council. A summary of the Annual Average Daily Traffic (AADT) flows entered into the model is provided in Table A1.1. Sections of St Andrew Street, Millbridge, Old Cross and Fore Street have been included in the model as a 'canyon'.

Table A1.1: Summary of AADT Flows (2010)

	MCL	Cars	LGV	BUS	HGV	Total
North Road (west of Cross Lane)	129	12,802	1,544	179	260	14,914
North Road (east of Cross Lane)	70	5,253	593	152	123	6,192
Cross Lane	96	10,353	1,189	60	246	11,944
Hertingfordbury Rd (west of Cross lane)	334	21,918	3,526	78	1,089	26,944
Hertingfordbury Rd (east of Cross lane)	357	29,348	4,325	98	1,221	35,350
Gascoyne Way (west of Castle St roundabout)	380	29,309	4,380	95	1,252	35,415
St Andrew St	75	5,121	653	160	113	6,122
Old Cross	107	7,828	908	70	234	9,147
Mill Bridge	85	7,036	929	207	186	8,443
Parliament Sq	92	7,110	1,017	83	194	8,497
Hale Rd	83	10,167	1,036	100	204	11,589
Gascoyne Way (east of Castle St roundabout)	376	32,176	5,149	366	2,156	40,224
Fore Street	10	2,721	421	137	112	3,401
Fore St (one-way)	23	1,308	352	155	23	1,862
London Rd	283	23,778	3,971	343	1,850	30,224
Ware Rd (west of Mill Road)	160	17,605	2,677	202	1,310	21,954
Mill Rd	51	3,837	1,412	0	362	5,662
Ware Rd (east of Mill Road)	122	13,554	1,991	389	374	16,430

Background Concentrations:

A1.3 Background concentrations of nitrogen dioxide have been taken from the national maps of background concentrations published by Defra (Defra, 2011b). The background concentrations used in the modelling are presented in Table A1.2.

Table A1.2: Background Concentrations (µg/m^3)[a]

	NOx	NO_2
2010	22.4 – 28.0	15.0 – 18.2

[a] The area lies within three grid squares

Model Verification:

A1.4 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 2010 at the diffusion tube monitoring sites within the area. Concentrations have been modelled at either 2 m or 2.5 m, depending on the height of the monitors.

A1.5 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 was calculated from the measured NO_2 concentrations and the predicted background NO_2 concentration using the NOx from NO_2 calculator available on the Defra LAQM Support website (Defra, 2011a).

A1.6 A primary adjustment factor was determined as the slope of the best fit line between the 'measured' road contribution and the model derived road contribution, forced through zero (Figure A1.1). This factor was then applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations. The total nitrogen dioxide concentrations were then determined by combining the adjusted modelled road-NOx concentrations with the predicted background NO_2 concentration within the NOx from NO_2 calculator available on the Defra LAQM Support website (Defra, 2011a). A secondary adjustment factor was finally calculated as the slope of the best fit line applied to the adjusted data and forced through zero (Figure A1.2).

A1.7 The following primary and secondary adjustment factors have been applied to all modelled nitrogen dioxide data:

- Primary adjustment factor : 4.999
- Secondary adjustment factor: 1.007

A1.8 The results imply that the model is under-predicting the road-NOx contribution. This is a common experience with this and most other models. The final NO_2 adjustment is minor.

A1.9 Figure A1.3 compares final adjusted modelled total NO_2 at each of the monitoring sites, to measured total NO_2, and shows a 1:1 relationship.

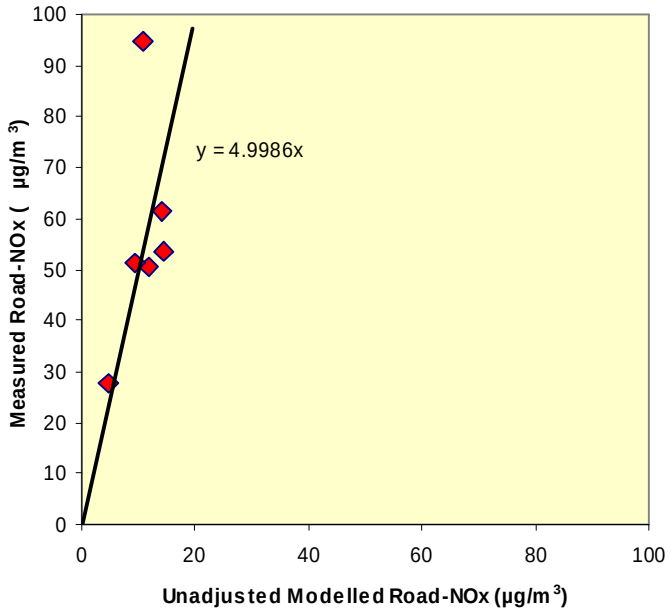

Figure A1.1: Comparison of Measured Road NOx to Unadjusted Modelled Road NOx Concentrations

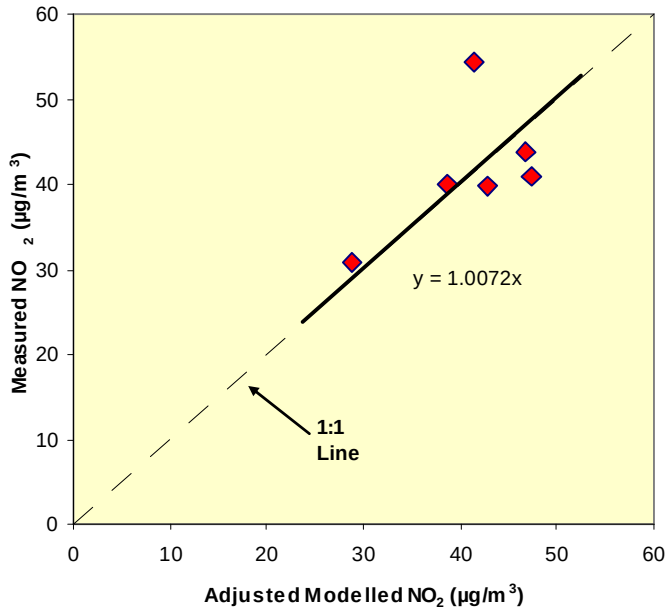

Figure A1.2: Comparison of Measured Total NO_2 to Primary Adjusted Modelled Total NO_2 Concentrations

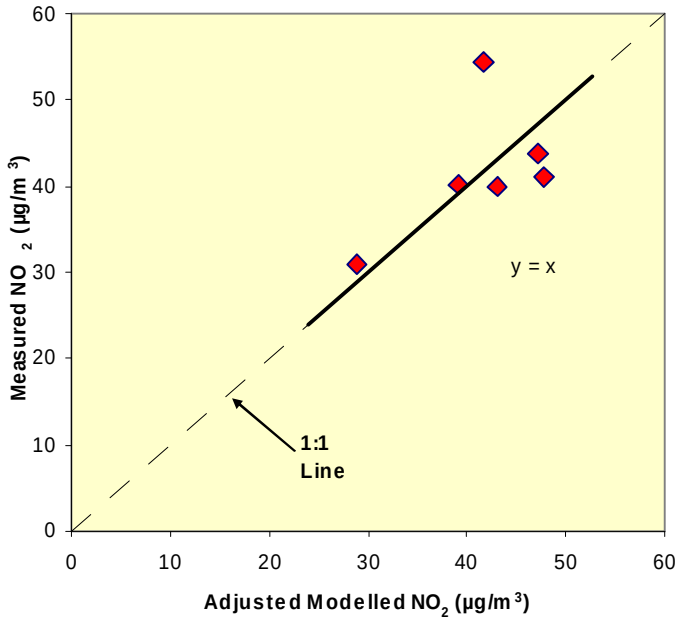

Figure A1.3: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations