Air Quality CONSULTANTS

Detailed Assessment of Air Quality at Garstang Road, Broughton and New Hall Lane, Preston for Preston City Council

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Experts in air quality management & assessment

Document Control

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Contents

Preston City Council confirms that it accepts the recommendations made in this report.

1 Introduction

1.1 Air Quality Consultants Ltd has been commissioned by Preston City Council to undertake a Detailed Assessment of air quality within Broughton and along New Hall Lane. In 2009, Preston City Council completed an Updating and Screening Assessment for air quality, which concluded that a Detailed Assessment was required for potential exceedences of the nitrogen dioxide annual mean objective along Garstang Road, Broughton and New Hall Lane, Preston.

1.2 The aim of this Detailed Assessment is to determine whether the annual mean nitrogen dioxide objective is exceeded at relevant locations and, if so, the extent of exceedences and thus the boundary of the Air Quality Management Area (AQMA) required. The opportunity has also been taken to provide information on source apportionment.

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 and third rounds of Review and Assessment, with the fourth round 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 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.

1.6 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. Subsequent to the declaration of an AQMA, a Further Assessment should be carried out to confirm that the AQMA declaration is justified; and

that the appropriate area has been declared; to ascertain the sources contributing to the exceedence; and 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.

1.7 This report represents a Detailed Assessment in the fourth round of Review and Assessment, following the findings of Preston City Council's USA published in July 2009 which concluded that there could be an exceedence of the annual mean nitrogen dioxide objective at locations of relevant exposure (Preston City Council, 2009). The report identified Garstang Road, Broughton, near to the junction of Whittingham/Woodplumpton Lane as a congested narrow street, with flows above 5,000 vehicles per day. The report also identified the junction of New Hall Lane and London Road, the junction of Corporation Street and Marsh Lane, and the junction of New Hall Lane and Blackpool Road as busy junctions, and predicted exceedences at these locations using the DMRB model. Diffusion tube monitoring began in October 2009 and exceedences of the objective were measured in Broughton and at the junction of New Hall Lane and London Road. No exceedences of the objective were measured at relevant locations along Marsh Lane or the junction of New Hall Lane and Blackpool Road, therefore these locations have not been included in this assessment. Preston City Council's Progress Report published in 2010, confirmed the findings of the 2009 USA, and the recommendation that a Detailed Assessment be undertaken along New Hall Lane, Preston and Garstang Road, Broughton (Preston City Council, 2010).

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). 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

1.9 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.

1.10 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 Monitoring for nitrogen dioxide was carried out by Preston City Council using two passive diffusion tube sites along New Hall Lane and three sites in Broughton. The monitoring sites and study areas are shown in Figures 1 and 2. Diffusion tubes were prepared and analysed by Gradko using the 20% TEA in water method. It is necessary to adjust diffusion tube data to account for laboratory bias. A bias adjustment factor for 2010 of 0.93 has been calculated from the local co-location study. The national bias adjustment factor from the database of national factors provided on the Review and Assessment Helpdesk website (spreadsheet version 04/11) was 0.92, which was based on 39 studies. The local bias adjustment factor was considered more appropriate than the national factor as it is more precautionary.

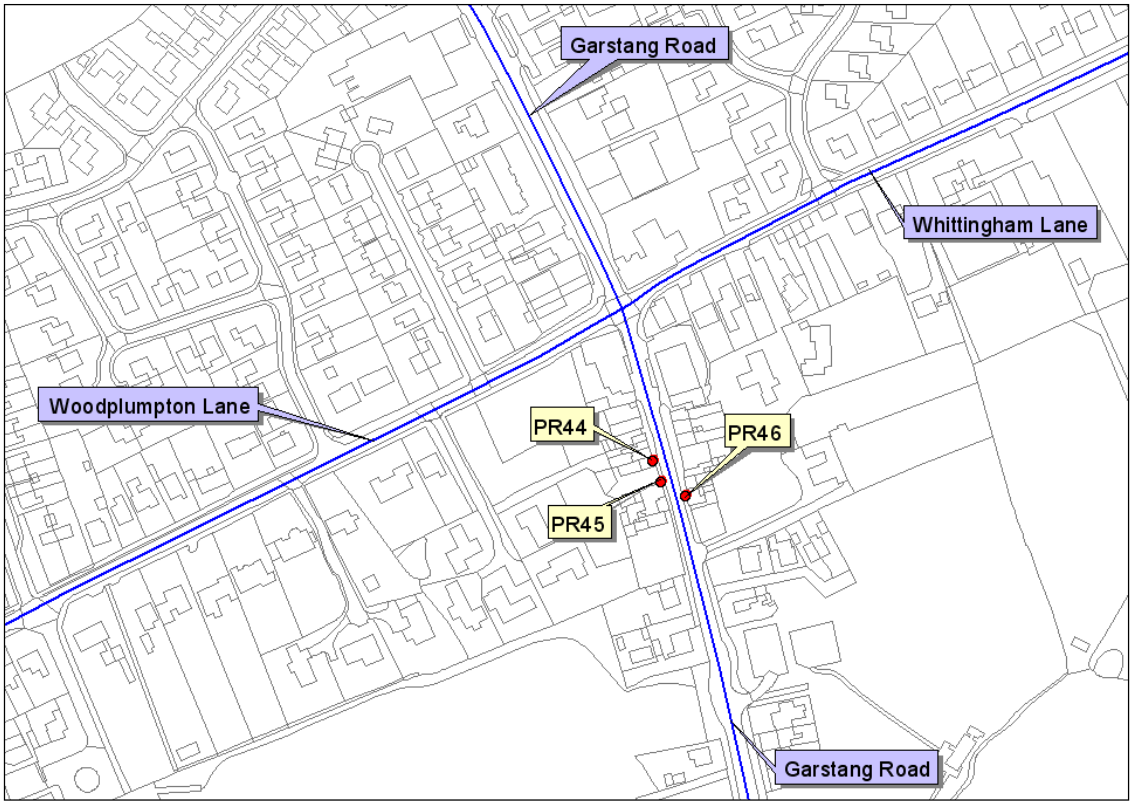

Figure 1 **Broughton Detailed Assessment Study Area and Monitoring Locations. Roads explicitly included in the model shown in blue.** © Crown copyright 2011. All rights reserved. License number: 100046099

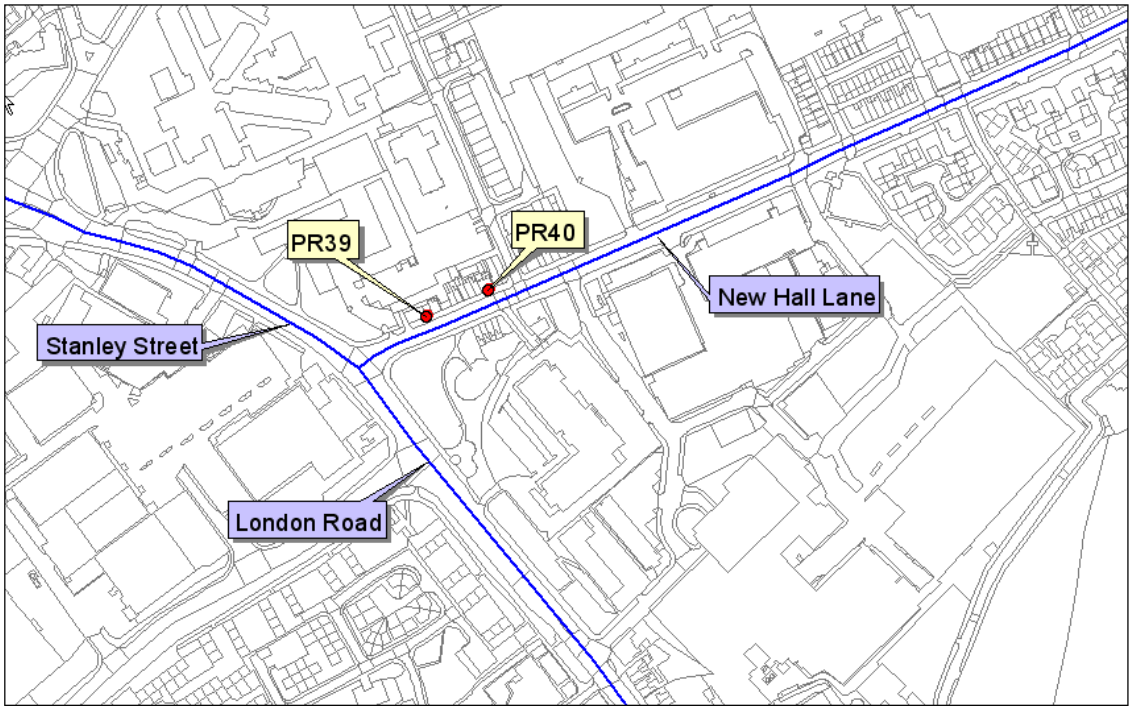

Figure 2 **New Hall Lane Detailed Assessment Study Area and Monitoring Locations. Roads explicitly included in the model shown in blue.** © Crown copyright 2011. All rights reserved. License number: 100046099

Modelling

2.2 Annual mean nitrogen dioxide concentrations have been predicted using detailed dispersion modelling (ADMS-Roads v3). The input data used are described in Appendix 2. The model outputs have been verified against the monitoring data described in paragraph 2.1. Further details of model verification are also supplied in Appendix 2. Concentrations have been predicted for a number of additional receptors to enable the extent of the exceedence area to be to be determined. In addition, concentrations have been predicted at a number of worst-case receptor locations (Figures 3 and 4). The worst-case receptors have been modelled at either ground or first floor, depending on the height of relevant exposure.

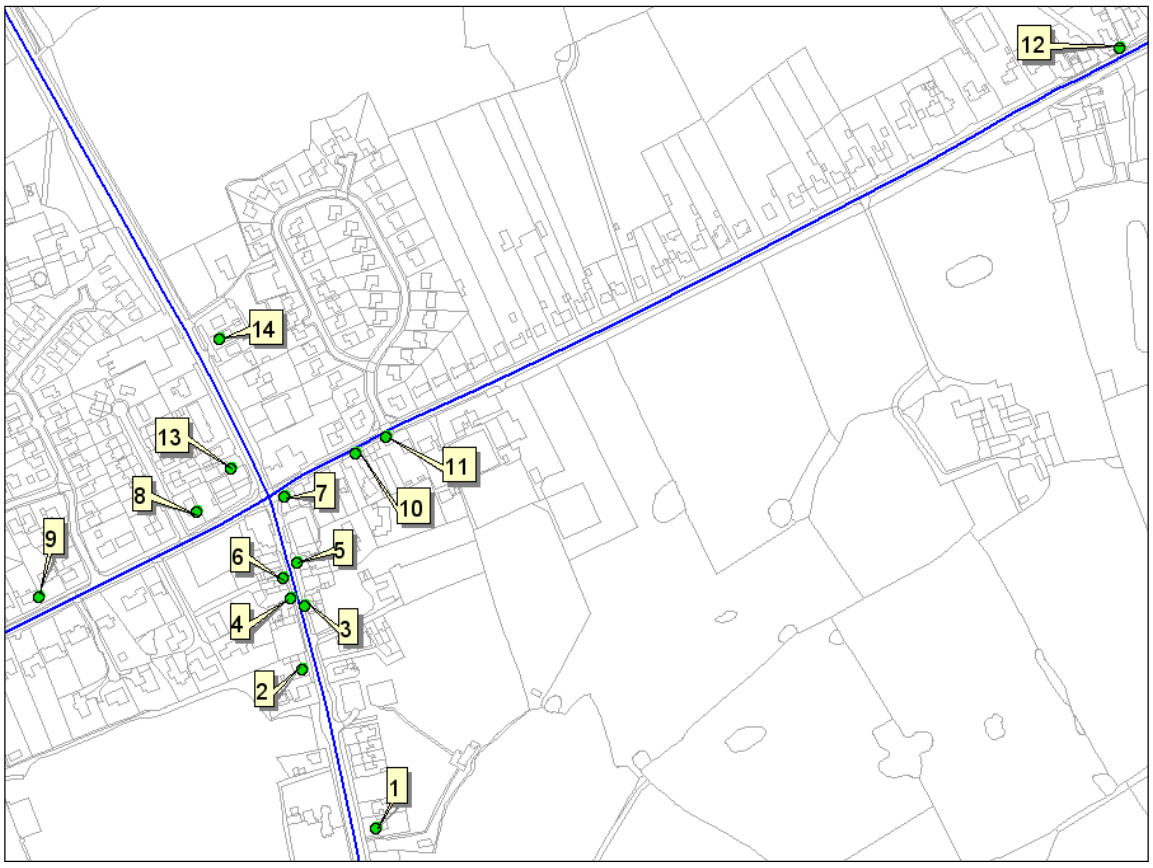

Figure 3 Specific Receptor Locations - Broughton

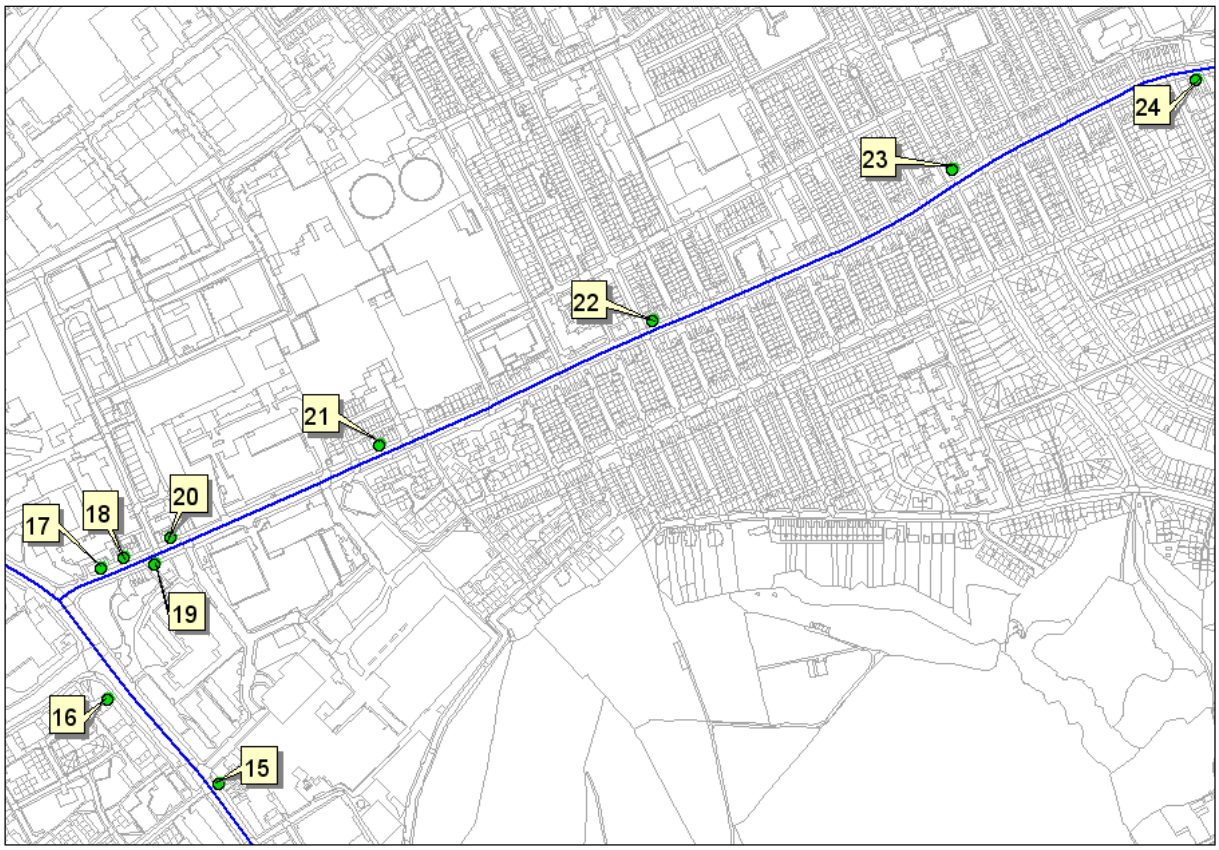

Figure 4 Specific Receptor Locations – New Hall Lane

Uncertainty

2.3 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 (2011) 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 determined from the interactive web-based map provided by the Department for Transport (DfT, 2011) and data provided by Preston City 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 Manchester Airport 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.

2.4 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.

3 Results

Monitoring

3.1 Monitoring data for the sites within the study areas (Figures 1 and 2) are summarised in Table 2.

Table 2: Measured Annual Mean Nitrogen Dioxide Concentrations (µg/m^3)

Site	Site Type	Site Description	2009[a]	2010[b]
New Hall Lane				
PR39	Roadside	7 New Hall Lane	**48.1**	**51.5**
PR40	Roadside	23 New Hall Lane	**44.2**	**44.6**
Broughton				
PR44	Roadside	507 Garstang Road	**40.6**	**50.6**
PR45	Roadside	503 Garstang Road	**46.4**	**45.5**
PR46	Roadside	482 Garstang Road	**73.3**	**71.0**
Objective			**40**	**40**

[a] Monitoring began October 2009. As reported in Preston City Council's 2010 Progress Report (Preston City Council, 2010). Data have been bias adjusted by the Council using a local factor (0.84).

[b] Data have been bias adjusted using the local factor (0.93).

3.2 The annual mean objective was exceeded at both of the monitoring locations on New Hall Lane. In Broughton all three of the sites exceeded the objective. Concentrations along Garstang Road are expected to be high due to heavy congestion during the morning and evening rush hours which can lead to queues of traffic over 1,000 metres back from the crossroads. Measured concentrations at 482 Garstang Road are exceeding 60 µg/m^3, suggesting exceedences of the 1-hour objective are likely.

Modelling

3.3 Predicted annual mean nitrogen dioxide concentrations in 2010 at each of the receptor locations shown in Figures 3 and 4, are set out in Table 3. Predicted concentrations exceed the annual mean objective at Receptors 2 – 7 in Broughton, these receptors are all located close to Garstang Road which experiences heavy congestion. Receptors 3 – 6 lie within a street canyon and are therefore expected to have higher results than those outside the street canyon. The predicted concentrations within the street canyon are, however, below 60 µg/m^3.

3.4 In the New Hall Lane study area predicted concentrations exceed the annual mean objective at Receptors 15, 17, 21 and 22. The highest modelled annual mean nitrogen dioxide concentration is 52.0 µg/m^3, predicted at Receptor 15. There are no predicted annual mean concentrations greater than 60 µg/m^3, and thus exceedences of the 1-hour objective are unlikely.

Table 3: Modelled Annual Mean Nitrogen Dioxide Concentrations at Specific Receptors

Receptor	Location	Height	2010 (µg/m^3)[a]
Broughton			
1	442 Garstang Road	1.5	33.2
2	497 Garstang Road	1.5	**40.4**
3	482 Garstang Road	1.5	**59.5**
4	503 Garstang Road	1.5	**57.8**
5	492 Garstang Road	1.5	**56.2**
6	511 Garstang Road	1.5	**57.0**
7	500 Garstang Road	1.5	**44.0**
8	1 Kingsway Avenue	1.5	23.2
9	24 Woodplumpton Lane	1.5	18.1
10	12 Whittingham Lane	1.5	30.7
11	20 Whittingham Lane	1.5	29.1
12	77 Whittingham Lane	1.5	28.1
13	529 Garstang Road	1.5	31.4
14	516a Garstang Road	1.5	30.0
New Hall Lane			
15	87 London Road	1.5	**52.0**
16	24 Grosvenor Street	2	38.8
17	7 New Hall Lane	4.5	**42.0**
18	17 New Hall Lane	4.5	38.9
19	26 New Hall Lane	4.5	36.2
20	35 New Hall Lane	4.5	36.5
21	61 New Hall Lane	1.5	**41.4**
22	151 New Hall Lane	1.5	**46.3**
23	229 New Hall Lane	1.5	38.6
24	348 New Hall Lane	1.5	35.6
Objective			**40**

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

3.5 Concentrations have also been predicted for a number of additional receptors (Figures 5 and 6). These show that the annual mean objective is likely to be exceeded in Broughton alongside Garstang Road from the crossroads to about 150 m south of the crossroads. There are also a number of additional locations where concentrations exceed 36 µg/m^3, which represents the

objective minus 10%. The predicted concentrations within the street canyon are, however, below 60 µg/m^3. There are a number of properties within the street canyon which only have relevant exposure at first floor height. Concentrations reduce with height and the predicted concentrations show there are no predicted exceedences above ground floor level.

3.6 Within the New Hall Lane study area, exceedences have been predicted along New Hall Lane and also along London Road, there are also a number of additional locations where concentrations exceed 36 µg/m^3, which represents the objective minus 10%. No exceedences of 60 µg/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. To the east of the study area the houses are set further back from the road and therefore concentrations are expected to be lower, monitoring has also been carried on New Hall Lane to the east of the study area which, when corrected for distance to relevant exposure, showed no exceedences of the objective.

Population Exposure

3.7 Objective exceedences are predicted at approximately 12 residential properties within Broughton. Assuming that each property has on average two occupants, this equates to approximately 24 residents.

3.8 Objective exceedences are predicted at approximately 70 residential properties within the New Hall Lane study area. Assuming that each property has on average two occupants, this equates to approximately 140 residents.

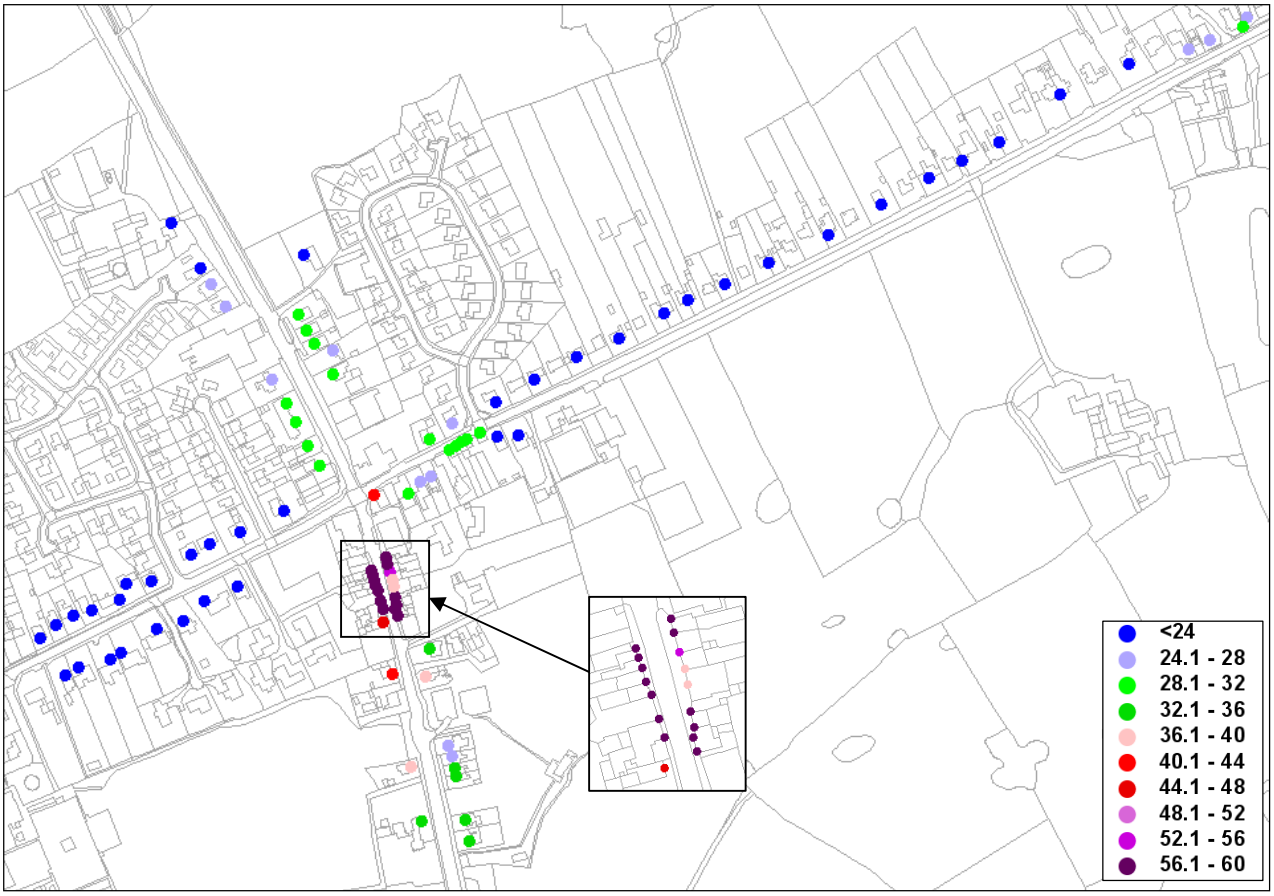

Figure 5 Predicted Concentrations of Nitrogen Dioxide (µg/m^3) modelled receptors in 2010 within Broughton.

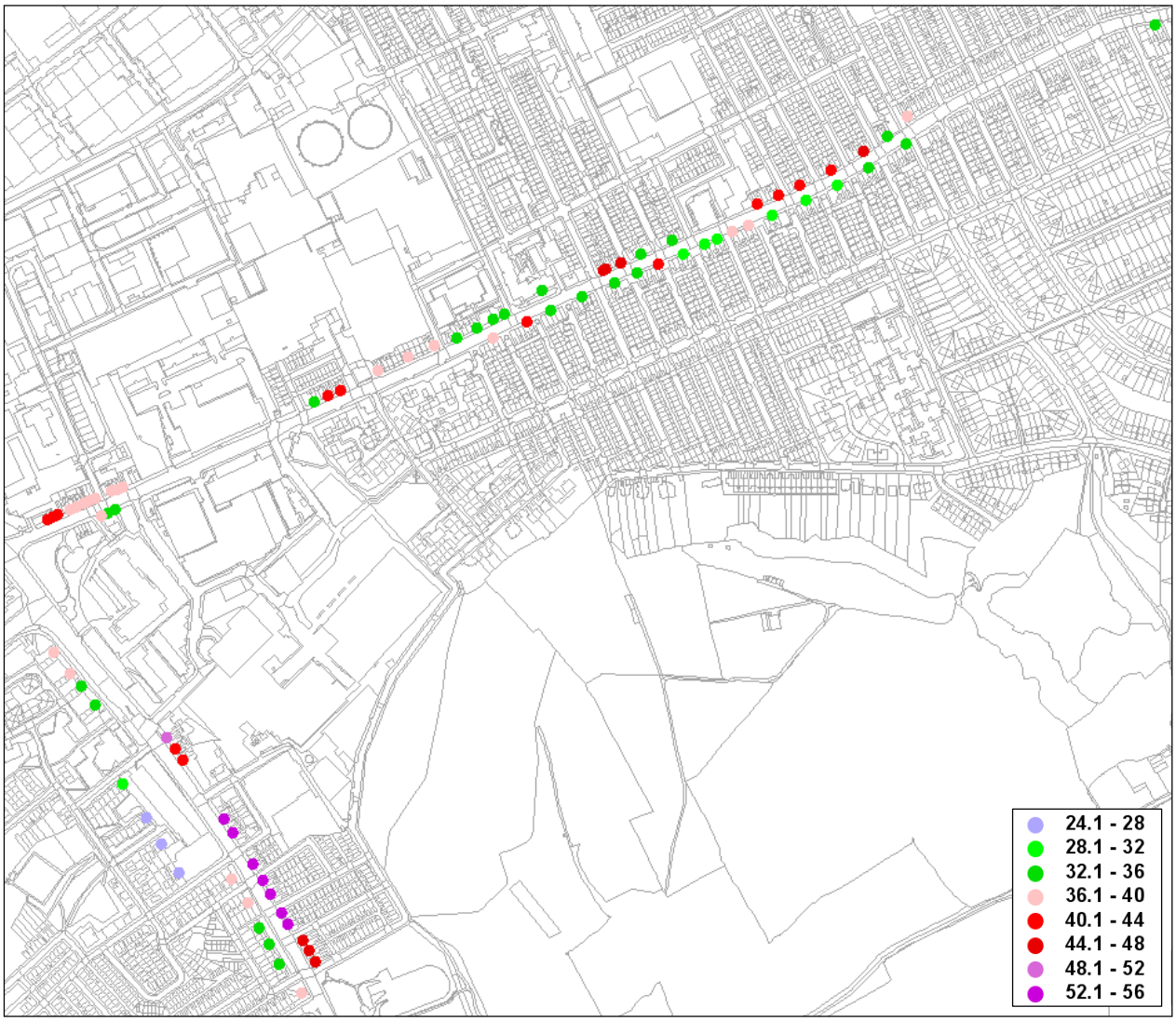

Figure 6 Predicted Concentrations of Nitrogen Dioxide (µg/m^3) modelled receptors in 2010 within the New Hall Lane study area.

4 Source Apportionment

4.1 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 decisions, and have been calculated in line with guidance provided in LAQM.TG(09) (Defra, 2009).

4.2 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);

4.3 Six receptor locations identified previously as exceeding the objective in Broughton have been used to provide an overview of source contributions. Table 4 and Figure 7 show the most significant component at all receptors is from HGVs, followed by emissions from cars. At Receptor 2, the most significant component is from background concentrations, followed by HGVs and cars.

4.4 Four receptor locations identified previously as exceeding the objective in the New Hall Lane study area have been used to provide an overview of source contributions. Table 5 and Figure 8 show the most significant component at all receptors is the ambient background concentration, followed by emissions from cars and HGVs.

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

No.	Annual Mean Concentration (µg/m^3)					
	Bkgd	MCL	Car	Bus	HGV	Total
2	15.1	0.1	10.7	1.7	12.9	40.4
3	12.5	0.1	19.6	3.2	24.1	59.5
4	12.5	0.1	19.0	3.1	23.2	57.8
5	12.5	0.1	18.3	2.9	22.4	56.2
6	12.5	0.1	18.7	3.0	22.7	57.0
7	12.5	0.1	13.1	1.7	16.6	44.0
	% Contribution to Total					
	Bkgd	MCL	Car	Bus	HGV	Total
2	37.4	0.1	26.5	4.1	31.9	100.0
3	21.0	0.2	32.9	5.4	40.5	100.0
4	21.6	0.2	32.8	5.3	40.1	100.0
5	22.2	0.2	32.5	5.2	39.8	100.0
6	21.9	0.2	32.8	5.2	39.9	100.0
7	28.4	0.2	29.8	4.0	37.6	100.0

Table 5: Predicted Annual Mean (2010) Nitrogen Dioxide Concentrations and the Contribution of Each Source Type to the Total within the New Hall Lane area

No.	Annual Mean Concentration (µg/m^3)						
	Bkgd	MCL	Car	LGV[a]	Bus	HGV	Total
15	20.8	0.1	12.2	4.5	7.2	7.3	52.0
17	20.8	0.0	8.1	1.1	4.1	7.9	42.0
21	18.8	0.0	9.4	0.1	3.2	9.8	41.4
22	18.8	0.0	11.1	0.0	3.7	12.7	46.3
	% Contribution to Total						
	Bkgd	MCL	Car	LGV	Bus	HGV	Total
15	39.9	0.2	23.4	8.7	13.9	14.0	100.0
17	49.4	0.1	19.3	2.5	9.9	18.9	100.0
21	45.4	0.1	22.8	0.2	7.8	23.8	100.0
22	40.6	0.1	23.9	0.1	8.0	27.3	100.0

[a] LGV data was only available for Stanley Road and London Road

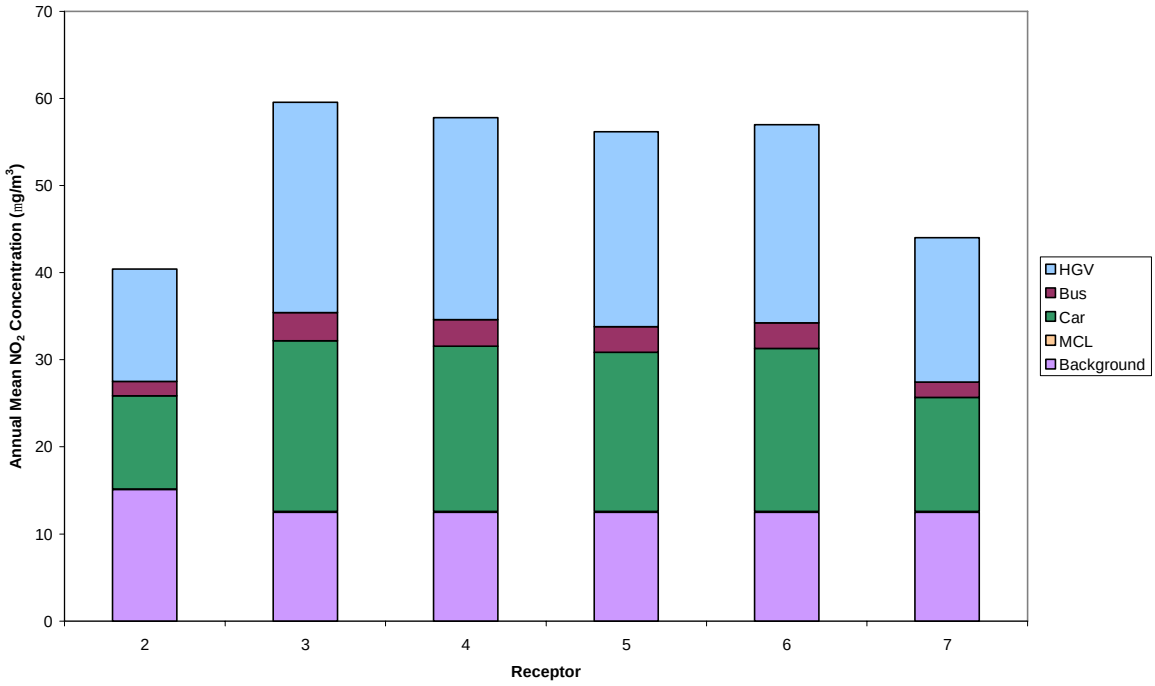

Figure 7: Relative Contribution of Each Source Type to the Total Predicted Annual Mean Nitrogen Dioxide Concentration (µg/m^3) at Receptor Locations within Broughton

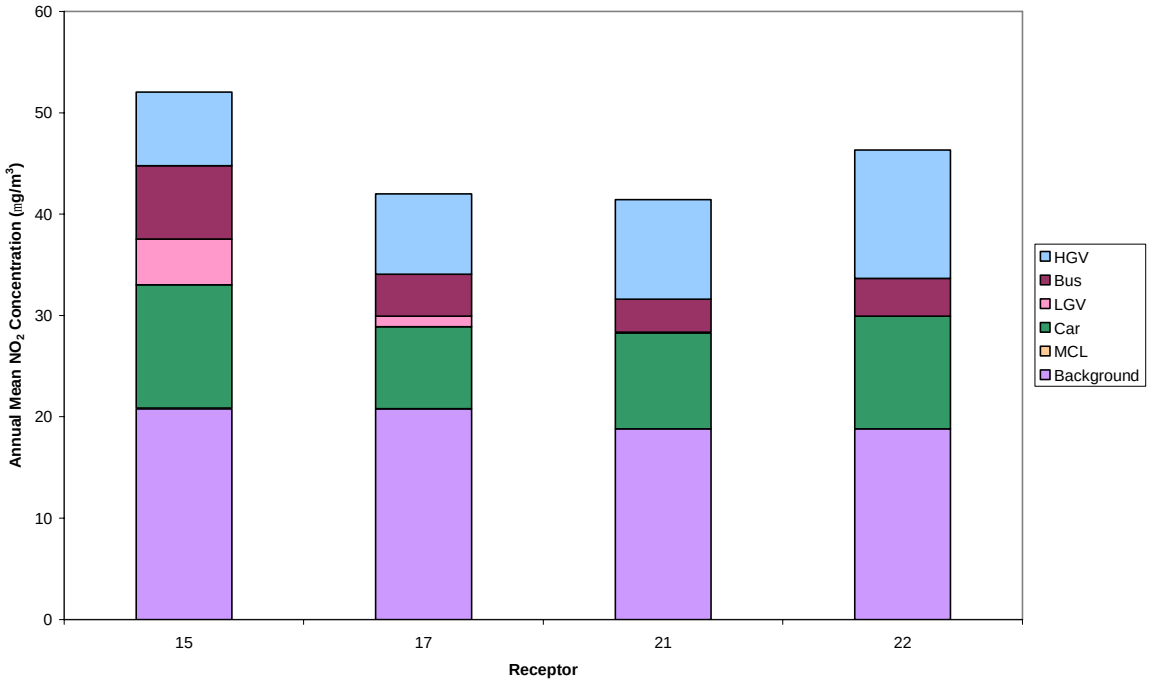

Figure 8: Relative Contribution of Each Source Type to the Total Predicted Annual Mean Nitrogen Dioxide Concentration (µg/m^3) at Receptor Locations within the New Hall Lane Study Area

5 Conclusions and Recommendations

5.1 A Detailed Assessment has been carried out for nitrogen dioxide within Broughton and along New Hall Lane, Preston. These areas were identified as being at risk of exceeding the annual mean air quality objective for nitrogen dioxide in Preston City Council's 2009 USA.

5.2 The Detailed Assessment has been carried out using a combination of monitoring data and modelled concentrations. Concentrations of nitrogen dioxide have been modelled for 2010 using the ADMS-Roads dispersion model. The model has been verified against measurements made at the five nitrogen dioxide diffusion tube monitoring locations which lie adjacent to the road network included in the model.

5.3 The assessment has identified that the annual mean nitrogen dioxide objective is being exceeded at a number of relevant locations along Garstang Road to the south of the crossroads in Broughton. Concentrations of over 60 $\mu g/m^3$ have been measured at locations of relevant exposure, and thus exceedences of the 1-hour objective are possible. It is therefore recommended that an AQMA is declared for the annual and also hourly mean objective. The AQMA should include, as a minimum, those residential properties that are exceeding the objective, although to allow for uncertainty in the modelling it would be appropriate to include all locations where concentrations exceed 36 $\mu g/m^3$.

5.4 The assessment has identified that the annual mean nitrogen dioxide objective is also being exceeded at a number of relevant locations within the New Hall Lane study area, both along New Hall Lane and along London Road. 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. It is therefore recommended that an AQMA is declared for the annual mean objective, which should include, as a minimum, those residential properties that are exceeding the objective, although to allow for uncertainty in the modelling it would be appropriate to include all locations where concentrations exceed 36 $\mu g/m^3$.

5.5 It is also recommended that Preston City Council continues monitoring nitrogen dioxide at the existing monitoring locations, and expands the network where possible, particularly along London Road. Monitoring results can then be used to inform the Further Assessment.

5.6 Source apportionment of the local traffic emissions has been undertaken. In Broughton HGVs contribute the largest proportion to the overall concentration, followed by emissions from cars. Within the New Hall Lane study area, ambient background concentrations contribute the largest proportion to the overall concentrations, followed by emissions from cars and HGVs on the local roads. On London Road, emissions from buses also contribute a significant proportion to the overall concentration.

5.7 Finally, Preston City Council should proceed with the completion of a Further Assessment for air quality within 12 months of the declaration of an AQMA.

6 References

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7 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.
NO_X	Nitrogen oxides (taken as NO + NO_2)
NO	Nitric Oxide
NO_2	Nitrogen dioxide.
$\mu g/m^3$	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).
HDV	Heavy Duty Vehicle
LDV	Light Duty Vehicle
MCL	Motorcycles
AADT	Annual Average Daily Traffic flows

A1 Appendix 1 – 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 Appendix 2 – Dispersion Modelling Methodology

Meteorological Data

A2.1 The model has been run using a full year of meteorological data for 2010 from the meteorological station near Manchester Airport. Missing cloud-cover data were from Liverpool.

Background Concentrations:

A2.2 Background concentrations of nitrogen dioxide have been taken from the national maps of background concentrations published by Defra (Defra, 2011). The background concentrations used in the modelling are presented in Table A2.1.

Table A2.1: Background Concentrations 2010 (µg/m^3)[a]

	NOx	NO_2
Broughton	16.4 – 26.2	12.5 – 18.9
New Hall Lane	23.7 – 29.7	17.2 – 20.8

[a] The study areas lie within a number of grid squares

Traffic Data

A2.3 The ADMS Roads model requires the user to provide various input data, including the Annual Average Daily Traffic (AADT) flow, the proportion of different vehicle classes, road characteristics (including road width and street canyon height, where applicable), and the vehicle speed.

A2.4 Preston City Council provided AADT flows, split into a number of vehicle classes, for roads within Broughton and New Hall Lane. The Broughton flows were based on 2011 traffic counts, whereas the New Hall Lane flows were based on 2008 traffic counts. Preston City Council also provided traffic data for previous years which showed no trend in traffic flows over the last four years, therefore, data have not been adjusted to 2010. Traffic flows for Stanley Road and London Road

were determined from the interactive web-based map provided by the Department for Transport (DfT, 2011). Traffic speeds were provided by the Council for the roads in Broughton and New Hall Lane, while traffic speeds for Stanley Road and London Road were estimated from local speed restrictions taking account of the proximity to junctions. The ADMS Roads model can not model congestion, therefore, in order to take into account the very slow moving traffic in Broughton, slower traffic speeds were entered into the model. The traffic data used in this Detailed Assessment are presented in Table A2.2.

Table A2.2: Summary of AADT Flows (2010)

	MCL	Cars	LGV[a]	BUS	HGV	Total
Broughton						
A6 Garstang Road (North Arm)	190	16,184	n/a	56	954	17,384
B5269 Whittingham Lane (East Arm)	77	6,481	n/a	18	344	6,920
A6 Garstang Road (South Arm)	210	21,556	n/a	89	1,064	22,919
B5269 Woodplumpton Lane (West Arm)	68	3,774	n/a	4	165	4,011
New Hall Lane junction						
A6 Stanley Street	257	28,619	3,371	606	950	33,803
A59 New Hall Lane (west of Scotforth Road junction)	96	18,024	n/a	223	883	19,226
A59 New Hall Lane (between Scotforth Road junction and Arnhem Road junction)	82	17,338	n/a	175	837	18,432
A59 New Hall Lane (east of Arnhem Road junction)	80	17,265	n/a	239	921	18,505
A6 London Road	327	29,366	4,153	648	813	35,307

[a] Traffic data provided by the Council categorised cars and LGVs together. These were entered into the model as cars.

Model Verification

A2.5 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 (NO_X = NO + NO_2). The model has been run to predict the annual mean road-NO_X concentration during 2010 at the five diffusion tube monitoring sites described in Table 2, which lie alongside the roads included in the model.

A2.6 The model output of road-NO_X (i.e. the component of total NO_X coming from road traffic) has been compared with the 'measured' road-NO_X. Measured road-NO_X for the diffusion tube sites was calculated from the measured NO_2 concentration and the predicted background NO_2 concentration using the NO_X from NO_2 calculator available on the LAQM Support website (Defra, 2011).

A2.7 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 A2.1 and A2.4). This factor was then applied to the modelled road-NO_X concentration for each receptor to provide adjusted modelled road-NO_X concentrations. The total nitrogen dioxide concentrations were then determined by combining the adjusted modelled road-NO_X concentrations with the predicted background NO_2 concentration within the NO_X from NO_2 calculator. 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 A2.2 and A2.5).

Broughton

A2.8 The following primary and secondary adjustment factors have been applied to modelled nitrogen dioxide data within Broughton:

- Primary adjustment factor : 3.047
- Secondary adjustment factor: 0.986

A2.9 The results imply that the model was under-predicting the road-NO_X contribution. This is a common experience with this and most other models. The final NO_2 adjustment is minor.

A2.10 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.

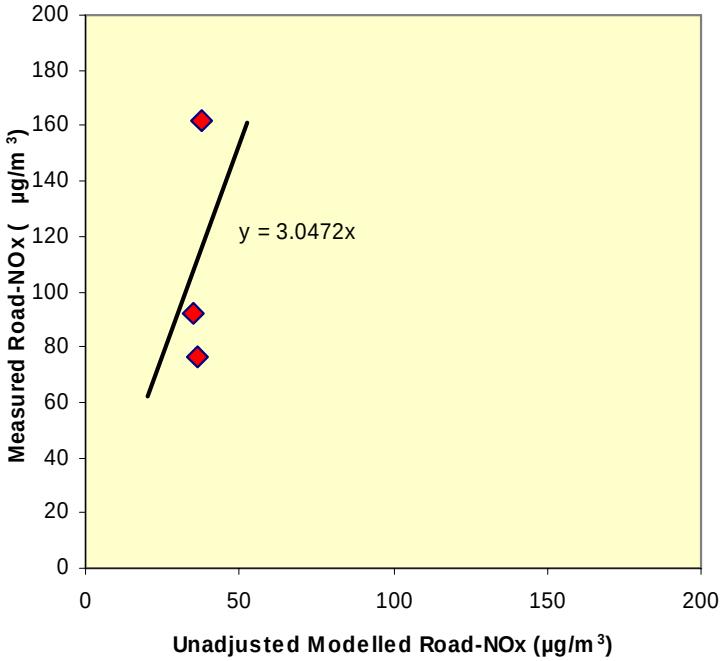

Figure A2.1: Comparison of Measured Road-NO_X to Unadjusted Modelled Road NO_X Concentrations

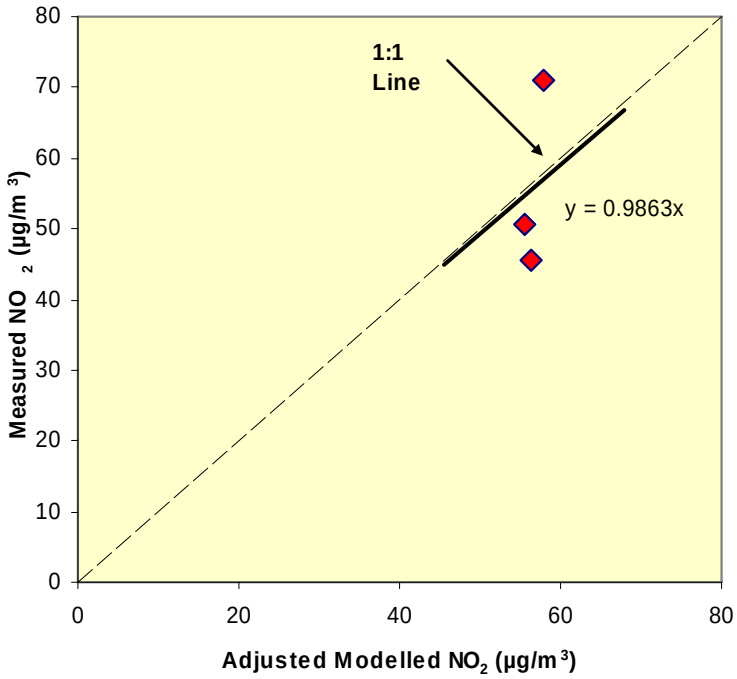

Figure A2.2: Comparison of Measured Total NO_2 to Primary Adjusted Modelled Total NO_2 Concentrations

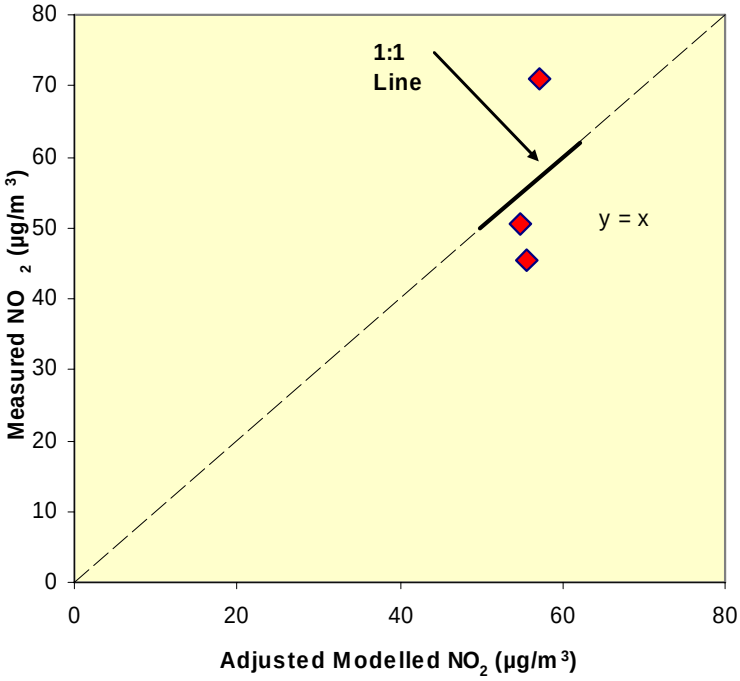

Figure A2.3: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations

New Hall Lane

A2.11 The following primary and secondary adjustment factors have been applied to modelled nitrogen dioxide data within the New Hall Lane study area:

- Primary adjustment factor : 4.393
- Secondary adjustment factor: 0.997

A2.12 The results imply that the model was under-predicting the road-NO_X contribution. This is a common experience with this and most other models. The final NO_2 adjustment is minor.

A2.13 Figure A2.6 compares final adjusted modelled total NO_2 at each of the monitoring sites, to measured total NO_2, and shows a 1:1 relationship.

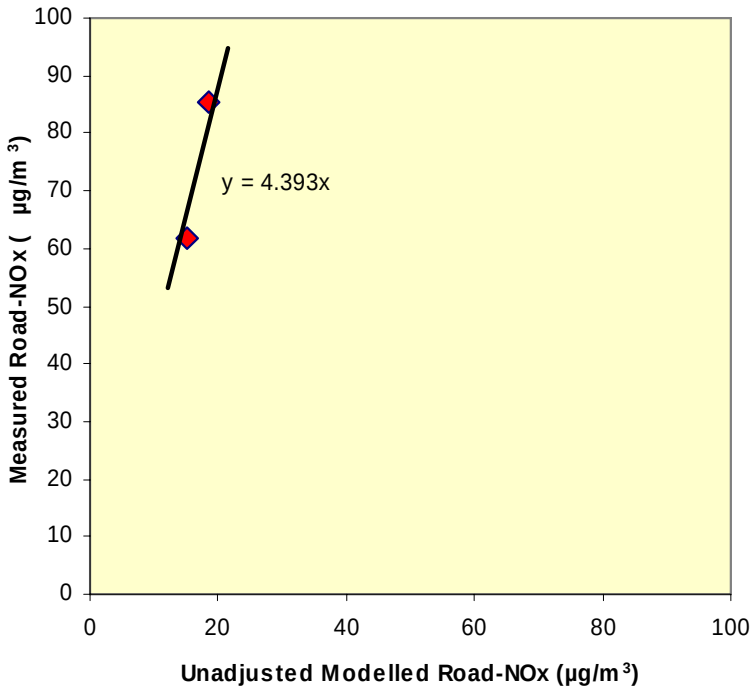

Figure A2.4: Comparison of Measured Road-NO_X to Unadjusted Modelled Road NO_X Concentrations

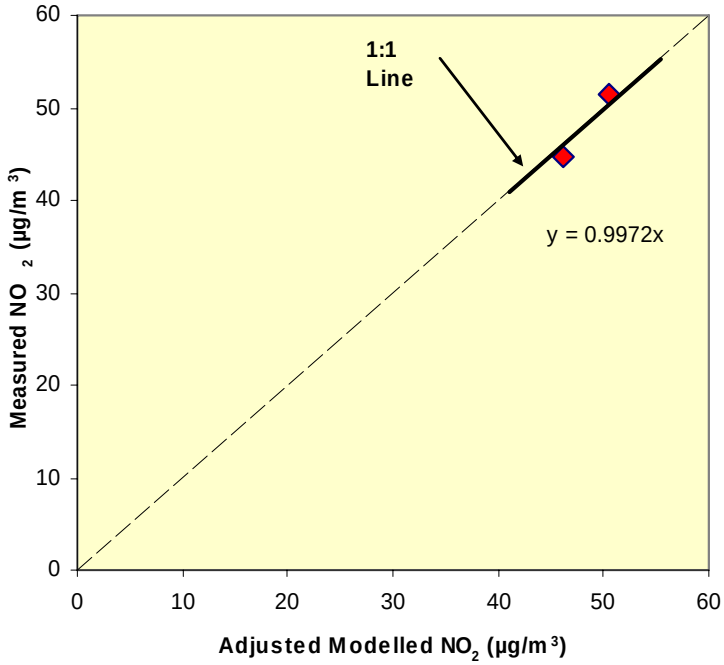

Figure A2.5: Comparison of Measured Total NO_2 to Primary Adjusted Modelled Total NO_2 Concentrations

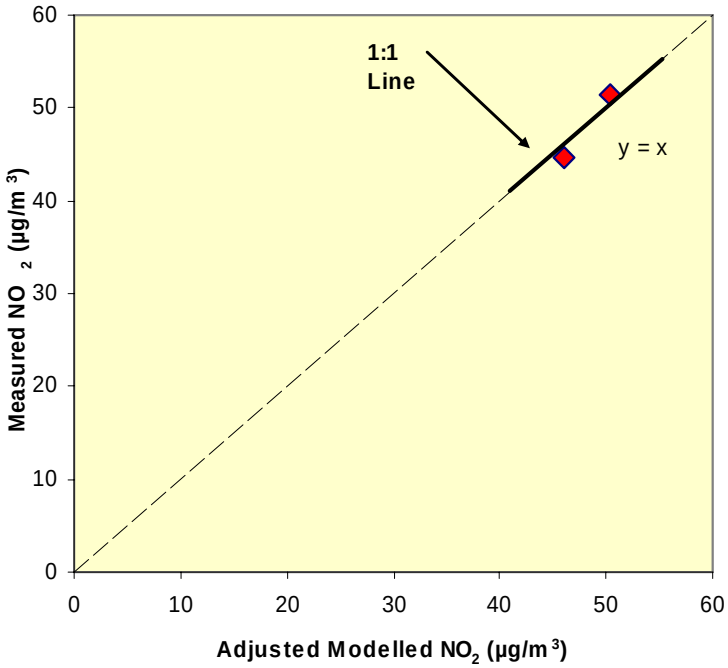

Figure A2.6: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations