Detailed Assessment of Air Quality at London Road, Sawbridgeworth, for East Hertfordshire Council

April 2013

Experts in air quality management & assessment

Document Control

Client	East Hertfordshire Council	**Principal Contact**	Cerys Williams

Job Number	J1703

Report Prepared By:	Dr Austin Cogan & Dr Clare Beattie

Document Status and Review Schedule

Report No.	Date	Status	Reviewed by
1703/1/F1	8th May 2013	Final Report	Prof. Duncan Laxen

Air Quality Consultants Ltd
23 Coldharbour Road, Bristol BS6 7JT Tel: 0117 974 1086
12 Airedale Road, London SW12 8SF Tel: 0208 673 4313
aqc@aqconsultants.co.uk

Registered Office: 12 St Oswalds Road, Bristol, BS6 7HT
Companies House Registration No: 2814570

Contents

East Hertfordshire Council confirms that it accepts the recommendations made in this report.

1 Introduction

1.1 Air Quality Consultants Ltd has been commissioned by East Hertfordshire Council to undertake a Detailed Assessment of air quality at London Road, Sawbridgeworth. In 2011, East Hertfordshire Council completed an Air Quality Progress Report, which concluded that a Detailed Assessment was required as a result of measured exceedences of the nitrogen dioxide annual mean objective at a number of diffusion tube locations at London Road, Sawbridgeworth.

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 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 East Hertfordshire Council's Air Quality Progress Report published in 2011, which concluded that there were measured exceedences of the annual mean nitrogen dioxide objective at locations of relevant exposure (East Herts Council, 2011). A background automatic monitor was co-located with three diffusion tubes in order to calculate a local bias adjustment. However, as a precautionary measure the national bias correction factor was used to inform the Detailed Assessment. East Hertfordshire Council's USA published in 2012, confirmed the findings of the 2011 progress report, and the recommendation that a Detailed Assessment be undertaken at London Road in Sawbridgeworth (East Herts Council, 2012).

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 $\mu g/m^3$ not to be exceeded more than 18 times a year
	Annual mean	40 $\mu g/m^3$

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 East Hertfordshire Council using two automatic sites and five passive diffusion tubes sites in Sawbridgeworth in 2012. The monitoring sites and study area are shown in Figure 1. 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 2012 of 0.58 has been calculated from a local co-location study by the Council. The national bias adjustment factor from the database of national factors provided on the Review and Assessment Helpdesk website (spreadsheet version 03/13) was 0.97. This was based on 27 studies, one of which was East Hertfordshire Council's study. The national bias adjustment factor was considered more appropriate than the local factor as the national factor provides a worst-case scenario for this assessment.

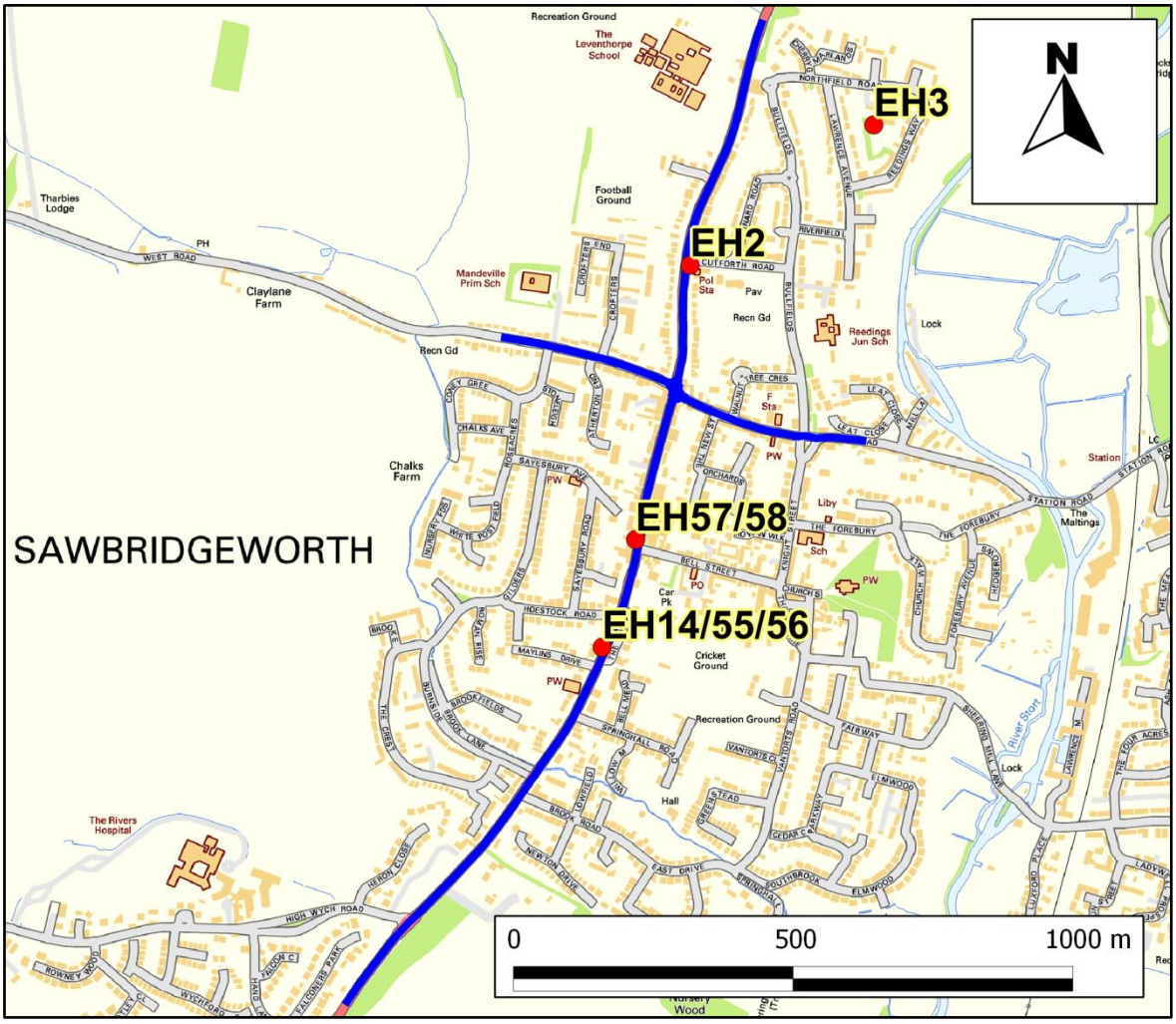

Figure 1 Detailed Assessment Study Area and Monitoring Locations. Roads explicitly included in the model shown in blue.

Contains Ordnance Survey data © Crown copyright and database right 2013

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 grid of receptors across the study area to allow concentration isopleths to be plotted. In addition, concentrations have been predicted at a number of worst-case receptor locations (Figure 2). The worst-case receptors have been modelled at either ground or first floor, depending on the height of relevant exposure.

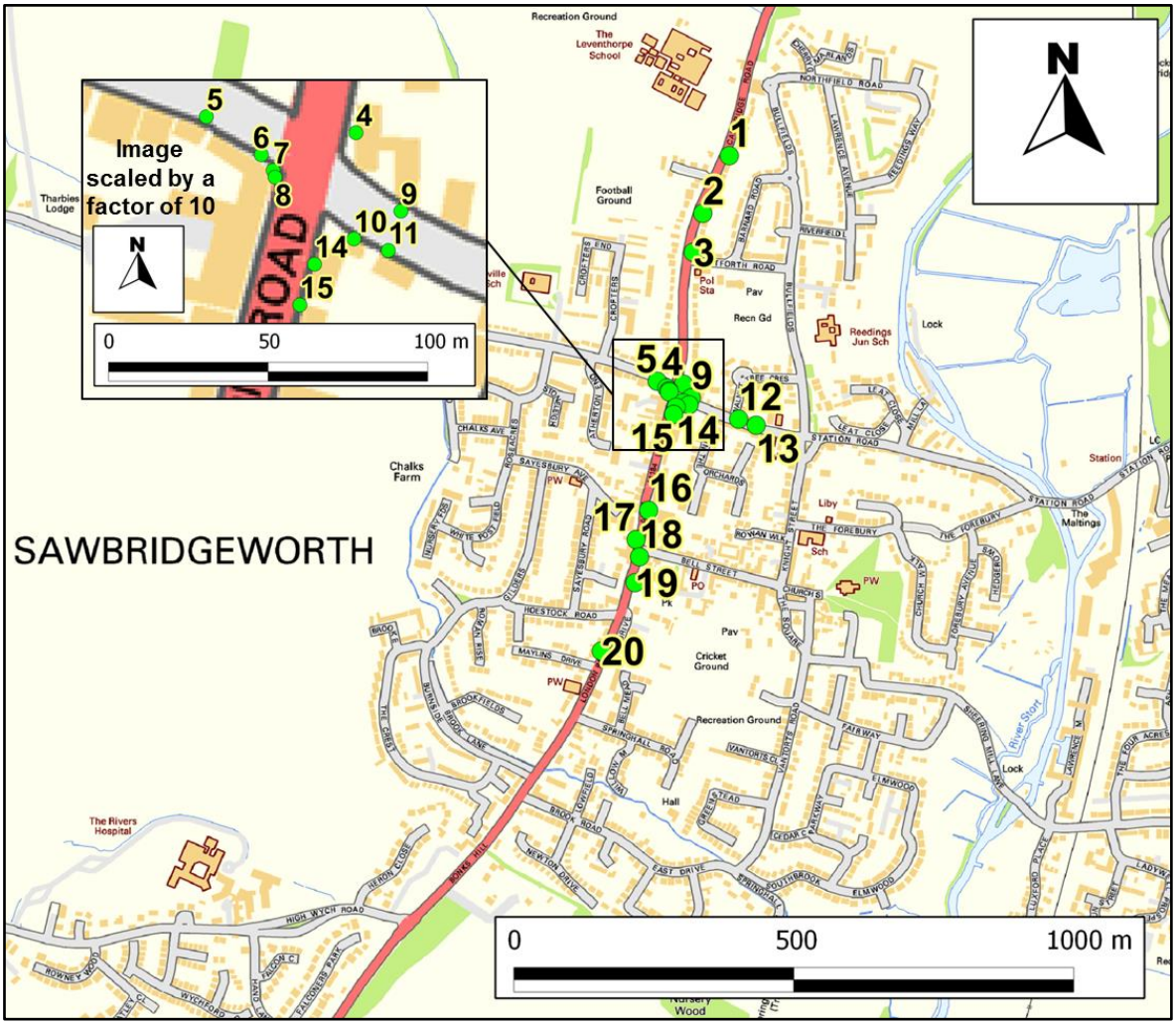

Figure 2 Specific Receptor Locations

Contains Ordnance Survey data © Crown copyright and database right 2013

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 provided by East Hertfordshire 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 Airport during 2012 will have occurred throughout the study areas during 2012; 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. 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 area (Figure 1) are summarised in Table 2.

Table 2: Nitrogen Dioxide Concentrations Measured within Sawbridgeworth

Site	Site Type	Site Description	2010[a]	2011[a]	2012[b]
Automatic Monitors – Annual Mean (µg/m^3)					
EH2	Roadside	East Herts Roadside	31	30 [c]	**41**
EH3	Urban Background	East Herts Background	16	16 [c]	12
Automatic Monitors – No. of Hours > 200 µg/m^3					
EH2	Roadside	East Herts Roadside	0	0	0
EH3	Urban Background	East Herts Background	0	0	0
Diffusion Tubes – Annual Mean (µg/m^3)					
EH14/55/56	**Roadside**	London Road, Sawbridgeworth	**41** [d]	**43** [d]	**46** [d]
EH57/58	**Roadside**	Junction between Bell Street and London Road Sawbridgeworth	**58** [e]	**56** [e]	**60** [e]
Objective			**40**	**40**	**40**

[a] As reported in East Hertfordshire Council's 2012 Updating and Screening Assessment (East Herts Council, 2012). Data have been bias adjusted by the Council using the Gradko 20% TEA in water national factor (0.96 for 2010, 0.89 for 2011).

[b] Data provided by East Hertfordshire Council. Data have been bias adjusted using the Gradko, 20% TEA in water national factor (0.97).

[c] Data have been annualised according to Box 3.2 of TG(09), as monitoring was not carried out for the full year.

[d] Average of triplicate diffusion tubes.

[e] Average of duplicate diffusion tubes.

3.2 The annual mean objective was exceeded at the diffusion tubes located at London Road between 2010 and 2012. These diffusion tubes are attached to lamp posts on the pavements and are therefore expected to measure higher concentrations than at the façades of the properties, however none of the monitoring locations are within street canyons, where concentrations are expected to be higher.

Modelling

3.3 Predicted annual mean nitrogen dioxide concentrations in 2012 at each of the receptor locations shown in Figure 2, are set out in Table 3. Predicted concentrations exceed the annual mean objective at Receptors 1 – 4, 9 – 16 and 19 – 20. The receptors where no exceedences are predicted are either at the first-floor of buildings or on roads with lower traffic flows.

3.4 The highest modelled annual mean nitrogen dioxide concentration is 78.7 µg/m^3, predicted at Receptor 4 where a low lying residential window is located close a road junction. There are predicted annual mean concentrations greater than 60 µg/m^3, and thus exceedences of the 1-hour objective are possible.

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

Receptor	Location	Height	2012 (µg/m^3)[a]
1	Residential property at 96 Cambridge Road	1.5	**58.8**
2	Residential property at 52 Cambridge Road	1.5	**59.4**
3	Residential property at 28 Cambridge Road	1.5	**56.0**
4	Residential property at 2 Cambridge Road	1.5	**73.8**
5	Residential property at Tudor Court, West Road	1.5	36.0
6	Residential property at Tudor Court, West Road	4.5	30.8
7	Residential property at Tudor Court, West Road	4.5	32.2
8	Residential property at Tudor Court, West Road	4.5	32.5
9	Residential property at Barn Court, Station Road	1.5	59.7
10	Residential property at 100 London Road	1.5	**64.5**
11	Residential property at 8 Station Road	1.5	**54.6**
12	Residential property at 1 Walnut Cottages, Station Road	1.5	**46.7**
13	Residential property at 1 Trojan Terrace, Station Road	1.5	**42.8**
14	Residential property at 96 London Road	1.5	**73.5**
15	Residential property at 92 London Road	1.5	**64.5**
16	Residential property opposite Tire Maples, London Road	1.5	**60.9**
17	Residential property at 55 London Road	4.5	28.1
18	Residential property at the White Lion, London Road	4.5	32.0
19	Residential property at 28 London Road	1.5	**57.7**
20	Residential property at Carpenters, London Road	1.5	**46.6**
Objective		**40**	

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

3.5 Isopleth maps of the modelled annual mean nitrogen dioxide concentrations at ground-floor level are presented in Figure 3. This shows that the annual mean objective is likely to be exceeded alongside the London Road and Cambridge Road, and a small section of Station Road and West Road.

3.6 The isopleths show the 40 µg/m^3 contour in red, as well as the 36 µg/m^3 contour in blue. 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.

3.7 There is relevant exposure along Cambridge Road, London Road, Station Road and West Road. It is recommended that monitoring is carried out at worst-case locations of relevant exposure along these roads to confirm the modelled concentrations.

Population Exposure

3.8 Objective exceedences are predicted at approximately 225 residential properties. Assuming that each property has on average two occupants, this equates to approximately 450 residents.

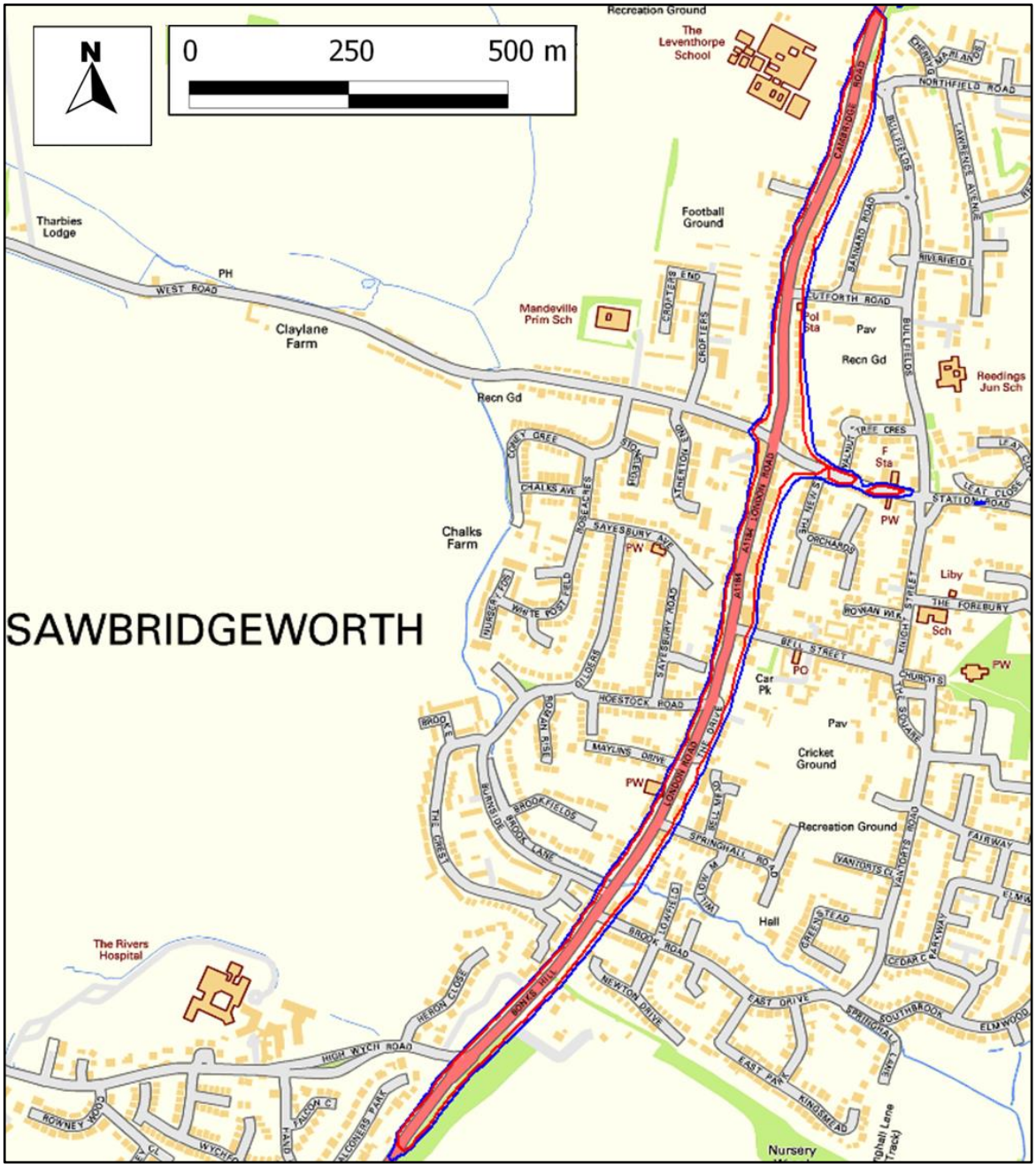

Figure 3 Extent of the Modelled 40µg/m^3 Contour (red line) and 36 µg/m^3 Contour (blue line) of Annual Mean Nitrogen Dioxide Concentrations in 2012 (modelled at 1.5 m).

4 Conclusions and Recommendations

4.1 A Detailed Assessment has been carried out for nitrogen dioxide along London Road, Sawbridgeworth, East Hertfordshire. This area was identified as being at risk of exceeding the annual mean air quality objective for nitrogen dioxide in East Hertfordshire Council's 2011 Air Quality Progress Report.

4.2 The Detailed Assessment has been carried out using a combination of monitoring data and modelled concentrations. Concentrations of nitrogen dioxide have been modelled for 2012 using the ADMS-Roads dispersion model. The model has been verified against measurements made at the two nitrogen dioxide diffusion tube monitoring locations and the roadside automatic monitor, which lie adjacent to the road network included in the model.

4.3 The assessment has identified that the annual mean nitrogen dioxide objective is being exceeded at a number of relevant locations alongside the main roads. 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 possible.

4.4 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 that lie within the 36 $\mu g/m^3$ contour to be precautionary.

4.5 It is also recommended that East Hertfordshire Council continues monitoring nitrogen dioxide at the existing monitoring locations, and expands the network where possible. It is also recommended that monitoring is carried out at worst-case locations of relevant exposure at the junction of London Road, Cambridge Road, West Road and Station Road.

4.6 East Hertfordshire Council should proceed with the completion of a Further Assessment for air quality in Sawbridgeworth within 12 months of the declaration of an AQMA, unless the requirement for a Further Assessment changes (DEFRA has recently consulted on plans to remove the requirement for a Further Assessment).

5 References

Defra, 2007. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, July 2007.

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

Defra, 2011. LAQM Support website. Available at: www.defra.gov.uk/environment/quality/air/airquality/local/support/index.htm

DfT, 2011. Annual Average Daily Flows. Available at: www.dft.gov.uk/matrix/

East Herts Council, 2011. 2011 Air Quality Progress Report for East Herts Council

East Herts Council, 2012. Air Quality Updating and Screening Assessment for East Herts Council.

Stationery Office, 2000. Air Quality Regulations, 2000, Statutory Instrument 928.

Stationery Office, 2002. Air Quality (England) (Amendment) Regulations, 2002, Statutory Instrument 3043.

6 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).

HGV Heavy Goods Vehicle

LGV Light Goods 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 2012 from the meteorological station near Stansted Airport. Cloud-cover data were missing for 11% of the time and these were therefore provided using data from London City Airport.

Background Concentrations:

A2.2 The background concentrations across the study area have been defined using the local background monitor (EH3) located at Edens Mount in Sawbridgeworth. The annual mean nitrogen dioxide background concentration for 2012 was 12 $\mu g/m^3$ and is considered suitable for the study area. This value has been used to carry out the verification process, see next section on Model Verification.

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 heavy duty vehicles (HDVs), road characteristics (including road width and street canyon height, where applicable), and the vehicle speed.

A2.4 Annual Average Daily Traffic (AADT) flows, and the flows split into a number of vehicle classes, have been determined from the traffic count data provided by the Council. Traffic flows were provided as 3 hour weekday counts for October 2012, these were converted to 24 hour flows using hourly traffic statistics taken from the Department for Transport (DfT). Traffic speeds have been based on local speed restrictions and take account of the proximity to junctions. The traffic data used in this Detailed Assessment are presented in Table A2.2.

Table A2.2: Summary of AADT Flows (2012)

Road	MCL	Cars	LGV	BUS	HGV	Total
Cambridge Road	151	15,811	2,672	322	911	19,867
London Road	131	18,840	3,004	322	664	22,961
Station Road	30	5,279	1,147	35	247	6,738
West Road	0	2,974	372	30	86	3,462

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 2012 at the two diffusion tube monitoring sites and the roadside automatic monitoring site 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 monitoring 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). 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).

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

- Primary adjustment factor : 5.047
- Secondary adjustment factor: 1.067

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.

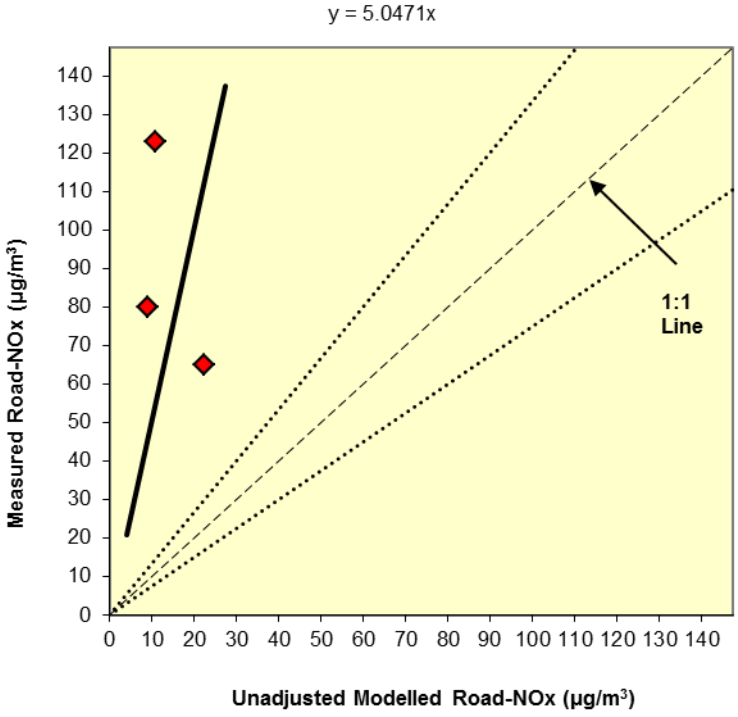

Figure A2.1: Comparison of Measured Road-NO_X to Unadjusted Modelled Road NO_X Concentrations

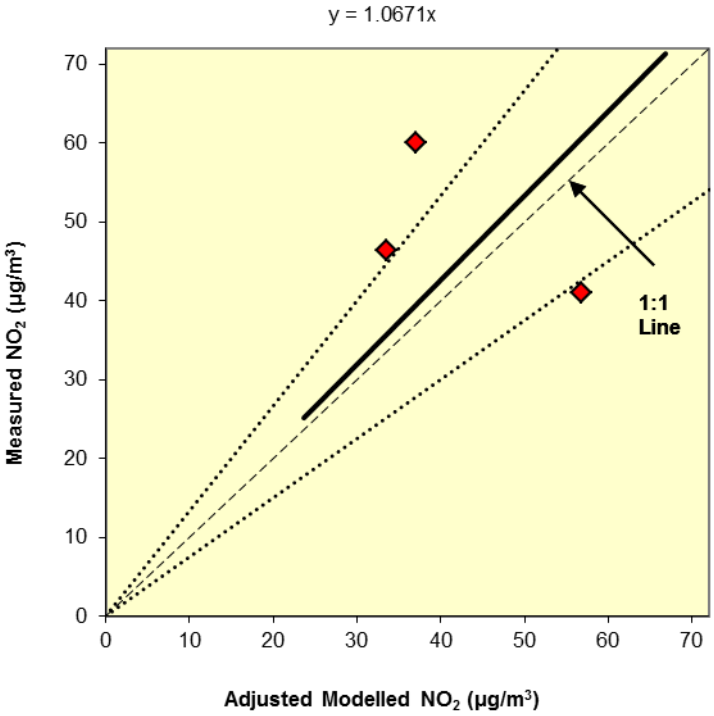

Figure A2.2: Comparison of Measured Total NO_2 to Primary Adjusted Modelled Total NO_2 Concentrations

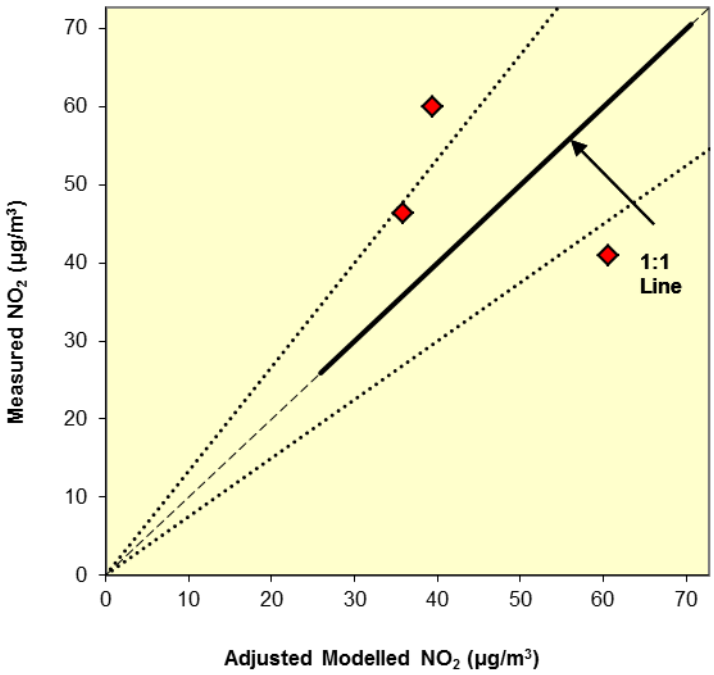

Figure A2.3: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations