# Further Assessment of Air Quality on Reigate Hill.

June 2011

Reigate & Banstead
BOROUGH COUNCIL
Banstead | Horley | Redhill | Reigate

# Document Control

| Client | Reigate and Banstead Borough Council | Principal Contact | Leon Hibbs |
|---|---|---|---|

| Job Number | J1230 |
|---|---|

| Report Prepared By: | Dr Denise Welch |
|---|---|

Document Status and Review Schedule

| Report No. | Date | Status | Reviewed by |
|---|---|---|---|
| J1230/1/F1 | 12th May 2011 | 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



**Reigate and Banstead Borough Council confirms that it accepts the recommendations made in this report.**

# 1 Introduction

1.1 This report is the Further Assessment of nitrogen dioxide concentrations within the Reigate Hill Air Quality Management Area (AQMA). The report is one of a series produced by, and on behalf of, Reigate and Banstead Borough Council (RBBC), which periodically review and assess air quality within the Borough.

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

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 were to be achieved by 2010 (Stationery Office, 2007). The Government is currently seeking a time extension from the European Commission to extend the date for achievement of the limit value to 2015.

## 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.

## Scope

1.10 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.

## Key Findings of Previous Review and Assessment Reports

1.11 In 2009, the Council completed an Updating and Screening Assessment, which concluded that a Detailed Assessment was required due to measured exceedences of the annual mean nitrogen dioxide objective at Reigate Hill (RBBC, 2009). In August 2010, a Detailed Assessment was subsequently undertaken which confirmed that exceedences of the annual mean objective were likely at locations of relevant exposure and that an AQMA would be required (RBBC, 2010a).

1.12 The 2010 Progress Report (RBBC, 2010b) concluded that concentrations at the RB125 monitoring site had dropped to just below the annual mean objective, but that an AQMA would still be declared in this area in 2011. The AQMA has yet to be declared.

1.13 The conclusions of this Further Assessment will be used to inform the Air Quality Action Plan for the area to be declared as an AQMA.

# 2 Study Area and AQMA Location

2.1 The Reigate Hill AQMA has not yet been formally declared, however the proposed area is shown in Figure 1. South of the area shown, there are existing AQMAs. The majority of properties along Reigate Hill are residential, and are thus relevant for the annual mean objective.

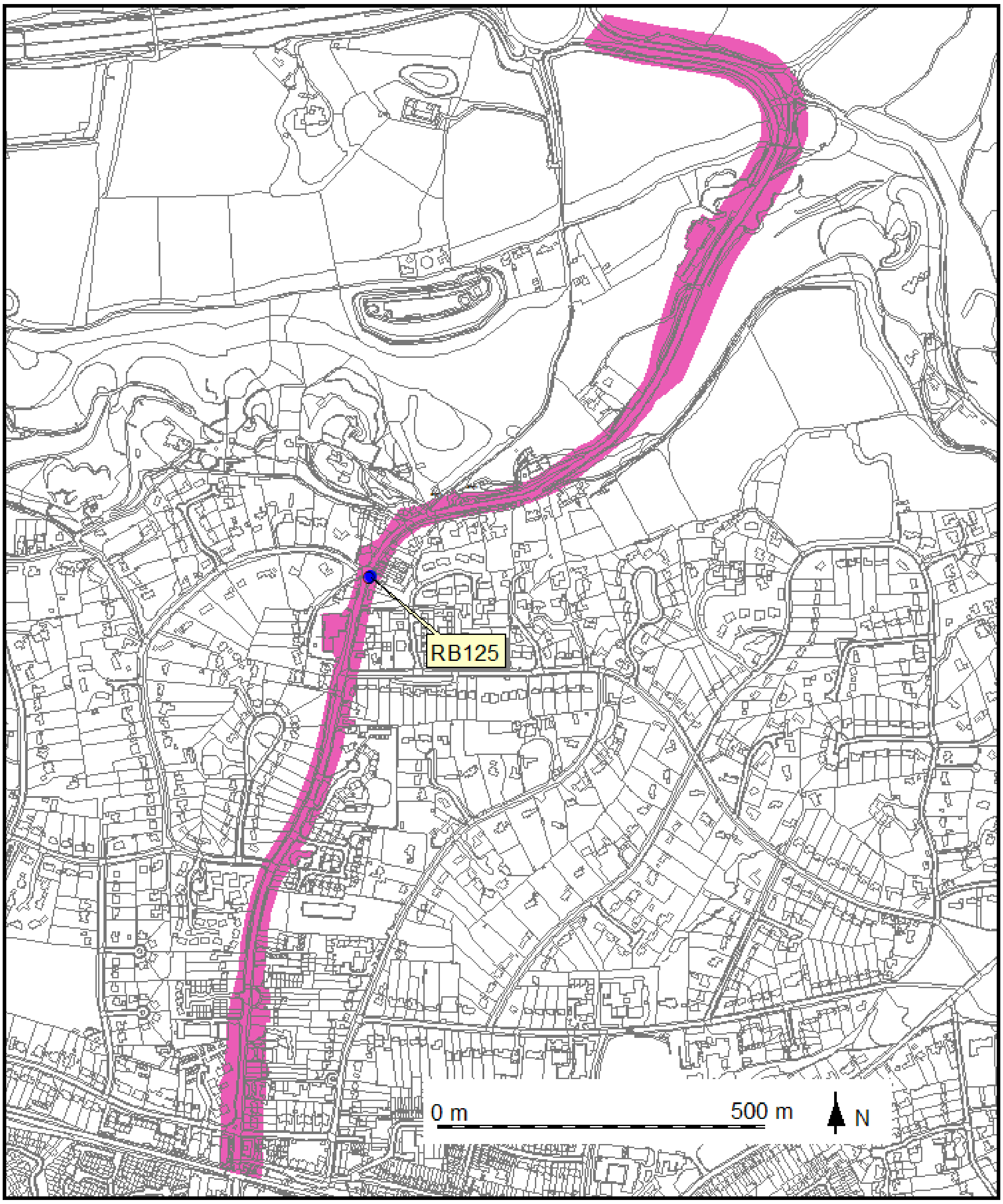


**Figure 1: Proposed Reigate Hill AQMA (pink area) and Diffusion Tube Monitoring Location (blue dot).** © Crown Copyright 2011. Reigate & Banstead Borough Council. Licence no. 100019405**.**

# 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.

## 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), and those subsequently updated, have been used for this assessment. The most recent version of ADMS-Roads (v3), which incorporates the latest emission factors (Version 4.2.2) has also been utilised in the assessment.

# 4 Responses to Consultees Comments

4.1 Defra's Appraisal Report accepted the conclusions reached within the Detailed Assessment. The Appraisal report made four comments:

1. In Reigate, where there is only one tube, where concentrations appear to have dropped consistently over the last 3 years, it would be helpful to compare this to any other monitoring to determine whether this may be due to changes in meteorological conditions or particular source changes near the monitoring site.
2. Reigate Hill lies on a significant gradient. The impact of this on air pollution concentrations and how this has been accounted for in the modelling has not been discussed. It would be worth considering these in the Further Assessment, and deploying additional monitoring, particularly to establish whether concentrations are significantly higher on the western side of the road.
3. It is worth noting that current evidence seems to be suggesting that it is unlikely that reductions in concentrations will be achieved in line with current predicted emissions reductions and that over the next five years actual reductions in concentrations may be negligible. For further information please contact the helpdesks.
4. All data used in calculations should be clearly included in the report, including the background values used in the modelling.

4.2 Responses are as follows:

1. The monitoring presented is the most representative of the study area, and takes account of local meteorological conditions and sources. The latest monitoring data (Table 2) shows no consistent reduction in concentrations.
2. Increased emissions relating to vehicles travelling up a gradient are balanced out by a reduction in emissions relating to vehicles travelling down a gradient. Traffic data used in the assessment are two-way flows and therefore it is not known which proportion would travel up the gradient (with increased emissions) and which proportion would travel down the gradient (with decreased emissions). A 50:50 split could be assumed, however this would be an assumption. It is unlikely that this would alter the size of the AQMA and the number of properties within the AQMA boundary, particularly as the boundary has been chosen to take into account uncertainty within the model. Additional monitoring will commence on Reigate Hill in January 2012.
3. The 2010 modelling carried out for this assessment has been verified against 2010 monitoring data. Uncertainties relating to future year projections do not apply to the conclusions relating to the size of the AQMA boundary. This does however affect the predictions for 2016, and this is discussed further in the report.
4. Further information is provided in the Appendices.

# 5 Assessment Methodology

## Monitoring

5.1 Monitoring for nitrogen dioxide is carried out using passive diffusion tubes at one location on Reigate Hill. The monitoring site is shown in Figure 1. The diffusion tubes are prepared and analysed by Lambeth Scientific Services using 50% TEA Acetone. It is necessary to adjust diffusion tube data to account for laboratory bias. RBBC has co-located triplicate diffusion tubes with three of its automatic monitoring sites: Michael Crescent (RG1), The Crescent (RG2), and Poles Lane (RG3). Results from these three local surveys have been combined using orthogonal regression[1]. The adjustment factor for 2010 calculated in this way was 1.050 (further details available in RBBC, 2011a).

## Modelling

5.2 Annual mean nitrogen dioxide concentrations within the study area have been predicted for 2010 and 2016 using detailed dispersion modelling (ADMS-Roads v3). ADMS Roads is one of the dispersion models accepted for modelling within the Government's Technical Guidance (Defra, 2009). The 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. Vehicle emissions are calculated within ADMS-Roads (v3) using this information and emission factors from the Emission Factor Toolkit (EFT, Version 4.2.2) published by Defra (Defra, 2011).

5.3 A full year of hour-by-hour meteorological data from Gatwick Airport in 2010 was used in the model. Traffic data used in this assessment are described in Appendix A1. Sources not included explicitly in the model were accounted for using the national maps of ambient background concentrations published by Defra (Appendix A1; Defra, 2011). The model outputs have been verified against the diffusion tube measurements. Details of model verification are presented in Appendix A2.

5.4 Concentrations have been predicted across grids of receptors to allow concentration isopleths to be plotted. In addition, concentrations have been predicted at eight receptor locations representing relevant exposure. The receptors are shown in Figure 2.

[1] Using the same method as is used in Defra's national co-location database.

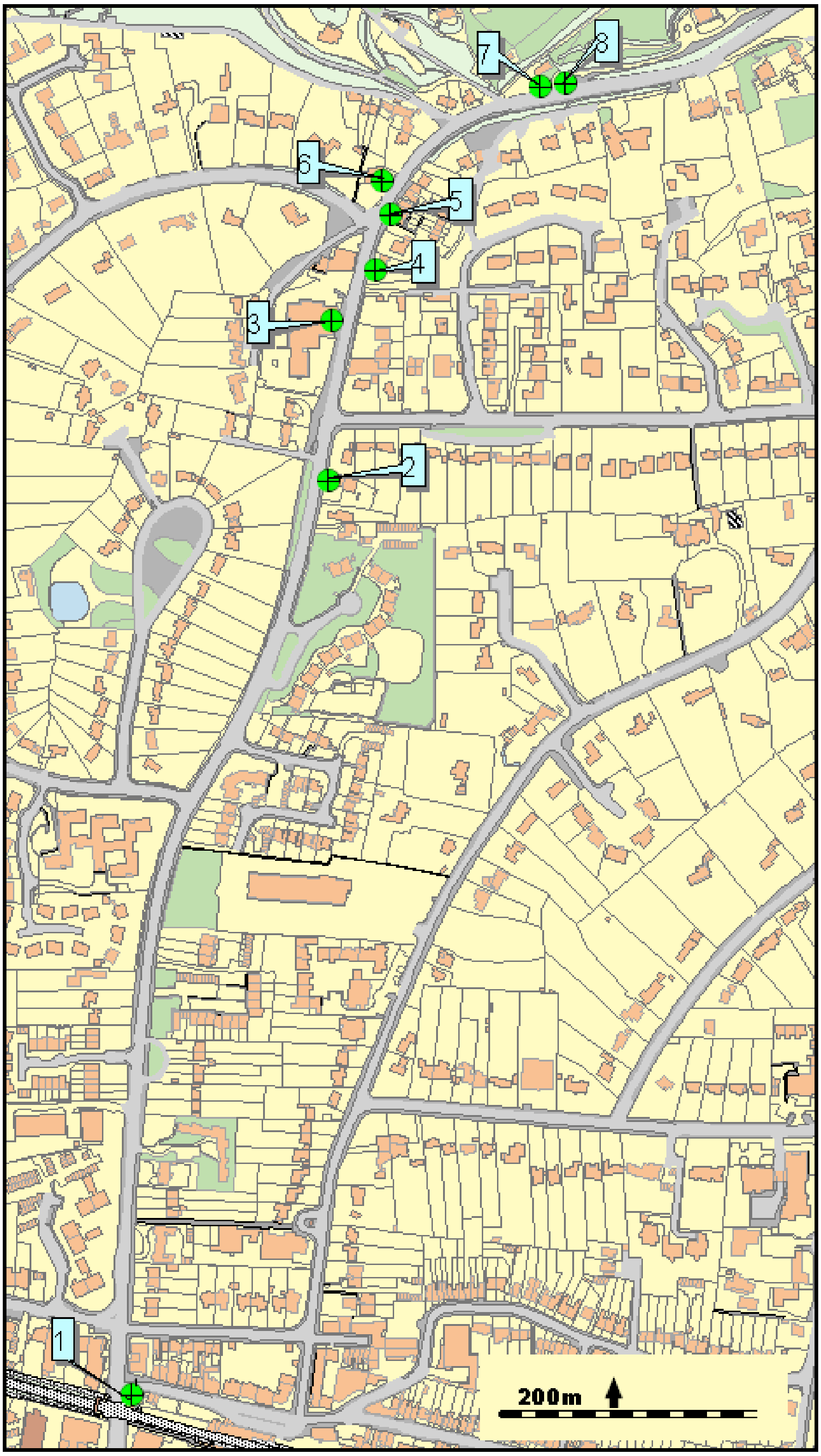


**Figure 2: Receptor Locations.** © Crown Copyright. Reigate & Banstead Borough Council. Licence no 100019405

## Uncertainty

5.5 There is an element of uncertainty 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-predictions or under-predictions. All of the measurements presented have an intrinsic margin of error. Defra (2009) suggests that this is of the order of plus or minus 20% for diffusion tube data, provided that appropriate QA/QC procedures are applied. The model results rely on measured and projected traffic data which has its own inherent uncertainty. 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 the emissions per vehicle conform to the factors published in Defra's Emission Factor Toolkit (EFT V4.2.2); it has been assumed that wind conditions measured at Gatwick Airport during 2010 will occur throughout the study area, and it has been assumed that the subsequent 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, data have been corrected for any under- or over-prediction (see Appendix A2 for details of the model verification).

5.6 Predicting pollutant concentrations in future years will always be subject to greater uncertainty. For obvious reasons, the model cannot be verified in the future, and it is necessary to rely on a series of projections as to what will happen to background pollutant concentrations, and to vehicle emissions. These projections are based on emission factors published by DfT.

5.7 Recently however, a disparity between the road transport emission projections and measured annual mean concentrations of nitrogen oxides and nitrogen dioxide has been identified by Defra (Carslaw et al, 2011). This applies across the UK, although there is considerable inter-site variation. Whilst the emission projections suggest that both annual mean nitrogen oxides and nitrogen dioxide concentrations should have fallen by around 15-25% over the past 6 to 8 years, at many monitoring sites levels have remained relatively stable, or have even shown a slight increase. This is reflected in the monitoring data presented in Section 6.

5.8 The precise reason for this disparity is not known, but is thought to be related to the actual on-road performance of diesel vehicles when compared to the calculations based on the Euro standards. It may therefore be expected that nitrogen oxides and nitrogen dioxide concentrations will not fall as quickly in future years as the current projections indicate. However, at this stage, there is no robust evidence upon which to carry out any revised predictions.

5.9 The implications for this assessment are that the nitrogen dioxide concentrations predicted in 2016 may be higher than shown, although these concentrations should still be lower than those predicted for 2010.

# 6 Results

## Monitoring

6.1 There is one diffusion tube monitoring site within the Reigate Hill study area (Figure 1). Data for the last three years at this site are presented in Table 2. The annual mean concentrations are approaching or exceeding 40 µg/m$^3$ in all three years.

6.2 There are no clear trends in monitoring results for the past three years. This contrasts with the expected decline due to the progressive introduction of new vehicles operating to more stringent standards, discussed in Section 5.

**Table 2: Annual Mean Nitrogen Dioxide Concentrations Measured at the Diffusion Tube Site on Reigate Hill (µg/m$^3$)**

| Site | Site Description | 2007[a] | 2008[b] | 2009[c] | 2010[d] |
|---|---|---|---|---|---|
| **RB125** | Lamp post 29, Opposite Reigate Hill Close, Reigate Hill | **54.9** | **43.9** | 39.4 | **42.9** |
| **Objective** | | **40** | | | |

[a] Data available for June to December, annual adjustment factor of 1.02 applied as described in Appendix B of RBBC, 2009. Bias adjusted using a local factor of 1.145.

[b] Bias adjusted using a local factor of 1.02.

[c] Bias adjusted using a local factor of 1.014.

[d] Bias adjusted using a local factor of 1.050.

## Modelling

6.3 Predicted annual mean nitrogen dioxide concentrations in 2010 and 2016 at each of the receptor locations shown in Figure 2 are set out in Table 3. In 2010, the annual mean objective is predicted to have been exceeded at five of the eight receptors, and is approached at one receptor (Receptor 4). Predicted concentrations are, however, below 60 µg/m$^3$, and therefore the hourly mean objective is unlikely to have been exceeded at any location in 2010.

6.4 By 2016, Defra expects a range of measures introduced at national and international levels to have reduced road traffic emissions and background air pollution levels. Thus, concentrations predictions for 2016 are lower than those for 2010, and there are no predicted exceedences at any of the receptors. The limitations to the assessment set out in the uncertainty section should, however, be borne in mind when considering the results set out in the following sections.

**Table 3: Modelled Annual Mean Nitrogen Dioxide Concentrations (µg/m³)**

| Receptor | 2010 | 2016 |
|---|---|---|
| **1** | **50.2** | 37.2 |
| **2** | **41.0** | 29.6 |
| **3** | 34.4 | 26.4 |
| **4** | 39.5 | 30.9 |
| **5** | **42.5** | 33.6 |
| **6** | 35.7 | 27.7 |
| **7** | **43.5** | 34.6 |
| **8** | **45.0** | 35.9 |
| **Objective** | **40** | |

6.5 Figures 3 and 4 show concentration isopleths along Reigate Hill in 2010 and 2016. In 2010, the annual mean objective is predicted to be exceeded at those properties closest to Reigate Hill, however all predicted exceedences lie within the proposed AQMA boundary. The AQMA boundary, as proposed, is thus appropriate.

6.6 The 40 µg/m³ exceedence contour in Figure 3 extends south beyond the edges of the study area. The area to the south of the railway line (i.e. immediately south of the Reigate Hill study area in Figure 1) is currently an AQMA. Monitoring at a site with relevant exposure within this AQMA confirms that there are no exceedences of the annual mean objective, and this AQMA is to be revoked.

6.7 The isopleths in Figure 4 show that by 2016, the annual mean objective will not be exceeded at any location of relevant exposure. This assumes the expected reduction in vehicle emissions takes place (see Section 5 on Uncertainty).

## Population Exposure

6.8 Up to 100 residential properties lie within the proposed AQMA boundary. The average household size in Reigate during the 2001 census was 2.3 (RBBC, 2011b). Thus, approximately 230 residents live within the proposed AQMA boundary.

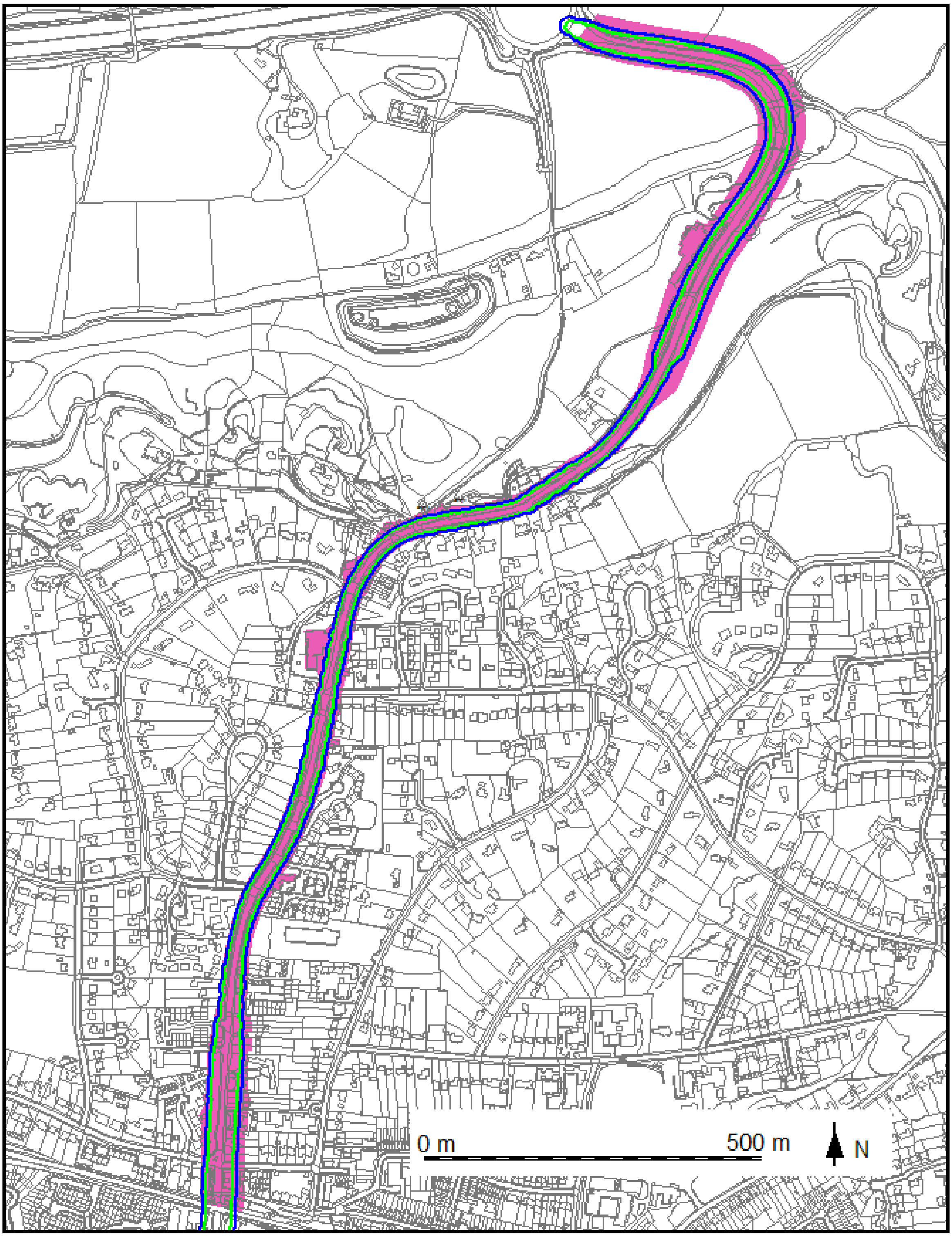


**Figure 3: Nitrogen Dioxide Concentration Contours 2010. The green line represents the 40 µg/m$^3$ contour and blue 36 µg/m$^3$.** © Crown Copyright. Reigate & Banstead Borough Council. Licence no 100019405

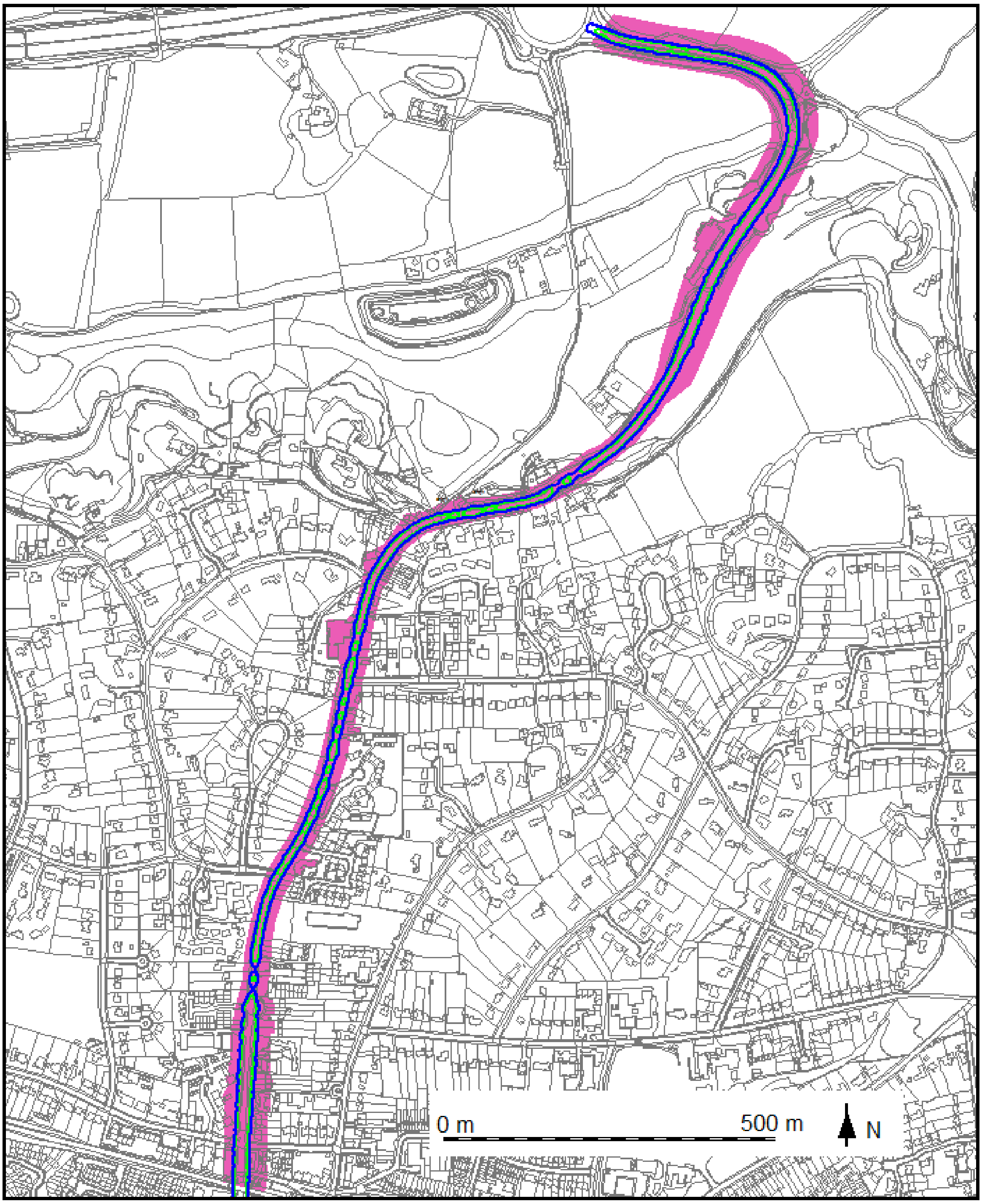


**Figure 4: Nitrogen Dioxide Concentration Contours 2016. The green line represents the 40 µg/m$^3$ contour and blue 36 µg/m$^3$.** © Crown Copyright. Reigate & Banstead Borough Council. Licence no 100019405

# 7 Source Apportionment

7.1 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).

7.2 Figure 5 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);
- Buses; and
- Heavy Goods Vehicles (HGV).

7.3 The eight receptor locations identified previously have been used to provide an overview of source contributions. Table 4 and Figure 5 show the most significant component at all receptors in 2010 is the ambient background concentration; emissions from cars and HGVs are the main local contributors to the overall concentration. In 2016 (Table 5 and Figure 6), ambient background concentrations continue to make up the most significant component at the majority of receptors, however, emissions from cars become the most significant component at a number of receptors (Receptors 5, 7 and 8).

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

| Receptor | Annual Mean Concentration (µg/m³) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Bkgd | MCL | Car | LGV | Bus | HGV | Total |
| 1 | 17.8 | 0.1 | 12.4 | 4.9 | 3.3 | 11.6 | 50.2 |
| 2 | 15.6 | 0.1 | 10.6 | 4.0 | 1.9 | 8.8 | 41.0 |
| 3 | 15.6 | 0.1 | 9.4 | 1.6 | 0.5 | 7.2 | 34.4 |
| 4 | 15.6 | 0.2 | 12.0 | 1.9 | 0.5 | 9.4 | 39.5 |
| 5 | 15.6 | 0.2 | 13.5 | 2.1 | 0.5 | 10.5 | 42.5 |
| 6 | 15.6 | 0.1 | 10.1 | 1.6 | 0.4 | 7.9 | 35.7 |
| 7 | 15.6 | 0.2 | 13.9 | 2.1 | 0.5 | 11.1 | 43.5 |
| 8 | 15.6 | 0.2 | 14.6 | 2.2 | 0.6 | 11.7 | 45.0 |
| | % Contribution to Total | | | | | | |
| | Bkgd | MCL | Car | LGV | Bus | HGV | Total |
| 1 | 35.6 | 0.2 | 24.8 | 9.8 | 6.5 | 23.2 | 100.0 |
| 2 | 38.1 | 0.3 | 25.7 | 9.7 | 4.8 | 21.4 | 100.0 |
| 3 | 45.4 | 0.4 | 27.4 | 4.5 | 1.3 | 21.0 | 100.0 |
| 4 | 39.5 | 0.4 | 30.3 | 4.8 | 1.3 | 23.7 | 100.0 |
| 5 | 36.8 | 0.4 | 31.9 | 4.9 | 1.3 | 24.8 | 100.0 |
| 6 | 43.7 | 0.4 | 28.2 | 4.4 | 1.2 | 22.1 | 100.0 |
| 7 | 35.9 | 0.5 | 32.0 | 4.9 | 1.3 | 25.5 | 100.0 |
| 8 | 34.7 | 0.5 | 32.5 | 5.0 | 1.3 | 26.0 | 100.0 |

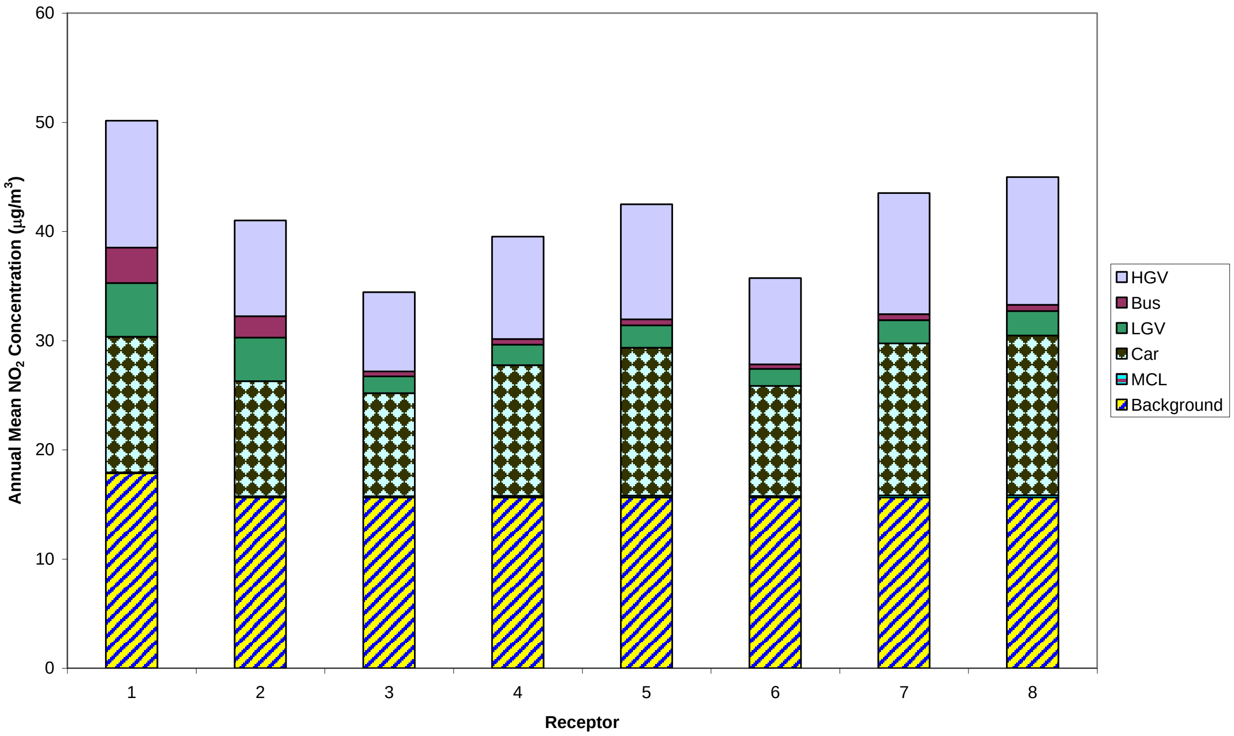


**Figure 5: Relative Contribution of Each Source to the Total Predicted Annual Mean Nitrogen Dioxide Concentration (µg/m$^3$) at Each Receptor in 2010.**

**Table 5: Predicted Annual Mean (2016) Nitrogen Dioxide Concentrations and the Contribution of Each Source to the Total**

| Receptor | Annual Mean Concentration (µg/m$^3$) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Bkgd** | **MCL** | **Car** | **LGV** | **Bus** | **HGV** | **Total** |
| **1** | 13.7 | 0.1 | 10.9 | 3.8 | 2.0 | 6.7 | 37.2 |
| **2** | 12.0 | 0.1 | 8.5 | 3.0 | 1.2 | 4.8 | 29.6 |
| **3** | 12.0 | 0.1 | 9.0 | 1.4 | 0.3 | 3.7 | 26.4 |
| **4** | 12.0 | 0.1 | 11.8 | 1.8 | 0.3 | 4.8 | 30.9 |
| **5** | 12.0 | 0.2 | 13.6 | 2.1 | 0.3 | 5.5 | 33.6 |
| **6** | 12.0 | 0.1 | 9.8 | 1.5 | 0.2 | 4.0 | 27.7 |
| **7** | 12.0 | 0.2 | 14.0 | 2.2 | 0.3 | 5.8 | 34.6 |
| **8** | 12.0 | 0.2 | 14.9 | 2.3 | 0.3 | 6.2 | 35.9 |
| | **% Contribution to Total** | | | | | | |
| | **Bkgd** | **MCL** | **Car** | **LGV** | **Bus** | **HGV** | **Total** |
| **1** | 36.7 | 0.3 | 29.3 | 10.2 | 5.5 | 17.9 | 100 |
| **2** | 40.5 | 0.4 | 28.8 | 10.2 | 3.9 | 16.3 | 100 |
| **3** | 45.3 | 0.4 | 34.0 | 5.5 | 1.0 | 13.9 | 100 |
| **4** | 38.8 | 0.5 | 38.1 | 6.0 | 1.0 | 15.7 | 100 |
| **5** | 35.7 | 0.5 | 40.3 | 6.2 | 0.9 | 16.4 | 100 |
| **6** | 43.3 | 0.4 | 35.4 | 5.5 | 0.9 | 14.5 | 100 |
| **7** | 34.7 | 0.5 | 40.7 | 6.3 | 0.9 | 16.9 | 100 |
| **8** | 33.4 | 0.5 | 41.5 | 6.4 | 1.0 | 17.3 | 100 |

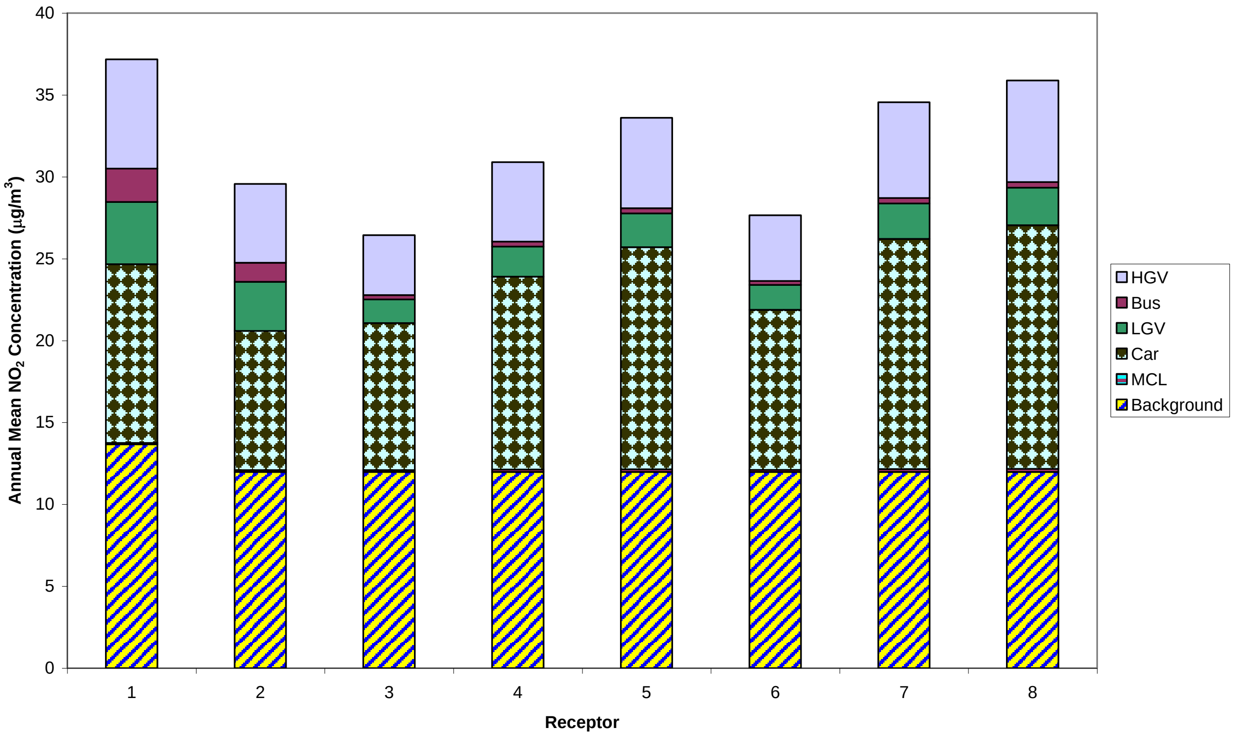


**Figure 6: Relative Contribution of Each Source to the Total Predicted Annual Mean Nitrogen Dioxide Concentration (µg/m$^3$) at Each Receptor in 2016.**

# 8 Air Quality Improvements Required

8.1 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 $\mu g/m^3$).

8.2 The highest nitrogen dioxide concentration is that measured at Receptor 1 (50.2 $\mu g/m^3$), requiring a reduction of 10.2 $\mu g/m^3$ in order for the objective to be achieved.

8.3 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 6 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 1, local emissions would need to have been 38.3% lower in order to meet the objective. In 2016, there are no predicted exceedences.

**Table 6: Improvement in Annual Mean Nitrogen Dioxide Concentrations and in Emissions of Oxides of Nitrogen at Receptors in 2010 and 2016.**

| Receptor | Required reduction in annual mean nitrogen dioxide concentration ($\mu g/m^3$) | | Required reduction in emissions of oxides of nitrogen from local roads (%) | |
|---|---|---|---|---|
| | 2010 | 2016 | 2010 | 2016 |
| 1 | 10.2 | n/a | 38.3 | n/a |
| 2 | 1.0 | n/a | 4.9 | n/a |
| 5 | 2.5 | n/a | 11.5 | n/a |
| 7 | 3.5 | n/a | 15.7 | n/a |
| 8 | 5.0 | n/a | 21.1 | n/a |

n/a – not applicable, as no predicted exceedence in 2016.

# 9 Management Planning

9.1 In the Reigate Hill AQMA, pollutant concentrations are influenced by vehicle flow patterns, including acceleration, deceleration, and congestion adjacent to the level crossing. Action Plan measures to reduce concentrations are likely to include traffic management measures. In order to inform the focus of potential measures within the Action Plan, a number of simple and hypothetical measures to deliver the required NOx reductions at each receptor have been explored. The measures that have been examined involve stepped reductions in emissions from each of the vehicle categories defined in Section 7. It is not within the remit of this report to speculate on how these reductions might be achieved, and the intention is simply to inform future management decisions. Table 7 sets out the results.

**Table 7: Modelled Annual Mean Nitrogen Dioxide Concentration During 2010 Assuming Hypothetical Emission Reductions from Different Vehicle Classes.**

| Vehicle Type | % Reduction in Emissions | Predicted Annual Mean Concentration (µg/m$^3$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| MCL | 10% | **50.1** | **41.0** | 34.4 | 39.5 | **42.5** | 35.7 | **43.5** | **45.0** |
| | 25% | **50.1** | **41.0** | 34.4 | 39.5 | **42.4** | 35.7 | **43.5** | **44.9** |
| | 50% | **50.1** | **41.0** | 34.4 | 39.5 | **42.4** | 35.7 | **43.4** | **44.9** |
| Car | 10% | **49.2** | **40.2** | 33.6 | 38.5 | **41.4** | 34.9 | **42.4** | **43.8** |
| | 25% | **47.8** | 38.9 | 32.4 | 37.0 | 39.8 | 33.6 | **40.8** | **42.1** |
| | 50% | **45.3** | 36.6 | 30.3 | 34.4 | 36.9 | 31.3 | 37.8 | 39.0 |
| LGV | 10% | **49.8** | **40.7** | 34.3 | 39.4 | **42.3** | 35.6 | **43.4** | **44.8** |
| | 25% | **49.2** | **40.2** | 34.1 | 39.1 | **42.1** | 35.4 | **43.1** | **44.5** |
| | 50% | **48.3** | 39.4 | 33.8 | 38.8 | **41.7** | 35.1 | **42.7** | **44.1** |
| Bus | 10% | **49.9** | **40.9** | 34.4 | 39.5 | **42.4** | 35.7 | **43.5** | **44.9** |
| | 25% | **49.5** | **40.6** | 34.3 | 39.4 | **42.4** | 35.7 | **43.4** | **44.9** |
| | 50% | **48.9** | **40.2** | 34.2 | 39.3 | **42.3** | 35.6 | **43.3** | **44.8** |
| HGV | 10% | **49.3** | **40.3** | 33.8 | 38.8 | **41.7** | 35.1 | **42.7** | **44.1** |
| | 25% | **47.9** | 39.2 | 32.9 | 37.6 | **40.4** | 34.1 | **41.3** | **42.7** |
| | 50% | **45.6** | 37.4 | 31.3 | 35.6 | 38.2 | 32.3 | 39.0 | **40.3** |
| All Vehicles | 10% | **47.7** | 39.0 | 32.8 | 37.6 | **40.3** | 34.0 | **41.3** | **42.7** |
| | 25% | **43.8** | 35.7 | 30.3 | 34.4 | 36.9 | 31.3 | 37.8 | 39.0 |
| | 50% | 36.4 | 29.7 | 25.8 | 28.8 | 30.7 | 26.5 | 31.3 | 32.3 |
| Do Nothing | - | **50.2** | **41.0** | 34.4 | 39.5 | **42.5** | 35.7 | **43.5** | **45.0** |

9.2 The results presented in Table 7 highlight that targeting vehicle types in isolation would achieve very little. The only effective measure for improving air quality would be to reduce total vehicle emissions by 50%. This is the only measure that, in 2010, would reduce the concentrations at the all locations where exceedences have been predicted, to a level where the annual mean air quality objective would be met.

# 10 Summary and Conclusions

10.1 Nitrogen dioxide concentrations within and around the Reigate Hill AQMA have been assessed through diffusion tube monitoring and detailed dispersion modelling. The results indicate that the annual mean nitrogen dioxide objective continues to be exceeded in 2010 within the AQMA, but that there are no exceedences outside of the AQMA.

10.2 It is therefore recommended that:

- The AQMA, as proposed, is appropriate, and should be declared as soon as possible.

10.3 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.

10.4 A reduction in the volume of traffic around the AQMA would result in a decrease in the concentrations of nitrogen dioxide within the AQMA, however a reduction in total vehicle emissions of 39% would be required to achieve the annual mean air quality objective at all modeled receptor locations in 2010.

# 11 References


Carslaw, D, Beevers, S, Westmoreland, E and Williams, M, 2011. Trends in NOx and $NO_2$ emissions and ambient measurements in the UK. Available at: http://uk-air.defra.gov.uk/library/reports?report_id=645

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. Defra Air Quality Website at: www.defra.gov.uk/environment/quality/air/airquality/

DfT, 2007. English Regional Traffic Growth and Speed Forecasts. Available at http://www.dft.gov.uk/pgr/economics/ntm/AF07_Annex_Baseline_summary.xls

DfT, 2009. TEMPRO (Version 6.2) System. Available at www.tempro.org.uk

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

Reigate and Banstead Borough Council, 2009. Updating and Screening Assessment of Air Quality within the Borough of Reigate and Banstead. Available at: www.reigate-banstead.gov.uk/Images/2009_03999_RPR_005_RBBC_final_050809incl%20consult1a_tcm9-37188.pdf

Reigate and Banstead Borough Council, 2010a. Detailed Assessment of Air Quality on Reigate Hill and in Redhill Town Centre. Available at: www.reigate-banstead.gov.uk/Images/2010_03097_RPR_005a_Reigate%20Hill%20and%20Redhill%20DA%20250810FINALwcover1_tcm9-41449.pdf

Reigate and Banstead Borough Council, 2010b. Progress Report (2010) on Air Quality within the Borough of Reigate and Banstead. Available at: www.reigate-banstead.gov.uk/Images/2010%20Progress%20Report%20110111%20FINALwithfront_tcm9-42553.pdf

Reigate and Banstead Borough Council, 2011a. Progress Report (2011) on Air Quality within the Borough of Reigate and Banstead.

Reigate and Banstead Borough Council, 2011b. 2001 Census Town / Village Profile – Reigate. Available at: www.reigate-banstead.gov.uk/Images/Reigate_tcm9-20823.pdf

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

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

Stationery Office, 2007. The Air Quality Standards Regulations, 2007 (No.64).

# 12 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. |
| **$\mu g/m^3$** | 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 |
| **TEA** | Triethanolamine – used to absorb nitrogen dioxide |

# A1 Appendix 1 – Traffic and Background Data

## Background Concentrations

A1.1 Background concentrations for the study area have been taken from the national maps of background concentrations available from the Defra LAQM Support website (Defra, 2011), and are presented in Table A2.1.

**Table A2.1: Background Concentrations within the Study Area**

| | NOx | $NO_2$ |
|---|---|---|
| **2010** | 18.7 – 34.7 | 13.5 – 23.0 |
| **2016** | 14.2 – 23.0 | 10.5 – 16.3 |

## Traffic Data

A1.2 Traffic counts were carried out for the A217 in 2009, and these data have been used in the model. Diurnal profiles for the average weekday, Saturday and Sunday were defined from the count data. In addition, data for Rushworth Road, London Road and Castlefield Road to the south of the study area were provided for 2002. The data were projected to the assessment years (2010 and 2016) using growth factors derived from the National Transport Model and associated guidance (DfT, 2007), adjusted to local conditions using the TEMPRO System v6.2 (DfT, 2009). Speeds have been estimated from local speed restrictions, and take account of the proximity to a junction. Information provided on barrier down times for the level crossing were used to determine an average queue length in order to determine a more accurate estimate of speed either side of the level crossing. The traffic data used in the assessment are presented in Table A2.2.

A1.3 A breakdown of flows in each vehicle category was available for the A217 north of Raglan Road, but not for the other roads. Traffic flows for the A217 south of Raglan Road, Castlefield Road and London Road, were apportioned to each vehicle category based on ratios determined from the data provided on the DfT interactive map for 2009 (DfT, 2011). For Rushworth Road, data are not provided on the DfT. Flows were apportioned to each vehicle category using an average of the split calculated for the A217, Castlefield Road and London Road.

**Table A2.2: AADT Traffic Data and Proportions**

| Road Link | MCL | Car | LGV | Bus | HGV | Total |
|---|---|---|---|---|---|---|
| **2010 AADTs** | | | | | | |
| A217 north of Raglan Road | 307 | 20,009 | 1,326 | 32 | 566 | 22,241 |
| A217 south of Raglan Road | 232 | 16,163 | 2,441 | 121 | 639 | 19,598 |
| Castlefield Road | 223 | 17,758 | 2,146 | 150 | 576 | 20,853 |
| London Road | 172 | 18,151 | 2,264 | 106 | 593 | 21,286 |
| Rushworth Road | 59 | 4,893 | 646 | 19 | 89 | 5,707 |
| **2010 Vehicle Proportions** | | | | | | |
| A217 north of Raglan Road | 1.4% | 90.0% | 6.0% | 0.1% | 2.5% | 100% |
| A217 south of Raglan Road | 1.2% | 82.5% | 12.5% | 0.6% | 3.3% | 100% |
| Castlefield Road | 1.1% | 85.2% | 10.3% | 0.7% | 2.8% | 100% |
| London Road | 0.8% | 85.3% | 10.6% | 0.5% | 2.8% | 100% |
| Rushworth Road | 1.0% | 85.7% | 11.3% | 0.3% | 1.6% | 100% |
| **2016 AADTs** | | | | | | |
| A217 north of Raglan Road | 346 | 22,514 | 1,623 | 32 | 635 | 25,151 |
| A217 south of Raglan Road | 262 | 18,187 | 2,987 | 122 | 718 | 22,275 |
| Castlefield Road | 251 | 19,982 | 2,626 | 151 | 646 | 23,656 |
| London Road | 193 | 20,423 | 2,770 | 106 | 666 | 24,159 |
| Rushworth Road | 67 | 5,506 | 790 | 19 | 100 | 6,482 |
| **2016 Vehicle Proportions** | | | | | | |
| A217 north of Raglan Road | 1.4% | 89.5% | 6.5% | 0.1% | 2.5% | 100% |
| A217 south of Raglan Road | 1.2% | 81.6% | 13.4% | 0.5% | 3.2% | 100% |
| Castlefield Road | 1.1% | 84.5% | 11.1% | 0.6% | 2.7% | 100% |
| London Road | 0.8% | 84.5% | 11.5% | 0.4% | 2.8% | 100% |
| Rushworth Road | 1.0% | 84.9% | 12.2% | 0.3% | 1.5% | 100% |

# A2 Appendix 2 – Model Verification

A2.1 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 location within the study area. Concentrations have been modelled at a height of 2 m, representing the height of the monitor.

A2.2 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, 2011).

A2.3 An adjustment factor was determined as the ratio of the 'measured' road contribution and the model derived road contribution. 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.

A2.4 The data used to calculate the adjustment factor are provided below:

- Measured $NO_2$ : 42.9 μg/m$^3$
- 'Measured' road-NOx (from NOx to $NO_2$ calculator): 70.1 μg/m$^3$
- Modelled road-NOx = 10.8 μg/m$^3$
- Road-NOx adjustment factor: 70.1/10.8 = **6.48**

A2.5 The factor implies that the model is under-predicting the road-NOx contribution. This is a common experience with this and most other models.