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Further Assessment of Air Quality at the Junction of the A2022 and A240 (Drift Bridge).

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Reigate and Banstead Borough Council, Environmental Health Services,
Town Hall, Castlefield Road, Reigate, Surrey, RH2 0SH. Telephone: 01737 276403 Fax: 01737 276404.

Air Quality Consultants

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Client	Reigate and Banstead Borough Council	Principal Contact	Leon Hibbs

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Report Prepared By:	Dr Denise Welch

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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

Contents

1 Introduction

1.1 This report sets out the Further Assessment of air quality in the Borough of Reigate and Banstead at a location declared as Air Quality Management Area (AQMA). It forms part of the air quality Review and Assessment process prescribed by Defra. The AQMA addressed in this report is the Drift Bridge AQMA, which is located at the junction of the A2022 and the A240, shown in Figure 1. It covers two individual residential properties, close to the junction where exceedences of the annual mean nitrogen dioxide objective are predicted.

Introduction to the Second and Third Round of Review and Assessment

1.2 The Government's Air Quality Strategy for England, Scotland, Wales and Northern Ireland (DETR, 2000) and the addendum to it published in February 2003 (Defra, 2003a), 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 the current, and likely future 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 by the due date. These locations must then be designated as AQMAs and a subsequent action plan developed in order to reduce pollutant emissions in pursuit of the objectives.

1.3 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 round of Review and Assessment and largely completed the second round, with the third round currently underway.

1.4 Local Air Quality Management Technical Guidance (LAQM.TG(03)) (Defra, 2003b) sets out a phased approach to the second and third rounds 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 (DA).

1.5 The purpose of the DA 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 DA 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; 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.

The Air Quality Objectives

1.6 The Government's Air Quality Strategy (DETR, 2000) defines both standards and objectives for each of a number of air pollutants. 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. The objectives are prescribed within The Air Quality (England) Regulations 2000 (The Stationery Office, 2000) and The Air Quality (England) (Amendment) Regulations 2002 (The Stationery Office, 2002). This latter publication set more stringent objectives for benzene and carbon monoxide. Table 1 summarises the objectives which are relevant to this report, which only covers nitrogen dioxide. Short-term exposure to high concentrations of nitrogen dioxide may cause inflammation of respiratory airways. Long-term exposure may affect lung function and enhance responses to allergens in sensitised individuals. The young, old and asthmatics will be particularly at risk (Defra, 2003a).

1.7 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.

1.8 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 $\mu g/m^3$ (Laxen and Marner, 2003). Thus, exceedences of 60 $\mu g/m^3$ as an annual mean nitrogen dioxide concentration may be used as an indicator of potential exceedences of the 1-hour mean nitrogen dioxide objective.

1.9 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 objective, but are to be achieved by 2010.

Table 1 Air Quality Objectives for Nitrogen Dioxide

Pollutant	Status	Time Period	Objective / Value	To be Achieved by[a]
Nitrogen Dioxide	Statutory UK Objective	1-hour mean	200 μg/m^3 not to be exceeded more than 18 times a year	2005
		Annual mean	40 μg/m^3	2005
	EU Limit Value	1-hour mean	200 μg/m^3 not to be exceeded more than 18 times a year	2010
		Annual mean	40 μg/m^3	2010

[a] The achievement dates for the UK objectives are the end of the specified year; achievement dates for the EU limit values are the start of the specified year.

Scope

1.10 This report represents the Further Assessment for the Drift Bridge AQMA. The study area encompasses the AQMA as well as the area immediately adjacent. Guidance available from the Review and Assessment Helpdesk website (Defra, 2007b) explains that a Further Assessment report allows authorities:

- to confirm their original assessment of air quality against the prescribed objectives, and thus to ensure that they were right to designate the AQMA;
- to calculate more accurately how much of an improvement in air quality would be needed to deliver the air quality objectives within the AQMA;
- to refine their knowledge of the sources of pollution so that air quality action plans can be properly targeted;
- to take account of national policy developments which may come to light after the AQMA declaration;
- to take account as far as possible of any local policy developments which are likely to affect air quality by the relevant date, and which were not fully factored into earlier calculations;
- to carry out real-time monitoring where this has not been done previously;
- to carry out further monitoring in problem areas to check earlier findings;
- to corroborate other assumptions on which the designation of the AQMA has been based, and to check that the original designation is still valid, and does not need amending in any way;
- to respond to any comments made by statutory consultees in respect of authorities' previous reports, particularly where these have highlighted that insufficient attention has been paid to, e.g., the validation of modelled data.

Report Structure and Issues Addressed

1.11 Section 2 of this report introduces the AQMA currently declared at Drift Bridge and hence the study area, with Section 3 introducing any new developments since the Detailed Assessment was produced. Section 4 sets out responses to the consultation exercise carried out. Section 5 comprises a review of monitoring data collected since the Detailed Assessment was produced and the results of new detailed dispersion modelling that has been carried out. These data are then used to determine the likelihood of exceedences of the objectives within the AQMA. Section 6 estimates the relative contribution of the most significant pollution sources to pollutant concentrations. Sections 7 and 8 set out the Air Quality Improvements required to meet the objectives and some hypothetical measures to achieve this.

Key Findings of the Progress Report and the Detailed Assessment

1.12 In July 2005 Reigate & Banstead Borough Council completed its Progress Report on Air Quality within the Borough. Routine monitoring of nitrogen dioxide concentrations around the junction of the A2022 and the A240 at Drift Bridge highlighted possible breaches of the 2005 annual mean objective at locations of relevant exposure. In addition, two further locations were identified as potentially breaching the objective and were immediately declared as AQMAs.

1.13 The Detailed Assessment subsequently carried out for Drift Bridge (Reigate and Banstead BC, 2006) concluded that exceedences of the annual mean nitrogen dioxide objective were likely at the Driftways and Crossways properties. Following the Detailed Assessment, Reigate and Banstead Borough Council declared an AQMA which came into force in January 2007 and is shown in section 2.

2 AQMA Location

2.1 The Drift Bridge AQMA includes the two properties labelled as Driftways and Crossways in Figure 1.

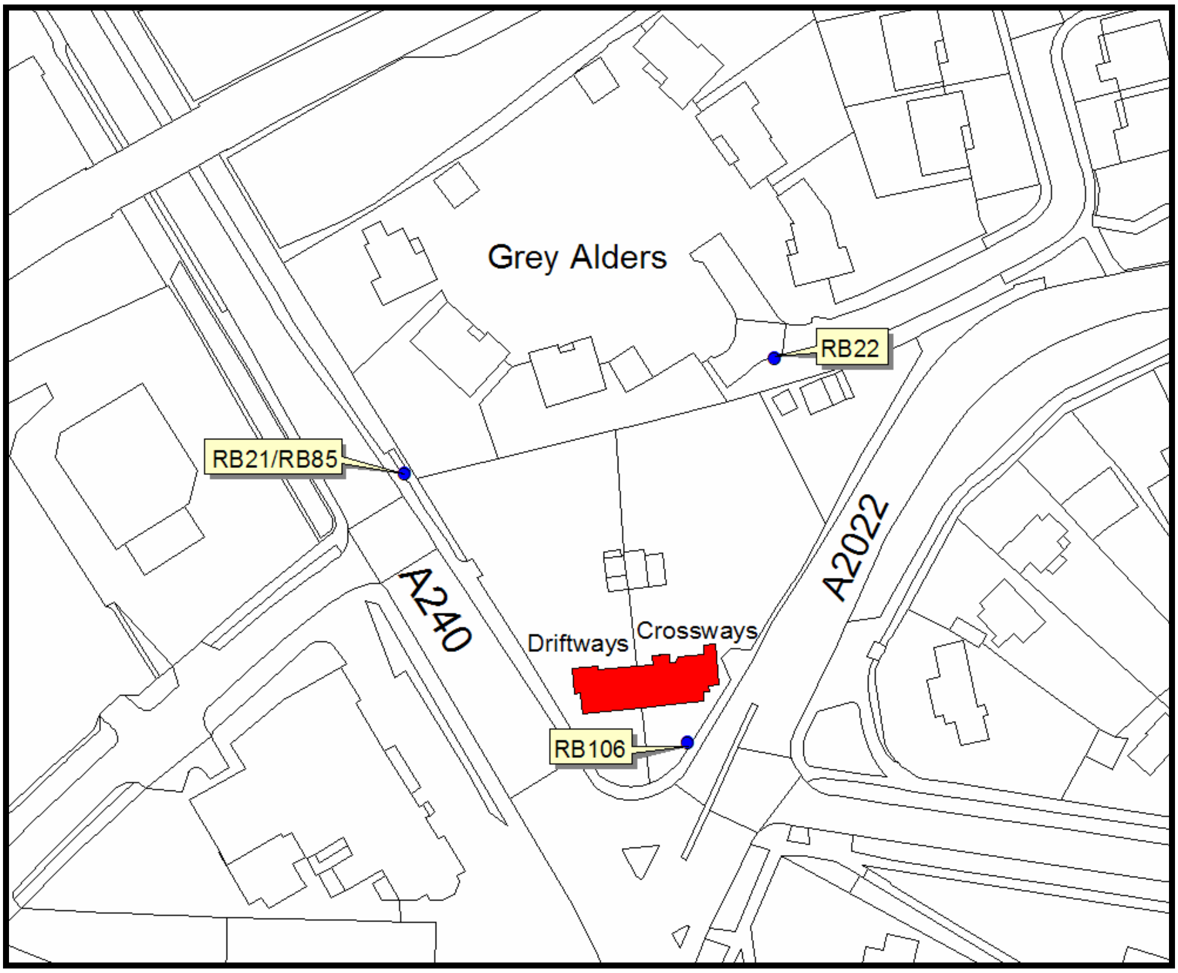

Figure 1: Drift Bridge AQMA (Red) and Study Area. Blue Dots Show Diffusion Tube Monitoring Locations. © Crown Copyright. Reigate & Banstead Borough Council. Licence no. 100019405.

3 Developments Since the Declaration of the AQMA

New/Proposed Local Developments

3.1 At the time of writing, a Planning Application proposing a three storey block of residential flats has been submitted to Reigate and Banstead Borough Council for the Driftways/Crossways site. In the current design, if planning permission is granted, additional residential properties would be introduced into the existing AQMA, and the surrounding area.

Local Transport Plan

3.2 The second Local Transport Plan (LTP2) for Surrey was published in March 2006. The LTP2 sets out five objectives, one of which is aimed at 'Enhancing the environment and quality of life'. The LTP2 aims to achieve this objective by implementing a comprehensive programme of public transport measures; improvements to facilities for sustainable transport modes (especially walking and cycling); a programme of local traffic management measures; and a programme of sustainable transport initiatives. The indicators of this objective include a reduction in concentrations of nitrogen dioxide in Air Quality Management Areas, and reductions in the total emissions of nitrogen dioxide and particulates (PM_{10}).

National Developments

3.3 New national maps of background pollutant concentrations have recently been issued by Defra (available on Defra, 2007a) and these have been used in this Further Assessment. Similarly, Defra (also available on Defra, 2007a) has also issued new factors for predicting concentrations in future years. These have also been used here. The new NOx/ NO_2 calculator available from the above website from April 2007 has also been used.

4 Responses to Consultees Comments

4.1 Reigate and Banstead Borough Council received responses to their consultation exercise from Crawley Borough Council and the Highways Agency. Crawley Borough Council concurred with the findings of the Drift Bridge Detailed Assessment. The Highways Agency had no comments however, as the conclusions do not affect the strategic road network.

4.2 Defra's Detailed Assessment Appraisal Report accepted the conclusion to declare an AQMA for nitrogen dioxide at the Driftways and Crossways properties, and no further comments were made on the assessment. Therefore there are no issues relating to these assessments that need to be addressed in this report.

5 New Monitoring and Modelling Data

New Monitoring

5.1 Reigate and Banstead BC do not carry out any automatic monitoring within the Drift Bridge AQMA. Monthly average nitrogen dioxide concentrations have been measured at three sites within the study area using diffusion tubes (Figure 1). Diffusion tubes are a type of passive sampler, which absorb the pollutant to be monitored directly from the surrounding air with no need for a power supply. Passive samplers are easy to use and relatively inexpensive. Reigate & Banstead BC uses diffusion tubes prepared and analysed by Lambeth Scientific Services (50% TEA in acetone). All of the data presented in this report have been adjusted to account for diffusion tube bias using a locally derived factor of 1.459. The factor provided for 2006 on the Review and Assessment Helpdesk website (Defra, 2007b) is 1.34, based on 8 studies, which include the 3 studies carried out by Reigate and Banstead BC. The local factor is higher than the national factor, and thus provides a worst-case assessment of the results. Full data for 2006 are included in Appendix 1, along with further details of the calculation of the local bias adjustment factor.

5.2 Monitoring data since 2003 are presented in Table 2, where available. In all cases, data are bias adjusted, and where appropriate, adjusted to represent an annual mean. Concentrations for 2010 have been estimated from the 2006 measured concentrations, using future year projection factors available from Defra (2007a).

Table 2: Measured and Projected 2010 Annual Mean Concentrations at each Diffusion Tube Monitoring Site (µg/m^3).

Tube Ref	Location	2003[a]	2004[b]	2005[c]	2006[d]	2010
RB21/85	Opp. Drift Bridge Hotel, Reigate Road	**48**	**48**	**45.2**	**51.6**	**44.7**
RB22	Opp. 2 Grey Alders	36	27	25.6	28.8	25.8
RB106	Crossways, Fir Tree Road	-	-	29.8[e]	**47.4**	**41.0**

NOTES: Data in bold denote exceedences of the air quality objectives.
[a] Local bias adjustment factor of 1.29 applied by RBBC.
[b] Local bias adjustment factor of 1.32 applied by RBBC.
[c] Local bias adjustment factor of 1.349 applied , calculated from three collocation studies.
[d] Local bias adjustment factor of 1.459 applied, calculated from three collocation studies (Appendix 1).
[e] Data represent the 2005 annual mean equivalent concentration, as only 5 months of monitoring carried out in 2005 at this site.

5.3 Concentrations measured in 2006 are higher than those measured in 2005, and where monitoring data are available, they are also higher than those measured in 2004. Modelling has been verified using 2006 data.

New Modelling

5.4 Annual mean concentrations of nitrogen dioxide during 2006, 2010 and 2015 have been modelled within the study area using the dispersion modelling methodology set out in Appendix 2. Specific locations representing worst-case residential exposure within the study area have been selected, and are shown in Figure 2. Figure 3 shows the extent of predicted exceedences of the annual mean in 2006. Figures 4 and 5 show predicted concentrations for 2010 and 2015, respectively.

5.5 Table 3 presents the concentrations predicted for specific receptor locations. The highest predicted annual mean nitrogen dioxide concentration in 2006 is 53.5 µg/m^3 (at receptor number 3), which is the closest receptor to the junction and to the A240. This is the only receptor location at which the annual mean nitrogen dioxide concentration is still predicted to be exceeded in 2015.

5.6 At locations representing relevant exposure within the AQMA, the air quality objectives are breached in all three years of assessment. There are, however, no predicted annual mean concentrations greater than 60 µg m^{-3} at relevant locations, and therefore it is unlikely that the 1-hour objective for nitrogen dioxide will be exceeded. It is clear from Figure 3 that the area of predicted exceedence of the annual mean nitrogen dioxide objective is not likely to include any properties other than the Driftways and Crossways properties which already lie within the declared AQMA.

Table 3: Annual Mean Nitrogen Dioxide Concentrations (µg/m[3]) Modelled for Specific Receptor Locations.

Receptor	Location	Relevant Exposure	2006	2010	2015
1	Closest point of property in Grey Alders to A240	Yes	38.2	32.8	29.6
2	Closest point of property in Grey Alders to A240	Yes	37.9	32.6	29.4
3	Closest point on Driftways to A240	Yes	**53.5**	**45.6**	**40.3**
4	Closest point of Crossways to A240	Yes	**45.7**	39.1	34.8
5	Closest point of Crossways to A2022	Yes	**49.9**	**42.8**	37.8

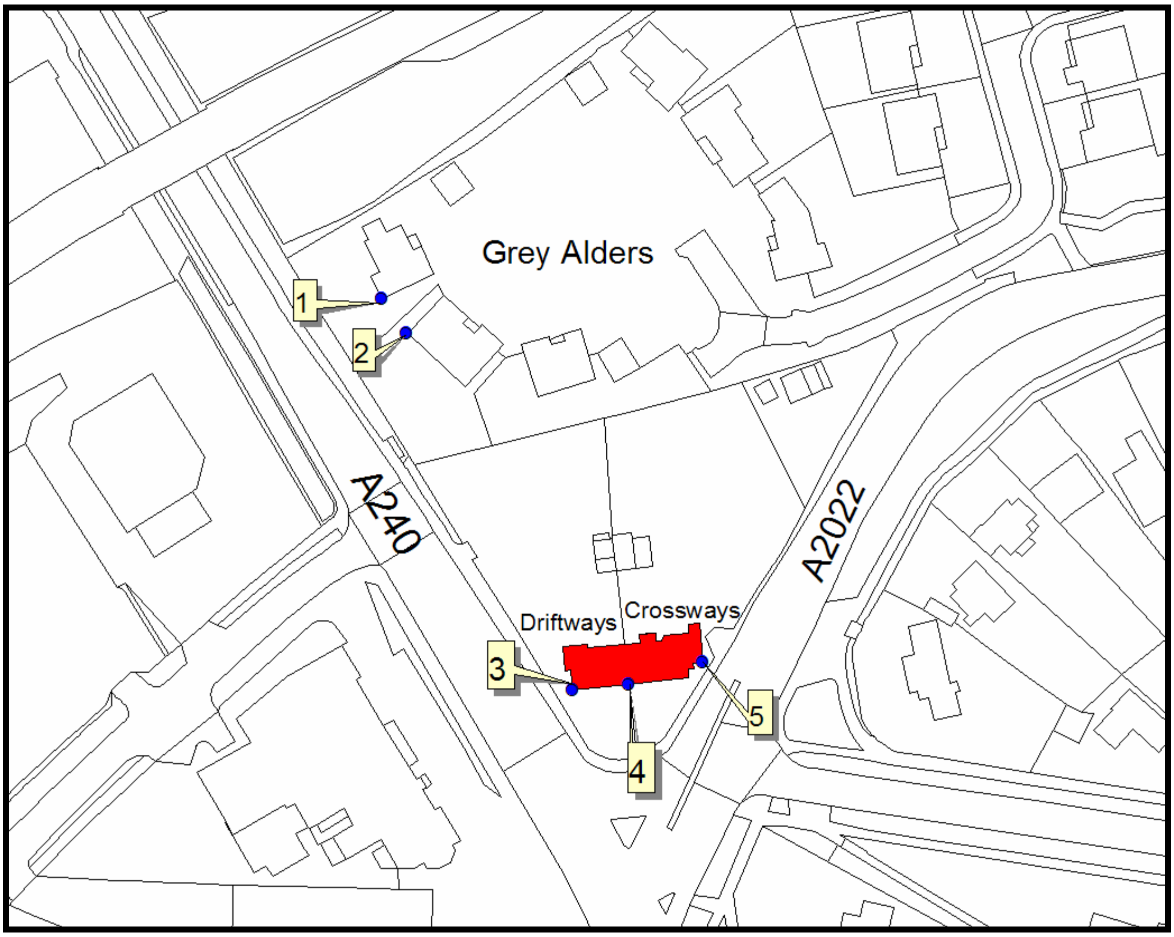

Figure 2: Specific Modelled Receptor Locations. The Red Area Represents the Current AQMA. © Crown Copyright. Reigate & Banstead Borough Council. Licence no. 100019405.

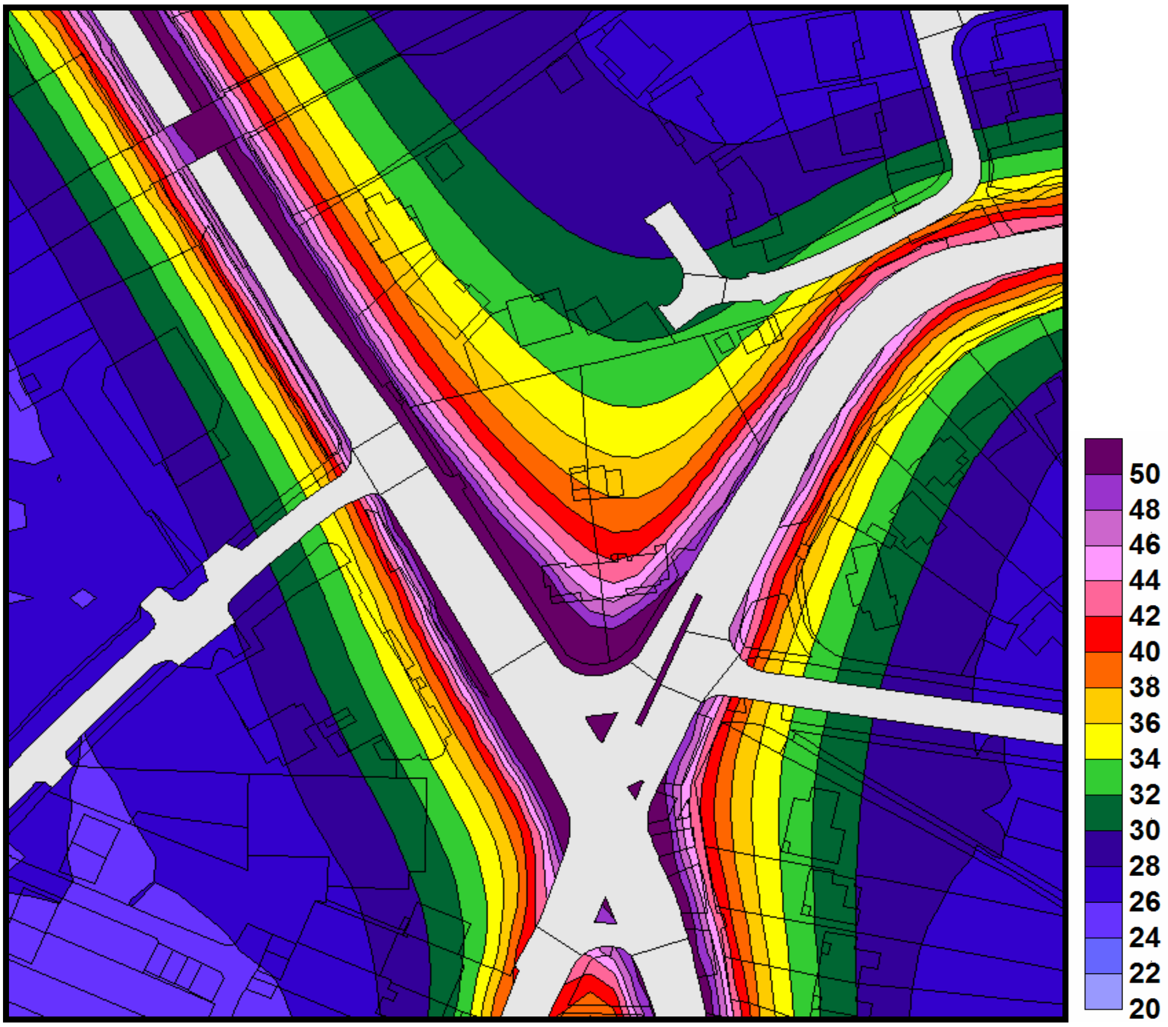

Figure 3: Modelled Annual Mean Nitrogen Dioxide Concentrations in 2006 around the Drift Bridge AQMA (μg/m^3). © Crown Copyright. Reigate & Banstead Borough Council. Licence no. 100019405.

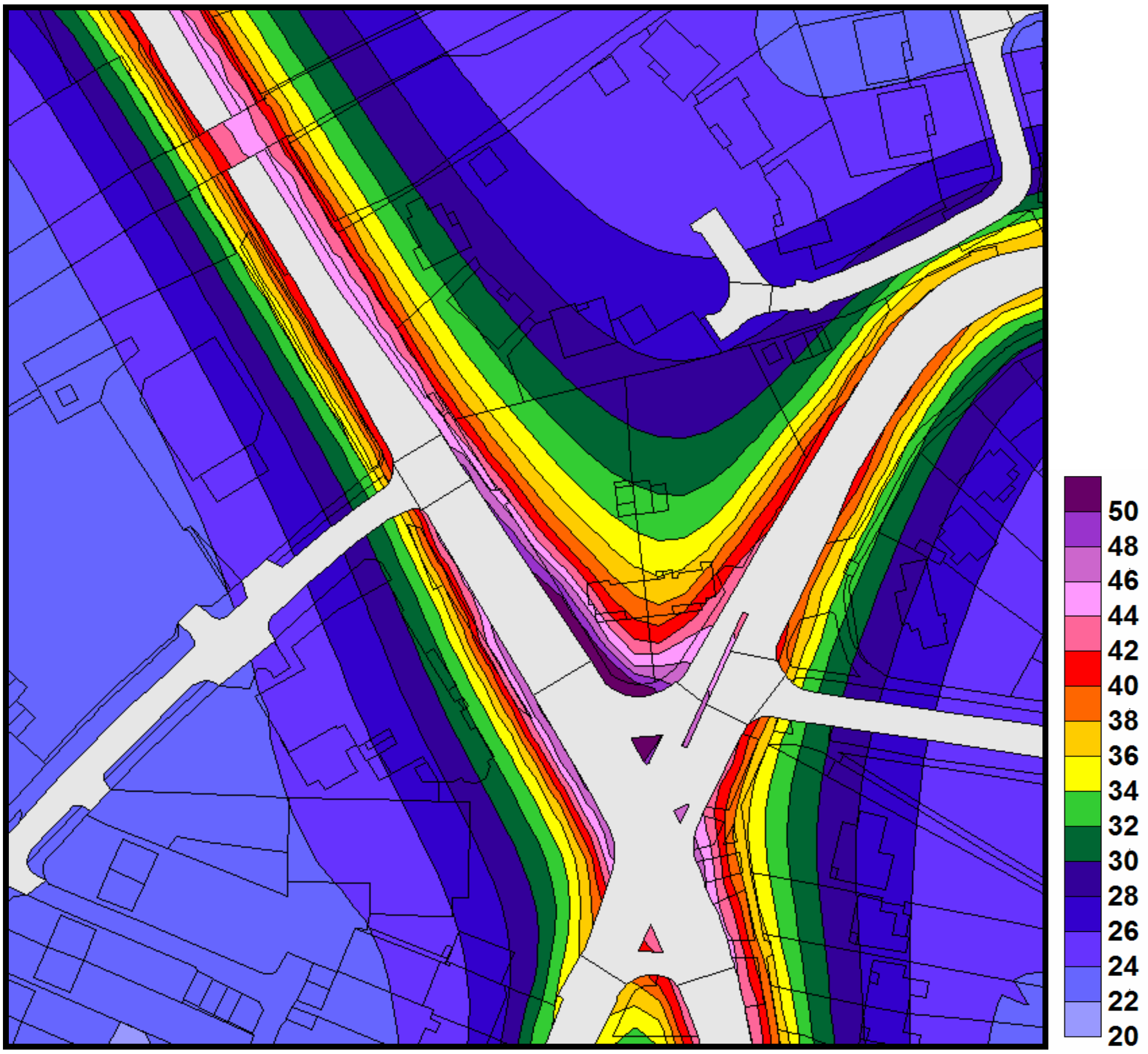

Figure 4: Modelled Annual Mean Nitrogen Dioxide Concentrations in 2010 around the Drift Bridge AQMA (µg/m^3). © Crown Copyright. Reigate & Banstead Borough Council. Licence no. 100019405.

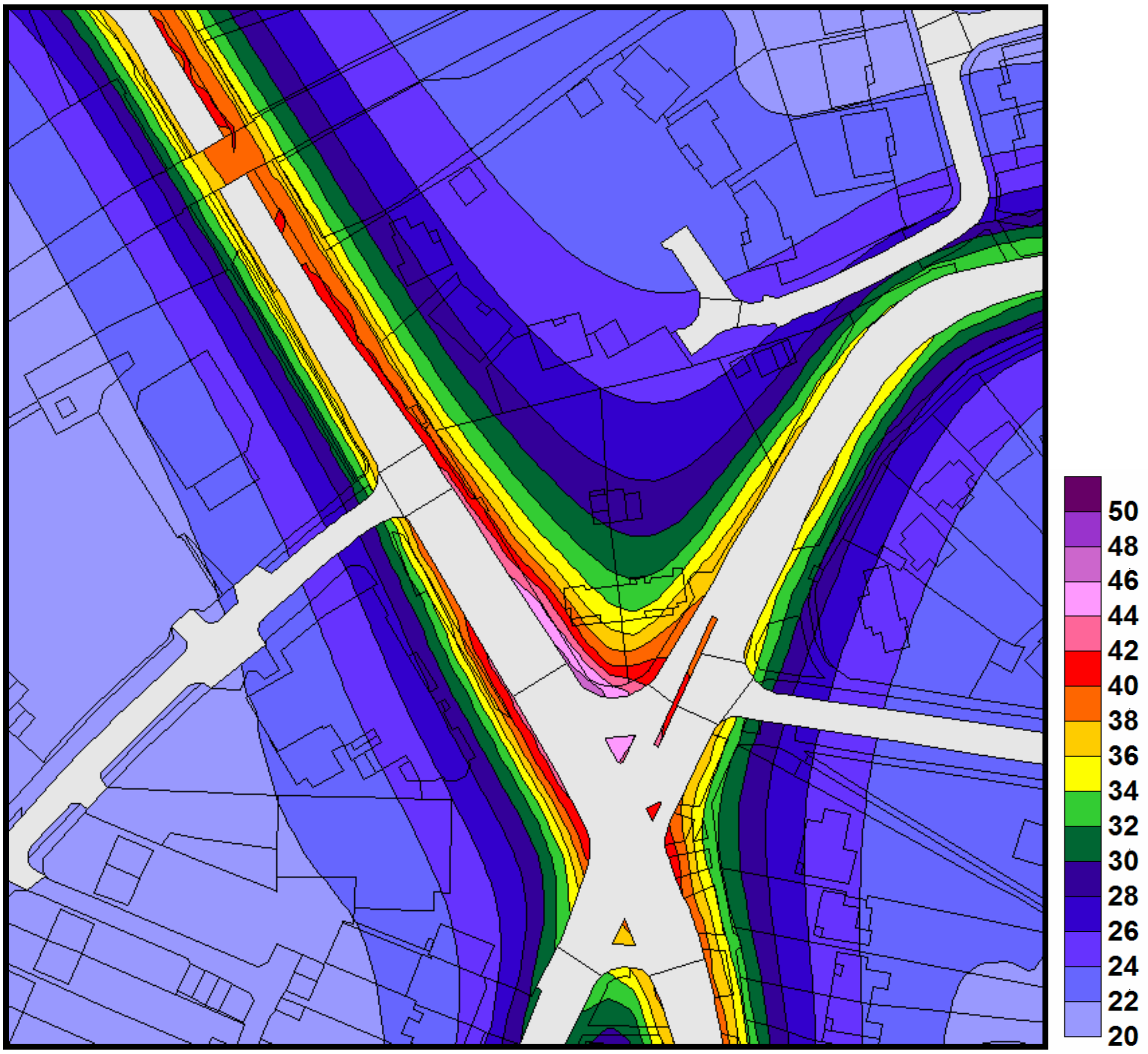

Figure 5: Modelled Annual Mean Nitrogen Dioxide Concentrations in 2015 around the Drift Bridge AQMA (µg/m³). © Crown Copyright. Reigate & Banstead Borough Council. Licence no. 100019405.

6 Source Apportionment

6.1 In order to develop an appropriate action plan it is necessary to identify the sources contributing to the objective exceedences at locations within the AQMAs. The data presented here could be used to inform any future traffic management decisions. Figure 6 and Table 4 set out the source contributions of traffic related sources, which have been apportioned to the following categories:

- Cars;
- Light Goods Vehicles;
- Heavy Goods Vehicles; and
- Ambient Background.

6.2 The five specific receptor locations shown in Figure 2 have been chosen to provide an overview of source contributions at these different locations. They represent worst-case locations for nitrogen dioxide concentrations, as well as a geographical spread across the modelled area. For each receptor, the most significant proportion of the locally-generated road component can be attributed to emissions from HGVs. In each case, the background concentration contributes the largest proportion to the overall concentration.

Table 4: Modelled Annual Mean (2006) Nitrogen Dioxide Concentrations at the Worst-Case Representative Receptors and the Contribution of Each Source to the Total.

Receptor	Annual Mean Concentration (μg/m^3)				
	Background	**Cars**	**LGVs**	**HGVs**	**Total**
1	20.7	7.6	1.2	8.7	38.2
2	20.7	7.5	1.2	8.6	37.9
3	20.7	12.9	1.9	18.0	**53.5**
4	20.7	10.3	1.4	13.3	**45.7**
5	20.7	13.1	1.3	14.8	**49.9**
	% Contribution to Total				
	Background	**Cars**	**LGVs**	**HGVs**	**Total**
1	54.3%	19.9%	3.1%	22.7%	100%
2	54.6%	19.7%	3.1%	22.6%	100%
3	38.7%	24.1%	3.5%	33.7%	100%
4	45.3%	22.6%	3.0%	29.1%	100%
5	41.5%	26.2%	2.7%	29.7%	100%

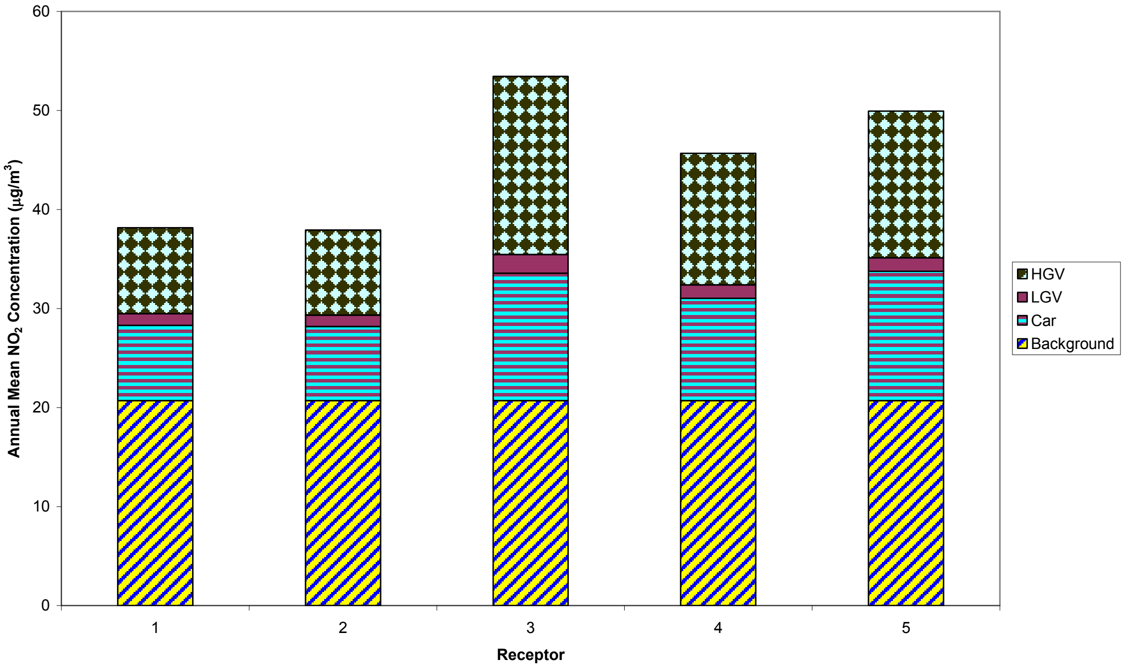

Figure 6: Relative Contribution of Each Source Type to the Total Modelled Annual Mean Nitrogen Dioxide Concentration (µg/m^3) at Worst Case Relevant Receptor Locations around the Drift Bridge AQMA.

7 Air Quality Improvements Required

7.1 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 predicted concentration in 2006 and the objective level (40 µg/m^3). The highest predicted concentration close within the Drift Bridge AQMA is at Receptor 3 (53.5 µg/m^3) requiring a reduction of around 13.5 µg/m^3 in order for the objective to be achieved.

7.2 In terms of describing the reduction in emissions that is required it is more useful to consider nitrogen oxides (NOx). Table 5 sets out the required reduction in local emissions of NOx that would be required at each receptor in order for the annual mean objective to be achieved in 2006. At Receptor 3, local emissions would need to fall by 48%.

7.3 Table 6 sets out the required reduction in local emissions of NOx that would be required, at receptor locations where exceedences have been predicted in 2010 and 2015, in order for the annual mean objective to be achieved. At Receptor 3 in 2015, local emissions would still need to fall by 2%.

Table 5: Improvement in Annual Mean Nitrogen Dioxide Concentrations and in Emissions of Oxides of Nitrogen at the Worst-Case Representative Receptors in 2006.

	Required reduction in annual mean nitrogen dioxide concentration (µg/m^3)	Required reduction in emissions of oxides of nitrogen from local roads (%)
1	0.0	0
2	0.0	0
3	13.5	48
4	5.7	19
5	9.9	35

Table 6: Improvement in Annual Mean Nitrogen Dioxide Concentrations and in Emissions of Oxides of Nitrogen at the Worst-Case Representative Receptors in 2010 and 2015.

	Required reduction in annual mean nitrogen dioxide concentration (µg/m^3)		Required reduction in emissions of oxides of nitrogen from local roads (%)	
	2010	**2015**	**2010**	**2015**
3	5.6	0.3	25	2
5	2.8	-	14	-

7.4 However, it is very important to stress that these anticipated improvements do not take specific account of local factors. Furthermore, there is evidence at a national level, that concentrations at some roadside sites have not followed these predicted trends. Reasons for this are currently being explored by the Government's expert advisory panel AQEG (2006); one potential factor may be the increased permeation of diesel vehicles into the national fleet, which emit a higher proportion of primary NO_2.

8 Management Planning

8.1 In the Drift Bridge AQMA, pollutant concentrations are influenced by vehicle flow patterns, including the acceleration and deceleration, and waiting times at the junction. Action Plan measures to reduce concentrations are likely to include traffic management measures. However, 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 the representative receptor locations 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. Tables 7 sets out the results.

Table 7: Modelled Annual Mean Nitrogen Dioxide Concentration During 2006 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
Car	10%	37.5	37.3	**52.4**	**44.8**	**48.9**
	25%	36.5	36.3	**50.9**	**43.6**	**47.3**
	50%	34.9	34.7	**48.3**	**41.4**	**44.6**
LGV	10%	38.1	37.8	**53.3**	**45.6**	**49.8**
	25%	37.9	37.7	**53.1**	**45.4**	**49.7**
	50%	37.7	37.4	**52.7**	**45.1**	**49.4**
HGV	10%	37.4	37.2	**52.0**	**44.6**	**48.8**
	25%	36.3	36.1	**49.9**	**42.9**	**46.9**
	50%	34.4	34.2	**46.1**	**40.1**	**43.8**
All Vehicles	10%	36.7	36.5	**50.9**	**43.6**	**47.6**
	25%	34.3	34.2	**46.8**	**40.4**	**43.9**
	50%	30.2	30.1	39.4	34.7	37.2
Do Nothing (results from Table 4)		38.2	37.9	**53.5**	**45.7**	**49.9**

8.2 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 numbers by 50%. This is the only measure that, in 2006, would reduce the concentrations at the three locations where exceedences have been predicted, to a level where the annual mean air quality objective would be met.

9 Summary and Conclusion

9.1 Nitrogen dioxide concentrations within and around the Drift Bridge AQMA have been assessed through diffusion tube monitoring and detailed dispersion modelling. The results indicate that the annual mean nitrogen dioxide objective was exceeded in 2006 within the AQMA, and that it will continue to be exceeded until 2015.

9.2 The results of the detailed modelling predict exceedences within the Drift Bridge AQMA. At relevant locations in close proximity to the AQMA, the annual mean nitrogen dioxide objective is predicted to be met. It is therefore recommended that:

- The Drift Bridge AQMA should remain in its present form and monitoring should continue; and
- Where practicable, consideration should be given to relocating the diffusion tubes to worst-case locations on the façades of the Driftways and Crossways properties (receptors 3 and 5).

9.3 Source apportionment of the local traffic emissions has been undertaken to inform the action plan. This shows that HGVs make greater local contributions to emissions than might be expected from the vehicle numbers and proportions. This highlights the importance of keeping all sources under consideration when contemplating measures to include within the action plan.

9.4 A reduction in the volume of traffic around the AQMA is predicted to result in a decrease in the concentrations of nitrogen dioxide within the AQMA, however a reduction in total vehicle numbers of greater than 50% would be required to achieve the annual mean air quality objective at all modeled receptor locations in 2006.

10 Technical Deficiencies

10.1 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 measured concentrations presented have an intrinsic margin of error. Defra (2007d) suggest 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 Reigate and Banstead Borough 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 during each year, the vehicle fleet within the study area will conform to the national (UK) average composition; it has been assumed the emissions per vehicle conform to the factors published in DMRB 11.3; it has been assumed that wind conditions measured at Gatwick airport during 2006 will occur throughout the study area during 2010 and 2015; 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 the apparent under-prediction of the model.

10.2 The UK Government's Air Quality Expert Group (AQEG) has published a draft report on trends in primary nitrogen dioxide in the UK (AQEG, 2006). This examines evidence that shows that while NOx emissions have fallen in line with predictions made a decade previously, the composition of NOx has, in some urban environments, changed. This may have caused nitrogen dioxide levels at some locations to fall less rapidly than was expected. The latest guidance from Defra has been followed regarding NOx to NO_2 relationships, but there is still uncertainty as to whether these relationships will continue to apply in 2010 and 2015. Any effect is likely to be greatest close to major roads, where future baseline concentrations may have been underestimated. The implications for the conclusions of this assessment are judged to be negligible in 2006.

10.3 The limitations to the assessment should be borne in mind when considering the results set out in preceding sections. While the model should give an overall accurate picture, i.e. one without bias, there will be uncertainties for individual receptors. Clearly in future years the uncertainties are likely to be greater than they are now. The results are 'best estimates' and have been treated as such in the discussion.

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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.
PM_{10}	Small airborne particles, more specifically particulate matter less than 10 micrometers in aerodynamic diameter.

NOx	Nitrogen oxides
NO_2	Nitrogen dioxide.
$\mu g/m^3$	Microgrammes per cubic metre.
Urban Background	An urban location distanced from sources and therefore broadly representative of city-wide background conditions (Defra, 2003b).
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, 2003b).
HGV	Heavy Goods Vehicle
LGV	Light Goods Vehicle

13 Appendix 1 – Diffusion Tube Monitoring

Table A1.1: Results of Diffusion Tube Monitoring 2006

Tube No	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Ann Mean	Bias adjust	No of Mnths	Ave
RB21	31	30	24	43	26	41	45	35	38	41	48	44	37.2	**54.2**	12	**51.6**
RB85	35	36	25	16	37	54	37	29	30	39	45	20	33.6	**49.0**	12	
RB22	29	15	13	20	15	14	18	16	17	24	28	28	19.8	28.8	12	-
RB106	29	32	32	40	21	42	35	37	27	22	37	36	32.5	**47.4**	12	-

13.1 Diffusion tubes are known to exhibit bias when compared to results from automatic analysers. Therefore diffusion tube results need to be adjusted to account for this bias. One of the main factors influencing diffusion tube performance is thought to be the laboratory that supplies and analyses the tubes. Reigate and Banstead Borough Council use diffusion tubes that are supplied and analysed by Lambeth Scientific Services. These are prepared using 50% TEA in acetone.

13.2 In order to determine the bias exhibited by these tubes, studies are carried out using triplicate tubes collocated with each of the three automatic monitors within the Borough of Reigate and Banstead (data capture 75% or greater). All 2006 diffusion tube data (Table A1.1) presented in this report have been adjusted using the overall factor calculated from the data presented in Table A1.2, with the optimum relationship defined using orthogonal regression.

Table A1.2: Results of Diffusion Tube and Continuous Monitor Collocation Studies in 2006

AQMS	Diffusion Tube	Automatic	Adjustment Factor
Michael Crescent, Horley	19.4	29.4	1.51
74 The Crescent, Horley	22.2	32.4	1.46
Poles Lane Pumping Station, Crawley	13.8	19.4	1.41
Overall Factor			**1.459**

14 Appendix 2 – Dispersion Modelling Methodology

14.1 Annual mean concentrations of nitrogen dioxide during 2006, 2010 and 2015 have been modelled using the Atmospheric Dispersion Modelling System for Roads (ADMS Roads). ADMS Roads is one of the dispersion models accepted for modelling within the Government's Technical Guidance (Defra, 2003b).

Meteorological Data:

14.2 The model has been run using a full year of meteorological data for 2006 from the meteorological station near Gatwick Airport, which is approximately 20 km south of the study area.

Horizontal Road Alignment:

14.3 Road alignment was based around Ordnance Survey road centreline data. Each carriageway of each road was entered into the model separately, where data were available. Those roads not explicitly included have been accounted for via the background component of the modelled results.

Traffic data:

14.4 Traffic data have been provided for the A240, the A2022 and the B291 at the Drift Bridge junction. These data have been factored forward to the assessment years by Reigate and Banstead Borough Council using annual growth factors derived from TEMPRO v5.3. The speeds and road characteristics assumed for each section of road entered into the model are presented in Table A2.1. The flows used for each assessment year are presented in Table A2.2.

Table A2.1: Summary of Road Characteristic Data

Link	Road width (m)	Speed (kph)[a]
A2022 to A240 N a	9	45
A2022 to A240 N b	15	20
A2022 to A240 N c	15	20
A2022 to A240 N d	6	60
A2022 to A240 S a	9	45
A2022 to A240 S b	15	20
A2022 to A240 S c	15	20
A2022 to A240 S d	8	45
A2022 to B291 a	9	45
A2022 to B291 b	15	20
A2022 to B291 c	13	20
A2022 to B291 d	7	45
A240 N to A2022 a	6	60
A240 N to A2022 b	13	20
A240 N to A2022 c	15	20
A240 N to A2022 d	9	45
A240 N to A240 S a	6	60
A240 N to A240 S b	14	20
A240 N to A240 S c	14	20
A240 N to A240 S d	8	45
A240 N to B291 a	6	60
A240 N to B291 b	15	20
A240 N to B291 c	12	20
A240 N to B291 d	8	45
A240 S to A2022 a	8	45
A240 S to A2022 b	14	20
A240 S to A2022 c	15	20
A240 S to A2022 d	9	45
A240 S to A240 N a	9	45
A240 S to A240 N b	13	20
A240 S to A240 N c	15	20
A240 S to A240 N d	9	45
A240 S to B291 a	8	45
A240 S to B291 b	13	20
A240 S to B291 c	11	20
A240 S to B291 d	8	45
B291 to A2022 a	8	45
B291 to A2022 b	13	20
B291 to A2022 c	15	20
B291 to A2022 d	9	45
B291 to A240 N a	8	45
B291 to A240 N b	13	20
B291 to A240 N c	15	20
B291 to A240 N d	9	45

[a] Average speed rounded to nearest 5 kph.

Table A2.2: Summary of AADT Traffic Flows used in Assessment

Link	2006			2010		2015	
	Car	LGV	HGV	Cars + LGV	HGV	Cars + LGV	HGV
A240 N Southbound	7704	1143	515	9416	548	10143	590
A240 N Northbound	8538	1504	597	10687	636	11513	685
A2022 Eastbound	4702	296	249	5319	266	5730	286
A2022 Westbound	5940	619	231	6981	246	7520	265
A240 S Southbound	5026	824	340	6226	362	6707	390
A240 S Northbound	4604	834	361	5788	384	6235	413
B291 Eastbound	2923	97	124	3215	132	3463	142
B291 Westbound	3029	115	35	3347	38	3605	41

Background Concentrations:

14.5 Background concentrations of nitrogen dioxide have been taken from the national maps of background concentrations available from the Air Quality Archive (Defra, 2007a).

Model Verification:

14.6 Most nitrogen dioxide (NO_2) is produced in the atmosphere by reaction of NOx with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions. The model has been run to predict annual mean road-NOx concentrations during 2006 at each diffusion tube location within the study area.

14.7 The model outputs of road-NOx (i.e. the component of total NOx coming from road traffic) have been compared with the measured road-NOx. Total measured NOx was calculated from the measured NO_2 concentrations at each of the three monitoring locations using the recently updated NOx from NO_2 calculator[1] available on the Air Quality Archive website (Defra, 2007a). The

[1] http://www.airquality.co.uk/archive/laqm/tools/NOxfromNO2calculator2007.xls

measured road-NOx contribution was then calculated as the difference between the total and the background value (determined as described in the previous section).

14.8 A primary adjustment factor was then determined as the inverse of the best fit line between the calculated (measured) road contribution and the model derived road contribution. The primary adjustment factor was then applied to each modelled road-NOx concentration to provide an adjusted modelled road-NOx concentration. The background concentration was added to these concentrations to determine the adjusted total modelled NOx concentration. The road contribution to the total annual mean nitrogen dioxide concentration was then determined from these adjusted modelled concentrations, following the method set out by Defra (2003b), taking into account the most recent guidance (Defra, 2007c):

$$NO_2\ (road) = NOx\ (road) \times (-0.0719*LN(NOx(total)) + 0.6248$$

14.9 The total nitrogen dioxide concentration was then determined by adding the background NO_2 concentration (determined as described above) to this calculated road contribution. A secondary adjustment factor was finally calculated as the inverse of the best fit line applied to the adjusted data.

14.10 Primary and secondary adjustment factors have been applied to all modelled data presented in this report.

Primary adjustment factor : 5.08

Secondary adjustment factor: 0.998

14.11 The results imply that the model was under-predicting the road NOx contribution. This is a common experience with this and most other models. The final NO_2 adjustments are minor. Figure A2.1 compares the modelled concentrations at each diffusion tube, after all adjustments have been made, to the measured concentrations at these locations.

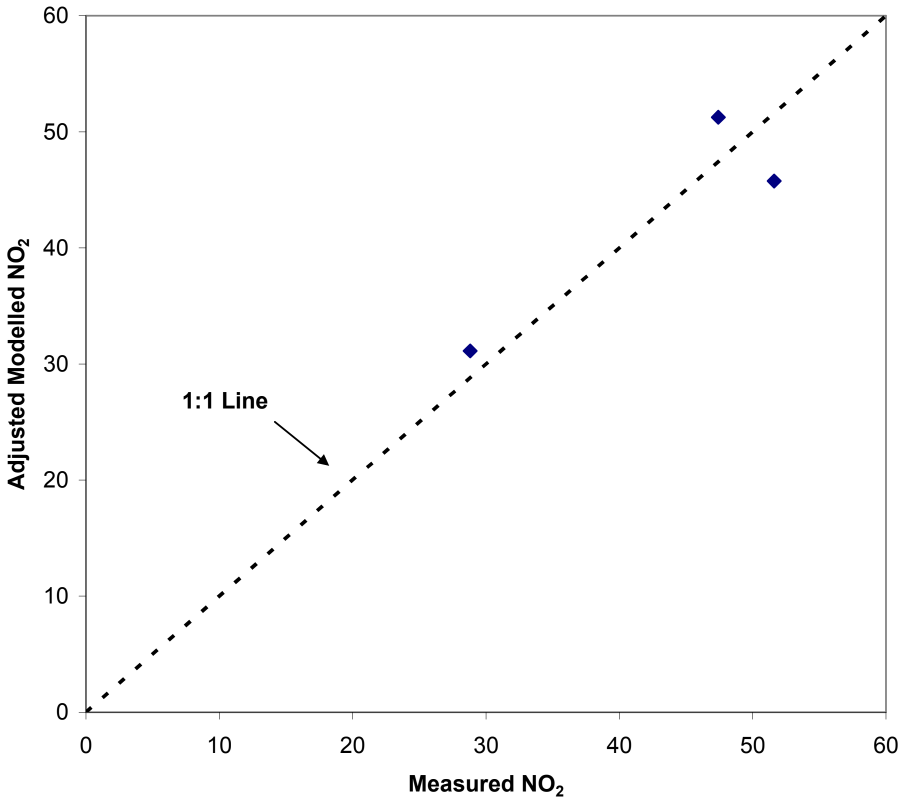

Figure A2.1: Comparison of Measured NO_2 to Fully Adjusted Modelled NO_2 Concentrations

Source Apportionment:

14.12 The model has been used to determine the proportion of emissions at the five receptor locations around the Drift Bridge AQMA for each of the following vehicle categories:

- Cars
- Light Goods Vehicles (LGVs)
- Heavy Goods Vehicles (HGVs)

14.13 Concentrations at each receptor have been modelled for each vehicle category independently. The total NO_2 concentration was initially apportioned to background and road components. The road NO_2 component was then further apportioned into source categories according to the relative contribution of each source to the total road NOx.