Further Assessment (Stage 4) of the Horley Air Quality Management Area – 2010 Addendum

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Abbreviations and Definitions

AADT	Annual Average Daily Traffic Flow.
APU	Auxiliary Power Unit - used on planes to provide power (especially for air conditioning at Gatwick) on the ground.
AQMA	Air Quality Management Area.
BAA	British Airports Authority.
DEFRA	Department of the Environment, Food and Rural Affairs (formerly DETR).
DfT	Department of Transport.
DMRB	Design Manual for Roads and Bridges.
EU	European Union.
g	gram.
Kg	kilogram.
m^3	cubic metre.
mppa	million passengers per annum.
NAEI	National Atmospheric Emissions Inventory.
netcen	National Environmental Technology Centre, UK.
NO_2	Nitrogen Dioxide.
NO_x	Oxides of Nitrogen (mainly NO and NO_2 expressed as NO_2 equivalent).
O_3	Ozone.
ppb	part(s) per billion.
TEMPRO	Trip End Model Program.
µg	microgram (1 millionth of a gram).
$\mu g\ m^{-3}$ ($\mu g/m^3$)	microgram(s) per cubic metre.

Executive Summary

E.1 In April 2002 Reigate and Banstead Borough Council declared an area of south Horley near to Gatwick Airport an air quality management area (AQMA), due to predicted breaches of the 2005 UK annual average air quality objective for nitrogen dioxide (NO_2) of 40 µg m^{-3}.

E.2 Following the declaration of an AQMA the council is under a statutory duty:

i) to complete a further assessment of the area to confirm the original findings, and to examine in greater detail the contribution of differing pollution sources to the area.

ii) to then produce an action plan detailing how it proposes to reduce pollutant concentrations to below the objective value(s).

E.3 A further assessment (Stage 4) of the Horley AQMA in April 2004 confirmed the original findings for 2005, and provided a detailed breakdown of the various sources contributing to the nitrogen dioxide concentrations predicted for the area.

E.4 However, as the airport is predicted to expand from around 34 million passengers per annum in 2005 to around 38 million passengers per annum in 2010, the concentration and sources of nitrogen dioxide within the Horley AQMA have also been modelled for 2010, assuming that no action has been taken to reduce pollution from the airport. This is to ensure that any measures intended to reduce the concentration of nitrogen dioxide within the AQMA are targeted at sources that are a continuing problem in the longer term, given the potential cost implications for the airport of any programs to reduce pollution.

E.5 The main findings of the 2010 assessment are:

i) residences in the south / south east corner of the AQMA nearest the airport, will exceed both the annual average UK objective and EU limit value for nitrogen dioxide of 40 µg m^{-3} in 2010, with concentrations around 42 µg m^{-3}, compared to 41 µg m^{-3} in 2005.

ii) Concentrations of nitrogen dioxide furthest from the airport, at the north tip of the AQMA, are predicted to fall by up to 10 to 12 % between 2005 and 2010, due to a decrease across the AQMA in the background and non airport related road traffic sources of nitrogen dioxide.

iii) The falls in nitrogen dioxide concentrations between 2005 and 2010 at sites furthest from the airport **are not** replicated at properties closest to the airport, as emissions from the airport have increased sufficiently over this period to more than off set the reductions in background and non airport road traffic sources. Hence the continuing exceedence of the 2005 UK objective and breach of the 2010 EU limit value for nitrogen dioxide at properties closest to the airport.

iv) Source apportionment of the NO_x concentrations at properties where the nitrogen dioxide concentration is predicted to breach the EU limit value demonstrate a significant shift in the sources of the pollution, with the airport related component increasing from 45 % in 2005 to 58 % in 2010, while the background and non airport related road traffic component falls from 55 % in 2005 to 42 % in 2010. This significant shift in the sources of the nitrogen dioxide occurs despite the concentration of NO_2 increasing only slightly from 41 to 42 µg m^{-3}.

v) Despite the predicted improvements in background and non airport road traffic off setting most of the increased emissions from the airport between 2005 and 2010, an examination of the trends in background concentrations and non airport road traffic emissions beyond 2010 indicates that the improvements between 2005 and 2010 will not continue, and will cease entirely by 2015.

E.6 In view of the above findings i.e. the predicted breach of the 2005 UK objective for nitrogen dioxide and 2010 EU limit value, the significant and potentially growing contribution of the airport to nitrogen dioxide concentrations with the AQMA, and as development at the airport is permitted up to 46 million passengers per annum, the presence and spatial extent of the AQMA is to remain unchanged in Horley.

1.0 Introduction

1.1 Background

1.1 In April 2002 Reigate and Banstead Borough Council declared an air quality management area (AQMA) in the vicinity of Gatwick Airport (Figure 1.1), based on predicted exceedences of the UK Government 2005 annual average nitrogen dioxide (NO_2) objective of 40 µg m^{-3}.

1.2 The AQMA was declared following a Stage 3 assessment of the area (AQC, 2001), and the findings of this study were confirmed by a further (Stage 4) assessment of air quality in 2005 within south Horley, near to Gatwick Airport, completed in April 2004 (AQC, 2004). The further assessment work was based on an extrapolation (see AQC, 2004 for full methodology) of the 2002/3 emissions inventory and dispersion modelling undertaken by netcen on behalf of BAA Gatwick (NETCEN, 2003a, 2003b)

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1.3 However, passenger throughput at Gatwick is predicted to grow from around 34 million in 2005 to around 38 million by 2010, and programs to reduce air pollution at a major airport inevitably take time to implement given the potential cost implications and work involved. Therefore, the concentrations of nitrogen dioxide and the contribution of differing sources to this pollution problem have also been examined for 2010, to ensure that any plans / actions to reduce pollution from the airport are targeted at sources that are a genuine problem both now and in the future.

1.4 Therefore the purpose of this report is to further inform the action planning process, and as such is an addendum to the original Stage 4 report (AQC, 2004) issued in 2004.

1.2 Changes since the Further (Stage 4) Assessment of April 2004.

1.5 There have been no major changes either within or in the vicinity of the Horley AQMA, since the further assessment in 2004.

1.6 However, some minor problems have since been noted in the original netcen modelling of nitrogen dioxide concentrations in 2002/3 (NETCEN 2003a), in relation to the apportionment of aircraft NO_x emissions along the runway, but this has no impact on the predicted nitrogen dioxide (NO_2) concentrations in 2005 within the Horley AQMA.

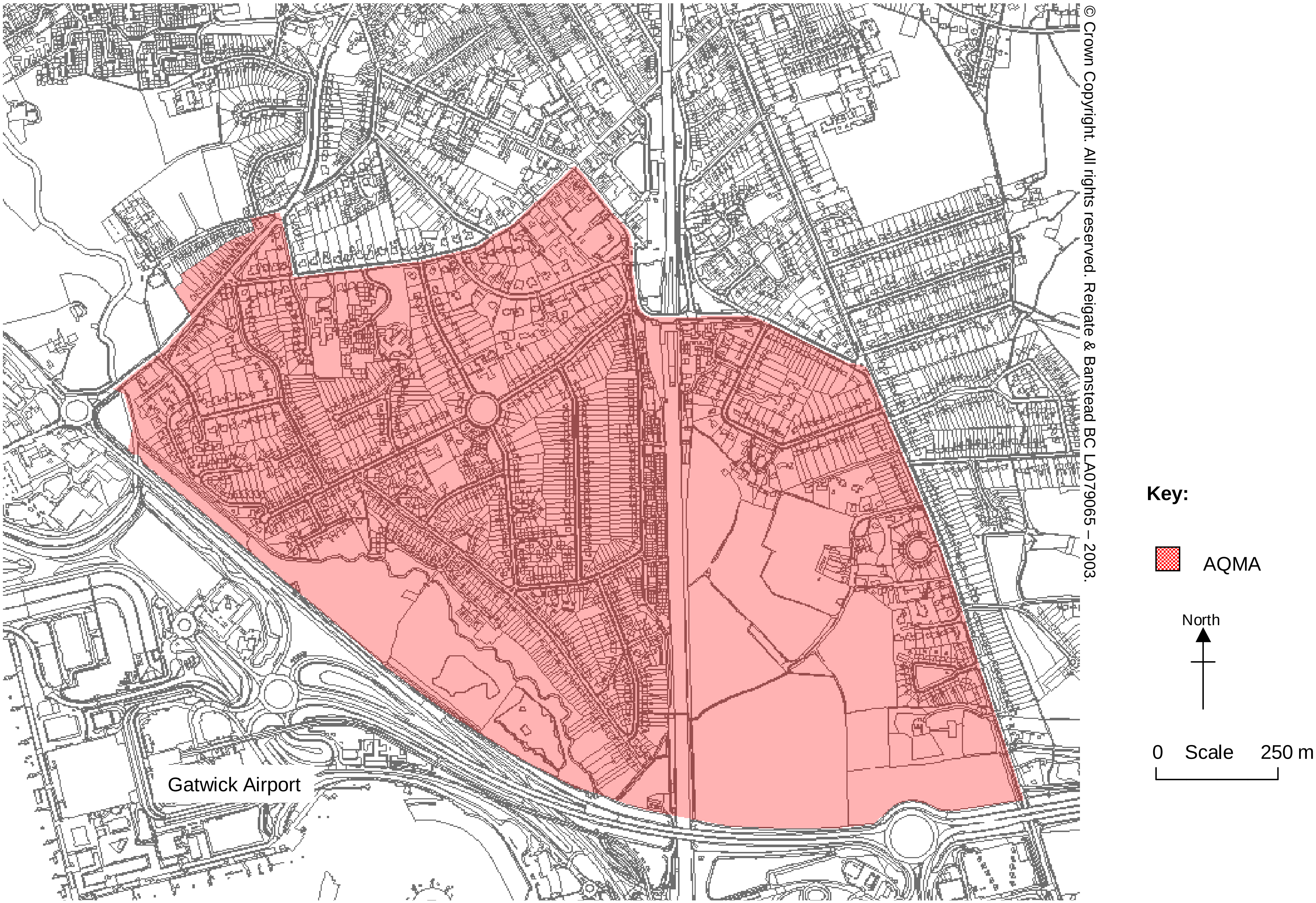

Figure 1.1: The Horley Air Quality Management Area (AQMA).

1.7 A further problem was also noted in the PM_{10} emissions inventory for 2002/3 (NETCEN, 2003a), but the PM_{10} concentrations predicted for the Horley area remain unchanged at around 20 to 25 $\mu g\ m^{-3}$, and so are below the UK annual average PM_{10} objective of 40 $\mu g\ m^{-3}$.

1.8 Nevertheless, netcen have reissued the 2002/3 inventory and 2002/3 dispersion modelling (NETCEN, 2004a, 2004b), and the 2010 results presented in this report take account of these changes in relation to the NO_x emissions.

1.9 Finally, it should be noted that following the revocation of two other air quality management areas within the borough the Horley AQMA, originally designated air quality management area number 5, is now designated Reigate and Banstead Air Quality Management Area number 3.

2.0 Methodology

2.1 In this report it is not proposed to discuss in detail the methodologies behind the 2010 inventory, or 2010 modelling exercise, as these are clearly set out in the relevant netcen reports (NETCEN 2004c, 2004d), both of which were produced following consultation with Reigate and Banstead BC. However, there are a few key points that should be borne in mind in relation to the 2010 emissions inventory and the 2010 modelling as discussed below.

2.1 Emissions Inventory

2.2 The 2010 emission inventory was drawn up on a similar basis to the 2002/3 inventory. However, while the 2002/3 inventory was based on data collected over the 2002/3 period, in order to ensure an accurate comparison of the modelled concentrations to those measured, the 2010 inventory by its very nature is a best estimate of what is considered to be the most likely scenario for the airport in 2010 based on current forecasts in 2004. The assumptions behind the 2010 inventory are based on BAA Gatwick's own forecasts for airport growth, coupled with the views of a range of other consultants (appointed by BAA Gatwick) on the likely type of aircraft and engine technology in operation, and the degree of fleet penetration of this technology.

2.3 The 2010 inventory assumes that the airport is handling 38.2 million passengers per annum, and that no measures have been implemented by the airport to reduce pollution i.e. it is a baseline case.

2.4 However, the underlying assumptions about airport related road traffic in the inventory are taken from a study by Mott McDonald, which worked on the assumption that the airport would be handling 40 million passengers per annum by 2010. This represents a potential over estimate of the emissions from road traffic of less than 5 %, and as road traffic at the worst case receptor within the AQMA makes up less than 20 % of the overall contribution to the NO_2 concentration, this slight overestimate of the traffic component is unlikely to have a significant impact on the predicted nitrogen dioxide concentrations within the AQMA.

2.2 2010 Modelling

2.5 The 2002/3 inventory was modelled by dispersion modelling (ADMS 3.1), and subsequent comparisons between the model results and the measured nitrogen dioxide concentrations over the same time period (AQC, 2004) demonstrated a very good agreement between the two data sets at Gatwick, with the model on average very slightly under predicting the measured concentrations in 2002/3.

2.6 However, following the publication of the UK Government's aviation white paper, the Department of Transport (DfT) has set up a study to investigate the methodologies for airport air quality assessments due to the apparent lack of agreement between the modelled and measured values at Heathrow airport.

2.7 In view of the above work BAA Gatwick were unwilling to complete a full dispersion modelling study for 2010, despite the previous good agreement between modelled and measured data at Gatwick, until the DfT study reports back to ensure a consistency of approach between Gatwick and Heathrow.

2.8 Consequently the 2010 model of the emissions inventory reported here does NOT represent a full dispersion modelling exercise, but a scaling of the NO_x concentrations from the airport and road traffic (which are then converted to NO_2 concentrations) in the Horley AQMA, based on the proportional increase in the NO_x emissions from the various sources on the airport and elsewhere. This approach was only made possible as the 2002/3 dispersion modelling was undertaken separately for a number of different source categories on the airport, to give an indication of the relative contribution of each of these sources. For full details of this approach see NETCEN (2004d).

2.9 The main drawbacks of the above approach are that the weather conditions used for 2010 are identical to those in 2002/3, and the assumption is being made that the spatial distribution of a given pollution source e.g. runway emissions, taxiing emissions etc, does not change significantly from 2002/3.

2.10 While the drawbacks mentioned above mean that the uncertainties associated with the 2010 nitrogen dioxide (NO_2) concentrations are higher than they would have been compared to if a full dispersion model study had been undertaken, particularly in the immediate vicinity of major roads, this approach will still give a good approximation of the concentrations of NO_2 within the AQMA and the sources of pollution that are contributing to the predicted NO_2 concentrations.

3.0 Results

3.1 Nitrogen Dioxide Concentrations

3.1 The predicted NO_2 concentrations within the Horley AQMA in 2010 are summarised in Table 3.1, along with data from 2002/3 and 2005. The location of these sites is shown in Figure 3.1, and a spatial representation of this data shown in Figures 3.2 for 2005 and Figure 3.3 for 2010. It should be noted that the adjusted 2010 model results shown in Table 3.1 have had the following adjustment factor applied, based on the 2002/3 modelling and monitoring comparison exercise (AQC, 2004).

$$\text{Final } NO_2 \text{ Conc.} = 1.176 \text{ x Modelled } NO_2 \text{ Conc.} - 5.606 \quad \text{(Equation 3.1)}$$

3.2 This factor has been applied to ensure a consistency of approach and allow direct comparison of the 2002/3, 2005, and 2010 data. A copy of the unadjusted and adjusted data is shown in appendix A, and at this stage it is impossible to say whether such an adjustment factor will or will not still apply in 2010.

3.3 In general Table 3.1 and Figures 3.2 and 3.3 show that no dramatic changes in concentration have occurred between 2005 and 2010. Figure 3.3 does demonstrate though that some properties in the south / south east corner of the AQMA, will continue to fail to meet the 2005 UK annual average objective for NO_2 in 2010, and that these same properties will also be breaching the EU limit value (which is also 40 $\mu g\ m^{-3}$), which comes into force in 2010.

3.4 If the percentage change in concentrations between 2005 and 2010 is examined (Table 3.1), it can be seen that at some sites there have been small increases of around 2 % in NO_2 concentrations e.g. RB57, 58, 59, and 60, but also some large falls e.g. ER1, ER2, ER3 and RB13.

3.5 When the percentage changes in concentration are plotted up on a map of the AQMA (Figure 3.4), then there is a very clear trend of small increases in NO_2 concentrations at points nearer to the airport, with a trend towards ever greater falls in concentrations the further the receptors are located from the airport.

Site code	Site Description	Nitrogen Dioxide (NO_2) Concentration			Change 2005-2010[*b]
		2002/2003[*a]	2005[*a]	2010[*a]	
RB11	Outside 38, Riverside, Horley	34.6	33.0	32.0	-3.1 %
RB13	Public CarPark, off Massetts Road, Horley	27.6	26.0	23.3	-10.4 %
RB51	Outside 17 Wolverton Gardens, Horley	30.4	28.7	26.2	-8.7 %
RB52	Outside 20 Wolverton Gardens, Horley	31.7	30.0	27.9	-7.0 %
RB53	Outside 66/68 Cheyne Walk, Horley	32.2	30.7	29.1	-5.2 %
RB54	Outside 7/9 Crescent Way, Horley	32.7	31.1	29.7	-4.4 %
RB55	Outside 40a Crescent Way, Horley	34.5	33.0	32.3	-1.8 %
RB56	Outside 8/10 The Crescent, Horley	36.1	34.7	34.8	+0.4 %
RB57	Outside 29/31 The Crescent, Horley	37.7	36.3	37.0	+2.0 %
RB58	Outside 39/ 41 The Crescent, Horley	38.9	37.5	38.6	+2.7 %
RB59	Outside 92/94 The Crescent, Horley	42.4	**41.0**	**42.1**	+2.7 %
RB60	Outside 120/122 The Crescent, Horley	37.8	36.4	37.0	+1.8 %
RB61	Outside 79/81 The Crescent, Horley	36.0	34.6	34.9	+0.8 %
RB64	Outside 16/22 The Drive, Horley	29.5	28.0	26.1	-6.8 %
RB65	Outside 4/6 The Drive, Horley	29.0	27.5	25.4	-7.6 %
RB66	Outside 3a/3b Fairfield Avenue, Horley	29.9	28.4	26.6	-6.3 %
RB67	Outside 30/32 Fairfield Avenue, Horley	31.2	29.7	28.4	-4.4 %
RB68	Outside 57 Fairfield Avenue, Horley	32.4	31.0	30.1	-2.8 %
RB69	Outside 61 Upfield, Horley	33.4	31.9	31.1	-2.3 %
RB70	Outside 58/60 Upfield, Horley	31.2	29.7	28.4	-4.6 %
RB72	Outside 25/27 Upfield, Horley	29.7	28.1	26.2	-7.0 %
RB73	Outside 9/11 Upfield, Horley	29.1	27.5	25.3	-8.0 %
RB74	On Green, 30a/30b Meadowcroft Close, Horley	34.8	33.2	32.2	-3.0 %
RB75	On Roundabout, The Coronet, Horley	35.3	33.3	30.9	-7.3 %
RB76	33 Limes Avenue, Horley	30.4	28.8	26.8	-6.8 %
RB77	Layby at Entrance to Staffords Place, Horley	29.4	27.9	25.8	-7.3 %
RG1	Horley Air Monitoring Station	32.2	30.7	29.5	-4.1 %
RG2	Outside 74 The Crescent Horley (BAA Site)	40.2	38.8	**40.1**	+3.5 %
ER1	Brighton Road, Near The Ave	37.5	34.8	27.8	-20.3 %
ER2	Brighton Road, opp. jcn. with Massetts Road	36.4	33.9	27.5	-18.7 %
ER3	Longbridge Road	36.9	34.7	30.3	-12.7 %
ER4	SW end of Cheyne Walk	39.4	37.3	33.8	-9.5 %
ER5	SW end of Woodroyd Gardens	38.9	37.0	34.3	-7.2 %
	2005 UK Government objective	*-*	*40.0*	*40.0*	-
	2010 EU Limit Value	*-*	*-*	*40.0*	-

[*a] 2002/3 are measured data, 2005 and 2010 are modelled values which have had a correction of (1.176 x modelled NO_2 – 5.606) applied, based on the results of the 2002/3 model comparison to the measured data. Whether this correction will still be appropriate in 2010 is open to question, but for comparison purposes it has been used above - unadjusted figures from the model are shown in appendix A1.

[*b] % changes calculated from un-rounded values using (2010-2002/3) ÷ 2002/3.

Table 3.1: Comparison of 2002/3 and predicted 2005 and 2010 annual average NO_2 concentrations at selected points within the Horley air quality management area (AQMA). All values μg m^{-3} unless stated otherwise.

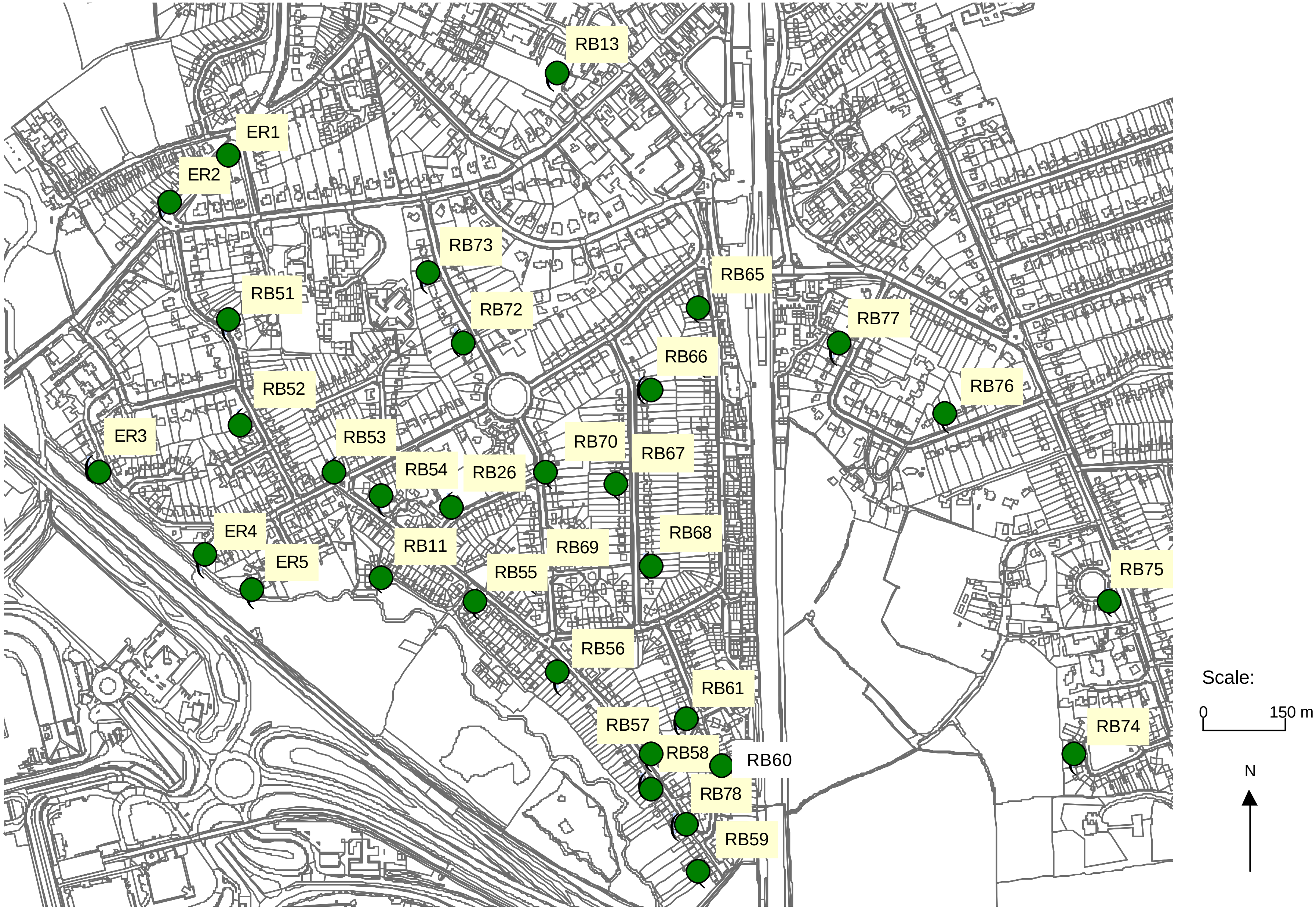

Figure 3.1: Location of Receptor Points used in Modelling and for Source Apportionment.

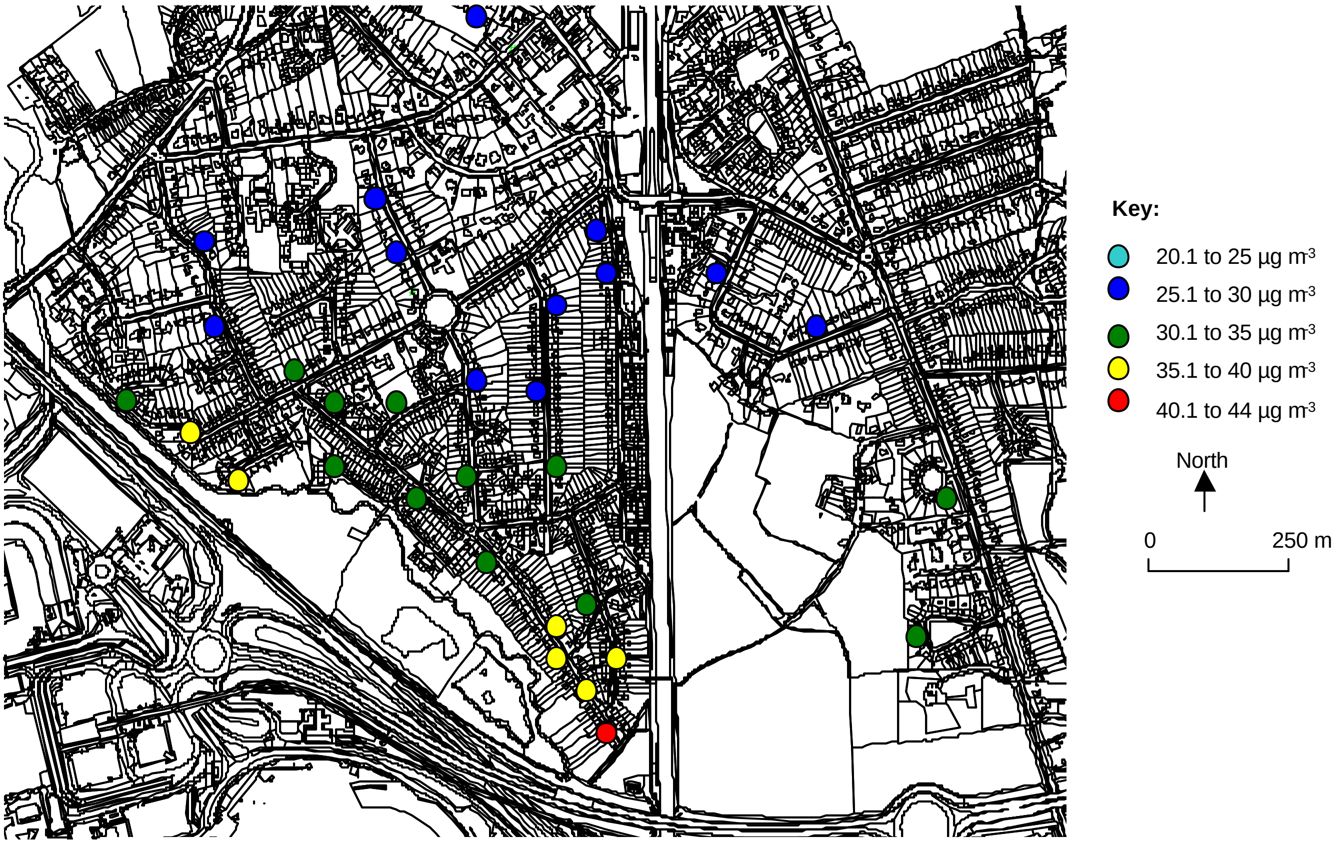

Figure 3.2: 2005 Annual Average NO_2 Concentrations in Horley near to Gatwick Airport.
Values based on dispersion modelling. For full methodology see AQC, 2004.

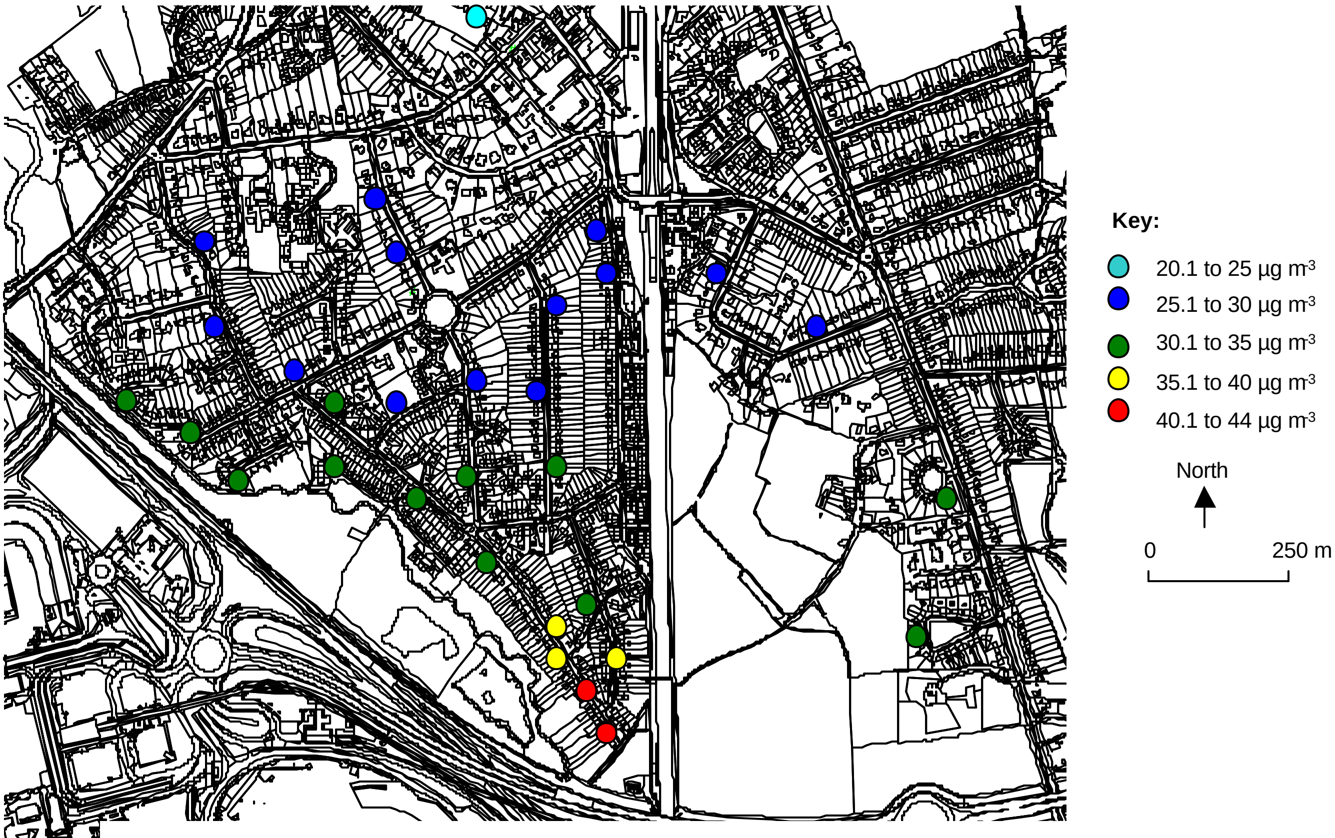

Figure 3.3: 2010 Annual Average NO_2 Concentrations in Horley near to Gatwick Airport.
Values based on scaled 2002/3 dispersion modelling and 2010 Emissions Inventory. For full methodology see NETCEN, 2004d).

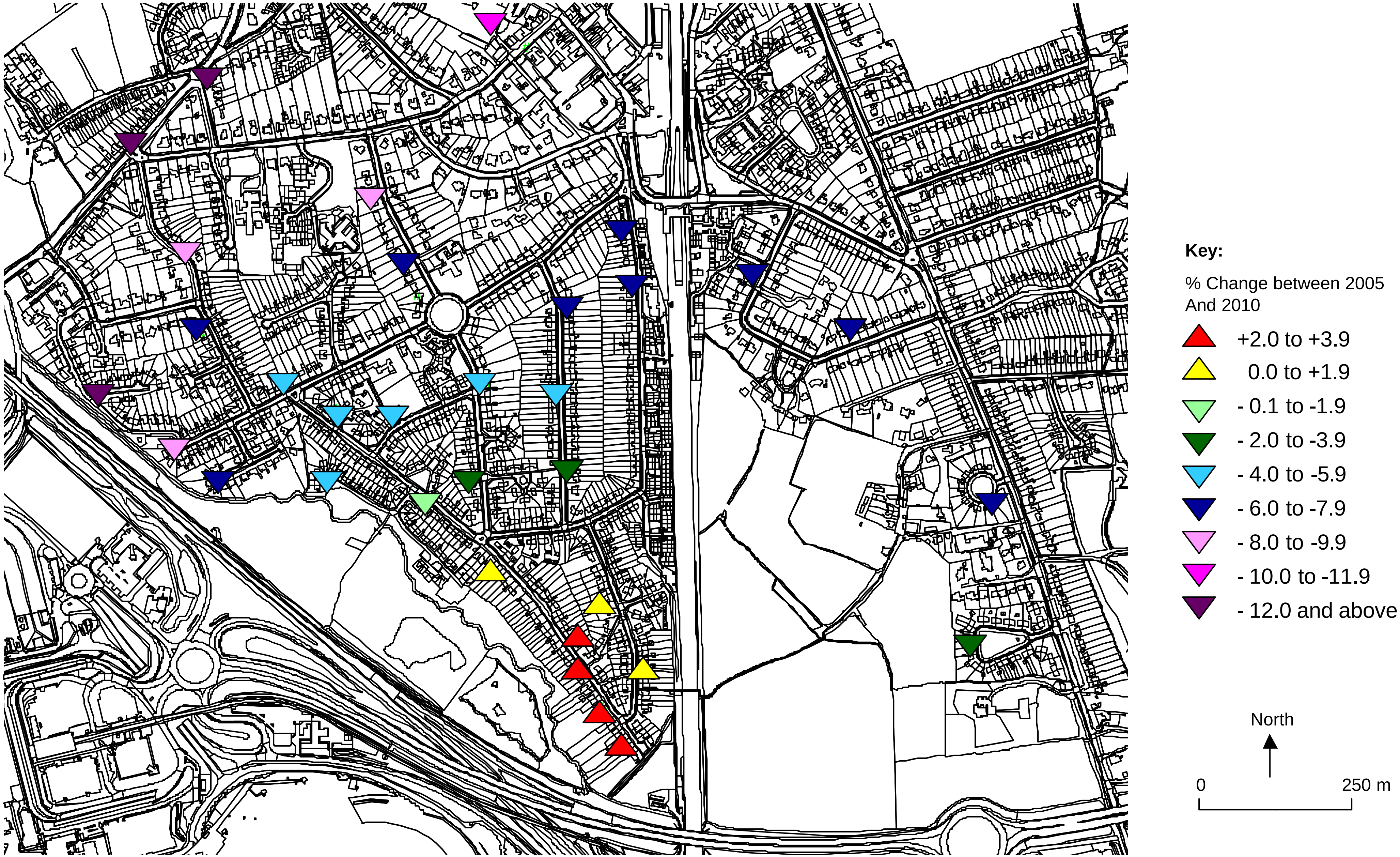

Figure 3.4: % Change (2005 and 2010) in Annual Average NO_2 Concentrations in Horley near to Gatwick Airport.

Values based on dispersion modelling. For full methodology see AQC, 2004, NETCEN 2004d. © Crown Copyright. All rights reserved. Reigate & Banstead BC LA079065 – 2003.

3.2 Source Apportionment

3.6 For the purposes of the 2010 source apportionment work, the NO_x emissions have been grouped into six main sources as per the original 2005 assessment (AQC, 2004).

a) Background: All sources not included explicitly in the dispersion model; including non specific local sources and long range transport (e.g. from London).

b) Non airport road vehicles: Emissions from any road vehicle making a journey that is not related to Gatwick Airport on the specified road network.

c) Airport related road vehicles: Emissions from any road vehicle making a journey that is related to Gatwick Airport on the specified road network.

d) Aircraft: Emissions from aircraft during landing and taking off.

e) APUs: Emissions from Auxiliary Power Units. Used to power the aircraft's air conditioning system on the ground, and generate electricity once the aircraft is disconnected from the fixed electrical supply on the ground.

f) Airside vehicles: Emissions from land bound non road vehicles operating within the airport.

g) Misc. Airport: Emissions from within the airport that have been explicitly included in the dispersion model, but not listed above e.g. boiler plant.

3.7 In this section where reference is made to airport related emissions this is the sum of categories c+d+e+f+g, while non airport emissions are the sum of categories a+b.

3.8 When airport related NO_x concentrations in 2005 and 2010 are plotted up onto the Horley AQMA map (Figure 3.5), it is very apparent that residents exposure to NO_x generated by the airport and its related activities has gone up, while the background and non airport related road traffic NO_x concentration has decreased across the entire AQMA (Figure 3.6).

Figure 3.5: Airport Related NO_x Concentrations (µg m^{-3}) in 2005 and 2010.

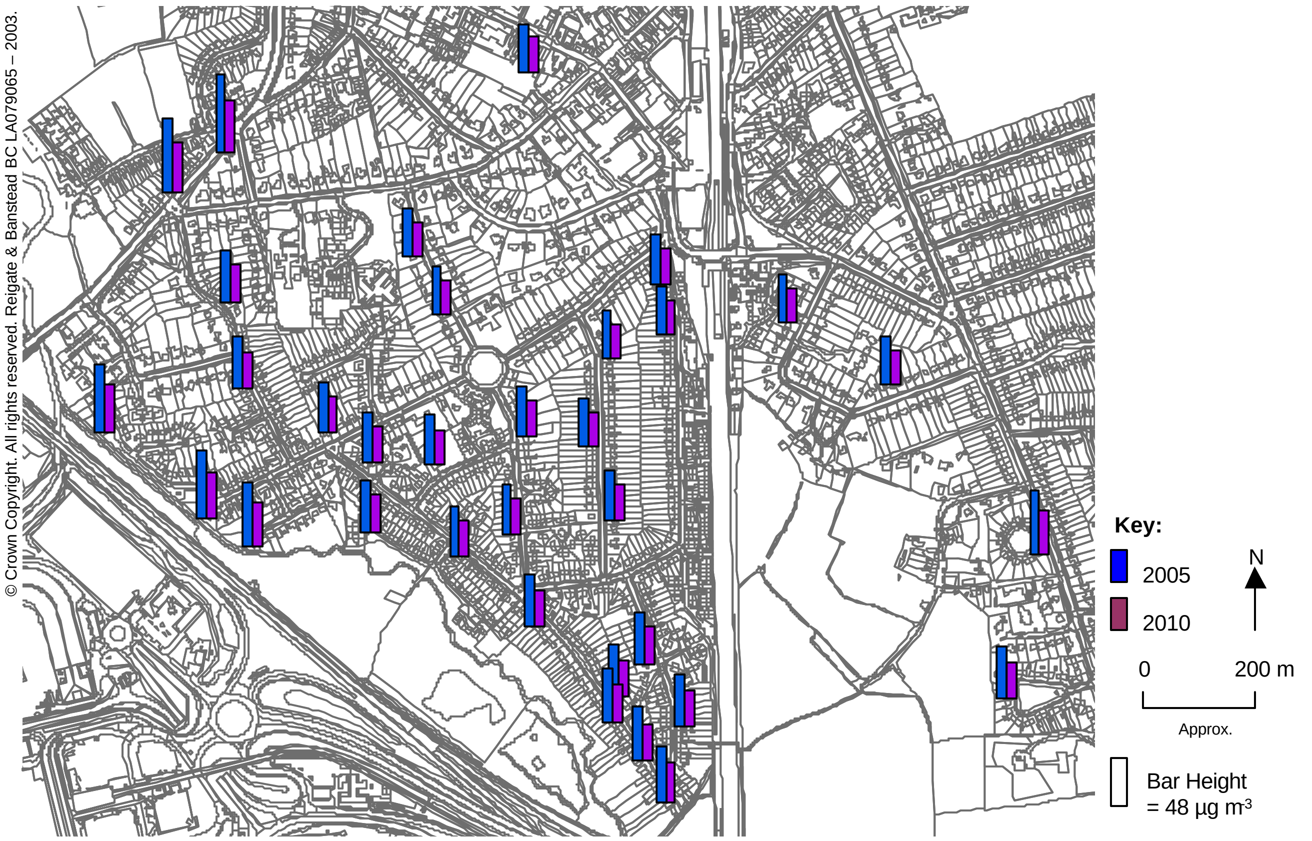

Figure 3.6: Non Airport Related NO_x Concentrations (µg m^{-3}) in 2005 and 2010.

3.9 When the proportion of airport and non airport related NO_x in these areas is examined in 2005 and 2010 (Figures 3.7 and 3.8), the NO_x pollution from the airport makes up an increasing proportion of the residents overall NO_x exposure in 2010, which would be expected given the rising airport emissions and declining background and non airport road emissions seen in Figures 3.5 and 3.6.

3.10 Given the changes in the NO_2 concentrations (Figure 3.4) this indicates that the falls in the non airport traffic and background NO_x emissions have more than offset the increasing emissions from the airport, with an overall fall in NO_x and thus NO_2 concentrations between 2005 and 2010 for areas of the AQMA *furthest* from the airport.

3.11 However, for properties close to the airport where NO_2 concentrations have gone up e.g. RB57, 58, 59, 60, and 78, the airport related NO_x emissions have more than offset the falls in background and non airport related road traffic emissions, and added to the pollution in the area.

3.12 At sites RB57 to 60, and RB78 i.e. areas where the NO_2 concentration has increased between 2005 and 2010 (Figure 3.4), the airport is predicted to be responsible for a minimum of 50 % of the residents NO_x exposure, compared to 30 to 45 % in 2005. At the worst case site (RB59) where the NO_2 concentration is predicted to breach the EU limit value, the airport contribution to the NO_x concentration has risen from 45 % in 2005 to 58 % in 2010.

3.13 If the airport and non airport sources of NO_x at RB59 are examined in greater detail (Figure 3.9a, 3.9b), it is apparent that the majority of the increase in the NO_x related airport emissions between 2005 and 2010 is due to the aircraft themselves, including a small increase from APUs.

3.14 This increase in the emissions from the aircraft, as opposed to the other emission sources associated with the airport, is also apparent if the actual tonnes of NO_x emitted per year by the airport is examined (Table 3.2).

Figure 3.7: Source Apportionment of NO_x Concentrations in 2005.

Figure 3.8: Source Apportionment of NO_x Concentrations in 2010.

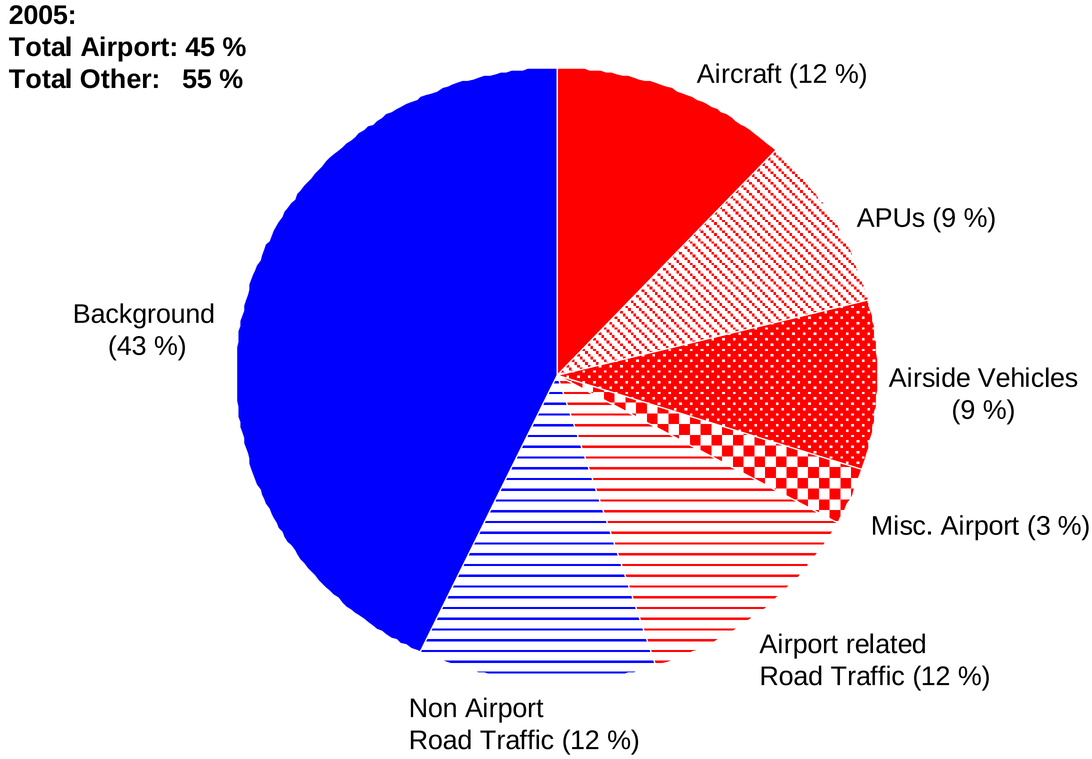

Figure 3.9a: NO_x Contribution by Source to RB59 in 2005 (NO_2 Concentration: 41 µg/m^3).

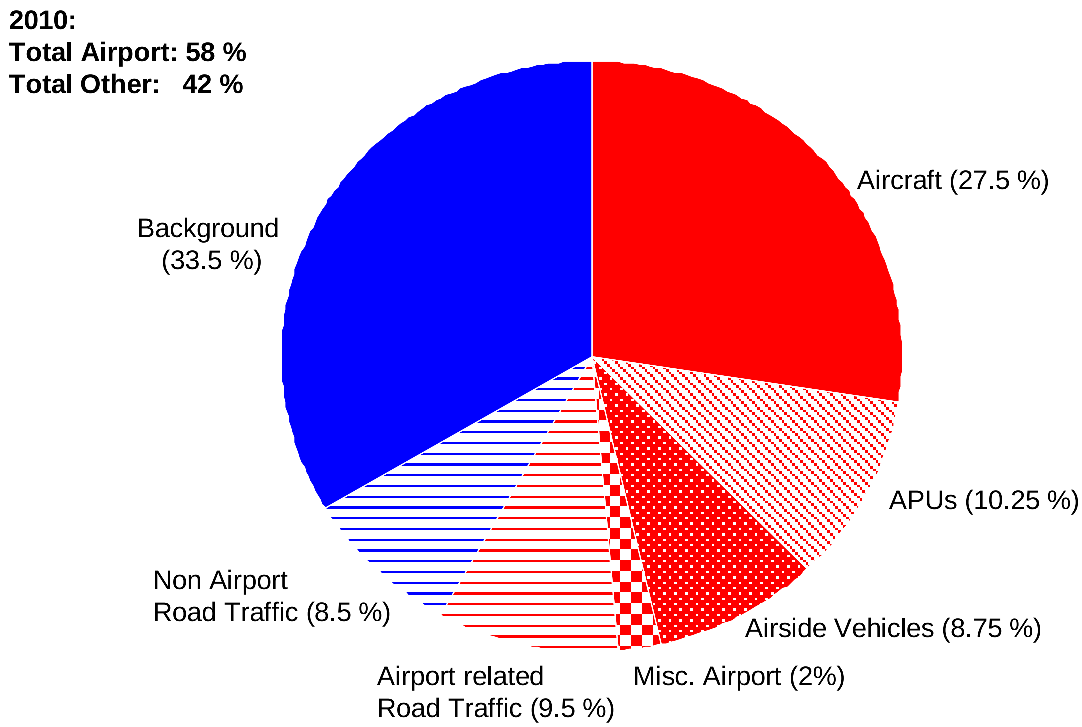

Figure 3.9b: NO_x Contribution by Source to RB59 in 2010 (NO_2 Concentration: 42 µg/m^3).

Source	Annual Emissions (tonnes / year)		% Change
	2002/3	2010	2002/3 to 2010[*a]
Aircraft:	1589.79	2456.69	+55 %
- Ground level	587.69	871.30	+48 %
- Elevated	1002.11	1585.39	+58 %
Airside vehicles / Plant	114.31	128.97	+13 %
Landside Road Vehicles:	199.31	144.36	-28 %
- Road Network	184.71	134.97	-27 %
- Car Parks, Taxis	14.60	9.39	-36 %
Heating Plant	21.23	23.46	+10 %
Total Airport Related	1924.84	2753.88	+43 %
Road Network: Non Airport	646.32	398.29	-38 %
[*a] (2010-2002/3) ÷ 2002/3			

Table 3.2: Comparison of predicted 2002/3 and 2010 annual NO_x emissions for Gatwick Airport, and selected major routes on the surrounding road network (NETCEN, 2004c).

3.15 It is important to note here that Table 3.2 compares 2002/3 with 2010, as a detailed emissions inventory for 2005 was not produced for Gatwick[1]. Nevertheless, this demonstrates that there is likely to be a large increase in the amount of NO_x emitted by aircraft at the airport, 55 % between 2002/3 and 2010, compared to more modest increases in the airside vehicles (+13 %) and heating plant (+10 %) as the airport grows.

3.16 Table 3.2 also demonstrates that despite the fall in road traffic emissions due to improved vehicle technology, the emissions from airport related road vehicles decreases (-27 %) to lesser extent than non airport related road traffic (-38 %), reflecting in part the fact that the amount of airport related road traffic is growing at a faster rate than the non airport related road traffic on the road network.

3.17 Based on Table 3.2 the amount of ground level[2] aircraft derived NO_x per passenger is predicted to increase between 2002/3 and 2010, from 20 g per passenger in 2002/3 to 23 g in 2010 (Table 3.3).

[1] Data for 2005 in this report was based on a scaling of the 2002/3 emissions inventory (see AQC (2004) for full details).

[2] Ground level NO_x has a bigger impact on NO_2 concentrations on the ground than elevated emissions (see p.234 AQEG (2004)). Nevertheless, the trend is the same if elevated emissions are also included.

	2002/3	2010	% Change (2010-2002/3) / 2002/3
Ground Level NO_x [*a]	587.69	871.3	+ 48 %
Passengers (mppa)	29.9	38.2	+ 28 %
Aircraft Movements	244 989	280 414	+ 14 %
Ground Level Aircraft NO_x per passenger (g)	20	23	+ 16 % [*b]
Passengers per aircraft movement	122	136	+ 11 %
Ground Level NO_x per aircraft movement (Kg)	2.4	3.1	+ 30 %
[*a] ground level NO_x has the biggest influence on ground level NO_2 concentrations (see p. 234 AQEG (2004)). [*b] based on unrounded figures.			

Table 3.3: Changes in NO_x production per passenger and per aircraft movement between 2002/3 and 2010.

3.18 This increase in the amount of NO_x generated per person as the passenger numbers increase is typical of airport growth, as airports / airlines increase passenger throughput by increasing the size of the aircraft operating out of the airport (Underwood, 2004). Thus in this respect Gatwick is no different, with aircraft movements up by 14 % and yet passenger numbers are up by 28 %, while the amount of aircraft generated ground level NO_x produced per annum is up 48 % reflecting in part the use of larger aircraft.

3.19 Therefore, any increase in passenger numbers beyond 2010 is likely to lead to a disproportionate increase in the immediate future (e.g. to 2020) in the amount of aircraft derived NO_x emitted by the airport compared to the increase in passenger numbers.

3.20 As aircraft derived NO_x is predicted to be such a large (Figure 3.9b) and growing component of airport NO_x emissions in 2010 and beyond, any action plan to reduce NO_2 concentrations within the AQMA will therefore need to examine measures for reducing the aircraft derived NO_x component.

3.3 Beyond 2010

3.21 In the absence of a detailed emissions inventory it is not possible to examine in any detail NO_x / NO_2 concentrations within the AQMA beyond 2010, and ultimately such an inventory would have a considerable degree of uncertainty associated with any of the predictions. However, for the purposes of action planning the following trends in NO_x / NO_2 concentrations do need to be borne in mind.

3.3.1 Aircraft Emissions

3.22 There is no reason to suspect that overall NO_x emissions from aircraft will fall in the near future (2010 to 2020) in a 'do nothing' scenario, given the projected increases in air transport in the Government's white paper on aviation, and based on growth at Gatwick to date and projected growth to 2010.

3.23 Technological improvements in aircraft engines aimed at reducing the NO_x output are in development. However, given the time it would take for these engines to penetrate the existing aircraft fleet (due to the operational life span of aircraft and as several of the charter operators out of Gatwick lease aircraft for 10 year periods), it remains to be seen whether such engines will lead to a reduction in overall aircraft NO_x emissions in the near future i.e. before 2020.

3.3.2 Background NO_x / NO_2 Concentrations

3.24 There has been a downward trend in background concentrations of NO_2 across the UK over the years, and this has been primarily due to improvements in road traffic emissions as these are a significant component of the background NO_2 concentrations.

3.25 Within the Horley AQMA the declining background NO_x / NO_2 concentrations have offset either entirely, or to a large extent, the increasing emissions from the airport, resulting in the overall NO_x / NO_2 exposure remaining relatively unchanged at properties closest to the airport e.g. between 2005 and 2010 (Figure 3.9).

3.26 However, the general trend in the background concentrations is towards much smaller year on year falls in concentrations beyond 2010, reaching a period of stability by around 2015 as demonstrated by a background site within Reigate and Banstead (Figure 3.10). Therefore, the growth in airport derived NO_x / NO_2 will be offset to a much smaller extent by falls in the background concentration beyond 2010. Consequently the impact of any rise in NO_x emissions from Gatwick will increasingly lead to a proportionate increase in the *overall* NO_2 concentrations within the Horley AQMA - a relationship that has not existed before 2010.

3.3.3 Road Traffic Emissions

3.27 The improvements in road vehicle emissions not only have an impact on the background NO_2 concentrations but also invariably mean that there are continual reductions in the NO_2 concentrations on the explicitly modelled roads around the airport. The impact of these improved emissions is very apparent between 2002/3 and 2010 despite 'business as usual' increases in traffic volume, with a predicted 38 % fall in non airport related road traffic emissions of NO_x, and a 28 % fall in airport related road traffic emissions (Table 3.2).

3.28 These improvements in vehicle emissions are predicted to continue beyond 2010, but the year on year rate on improvement declines as the technological improvements in vehicle emissions are off set by traffic growth. Thus by around 2015 the road traffic contribution to pollution within the Horley AQMA is likely to stabilise (Figure 3.11), and so no longer make a contribution to off setting any further increases in aircraft emissions.

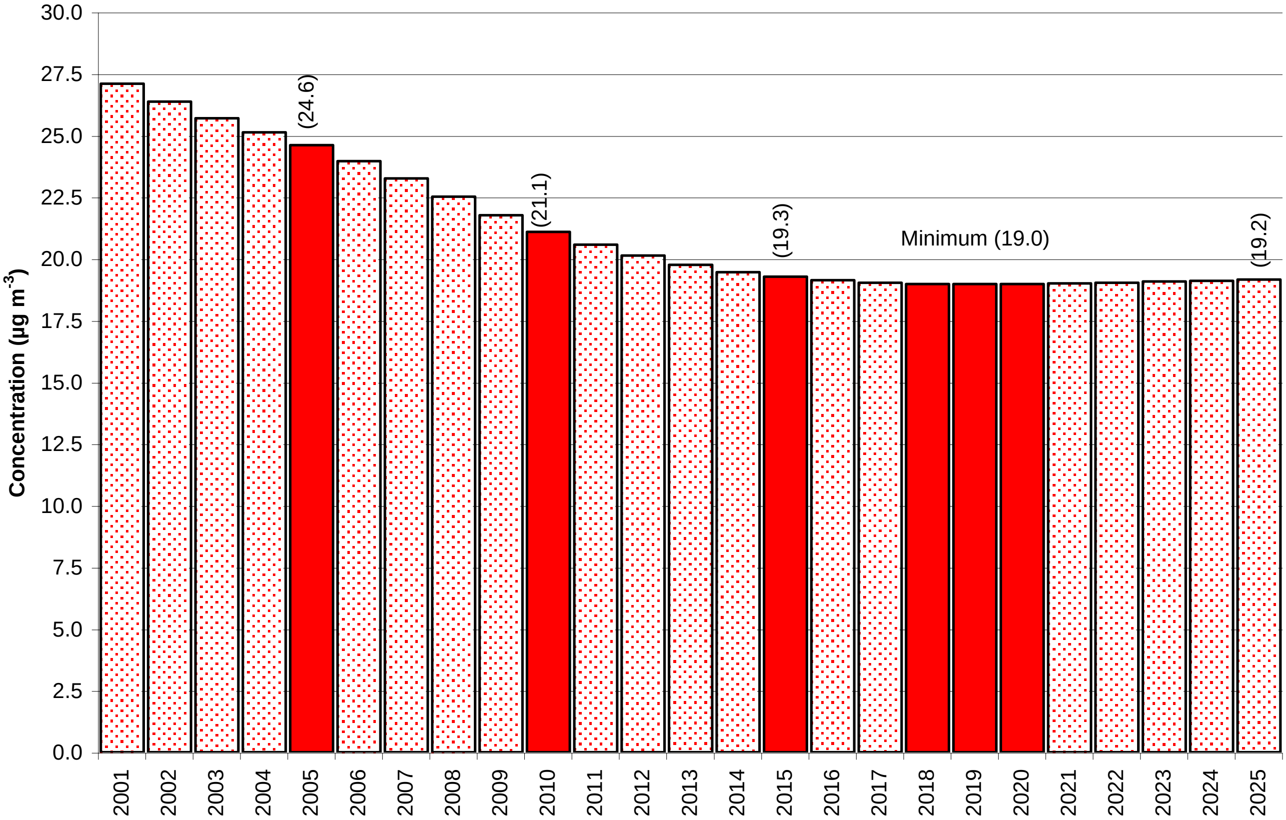

Figure 3.10: Background NO_2 Concentrations 2001 - 2025 (Grid Ref: 528500, 157500: NAEI, 2005)

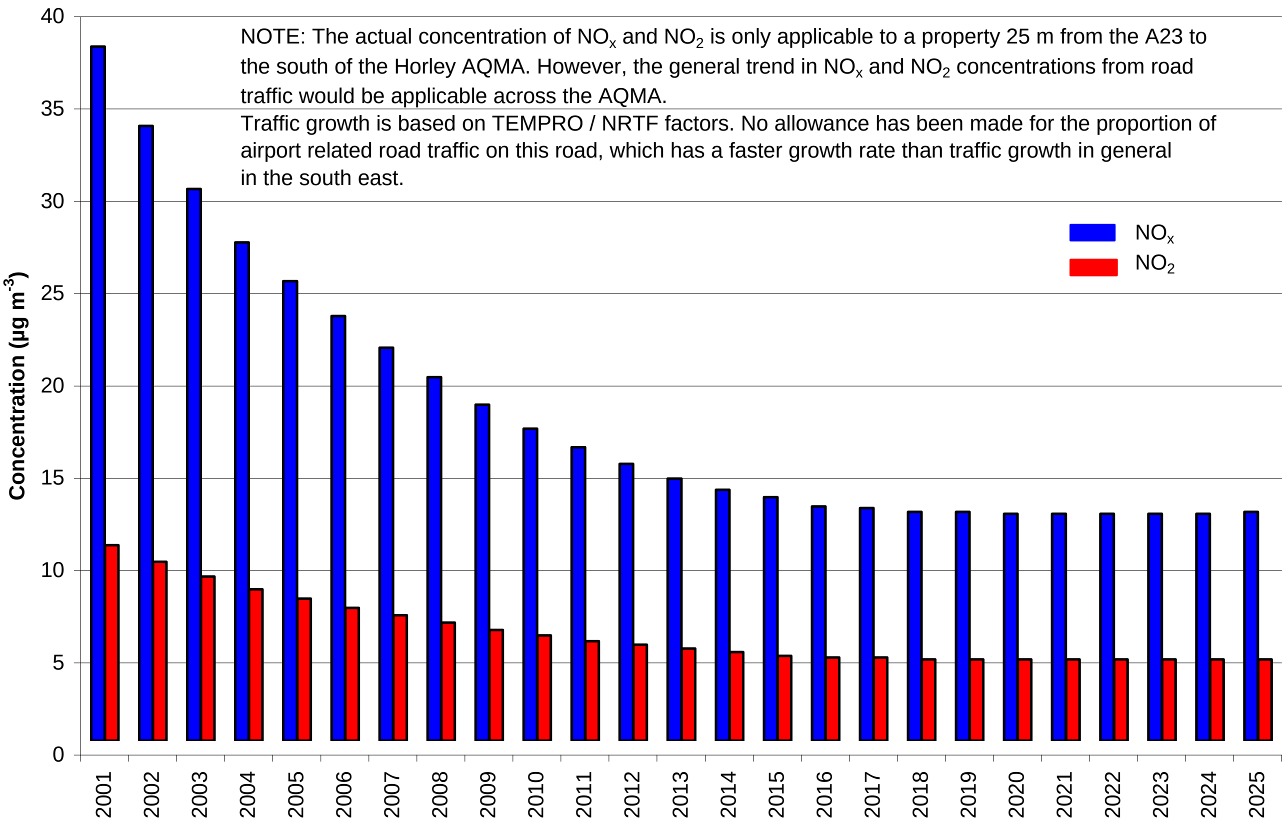

Figure 3.11: Annual Average NO_x and NO_2 Concentrations 25 m from A23
(within grid 528 000, 141 910) due to Traffic EXCLUDES Background Concentrations

3.3.4 Other Factors

3.3.4.1 Ozone

3.29 Combustion sources such as diesel road vehicles, gas cookers, gas central heating, and aircraft engines mainly emit nitrogen monoxide (NO) into the atmosphere, and it is only then that this is converted into nitrogen dioxide (NO_2) - the pollutant under consideration in this report. The reaction that 'converts' NO into NO_2 involves ozone (O_3). Here:

$$NO + O_3 \rightarrow NO_2 + O_2 \qquad \text{Equation 3.1 (from Colls, 1997)}$$

3.30 Thus ozone is an important component in the production of NO_2, and in general in the UK ozone concentrations are increasing by around 0.96 µg m^{-3} per year based on measurements at Mace Head (AQEG, 2004), with no indications that these increases will not continue into the future.

3.31 Therefore ozone concentrations are likely to be around 10 µg m^{-3} higher in 2015 than in 2005, and work by Clapp and Jenkin (2001) suggests that such a rise would need to be matched by a fall of 12 to 22 µg m^{-3} in the NO_x concentration just for the NO_2 concentration to remain unchanged at 40 µg m^{-3}. Other modelling studies that have examined the impact of rising ozone concentrations on London, suggest that an increase in ozone concentrations of 12 µg m^{-3} could lead to an increase in NO_2 concentrations of between 4 and 7 µg m^{-3} (AQEG, 2004).

3.32 The nature of the pollution 'climate' in London means that the impact of rising ozone concentrations on NO_2 concentrations is likely to be higher than in the vicinity of Gatwick Airport. Nevertheless, the impact of rising ozone concentrations in the future will certainly *not* help to reduce NO_2 concentrations within the Horley AQMA.

3.3.4.2 Diesel Emissions

3.33 The national emissions factors used to calculate the road traffic emissions, and to a lesser extent the background concentrations, make certain assumptions about the UK vehicle fleet mix over the coming years, which includes the proportion of diesel engined cars on the road.

3.34 Diesel engines emit more NO_x / NO_2 than an equivalent petrol engine equipped with a catalytic converter. However, UK Government tax policy is causing a significant shift towards diesel vehicles, and so the background and road traffic emissions may be a slight underestimate of the 'true' NO_x / NO_2 concentrations from these sources in the future.

3.35 The impact of these increased NO_x / NO_2 emissions on the Horley AQMA is unlikely to be that significant in terms of measured concentrations from these sources. However, it does mean that the rate of decline in the background and road traffic sourced NO_2 concentrations may 'level out' sooner than would otherwise be predicted.

4.0 Summary and Conclusions

4.1 The 2010 model of nitrogen dioxide (NO_2) concentrations within the Horley AQMA demonstrates that the annual average NO_2 concentrations at residences closest to the airport in the south of the AQMA will be over 40 µg m^{-3} in 2010, if no remedial action is taken by BAA Gatwick. Therefore the decision to retain the AQMA based on modelling of the NO_2 concentrations in 2005 remains unchanged. If no remedial action is taken by 2010 then the properties closest to the airport will breach the 2010 EU annual average limit value for NO_2, and will have breached the UK annual average objective for NO_2 for five years.

4.2 Nitrogen dioxide concentrations within the AQMA at points *furthest* from the airport are predicted to fall by up to 10 to 12 % between 2005 and 2010, despite increasing emissions from the airport. This occurs due to improvements in road traffic emissions leading to falls in the explicitly modelled road traffic and in the general background NO_2 concentrations, which more than off set the increasing airport emissions.

4.3 However, the concentration of NO_2 at properties closest to the airport is likely to rise by up to 2.8 % over the same period, as emissions from the airport at these sites more than offsets the improvements in emissions from background and road traffic sources.

4.4 At the 'worst case' receptor within the AQMA the concentration of NO_2 is predicted to rise from 41 µg m^{-3} in 2005 to 42 µg m^{-3} in 2010. However, the proportion of this pollution due to the airport rises from 45 % in 2005 to 58 % in 2010, with the contribution from aircraft (excluding APUs) rising from 12 % in 2005 to 27.5 % by 2010. Thus the main and fastest growing source of pollution are the actual aircraft.

4.5 A comparison of the 2002/3 and 2010 emissions inventory indicates that the amount of aircraft derived NO_x pollution per passenger at Gatwick is increasing, in line with trends seen at other major airports around the UK.

4.6 An analysis of the trends in background NO_2 concentrations and road traffic emissions beyond 2010 indicates that these sources of NO_2 pollution will continue to decline beyond 2010, but at a slower rate than between 2005 and 2010 and are likely to cease falling after 2015. Therefore if the emissions from Gatwick continue to increase beyond 2010 the concentrations of NO_2 within the Horley AQMA are likely to rise at a faster rate than between 2005 and 2010, as the increases in emissions from the airport are off set to a lesser extent by the improvements in the non airport emission sources.

4.7 As the potential for improvement in non airport sources of NO_2 pollution declines beyond 2010, the amount of NO_x produced per aircraft passenger is increasing, a breach of the EU limit value is predicted, and as Gatwick is permitted to expand to handle 46 million passengers per annum (the 2010 scenario considers 38 million passenger per annum), the Horley AQMA is to be retained and the spatial extent of the AQMA remain unchanged.

Appendix A.

2002/3, 2005, 2010, and uncorrected 2010 NO_2 Concentrations.

Site code	Site Description	2002/2003	2005	2010* unadjusted	2010	Change 2005-2010
RB11	Outside 38, Riverside, Horley	34.6	33.0	32.0	32.0	-3.1 %
RB13	Public Car Park, off Massetts Road, Horley	27.6	26.0	24.6	23.3	-10.4 %
RB51	Outside 17 Wolverton Gardens, Horley	30.4	28.7	27.0	26.2	-8.7 %
RB52	Outside 20 Wolverton Gardens, Horley	31.7	30.0	28.5	27.9	-7.0 %
RB53	Outside 66/68 Cheyne Walk, Horley	32.2	30.7	29.5	29.1	-5.2 %
RB54	Outside 7/9 Crescent Way, Horley	32.7	31.1	30.1	29.7	-4.4 %
RB55	Outside 40a Crescent Way, Horley	34.5	33.0	32.3	32.3	-1.8 %
RB56	Outside 8/10 The Crescent, Horley	36.1	34.7	34.4	34.8	+0.4 %
RB57	Outside 29/31 The Crescent, Horley	37.7	36.3	36.3	37.0	+2.0 %
RB58	Outside 39/41 The Crescent, Horley	38.9	37.5	37.6	38.6	+2.7 %
RB59	Outside 92/94 The Crescent, Horley	42.4	**41.0**	**40.6**	**42.1**	+2.7 %
RB60	Outside 120/122 The Crescent, Horley	37.8	36.4	36.2	37.0	+1.8 %
RB61	Outside 79/81 The Crescent, Horley	36.0	34.6	34.2	34.9	+0.8 %
RB64	Outside 16/22 The Drive, Horley	29.5	28.0	27.0	26.1	-6.8 %
RB65	Outside 4/6 The Drive, Horley	29.0	27.5	26.4	25.4	-7.6 %
RB66	Outside 3a/3b Fairfield Avenue, Horley	29.9	28.4	27.4	26.6	-6.3 %
RB67	Outside 30/32 Fairfield Avenue, Horley	31.2	29.7	29.0	28.4	-4.4 %
RB68	Outside 57 Fairfield Avenue, Horley	32.4	31.0	30.4	30.1	-2.8 %
RB69	Outside 61 Upfield, Horley	33.4	31.9	31.2	31.1	-2.3 %
RB70	Outside 58/60 Upfield, Horley	31.2	29.7	28.9	28.4	-4.6 %
RB72	Outside 25/27 Upfield, Horley	29.7	28.1	27.0	26.2	-7.0%
RB73	Outside 9/11 Upfield, Horley	29.1	27.5	26.3	25.3	-8.0 %
RB74	On Green, 30a/30b Meadowcroft Close, Horley	34.8	33.2	32.2	32.2	-3.0 %
RB75	On Roundabout, The Coronet, Horley	35.3	33.3	31.1	30.9	-7.3 %
RB76	33 Limes Avenue, Horley	30.4	28.8	27.6	26.8	-6.8 %
RB77	Layby at Entrance to Staffords Place, Horley	29.4	27.9	26.7	25.8	-7.3 %
RG1	Horley Air Monitoring Station	32.2	30.7	29.8	29.5	-4.1 %
RG2	Outside 74 The Crescent Horley (BAA Site)	40.2	38.8	37.4	**40.1**	+3.5 %
ER1	Brighton Road, Near The Ave	37.5	34.8	28.4	27.8	-20.3 %
ER2	Brighton Road, opp. jcn. with Massetts Road	36.4	33.9	28.2	27.5	-18.7 %
ER3	Longbridge Road	36.9	34.7	30.5	30.3	-12.7 %
ER4	SW end of Cheyne Walk	39.4	37.3	33.5	33.8	-9.5 %
ER5	SW end of Woodroyd Gardens	38.9	37.0	34.0	34.3	-7.2 %

*Unadjusted figures are model output. For comparison purposes to the 2002/3 and 2005 data use the 2010 column which has had a correction of 1.176 x modelled NO_2 – 5.606 applied.
% changes calculated from un-rounded values.

Note: The adjustment factor applied to the 2010 values is to ensure a consistency of approach, and does not mean that the adjusted data is any more accurate in terms of the 'actual' concentration that will be measured in 2010 than the unadjusted data, especially given the small correction to the data and the uncertainty associated with the predictions for the future fleet mix, passenger numbers etc.

Appendix B.

NETCEN Modelling Results (Unadjusted).

NO_x concentrations in µg m^{-3}			Airport											Non-airport					NO_2 (µg m^{-3})
Site	X	Y	Runway 08 ground	Runway 08 elevated	Runway 26 ground	Runway 26 elevated	APUs	Airside vehicles	Engine testing	Car parks etc	Fire training ground	Boiler houses	Airport-related roads	Non-airport roads	Back-ground	Total airport-related	Total non-airport	Total	Total
ER1	527865	142850	1.58	0.04	3.11	0.49	1.58	1.17	0.03	0.09	0.00	0.26	6.81	19.35	27.82	**15.15**	**47.17**	**62.31**	**28.38**
ER2	527777	142786	1.67	0.05	3.05	0.49	1.67	1.24	0.03	0.10	0.00	0.29	6.01	17.06	27.81	**14.59**	**44.86**	**59.45**	**28.18**
ER3	527666	142392	3.34	0.06	3.82	0.61	3.34	2.47	0.04	0.34	0.00	0.81	5.89	14.05	27.84	**20.72**	**41.89**	**62.62**	**30.54**
ER4	527834	142249	4.60	0.05	5.45	0.70	4.60	3.48	0.05	0.78	0.00	2.14	6.97	13.88	27.94	**28.81**	**41.82**	**70.64**	**33.50**
ER5	527910	142202	4.96	0.05	6.22	0.75	4.96	3.79	0.06	0.56	0.00	2.34	6.59	11.94	27.97	**30.28**	**39.92**	**70.19**	**33.94**
RB11	528104	142226	4.61	0.04	6.86	0.78	4.61	3.57	0.06	0.33	0.00	1.27	3.97	5.50	28.02	**26.09**	**33.52**	**59.61**	**31.95**
RB12	528424	142934	1.55	0.03	3.39	0.53	1.55	1.17	0.03	0.09	0.00	0.30	1.22	2.88	27.92	**9.84**	**30.80**	**40.64**	**24.76**
RB13	528362	142983	1.46	0.03	3.24	0.51	1.46	1.10	0.03	0.08	0.00	0.27	1.19	2.93	27.89	**9.37**	**30.82**	**40.19**	**24.57**
RB26	528208	142337	3.71	0.04	6.17	0.74	3.71	2.86	0.05	0.24	0.00	0.91	2.79	4.06	28.01	**21.21**	**32.07**	**53.27**	**29.83**
RB51	527873	142606	2.33	0.05	3.87	0.56	2.33	1.73	0.03	0.15	0.00	0.46	2.15	4.70	27.85	**13.67**	**32.55**	**46.21**	**27.02**
RB52	527892	142463	3.04	0.05	4.54	0.62	3.04	2.27	0.04	0.25	0.00	0.77	2.67	5.01	27.88	**17.29**	**32.89**	**50.18**	**28.50**
RB53	528033	142390	3.48	0.04	5.43	0.68	3.48	2.64	0.05	0.28	0.00	1.05	2.78	4.53	27.94	**19.91**	**32.48**	**52.39**	**29.49**
RB54	528107	142341	3.75	0.04	5.95	0.71	3.75	2.88	0.05	0.27	0.00	1.08	2.94	4.45	27.98	**21.44**	**32.43**	**53.87**	**30.06**
RB55	528250	142186	4.86	0.04	7.54	0.83	4.86	3.80	0.06	0.28	0.00	0.88	3.82	4.80	28.07	**26.95**	**32.86**	**59.81**	**32.27**
RB56	528372	142072	6.10	0.03	8.92	0.91	6.10	4.83	0.07	0.27	0.00	0.65	4.39	5.06	28.13	**32.27**	**33.19**	**65.46**	**34.37**
RB57	528510	141956	7.06	0.03	10.50	0.97	7.06	5.77	0.08	0.27	0.00	0.56	4.93	5.29	28.19	**37.24**	**33.48**	**70.72**	**36.26**
RB58	528501	141914	7.72	0.03	11.23	1.00	7.72	6.39	0.08	0.29	0.00	0.57	5.57	5.82	28.21	**40.61**	**34.03**	**74.64**	**37.56**
RB59	528589	141783	8.61	0.02	13.39	1.06	8.61	7.38	0.09	1.02	0.00	0.61	7.97	7.00	28.21	**48.78**	**35.21**	**83.99**	**40.59**
RB60	528620	141907	6.84	0.02	10.97	0.99	6.84	5.69	0.08	0.33	0.00	0.55	5.09	5.13	28.16	**37.40**	**33.28**	**70.69**	**36.24**
RB61	528554	142011	6.12	0.03	9.58	0.94	6.12	4.96	0.07	0.25	0.00	0.54	4.17	4.65	28.16	**32.77**	**32.81**	**65.58**	**34.42**
RB64	528589	142552	2.50	0.03	4.89	0.68	2.50	1.92	0.04	0.15	0.00	0.46	1.75	3.13	27.98	**14.92**	**31.11**	**46.02**	**26.97**
RB65	528581	142635	2.23	0.03	4.49	0.65	2.23	1.71	0.04	0.13	0.00	0.42	1.59	3.04	27.96	**13.53**	**31.00**	**44.53**	**26.36**
RB66	528499	142512	2.68	0.03	5.12	0.69	2.68	2.06	0.05	0.16	0.00	0.51	1.88	3.18	28.03	**15.85**	**31.21**	**47.06**	**27.39**
RB67	528462	142366	3.37	0.03	6.05	0.75	3.37	2.61	0.05	0.19	0.00	0.59	2.35	3.47	28.06	**19.37**	**31.53**	**50.90**	**28.91**
RB68	528505	142246	4.10	0.03	6.99	0.81	4.10	3.20	0.06	0.21	0.00	0.57	2.80	3.74	28.11	**22.87**	**31.85**	**54.71**	**30.38**
RB69	528335	142224	4.44	0.03	7.22	0.81	4.44	3.46	0.06	0.25	0.00	0.74	3.25	4.19	28.08	**24.71**	**32.27**	**56.98**	**31.24**
RB70	528360	142384	3.34	0.03	5.92	0.73	3.34	2.58	0.05	0.20	0.00	0.68	2.38	3.55	28.03	**19.26**	**31.58**	**50.84**	**28.88**
RB71	528246	142527	2.73	0.03	4.99	0.65	2.73	2.08	0.04	0.17	0.00	0.64	1.97	3.39	27.96	**16.03**	**31.35**	**47.38**	**27.52**
RB72	528220	142583	2.52	0.03	4.67	0.63	2.52	1.91	0.04	0.16	0.00	0.58	1.82	3.33	27.94	**14.88**	**31.28**	**46.16**	**27.02**
RB73	528172	142679	2.19	0.04	4.18	0.58	2.19	1.65	0.04	0.13	0.00	0.47	1.64	3.31	27.91	**13.10**	**31.22**	**44.32**	**26.28**
RB74	529149	141953	3.79	0.01	9.69	0.88	3.79	3.07	0.07	0.25	0.00	0.47	4.32	5.14	27.90	**26.36**	**33.04**	**59.40**	**32.15**
RB75	529203	142192	3.07	0.01	7.33	0.79	3.07	2.46	0.06	0.17	0.00	0.35	2.52	10.95	27.78	**19.83**	**38.74**	**58.57**	**31.05**
RB76	528958	142468	2.62	0.02	5.32	0.71	2.62	2.05	0.05	0.14	0.00	0.34	1.79	4.11	27.81	**15.67**	**31.92**	**47.59**	**27.60**
RB77	528789	142570	2.38	0.02	4.75	0.68	2.38	1.84	0.04	0.13	0.00	0.38	1.65	3.33	27.87	**14.25**	**31.20**	**45.45**	**26.74**
RB78	528550	141853	8.17	0.03	12.22	1.03	8.17	6.91	0.09	0.47	0.00	0.58	4.33	4.14	28.21	**42.00**	**32.34**	**74.34**	**37.41**
CR1	529500	141460	2.39	0.00	10.88	1.02	2.39	2.00	0.07	0.50	0.00	0.70	1.75	3.37	27.95	**21.70**	**31.31**	**53.02**	**29.04**
CR2	526300	139860	0.99	1.69	1.38	0.19	0.99	0.80	0.12	1.56	0.00	0.12	1.37	3.26	27.78	**9.22**	**31.04**	**40.26**	**24.59**
CR3	527800	139980	1.76	0.05	5.59	1.25	1.76	1.41	0.10	0.09	0.00	0.21	1.40	3.27	29.51	**13.62**	**32.78**	**46.40**	**24.67**

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