Updating and Screening Assessment of Air Quality

in

The Borough of Reigate and Banstead

May 2003.

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

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Abbreviations and Definitions

AADT	Annual Average Daily Traffic Flow.
AQMA	Air Quality Management Area.
BAA	British Airports Authority (Gatwick).
CO	Carbon Monoxide.
DETR	Department of the Environment, Transport and the Regions.
DEFRA	Department of the Environment, Food and Rural Affairs (formerly DETR).
DMRB	Design Manual for Roads and Bridges.
EPAQS	Expert Panel on Air Quality Standards.
HGV	Heavy Goods Vehicle.
LGV	Light Goods Vehicle (for the DMRB model this includes cars).
m^3	cubic metre.
mg	milligram (1 thousandth of a gram).
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.
Pb	Lead.
PM	Particulate Matter.
PM_{10}	Essentially particles under 10 µm in diameter. Officially defined as the size fraction below 10µm in aerodynamic diameter, which has a cut off point at 50% of the particles which are 10µm in aerodynamic diameter.
ppb	part(s) per billion.
ppm	part(s) per million.
SO_2	Sulphur Dioxide.
TEA	Triethanolamine.
TEOM	Tapered Element Oscillating Microbalance. (Device for measuring PM_{10} concentrations in real time).
µg	microgram (1 millionth of a gram).
VOC	Volatile Organic Compound(s).
WHO	World Health Organisation.

Definition of Sampling Sites
(from DETR, 1998)

Urban Centre	A non kerbside site located in an area representative of typical population exposure in town or city centres (e.g. pedestrian precincts and shopping areas). This is likely to be strongly influenced by vehicle emissions, as well as other general urban sources of pollution. Sampling at or near breathing zone heights will be applicable.
Urban Background	An urban location distanced from sources and therefore broadly representative of city wide background conditions e.g. elevated locations, parks, and urban residential areas.
Urban Industrial	An area where industrial sources make an important contribution to the total pollution burden.
Suburban	A location type situated in a residential area on the outskirts of a town or city.
Rural	An open country location, in an area of low population density, distanced as far a possible from roads and polluted industrial areas.
Remote	A site in open country, located in an isolated rural area experiencing regional background pollutant levels for much of the time.
Special	A special source orientated category covering monitoring studies undertaken in relation to specific emission sources such as power stations, garages, car parks or airports.

Executive Summary

Part IV of the Environment Act 1995 requires local authorities to periodically review air quality in their area against current and future air quality objectives as set out in the Air Quality Strategy (2000), the Air Quality Regulations (England) 2000, the Air Quality (Amendment) Regulations 2002, and the Air Quality Strategy Addendum document (2003).

As part of these acts the council is required to complete an updating and screening assessment of air quality in the Borough against objective values for seven different pollutants by the end of May 2003. The aim of this process is to identify areas in the Borough where breaches of the objective values might occur, and once identified to proceed to a detailed assessment of these areas which is to be completed by 30th April 2004.

In Reigate and Banstead concentrations of the pollutants, carbon monoxide, benzene, 1,3 butadiene, lead, and sulphur dioxide, will meet and in most cases are considerably lower than the Governments objective values, and therefore a detailed assessment of these pollutants is **not** required.

For nitrogen dioxide four sites have been identified as in need of a detailed assessment. These are:

i) the property at the SE corner of the junction of Rushworth Road and the A217, which is predicted to breach the 2005 objective.

ii) the M25 air quality management area (AQMA) with a view to narrowing the extent of the AQMA.

iii) the M23 and individual properties on the A217 with a view to narrowing and / or revoking the AQMAs.

iv) the southern area of Horley near to Gatwick airport to better define the extent of the AQMA.

PM_{10} concentrations in the Borough in general meet the Governments 2004 objectives. However, a single site at the SE corner of the junction of Rushworth Road and the A217 is predicted to breach the permitted number of exceedences of the 50 µg m^{-3} fixed 24 hour average objective, and thus a detailed assessment will be required.

Assessment of air quality within the Borough against the 2010 PM_{10} objectives is *not a statutory requirement*, but modelling work undertaken as part of the review and assessment suggests that the Borough will breach the proposed 2010 annual average PM_{10} objective at a number of sites. However, the high regional background concentrations of PM_{10} in the Borough, relative to the objective value, means that the Council will have limited ability to effect major changes in PM_{10} concentrations to meet the objective if implemented. At this stage it is proposed that the Council do not undertake a detailed assessment of PM_{10} originating from the road network with respect to the 2010 objectives, due to the uncertainties associated with the traffic emissions factors and flow patterns over a long time frame, and as the objectives have yet to be made law.

1.0 Introduction

Part IV of the Environment Act 1995 requires local authorities to periodically review air quality in their area against current and future air quality objectives as set out in the Air Quality Strategy for England, Scotland, Wales and N. Ireland (The Air Quality Strategy, January 2000), the Air Quality Regulations (England) 2000, the Air Quality (Amendment) Regulations 2002, and the Air Quality Strategy Addendum document (2003). The air quality objectives set out in these documents (Table 1.1) are derived from health based standards recommended by the Governments' Expert Panel on Air Quality Standards (EPAQS), but the objectives also take into account the costs, benefits, feasibility, and practicality of reaching such standards.

Under these regulations the council is required to undertake an updating and screening assessment of air quality in the Borough by the end of May 2003, and by the end of April 2006 and 2009. Where the updating and screening assessment identifies areas which may break the air quality objective values, then a detailed assessment is required by the April of the following year i.e. 2004, 2007, and 2010. In situations where a detailed assessment is not needed, the council is required to produce a progress report on air quality in the Borough for that year, in addition to progress reports in 2005 and 2008. The timetable for the air quality reporting procedure is set out in Table 1.2, but in essence the council is required to produce a report on air quality in the Borough on an annual basis.

This report covers the updating and screening assessment of air quality in the Borough, with regard to the objectives set out in Table 1.1. Although there is no statutory requirement to examine the objectives beyond 2004 for PM_{10}, the PM_{10} concentrations have also been calculated and assessed against the proposed 2010 objective to give an indication as to whether the council would meet these provisional objectives.

	Limit	Exceedences	Measure	Annual Mean Limit	Reach By
CO	10 mg m^{-3}	-	maximum daily running 8 hour mean		31/12/03
NO_2	200 µg m^{-3} (105 ppb)	18 x $year^{-1}$	1 hr mean	40 µg m^{-3} (21 ppb)	31/12/05
SO_2	350 µg m^{-3} (132 ppb)	24 x $year^{-1}$	1 hr mean	-	31/12/04
	125 µg m^{-3} (47 ppb)	3 x $year^{-1}$	24 hr mean	-	31/12/04
	266 µg m^{-3} (100 ppb)	35 x $year^{-1}$	15 min mean	-	31/12/05
Benzene	16.25 µg m^{-3} (5 ppb)	-	running annual mean		31/12/03
	5 µg m^{-3} (1.54 ppb)	-	annual mean	-	31/12/10
1,3 Butadiene	2.25 µg m^{-3} (1 ppb)	-	running annual mean		31/12/03
Pb	-	-	-	0.5 ng m^{-3}	31/12/04
	-	-	-	0.25 ng m^{-3}	31/12/08
PM_{10}	50 µg m^{-3}	35 x $year^{-1}$	24 hr mean	40 µg m^{-3}	31/12/04
	50 µg m^{-3}	7 x $year^{-1}$	24 hr mean	20 µg m^{-3}	31/12/10

Table 1.1: Air Quality Objectives for the Purposes of Local Air Quality Management.

Report Type	**Due date (end of)**	**Comments**
Updating & Screening Assessment	May 2003	Required from all authorities in England.
Detailed Assessment or Progress Report	April 2004	Detailed assessment if identified in the updating and screening assessment, otherwise progress report.
Progress Report	April 2005	Required from all authorities in England.
Updating & Screening Assessment	April 2006	Required from all authorities in England.
Detailed Assessment or Progress Report	April 2007	Detailed assessment if identified in the updating and screening assessment, otherwise progress report.
Progress Report	April 2008	Required from all authorities in England.
Updating & Screening Assessment	April 2009	Required from all authorities in England.
Detailed Assessment or Progress Report	April 2010	Detailed assessment if identified in the updating and screening assessment, otherwise progress report.

Table 1.2: Regulatory Timetable for the Assessment of Local Authority Air Quality.

2.0 Methodology

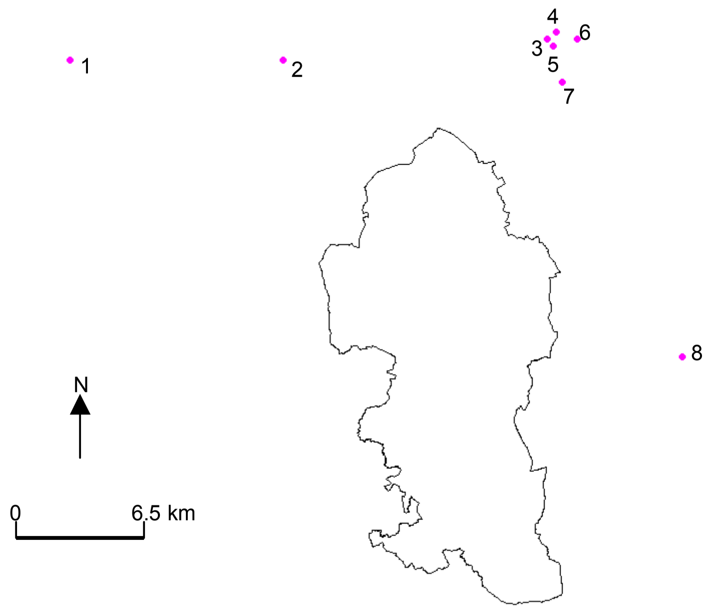
The methodologies for the updating and screening assessment procedure are drawn primarily from the technical guidance - LAQM.TG (03) (DEFRA, 2003a). This report follows a similar approach to the guidance with each of the seven pollutants, for which objectives have been set, considered in turn in chapter 3.

The main potential sources of pollution that might affect the Borough were identified as coming from large scale industrial sources either adjacent to or within the Borough, smaller scale industrial processes within the Borough, and road traffic within the Borough. Pollution from local residential heating was not considered a significant problem, as the majority of houses within the Borough use natural gas and / or mains electricity as their primary source of heating and power. Thus while oxides of nitrogen (NO_x) will result from gas combustion, this will be rapidly diluted to background concentrations.

2.1 Industrial Sources

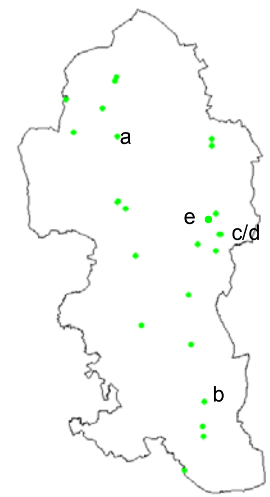
Potential major industrial pollution sources were identified from the national database of Part A Industrial Processes held by the Environment Agency (EA, 2003), and by liaison with the surrounding local authorities to identify any proposed / future Part A industrial developments in the vicinity of the Borough, which might impact on air pollution within the Borough. Reigate and Banstead has no Part A industrial processes 'of its own', and there are no Part A processes to the west or south of the Borough (Figure 2.1a).

Part B industrial processes within the Borough (Figure 2.1b) were identified from the Councils own Part B database. The databases of Part B processes in authorities which surround the Borough were also examined, though no processes which would have an impact on air quality within Reigate and Banstead were identified. The Part B processes within the Borough consist of three paint spraying businesses, a small engineering firm operating a waste oil burner as a power plant, a sand drying operation which will close in April 2004, and the remaining processes are involved in petrol retail. The contribution that both the Part A and B industries may have to each of the specific pollutants is set out in Table 2.1, and whether these inputs are significant are discussed in chapter 3 in the relevant section for that particular pollutant.



Company	Authorisation	Process
1. Walton Plating Ltd.	AO7720	Inorganic Chemical Processes
2. Engelhard Clal UK Ltd.	AS7299	Non Ferrous Metals
3. Alpha Fry Ltd.	AS6861	Non Ferrous Metals
4. Walterisation (UK) Ltd.	AO1721	Inorganic Chemical Processes
5. AIK Electronics (UK) Ltd.	AL9521	Halogens Process
6. Croydon Energy Ltd.	BK1287	Power Station
7. Sigma Aerospace Ltd.	AO5336	Inorganic Chemical Processes
8. Star Energy UK Onshore Ltd.	AF7177	Petroleum Processes

Figure 2.1a: Part A Processes in the Vicinity of Reigate & Banstead.



Company	Process
a. Walton Coachworks	Paint Spraying
b. The Repair Centre	Paint Spraying
c. Crash Repair Centre Ltd.	Paint Spraying
d. Witmun Engineering	Waste Oil Burner (<0.4MW)
e. MBB Minerals	Sand Drying & Processing
All other locations	Petrol Retailing

Figure 2.1b: Part B Processes in Reigate & Banstead.

Company	CO	Benzene	1,3 Butadiene	NO_2	PM_{10}	SO_2	Pb	Comments
1. Walton Plating Ltd.	-	-	-	-	-	-	-	Emits mainly organics to air.
2. Engelhard Clal (UK) Ltd.	<10t$^{(98)}$	<100kg$^{(98)}$	<100kg$^{(98)}$	<10t$^{(01)}$	<1t$^{(98)}$	<10t$^{(01)}$	<10kg$^{(01)}$	Range of organics & metals.
3. Alpha Fry Ltd.	-	-	-	<10t$^{(00)}$	<10t$^{(00)}$	-	<10kg$^{(00)}$	PM is as TSP.
4. Walterisation (UK) Ltd.	-	-	-	<10t$^{(01)}$	<10t$^{(01)}$	-	<10kg$^{(98)}$	PM is as TSP.
5. AIK Electronics (UK) Ltd.	-	-	-	<10t$^{(00)}$	-	<10t$^{(00)}$	-	
6. Croydon Energy Ltd.	-	-	-	✓	✓	✓	-	Not operational.
7. Sigma Aerospace Ltd.	-	-	-	-	-	-	<10kg$^{(00)}$	
8. Star Energy (UK) Onshore Ltd.	<10t$^{(01)}$	<100kg$^{(01)}$	-	<10t$^{(01)}$	-	<10t$^{(99)}$	-	
a. Walton Coachworks.	-	-	-	-	-	-	-	Not a significant source.
b. The Repair Centre.	-	-	-	-	-	-	-	Not a significant source.
c. Crash Repair Centre Ltd.	-	-	-	-	-	-	-	Not a significant source.
d. Witmun Engineering.	-	-	-	-	-	-	-	Not a significant source.
e. MBB Minerals.	-	-	-	-	●	-	-	Closes April 2004.
Petrol Stations.	-	●	-	-	-	-	-	

Key:

t — Metric Tonne.
(xx) — Last available year for data.
\- — Does not emit pollutant or for Part A processes no data reported.
TSP — Total suspended particulates i.e. all particles.
✓ — Croydon Energy not yet operational. Thus represents possible releases.
● — For Part Bs: Possible source of pollutant but not necessarily significant.

Table 2.1: Part A Emissions Inventory and Possible Part B Pollutant Sources in and around the Borough.

2.2 Traffic Sources

Previous assessments of air quality in the Borough (SEIPH, 1999a, 1999b, AQC, 2001) have consistently identified roads in the Borough as by far the biggest source of air pollution. Following changes in the National Air Emissions inventory database (NAEI, 2002), which lead to an increase in the emissions factors for NO_x from vehicles, major roads within the Borough were reassessed using the Design Manual for Roads and Bridges (DMRB) spreadsheet v.1.01 (February). A later version of the DMRB was released in April 2003 to fix some minor faults with the model, but these problems did not affect the sites studied as part of this assessment.

The aim of the roads assessment was to identify the busiest junctions within the Borough where residential housing is close to the junctions i.e. pollution 'hot spots', from a combination of personal knowledge, use of the Councils Geographical Information System (GIS), and / or where over 10 000 vehicles (AADT) used the junction. As these junctions have the highest potential pollution concentrations associated with them, if the results of the modelling of the junctions are below the air quality objectives, then residences at similar distances from the single roads are unlikely to exceed the objectives.

The technical guidance (DEFRA, 2003a) also requires that consideration be given to new / proposed roads, significant changes in traffic flow since the original review and assessment, and roads with high flows (>20 %) of HGVs and buses, especially in relation to PM_{10} and NO_2. These considerations were taken into account when undertaking the roads assessment, although there have been no significant changes in traffic flows or new roads since the first round of reviews and assessments. Within Reigate and Banstead HGVs and buses make up 10 % or less of the road traffic on all the Boroughs A and B roads, although this rises to between 10 % and 20 % on the M25.

The updating and screening procedure does not require screening of individual junctions, merely the identification of potential problem areas e.g. junctions in Reigate or Banstead and so on. However, individual junctions have been screened in this assessment, so that only individual junctions / roads which might exceed the objective values are considered in the detailed assessment, to minimise the work needed at the detailed assessment stage.

The motorways, A, and B roads within the Borough are shown in Figure 2.2. Predicted traffic data (AADT, vehicle speeds, and LGV / HGV vehicle splits), based on the Surrey traffic model, was obtained for all roads in the Borough from Surrey County Council.

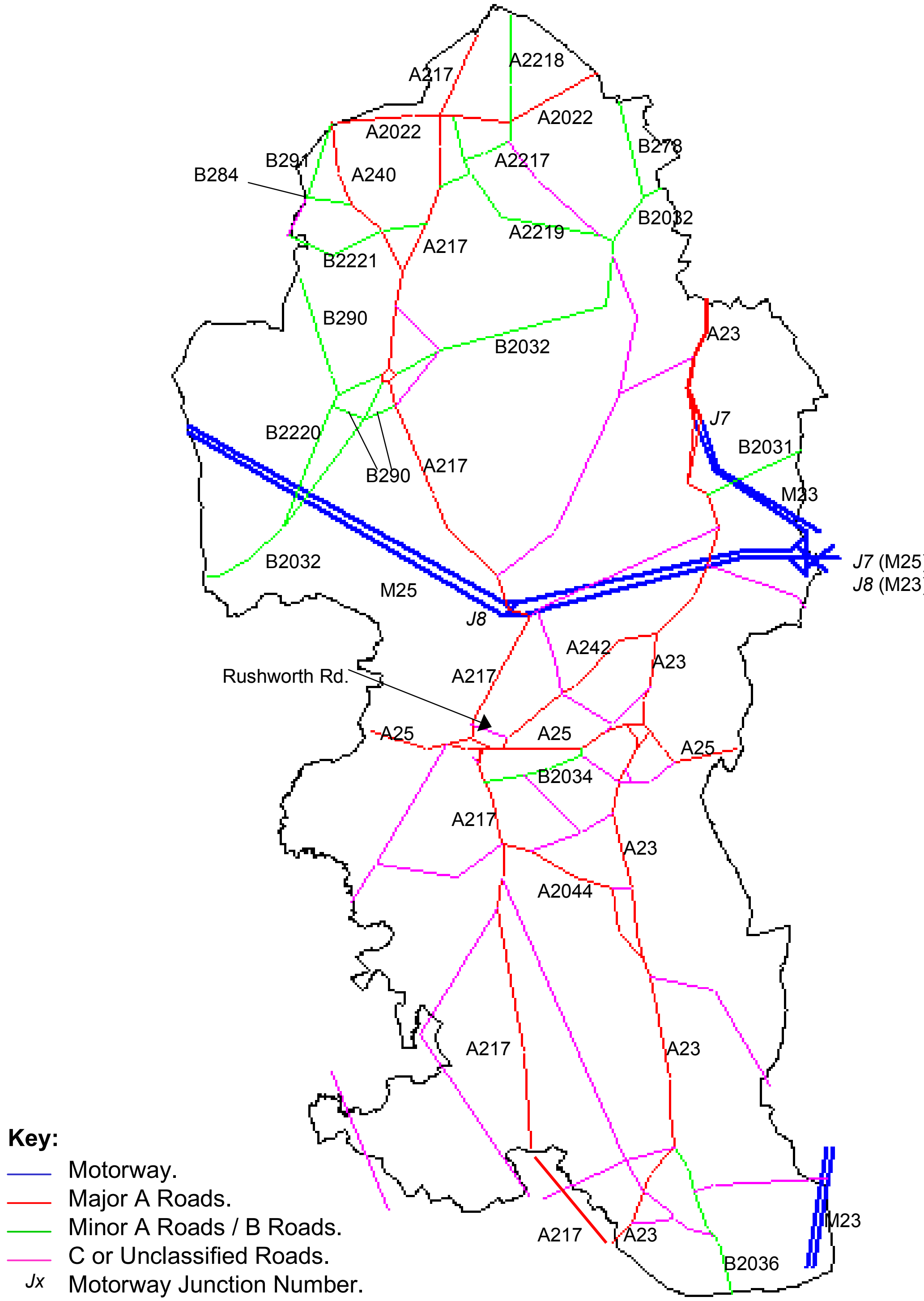


Figure 2.2: Main Road Network within Reigate and Banstead.

The predicted traffic figures assume 'average' traffic growth i.e. represent neither the worst nor best case scenario. While no figures were available for this report as to the accuracy and precision of the Surrey County Traffic model, some comparisons are possible between the modelled 2002 traffic data for parts of the M25 / M23 and measured data obtained from the highways agency (HA, 2003) as shown in Table 2.2.

	M25 J7/8		M25 J8/9		M23 7/8	
	AADT	% HGV	AADT	% HGV	AADT	% HGV
Modelled	163134	10.75	149526	11.48	34276	10.02
Measured	160499	n/a	147212	12.60	33630	n/a

Table 2.2: Comparison of Modelled and Measured Traffic Data for 2002.

It is difficult to draw any definitive conclusions from this data due to:

i) the small sample size.

ii) as the measured data available for this report is confined to the motorway network, and so is not necessarily representative of the error on A and B road traffic predictions.

However, there does appear to be a reasonable agreement between the 'actual' and modelled values. Nevertheless it is worth bearing in mind that the greater the forward projections of traffic data, the larger the likely error associated with that predicted value, and thus the greater the error associated with the predicted pollution concentrations.

The other data inputs into the DMRB model were the distances between the centre of the road(s) and the receptor i.e. residence, which were obtained from the Councils own GIS system, and the predicted regional background pollution concentrations for the Borough which were obtained from the local air quality management (LAQM) website (DEFRA, 2003b).

2.3 Existing Monitoring of Air Quality in the Borough

The Council has an existing program of air quality monitoring in the Borough, and the data from this monitoring program is reported in the appropriate sections of chapter 3. It is not proposed in this report to discuss in detail the methodologies of real time monitoring and / or passive diffusion tubes. However, the diffusion tube network in the Borough operates in accordance with the practices and exposure periods of the UK diffusion tube network, and the real time monitoring equipment is operated in accordance with the manufacturers operating instructions, national and European best practice, and calibrated to national and international standards.

All of the data presented in this report has been fully ratified and verified, with correction factors applied where appropriate. The correction factors are clearly stated on the relevant graphs, but for reference a correction factor of 1.3 has been applied to the PM_{10} TEOM data sets, and for the 2002 nitrogen dioxide diffusion tube data a correction factor of 0.995 has been applied.

3.0 Results

3.1 Carbon Monoxide (CO)

Objective value: 10 mg m^{-3} (8.6 ppm) as a maximum daily running 8 hour mean, with the objective to be met by 31st December 2003.

3.1.1 Health Effects of Carbon Monoxide

Unlike most atmospheric pollutants, the mechanism by which CO exerts an effect on human health is well understood. Its main effect is to limit oxygen transport around the body, and studies (Turner *et al*., 1993) have shown that exposures of 10 ppm over an 8 hour period lead to a decrease in the aerobic capacity of healthy individuals, while people with angina find that chest pains occur earlier during exercise.

3.1.2 Main Sources of Carbon Monoxide in the UK

The main source of carbon monoxide in the UK is road transport, with 67 % of all releases in 2000 coming from road transport, although current predictions are that road transport emissions of carbon monoxide will decline by 42 % by 2005 (DEFRA, 2003a).

3.1.3 Carbon Monoxide Concentrations in Reigate and Banstead

There are no industrial sources either in or within the vicinity of the Borough that emit sufficient quantities of carbon monoxide to impact on the carbon monoxide concentration in the Borough.

The results of the DMRB modelling of carbon monoxide concentrations at receptors around busy road junctions for 2003 are shown in Appendix A, with the 'top 10' hot spots in the Borough shown in Table 3.1.

Receptor	Location	mg m^{-3}
16	A217 / Rushworth Road	0.88
8	A217/A240	0.56
17	A25 Castlefield Rd / A25 Church St	0.53
18	A25 Church St after Bancroft Road	0.52
29	A240 / A2022 / B291	0.52
5	A217/B2221	0.52
39	A2022 / B2218 / B2217	0.51
36	A2022 / B2218 / B2217	0.50
4	A217/B2221	0.50
38	A2022 / B2218 / B2217	0.50

Table 3.1: Highest Annual Average Carbon Monoxide Concentrations in Reigate and Banstead (2003 - DMRB modelled data).

The concentrations in Table 3.1 are annual average values, and there is no direct link between annual average values and maximum running 8 hour mean values upon which the standards are based. However, provided that the predicted annual mean CO concentration is below 2 mgm^{-3}, then it is considered unlikely that the maximum 8 hour running mean will be exceeded (DEFRA, 2003a). Therefore, Table 3.1 demonstrates that CO concentrations in Reigate and Banstead are likely to be well below the objective value even at the highest receptor concentration in the Borough. The modelled annual mean CO concentrations (Appendix A) also indicate that CO concentrations will continue to fall in the Borough until at least 2010.

Previous studies of CO concentrations within the Borough (SEIPH 1999a, 1999b, AQC 2001) have also found that the CO objective is unlikely to be breached, and consequently no CO monitoring is undertaken within the Borough.

3.1.4 Conclusions and Recommendations

Carbon monoxide concentrations in the Borough, even at the receptor with the highest concentrations, are likely to be below the government objective for 2003, and based on modelling studies will fall further in the years ahead. Therefore a detailed assessment of carbon monoxide concentrations within the Borough is **not** required.

3.2 Benzene

Objective value: 16.25 µg m^{-3} (5ppb) as a running annual mean, to be met by 31st December 2003, and an annual mean of 5 µg m^{-3} (1.54ppb) to be achieved by 31st December 2010.

3.2.1 Health Effects of Benzene

Benzene is considered a human carcinogen by the International Agency for Research on Cancer (IARC, 1987). The WHO in an update of its Air Quality Guidelines for Europe concluded that at an exposure of 5 - 15 µg m^{-3} over a persons lifetime is likely to result in an extra 30 to 90 cases of leukaemia per million of population.

3.2.2 Main Sources of Benzene in the UK

The main source of benzene emissions in the UK is petrol engined vehicles, followed by petroleum refining, and the distribution and uncontrolled emissions from petrol station forecourts without vapour recovery systems (DEFRA, 2003a).

3.2.3 Benzene Concentrations in Reigate and Banstead

The contribution to benzene concentrations within the Borough from Part A industrial sources outside of the Borough are negligible; as the two industrial processes that emit benzene in the vicinity of the Borough emit less than 100 kg per annum (Table 2.1), and are over 7 km away from the Reigate and Banstead boundary (Figure 2.1a). Past studies (SEIPH, 1999a, 1999b) of benzene concentrations within the Borough have also concluded that the contribution from Part A processes is negligible.

Although there are no major fuel storage depots within the Borough, the other potential industrial source of benzene within the Borough is from petrol stations (Figure 2.1b). However, a study by Jones (2000) found that the presence of a petrol station is unlikely to have a significant influence on the concentrations of benzene close to residential properties, where the petrol distribution pumps are more than 10 m from the residential properties. As all of the residential properties in the Borough are over 10m from petrol pumps, it is unlikely that there will be a significant residential exposure to benzene from the petrol stations within the Borough.

The technical guidance (DEFRA, 2003a) indicates that there is no need to screen potential receptors against the 2003 objective for traffic derived benzene, as kerbside sites around the UK are below the 2003 objective, and that the screening assessment for the 2010 objective is only necessary where the 'regional' background concentration exceeds 2 µgm^{-3}, and AADT traffic flows exceed 80 - 120 000 vehicles a day. In Reigate and Banstead the background level is around 0.5 μgm^{-3}, but the benzene concentrations were still calculated using the DMRB model as:

i) the advice from the Expert Panel on Air Quality Standards (EPAQS) and the Department of Health Committee on the Carcinogenicity of Chemicals in food, consumer products and the environment (COC), is to reduce the concentrations of benzene to as low as possible (DEFRA, 2003a).

ii) little extra work was involved.

The results of the DMRB model for benzene in 2003 and 2010 are shown in appendix A, and the highest annual mean concentrations in the Borough in 2003 and 2010 shown in Table 3.2.

Receptor	Location	2003 (μgm^{-3})	Receptor	Location	2010 (μgm^{-3})
16	A217 / Rushworth Road	1.05	**16**	A217 / Rushworth Road	0.67
69	M25 (Ashcombe Road)	1.05	**69**	M25 (Ashcombe Road)	0.66
8	A217/A240	0.86	**35**	B290 near junction B2221	0.58
36	A2022 / B2218 / B2217	0.86	**8**	A217/A240	0.58
38	A2022 / B2218 / B2217	0.83	**36**	A2022 / B2218 / B2217	0.58
39	A2022 / B2218 / B2217	0.83	**38**	A2022 / B2218 / B2217	0.56
5	A217/B2221	0.81	**39**	A2022 / B2218 / B2217	0.56
4	A217/B2221	0.80	**34**	B290 near junction B2221	0.56
35	B290 near junction B2221	0.79	**5**	A217/B2221	0.55
29	A240 / A2022 / B291	0.78	**4**	A217/B2221	0.55

Table 3.2: Highest Annual Average Benzene Concentrations in Reigate and Banstead (2003 and 2010 - DMRB modelled data).

Table 3.2 demonstrates that the council already meets the 2010 objective for benzene based on DMRB modelling, and that concentrations will continue to fall still further to at least 2010, when benzene concentrations in the Borough will be a minimum of seven times lower than the national standard, and typically more than ten times lower than the national standard.

The council undertakes a very limited amount of benzene monitoring in the Borough, using benzene diffusion tubes (BTEX tubes supplied by Lambeth Scientific) at three sites. The tubes are not calibrated against an automatic analyser, as they are used simply as a 'quick' method of examining the relative concentrations of benzene in the Borough. The results from these tubes for 2002 are shown in Table 3.3, but the values should be interpreted with caution, given that they are not calibrated against an automatic analyser, and throughout

2002 the concentrations of benzene have been double the expected value based on the analysis of the ethyl benzene and ortho xylene concentrations.

Location	Measured Value 2002 (µg m^{-3}).	n	2010 Projection of Measured data. (µg m^{-3}). (Conversion to 2001 then 2010 DEFRA (2003a) method).
Reigate High St.	2.7	8	1.9
Riverside, Horley.	1.8	9	1.3
London Rd., Merstham.	2.2	9	1.5

Table 3.3: Benzene diffusion tube monitoring results for 2002, and projected 2010 values.

The DMRB calculated values for Reigate High street in 2010 (Appendix A, receptor 20) are 0.34 µgm^{-3}. Thus the diffusion tubes suggest a concentration 5.5x higher than the calculated values, although this is still well below the objective value for 2010. As has already been pointed out, the benzene concentrations in the Borough in 2002 have been about double the expected concentrations based on the ratios of the other VOCs measured as part of the analysis, and the tubes are not calibrated against a real time monitor. Thus the discrepancy between the modelled and measured results is likely to be far smaller. However, even if the modelled values are a factor of 5.5 out from the 'true' value, the benzene concentrations at the 'worst case' site in the Borough in 2010 rise from 0.67 µg m^{-3} to 3.69 µg m^{-3}, which is still 25 % lower than the 2010 objective value.

3.2.4 Conclusions and Recommendations

Benzene concentrations in Reigate and Banstead based on modelled data are well below the government objectives for 2003, and the modelled 2010 concentrations are likely to be 7 to 10 times lower than the government objective for 2010 and EU limit value. Therefore a detailed assessment of benzene concentrations within the Borough is **not** required.

3.3 1,3-Butadiene

Objective value: 2.25 µg m^{-3} (1 ppb) as a running annual mean, to be achieved by 31^{st} December 2003.

3.3.1 Health effects of 1,3 Butadiene

1,3 butadiene is considered a probable carcinogen (IARC, 1992) but due to a lack of experimental data, and lack of consistency between data sets, there are no definitive estimates of the risks associated with differing levels of exposure.

3.3.2 Main Sources of 1,3 Butadiene in the UK

The main source of 1,3 butadiene in the UK is emissions from motor vehicle exhausts, although some industries handle the material in bulk for use in various industrial processes (DEFRA, 2003a).

3.3.3 1,3 Butadiene Concentrations in Reigate and Banstead

One industrial process in the vicinity of Reigate and Banstead discharges 1,3 butadiene to the air, but the small quantity of material discharged and the distance from the Borough boundary means that this will have no noticeable impact on 1,3 Butadiene concentrations within the Borough.

The technical guidance (DEFRA, 2003a) indicates that there are unlikely to be any exceedences of the 1,3 butadiene objective due to road traffic emissions, and this is likely to be the case in Reigate and Banstead. Although the DMRB model allows the calculation of annual mean 1,3 butadiene concentrations, and these have been calculated for the Borough (Appendix A), these are not comparable to the running 8 hour average concentrations stated in the objective and there is no direct relationship between the two measures of concentration. The DMRB model is also thought to significantly over estimate the annual mean concentrations of 1,3 butadiene (DMRB, 2002), and so any calculated annual mean concentrations should be viewed as at the higher end of the concentrations that might actually be measured in the Borough. Despite the lack of a relationship between the running 8 hour mean and the annual average means, the annual average means are all considerably lower than the 8 hour running mean concentrations as would be expected, and so there are no obvious indications that the 1,3 butadiene concentrations in the Borough will exceed the objective values. The ten highest *annual* average concentrations in 2003 are shown in Table 3.4.

Receptor	Location	$\mu g\ m^{-3}$
69	M25 (Ashcombe Road)	1.21
16	A217 / Rushworth Road	0.97
8	A217/A240	0.60
36	A2022 / B2218 / B2217	0.57
70	M25 (Glade House)	0.56
14	A217 / M25	0.51
39	A2022 / B2218 / B2217	0.50
38	A2022 / B2218 / B2217	0.49
6	A217/A240	0.48
7	A217/A240	0.46

Table 3.4: Highest Annual Average 1,3 Butadiene Concentrations in Reigate and Banstead (2003 - DMRB modelled data).

Over the longer term the annual average concentrations of 1,3 butadiene are set to fall still further, with the highest concentrations in the Borough at receptor 69 predicted to decline by 40 % by 2010.

The council does not undertake any 1,3 butadiene monitoring as previous assessments (SEIPH, 1999a) indicated that 1,3 butadiene was not a significant problem in the Borough and, as mentioned above, national guidance (DEFRA, 2003a) suggests that 1,3 butadiene concentrations due to traffic emissions are unlikely to exceed the objective values.

3.3.4 Conclusions and Recommendations

The are no significant industrial sources of 1,3 butadiene which affect the Reigate and Banstead borough, and national guidance states that 1,3 butadiene concentrations are well below the 2003 objective at roadside locations around the country. In Reigate and Banstead the calculated *annual* mean concentrations are low, and will continue to decline until at least 2010 despite increasing traffic flow. Therefore a detailed assessment of 1,3 butadiene concentrations within the Borough is **not** required.

3.4 Lead (Pb)

Objective values: 0.5 ng m^{-3} as an annual mean to be achieved by the end of 2004, and 0.25 ng m^{-3} as an annual mean to be achieved by the end of 2008.

3.4.1 Health Effects of Lead

Exposure to airborne lead can lead to impaired neurological function and development. It was these findings that resulted in the declining lead content of petrol, and its subsequent ban in January 2000. More recent studies (Stohs *et al.*, 1995) also suggest that even at low concentrations lead can cause oxidative damage to cells within the body.

3.4.2 Main Sources of Lead in the UK

The main sources of lead in the UK result from industry now that it is banned from petrol, including car battery manufacture and other non-ferrous foundry and production processes (DEFRA, 2003a).

3.4.3 Lead Concentrations in Reigate and Banstead

There are two industrial processes in the vicinity of the Reigate and Banstead area which are classed as non-ferrous metal processes (Figure 2.1a). However, the lead emissions from these processes are small (under 10 kg per annum - Table 2.1), and as these businesses are over 7 km from the Borough boundary, these processes will have minimal impact on the lead concentrations within the Borough.

The emissions of lead from road traffic today are minimal, and the technical guidance (DEFRA, 2003a) states that neither the 2004 nor the 2008 objective for lead has been exceeded anywhere in the UK monitoring network as a consequence of traffic emissions.

Previous assessments of lead concentrations in the Borough (SEIPH, 1999a) also concluded that Reigate and Banstead would not breach the 2004 objective. As a consequence of these previous findings, and the findings of the national network, the council does not monitor lead concentrations in the Borough on a routine basis.

3.4.4 Conclusions and Recommendations

Lead concentrations in Reigate and Banstead are likely to be below the 2004 and 2008 objective values, as there are no significant industrial sources either in or near the Borough, and as lead concentrations from traffic sources recorded at all locations elsewhere in the UK are below the lead objective values. Therefore a detailed assessment of lead concentrations within the Borough is **not** required.

3.5 Nitrogen Dioxide (NO_2)

Objective values: 40 µg m^{-3} (21 ppb) as an annual mean, and 200 µg m^{-3} (105 ppb) as a 1 hour mean value not to be exceeded more than 18 times per year. Both objectives are to be met by 31st December 2005.

3.5.1 Health Effects of Nitrogen Dioxide

Nitrogen dioxide is a respiratory irritant at high concentrations (over 1000 ppb), leading to inflammation of the airways in the lungs. Asthmatics and people with other respiratory or lung diseases are generally more sensitive to NO_2, with lung function affected after 30 minutes exposure at concentrations of 250 to 500 ppb (Jorres *et al*., 1990). There is also some evidence to suggest that NO_2 may act as a 'priming' agent, making the lung more sensitive to other pollutants (Tunnicliffe *et al*., 1994), although the mechanism by which this occurs is currently unknown.

3.5.2 Main Sources of Nitrogen Dioxide in the UK

Nitrogen dioxide (NO_2) and nitrogen oxide (NO) are collectively referred to as NO_x - nitrogen oxides or oxides of nitrogen. All combustion processes produce NO_x, which initially is largely in the form of NO. However, NO reacts rapidly (in less than an hour) with mainly low level ozone in the atmosphere to form NO_2, and it is the NO_2 that has the adverse impacts on human health.

Over 49 % of all the NO_x in the UK is derived from road traffic (DEFRA, 2003a). However, in urban areas the contribution of road traffic to NO_x concentrations is usually much higher e.g. up to 75 % in London (DEFRA, 2003a).

3.5.3 Nitrogen Dioxide Concentrations in Reigate and Banstead

3.5.3.1 Industrial Point Sources

Industrial sources within the Borough and immediately outside of the Borough, excluding Gatwick which is considered separately, will have little impact on the NO_x / NO_2 concentrations within Reigate and Banstead. SEIPH (1999a) reached a similar conclusion in a previous review of the nitrogen dioxide concentrations within the Borough. The new power plant operated by Croydon Energy (Figure 2.1a), which was developed after the SEIPH report, is not currently operational but studies undertaken as part of the planning process, examining plume grounding, suggest that the plant will not affect NO_2 concentrations within Reigate and Banstead.

3.5.3.2 Traffic Sources

NO_x / NO_2 from traffic sources has been identified as a potential problem area in previous review and assessments of the Boroughs air quality (SEIPH, 1999a, 1999b). A stage 3 assessment of air quality in the Borough resulted in air quality management areas (AQMAs) being declared on 30th April 2002 on the M25, M23, and two individual properties on the A217, due to predicted exceedences of the 2005 objective at properties near to these roads.

Consequently the Council undertakes NO_2 monitoring at a number of sites, with a real time background monitoring site in Horley, and a second real time site close to Gatwick airport operated in conjunction with BAA. The Council also operates a diffusion tube network of around 80 tubes, 60 of which are involved in delineating the spatial extent of the declared AQMAs, whilst the remaining 20 sites monitor relevant exposure at background sites around the Borough. The diffusion tubes use 50 % TEA in acetone, and are supplied by Lambeth Scientific which in a recent NETCEN 'round robin' were considered one of the better laboratories.

Three diffusion tubes are co-located with the Councils real time NO_x monitor in Horley, and these tubes were used to calculate the diffusion tube correction factor (Equation 1) for 2002.

$$\frac{\text{Annual mean chemiluminescence conc. (9 months matched to tubes)}}{\text{Annual mean diffusion tube conc. (based on 9 months data)}} = \frac{30.58}{30.75} = 0.995 \quad \text{(Eq. 1)}$$

As part of the updating and screening assessment for nitrogen dioxide potential hot spots were modelled using the DMRB model, and the results for 2005 and 2010 for the 10 highest locations are shown in Table 3.5.

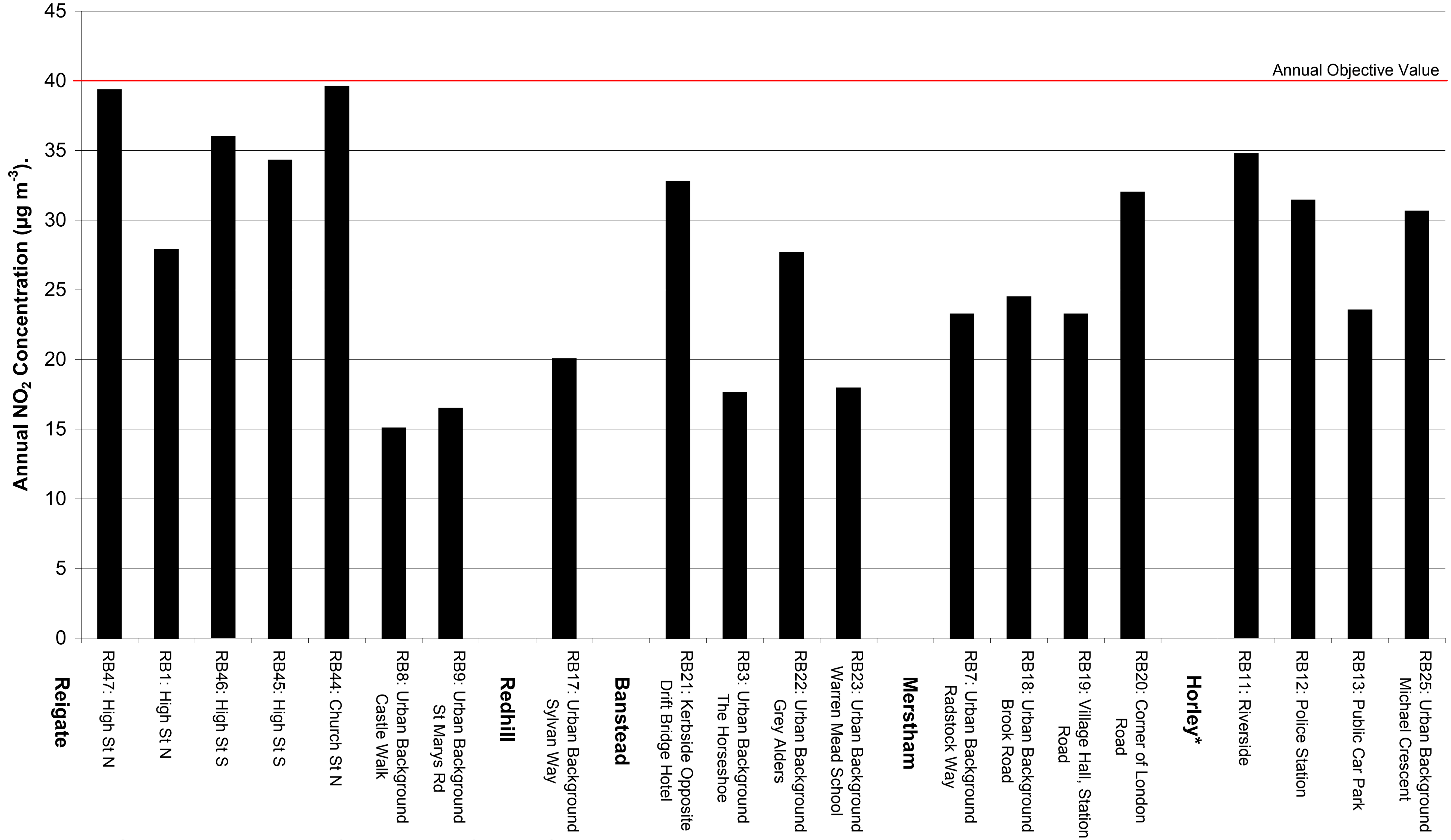
Receptor	Location	2005 (µgm^{-3})	Receptor	Location	2010 (µg m^{-3})
69	M25 (Ashcombe Road)	43.6	**69**	M25 (Ashcombe Road)	35.7
16	A217 / Rushworth Road	43.1	**16**	A217 / Rushworth Road	35.1
8	A217/A240	36.3	**54**	A23 / A242	29.9
36	A2022 / B2218 / B2217	36.0	**50**	A23 / School Hill	29.9
54	A23 / A242	35.6	**36**	A2022 / B2218 / B2217	29.8
44	A23 / M23	35.4	**51**	A23 / School Hill	29.7
51	A23 / School Hill	35.3	**8**	A217/A240	29.7
53	A23 / A242	35.3	**53**	A23 / A242	29.7
50	A23 / School Hill	35.2	**44**	A23 / M23	29.7
39	A2022 / B2218 / B2217	35.0	**45**	A23 / M23	29.1

Table 3.5: Highest Annual Average Nitrogen Dioxide Concentrations in Reigate and Banstead (2005 and 2010 - DMRB modelled data).

From Table 3.5 it is apparent that the receptor at the junction of the A217 / Rushworth Road might breach the 2005 annual objective value of 40 µg m^{-3}, as might some of the properties closest to the M25, although it is unlikely that they will breach the 1 hour objective value based on the results of continuous monitoring elsewhere in the UK (DEFRA, 2003a). Nevertheless, when the EU limit values (identical to the 2005 objective values) come into force in 2010 both receptors will be below the EU limit value. However, a detailed assessment will be undertaken at the Rushworth Road site to confirm the DMRB findings, as detailed modelling of this site as part of the stage 3 assessment indicated concentrations of 30 to 34 µg m^{-3} in 2005 and therefore it was not in breach of the 2005 objective value, unlike the M25 sites. While the emissions factors for NO_x / NO_2 used in the stage 3 assessment have subsequently been revised upwards by DEFRA, and hence some differences with the stage 3 results might be expected, the predicted concentrations at other sites in the original stage 3 assessment that were around 30 - 34 µgm^{-3}, e.g. receptor 8 in Table 3.5, have not shown such a dramatic increase in the predicted 2005 concentration.

All other receptors near to major roads in the Borough are predicted to have NO_2 concentrations below the 2005 objective values, even if a +10 % model error is assumed, and are also predicted to be below the EU limit value in 2010. These findings agree with the findings of the original stage 3 report, as do the elevated concentrations on the M25, although there are some further ‘issues’ relating specifically to Reigate High Street which are addressed below.

Figure 3.1: Mean NO_2 Concentrations around Reigate and Banstead in 2002 - Corrected Diffusion Tube data (n = 9, correction factor = 0.995).



*values exclude AQMA monitoring study, as n=5 for 2002. Data will form part of a more detailed study in late 2003.

Receptor 20 (Appendix A) is for properties in Reigate High Street, which in places forms what is termed a 'street canyon' i.e. the height of the surrounding buildings is greater than the width of the road. With a street canyon the technical guidance (DEFRA, 2003a) suggests multiplying the traffic component of the DMRB model results by a factor of 2 and adding this to the background value. This method predicts NO_2 concentrations in Reigate High Street of 37.9 µg m^{-3} in 2005 and 24.1 µg m^{-3} in 2010. Under these criteria Reigate High Street will still meet the 2005 objective value, and the 2010 EU limit value. Monitoring data from Reigate High Street for 2002 (Figure 3.1) suggests that while concentrations can vary considerably along the High Street, influenced by roads or footpaths potentially allowing pollutants out of the High Street e.g. at RB46 (junction of High Street and Bell Street) and RB1 (building façade of Boots but next to a footpath leading of the High Street), the concentrations are not dramatically higher than the modelled DMRB values (Table 3.6), and lower than the concentrations obtained when multiplying the DMRB traffic component results by 2.

Site	2002 DMRB Modelled Concentrations	2002 DMRB (traffic component x2) Modelled Concentrations	2002 Measured Concentrations	Projected 2005 concentrations* (based on 2002 measured concentrations)
RB44	35.7	42.8	39.5	36.3
RB47	36.6	44.6	39.3	36.1
*projection based on DEFRA 2003a.				

Table 3.6: Modelled vs. Measured (mean, n = 9) Annual Average NO_2 Concentrations (µg m^{-3}) and Projected 2005 Concentrations based on Measured 2002 Concentrations.

The measured data if projected forward to 2005 by applying the correction factors in the technical guidance (DEFRA, 2003a), suggests that NO_2 concentrations in Reigate High Street will be below the 2005 objective values and therefore a detailed assessment is not required. However, given the potentially complicating factor of the street canyon, and that the street is used by a number of people as a shopping centre, current monitoring on the High Street will continue to confirm that the annual NO_2 concentrations are declining each year as predicted.

At other points around the Borough it can be seen that the concentrations in residential areas in Redhill, Banstead, and Merstham, (Figure 3.1) are all below the 2005 objective in 2002, and if anything will decline still further by 2005 and 2010. Concentrations at Riverside in Horley are comparatively high at 35 µg m^{-3}, but this is due to the influence of Gatwick airport, which will be discussed below. The one 'major' bus station in Redhill was examined as part of the review and assessment, but there were no relevant receptors within 20 m of the bus station, and so this was not considered further.

3.5.3.3 Traffic Sources within Air Quality Management Areas (AQMAs)

The results of the DMRB modelling of the major traffic routes within the Borough in general agreed with the more detailed modelling carried out as part of the stage 3 assessment of NO_2 concentrations within the Borough (AQC, 2001). However, the DMRB modelling of the properties on the M25, receptors 69 and 70 (Appendix A), suggested that NO_2 concentrations in 2005 would be 34.3 µg m^{-3} at receptor 70, and 43.6 µg m^{-3} at receptor 69. While the 2005 concentrations for receptor 70 are broadly similar to those modelled in the stage 3 assessment (Table 3.7), though the DMRB model gives a lower concentration despite the higher emission factors used in the model, the DMRB concentration for receptor 69 differed to a greater extent from the modelled concentration in the stage 3 assessment (Table 3.7).

Site / Receptor	2005 DMRB Modelled Concentrations.	2005 Stage 3 Modelled Concentrations	Projected 2005 concentrations*	2002 DMRB Modelled Concentrations	2002 Measured Concentrations
RB37	33.3	-	32.0	-	-
RB38	36.3	-	34.6	39.0	37.6
RB39	37.6	-	35.5	-	-
69	43.6	56	-	-	-
70	34.3	38	-	-	-
*projection based on 2002 measured concentrations using method in DEFRA 2003a.					

Table 3.7: Modelled vs. Measured (mean, n = 9) Annual Average NO_2 Concentrations (µg m^{-3}) in 2002 and Modelled and Projected 2005 Concentrations.

However, the modelling undertaken as part of the stage 3 assessment took account of meteorological factors including wind direction, unlike the DMRB model. The prevailing wind direction in the UK is from the SW, and as the Ashcombe Road receptors (RB37, RB38, RB39 and **69**) are to the north of the motorway, while receptor **70** is to the south, this would explain a great deal of the discrepancy between the two modelled values for site **69**.

However, both models suggest that receptors close to the motorway (within 25 m) are likely to be over the 2005 objective values, and projected monitoring data from Ashcombe Road (RB37 - 39) in Table 3.7 tends to confirm this. Here the Ashcombe Road monitoring clearly shows increasing NO_2 concentrations with decreasing distance from the motorway, as might be expected, and as receptor 69 is closer to the motorway than the monitoring site at RB39 it is likely to be over the 2005 objective value.

Although the focus so far has been on a small area of the M25, monitoring takes place at a range of sites (all building façades) along the M25 (Figure 3.2). While the monitoring data for 2002 suggests that all of the monitored sites will be below the 2005 objective, there are properties closer to the motorway than either RB28 (Figure 3.2), or RB39 as in the Ashcombe Road example above, and these are likely to be very close to / over the 2005 objective value. Thus a detailed assessment of the M25 AQMA is required to more accurately define the spatial extent of the AQMA.

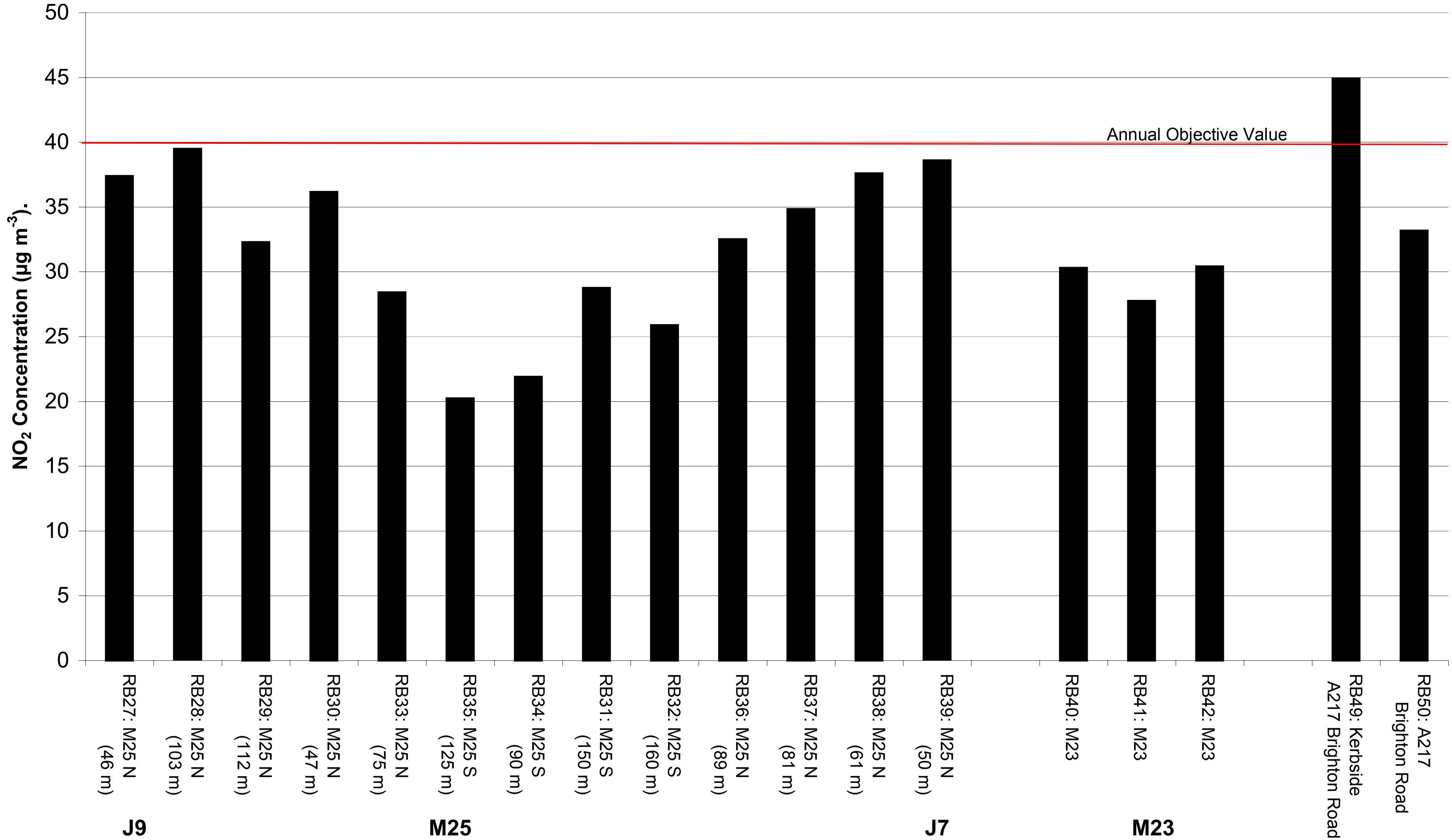
A detailed assessment is also recommended for the properties on the M23, and A217 to look into revoking the AQMAs at these sites (Figure 3.2), given the low measured concentrations in 2002 at the receptor sites (as opposed to the kerbside sites), which are below the 2005 objective values and which are likely to fall still further by 2005.

3.5.3.4 The Horley Air Quality Management Area

The air quality management area in Horley was declared based on modelled NO_x / NO_2 emissions from both Gatwick airport and the traffic on the main roads near the airport. The technical guidance (DEFRA, 2003a) states that for airports handling over 5 million passengers per annum, and where a receptor is within 1 km of the airport perimeter, a detailed assessment is required. A detailed assessment of the area was undertaken as part of the stage 3 assessment, and the AQMA declared based on this, and further detailed assessments will be made to better define the extent of the AQMA in Horley.

Diffusion tube monitoring does take place on the residential estates closest to the airport, to examine the spatial extent of the NO_2 concentrations. However, the data is not presented in this report as 9 - 12 months of diffusion tube data are required to calculate annual averages, and only five months of diffusion tube data are available at present. Diffusion tube data is though available from a single site at Riverside in Horley (Figure 3.1) on the airport boundary, where monitoring has gone on for several years, and this indicates that concentrations in 2002 were around 35 $\mu g\ m^{-3}$. Nevertheless, it is difficult to predict how this will change by 2005 as the NO_2 concentration 'contains' contributions from both the airport and traffic, and while the contribution to NO_2 from traffic is predicted to fall it is unclear at the present time what proportion of the NO_2 exposure in Riverside derives from the airport and how much from the roads around the airport.

Figure 3.2: Mean NO_2 Concentrations along the M25, M23, and A217 in 2002 - Corrected Diffusion Tube data (n = 9, correction factor = 0.995).



(*xx* m) Distance from centre of carriageway to building façade. Note: Differences in M25 NO_2 concentrations are largely a function of receptor distance from the motorway, although local conditions mean that this is not necessarily a fixed function e.g. RB 28 & RB29 are at a similar location, as are RB31 & RB32.

Figure 3.3 shows data from the real time background NO_x monitoring site in Horley at the Scout Hut. From Figure 3.3 it is apparent that there are no exceedences of the 2005 hourly mean objective in 2002, and that the annual mean for 2002 is also below the 2005 objective. Figure 3.3 also shows data from the first seven months of the BAA / Reigate and Banstead joint site located in The Crescent, which is closer to the airport. Although the annual average NO_2 concentration for the BAA joint site is lower, it is worth pointing out that as the site has only been operating for seven months, it 'misses' the generally higher NO_2 concentrations in the earlier part of the year.

However, Figure 3.4 also suggests that the concentrations nearer to the airport are generally lower than those at the background site based on the data to date. This is surprising given the higher annual concentrations recorded by the diffusion tubes at the site in Riverside, which is also close to the airport, compared to the diffusion tubes located at the Scout hut (Michael Crescent, Figure 3.1), and so the real time monitoring data needs to be viewed with caution at the present time.

3.5.4 Conclusions and Recommendations

Screening of the major roads and junctions in the Borough using the DMRB model, examination of the 2002 monitoring data within the Borough, and detailed modelling of the NO_2 concentrations in the Borough undertaken as part of the stage 3 assessment, indicate that most areas of the Borough will meet, or are already below, the 2005 objective value for NO_2. However, a detailed assessment is recommended for the following sites:

i) The receptor on the SE corner of the junction of Rushworth Road and the A217 in Reigate, as the DMRB model suggests that this site will exceed the 2005 objectives for NO_2.

ii) The M25 AQMA with a view to narrowing the width of the declared AQMA.

iii) The M23 / A217 with a view to revoking the AQMAs at these sites.

iv) The Horley AQMA to better define the spatial extent of the AQMA.

Figure 3.3: 2002 Mean Daily NO_2 Concentrations in Horley (µg m^{-3}).

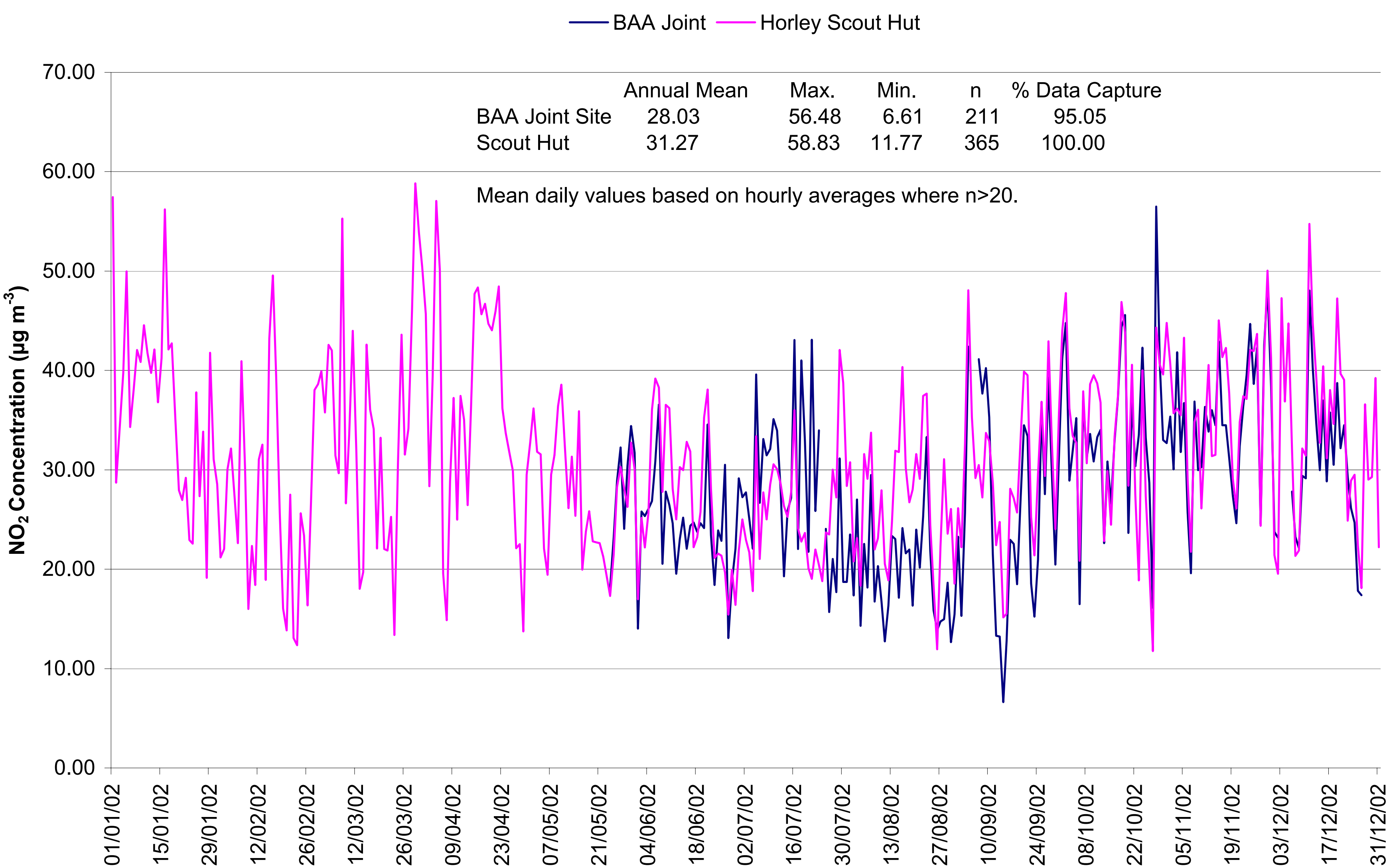
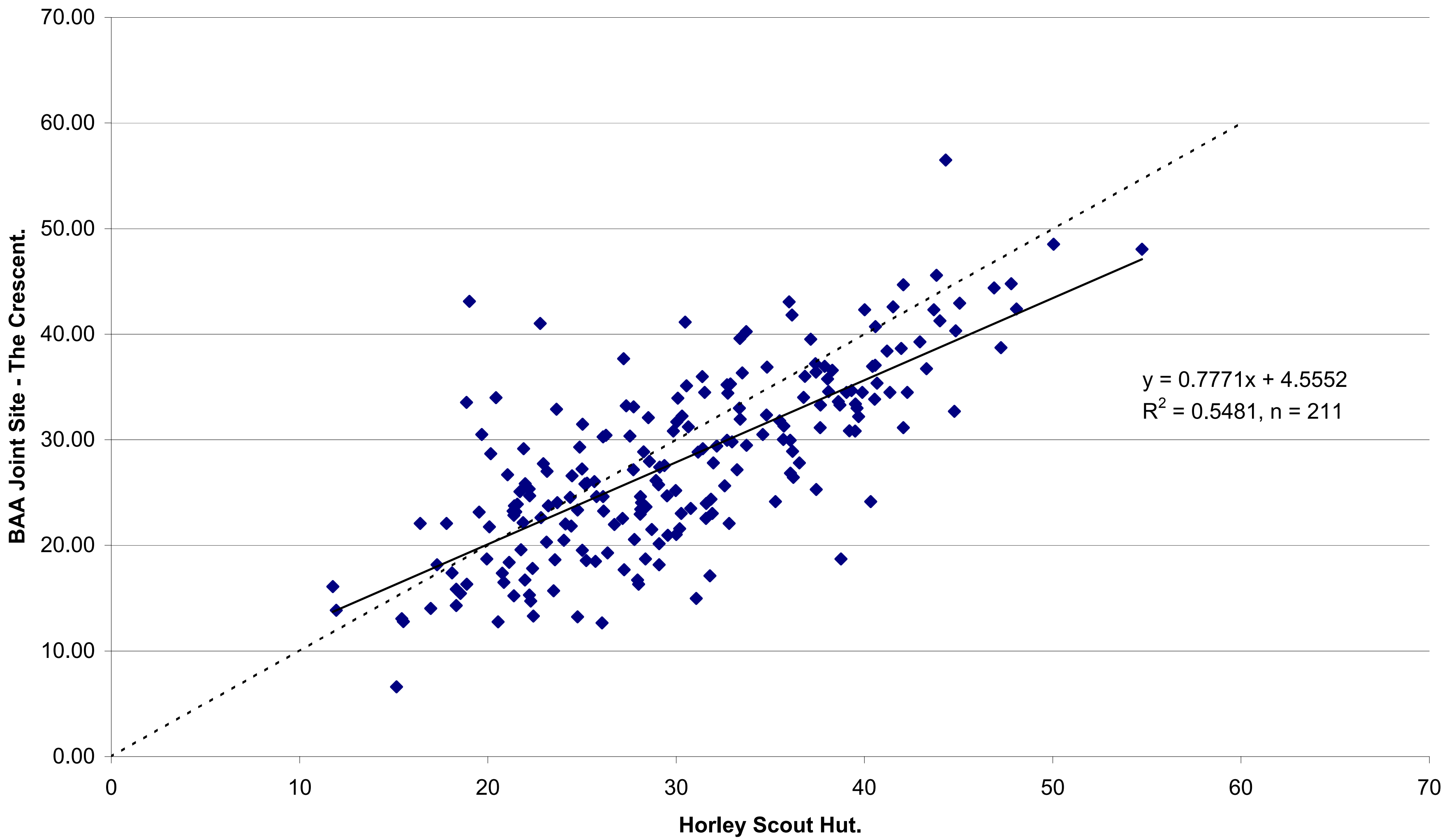


Figure 3.4: Correlation Between Daily NO_2 Concentrations (µg m^{-3}) at the Two Horley Monitoring Sites (2002 data).



3.6 Sulphur Dioxide (SO_2)

Objective values: 266 µg m^{-3} based on a fifteen minute mean which is to be exceeded no more than 35 times per year, and to be achieved by 31st December 2005. Also two further objectives have been set, to be achieved by the 31st December 2004:

i) 350 µg m^{-3} based on a 1 hour mean, with only 24 exceedences per year.

ii) 125 µg m^{-3} based on a 24 hour mean, which is not to be exceeded, more than 3 times per year.

3.6.1 Health Effects of Sulphur Dioxide

Sulphur dioxide is a respiratory irritant. Exposure to high concentrations causes coughing and chest tightness, but exposure to even relatively low concentrations comparable to the objective values can decrease lung function, particularly in asthmatics and other susceptible individuals.

3.6.2 Main Sources of Sulphur Dioxide in the UK

The biggest source of sulphur dioxide in the UK is power stations, although there are also significant industrial combustion sources, and domestic sources (coal burning) can be significant in localised areas. Road transport on the other hand is responsible for less than 1% of SO_2 in the UK (DEFRA, 2003a).

3.6.3 Sulphur Dioxide Concentrations in Reigate and Banstead

The main Part A processes in the vicinity of Reigate and Banstead emit less than 10 tonnes of SO_2 annually, and are around 7 km away, and so are unlikely to lead to an exceedence of the sulphur dioxide air quality objectives within the Borough. This was also the conclusion of the original stage 1 assessment in 1999 (SEIPH, 1999a). The Croydon Energy power plant (Figure 2.1a) is not yet operational, but is a new gas fired power station built since the 1999 assessment. As a gas fired plant emissions of SO_2 are likely to be minimal, and detailed modelling of the plant by the company shows that plumes from the power station ground within a couple hundred metres of the power plant, and so will have little impact on air quality within the Borough.

Within Reigate and Banstead there are no industrial processes likely to emit significant amounts of SO_2, which might lead to a breach of the air quality objectives. Witmum engineering operates a small (0.4 MW) waste oil burner but the technical guidance indicates that only boilers over 5 MW in size are likely to risk a breach of the objective values, and there are no such boilers of this size operating within the Borough.

Domestic heating in the Borough is unlikely to lead to a breach of the objectives since the majority of housing in the area uses natural gas and / or electricity as a primary heating source, rather than coal.

Traffic is not considered a significant emission source of SO_2 at the national level (DEFRA, 2003a), and therefore there is no reason for traffic to be a significant source within Reigate and Banstead.

Limited monitoring of SO_2 is undertaken in Reigate and Banstead, with tubes located at three points in the Borough, Horley, Reigate, and Banstead. However, the aim of this monitoring, using diffusion tubes (Lambeth Scientific), is to monitor long term annual background SO_2 concentrations and so the data is not appropriate for examining 15 minute and 24 hour averages, as used in the standards.

3.6.4 Conclusions and Recommendations

Reigate and Banstead is unlikely to breach the various objective values for SO_2, as there are no significant industrial sources either in or near the Borough. Exceedences of the standards are also unlikely due to domestic heating as the majority of houses in the Borough use natural gas or electricity as there primary source of heating.

Therefore a detailed assessment of sulphur dioxide concentrations in Reigate and Banstead is **not** required.

3.7 Particulate Matter less than 10 µm in Aerodynamic Diameter (PM_{10})

Objective values: 40 µg m^{-3} annual mean, with a fixed 24 hour average limit value of 50 µg m^{-3} which is to be exceeded no more than 35 times per year, with both objectives to be met by 31st December 2004. There is also a *proposed* further objective to be achieved by 31st December 2010 of 20 µg m^{-3} annual mean, with a fixed 24 hour limit value of 50 µg m^{-3} to be exceeded no more than 7 times per year.

There is no statutory requirement to examine PM_{10} concentrations in the Borough against the 2010 PM_{10} objective as part of this review and assessment, but this has been done to give the council an indication of whether the Borough is likely to meet the objective.

3.7.1 Health Effects of PM_{10}

Epidemiological studies have shown a positive linear relationship between PM_{10} concentrations and the exacerbation of asthma, chronic obstructive pulmonary disease (COPD), and cardiovascular diseases i.e. heart attacks and strokes. These studies also indicate that the relationship is without a threshold value i.e. no 'safe' dose. However, while the epidemiologists are able to show such effects at ambient PM_{10} concentrations, toxicological studies are unable to show similar effects at the low concentrations found in the ambient environment, and so as yet there is no clear understanding of the mechanism by which PM_{10} causes these adverse health effects. At the present time research is focused on particle composition and / or particle size, particularly the very fine particles under 1 µm, which are a constituent of PM_{10}.

3.7.2 The Main Sources of PM_{10} in the UK

PM_{10} consists of particles from a number of different sources, and is composed of what is termed a primary and secondary component. Primary particles are derived from fuel combustion, but also arise from resuspended dust from roads, construction work, wind blown soil, and even pollen and fungal spores. Secondary particles result from chemical reactions in the atmosphere between SO_2 and NO_x, and in many cases are transboundary in origin. Figure 3.5 gives an indication of some of the different sources that will make up an 'average' PM_{10} sample in the UK.

Type of particle	Source location	Main source categories	Main source types	Typical contribution to annual mean concentration (µg/m³ gravi.)
Coarse 2.5-10µm	Immediate local (very close)	Traffic	resuspended dusts tyre wear	1 - 6
		Industry	fugitive dusts stockpiles quarries construction	variable, up to 5
	Urban background	Traffic	resuspended dusts tyre wear	1 - 2
		Industry	fugitive dusts stockpiles quarries construction	variable, up to 2
	Regional (including distant sources)	Natural	resuspended dust/soil sea salt biological	2 - 3 1 - 2 1
Fine <2.5µm	Immediate local (very close)	Traffic	vehicle exhaust	1 - 4
		Industry	combustion industrial processes	variable
		Domestic	coal combustion	variable
	Urban background	Traffic	vehicle exhaust	1 - 4
		Industry	combustion industrial processes	variable, up to 8
		Domestic	coal combustion	variable, up to 8
	Regional (including distant sources)	Secondary	power stations industrial processes vehicles	4 - 8
		Primary (Imported)	power stations vehiclesw industrial processes	1 - 2
		Natural	sea salt	<1

Figure 3.5: Typical Composition and Sources of an 'average' PM_{10} Sample (DEFRA, 2003a).

Thus it is important to realise that several of the factors which govern PM_{10} concentrations are to an extent outside of the Councils control, and that much of the PM_{10} in the Borough is likely to be a regional wide background concentration.

3.7.3 Sources of PM_{10} in Reigate and Banstead

There are no industrial sources of PM_{10} either within the Borough or in the vicinity of the Borough, which will have a significant impact on the PM_{10} concentrations recorded within the Borough (Figure 2.1a/b, Table 2.1). This is due to either little or no PM_{10} being released by industry within the Borough and / or the distances the released particles need to be transported to the nearest receptors in the Borough. MBB minerals was identified as a potential source of localised PM_{10} in the original stage 1 assessment of the Borough (SEIPH, 1999a), but not considered significant at that time, and this site will close by 31st March 2004. The other potential source of PM_{10} within the Borough is a landfill site operated by Biffa waste near Redhill. However, at this site the nearest receptor is over 500 m away and there have been no complaints about dust from the site, nor does there appear to be a dust problem when visiting the site, and so PM_{10} concentrations are unlikely to breach the objective values.

Domestic heating in the Borough is unlikely to lead to a breach of the objectives since the majority of housing in the area uses natural gas and / or electricity as a primary heating source, rather than coal.

To assess the likelihood of the PM_{10} objectives being breached by traffic, the DMRB model was run at a number of potential 'hot spots' (as discussed in Section 2.2) in the Borough, and the results for 2004 are 2010 are shown in Appendix A. The ten highest locations in 2004 and 2010 are shown in Table 3.8 below.

Receptor	Location	2004 ($\mu g\ m^{-3}$)	Days >50mg m^{-3}	Receptor	Location	2010 ($\mu g\ m^{-3}$)	Days >50mg m^{-3}
16	A217 / Rushworth Road	33.3	41	**16**	A217 / Rushworth Road	25.2	13
69	M25 (Ashcombe Road)	28.5	22	**69**	M25 (Ashcombe Road)	23.2	9
8	A217/A240	26.7	17	**8**	A217/A240	21.9	6
36	A2022 / B2218 / B2217	25.7	14	**36**	A2022 / B2218 / B2217	21.5	5
29	A240 / A2022 / B291	25.3	13	**29**	A240 / A2022 / B291	21.4	5
39	A2022 / B2218 / B2217	25.2	13	**39**	A2022 / B2218 / B2217	21.3	5
38	A2022 / B2218 / B2217	24.8	12	**17**	A25 Castlefield Rd / A25 Church St.	21.3	5
33	A240 / B2221	24.8	12	**38**	A2022 / B2218 / B2217	21.1	5
17	A25 Castlefield Rd / A25 Church St.	24.6	12	**33**	A240 / B2221	21.0	5
32	A240 / B2221	24.3	11	**5**	A217/B2221	20.8	4
				Lowest of the Sites examined:			
				15	A217 / M25 (Lowest ranked of 74 sites)	18.2	2

Table 3.8: Highest Annual Average PM_{10} Concentrations in Reigate and Banstead (2004 and 2010 - DMRB modelled data).

3.7.3.1 PM_{10} Concentrations in the Borough and the 2004 Objective

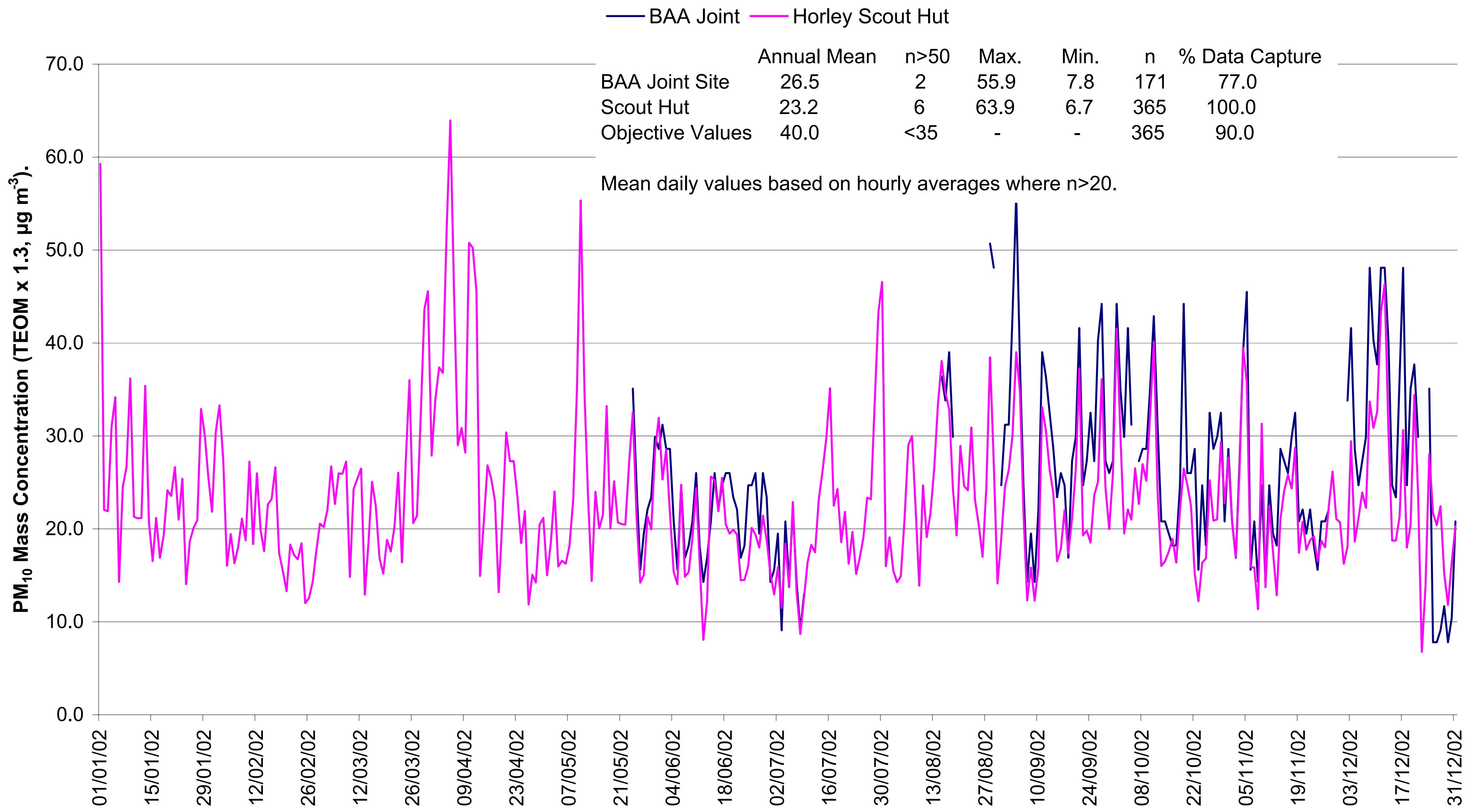
Table 3.8 demonstrates that there is only one potential site in Reigate and Banstead that will breach the 2004 objective of no more than 35 exceedences of the 50 µg m^{-3} fixed 24 hour average concentration, and that is the A217 / Rushworth Road receptor. However, this site is within the annual objective value of 40 µg m^{-3}. Therefore a detailed assessment of the site in terms of PM_{10} is required to confirm the model findings.

Elsewhere in the Borough PM_{10} concentrations are predicted to be well below the objective values, both in terms of the annual average objective value and the number of exceedences of the 50 µg m^{-3} 24 hour average objective, which agrees with the findings of the stage 3 assessment of PM_{10} (AQC, 2001).

As previous assessments of PM_{10} concentrations in the Borough suggest concentrations below the objective values, monitoring of PM_{10} only takes place at two sites in Horley, the Scout Hut and The Crescent, both using TEOMs. The Scout Hut site is used to examine trends in urban background concentrations of PM_{10} in the Borough, while The Crescent site monitors the PM_{10} concentrations at residences close to Gatwick airport. The results from these sites are shown in Figure 3.6.

The TEOM data from the Scout Hut in Horley demonstrates that the area is below the PM_{10} objectives for 2004 as would be expected. The site in The Crescent (BAA joint site) has a slightly higher annual average concentration, but the site has operated for less than a year and there have also been a number of technical problems. As the data capture at The Crescent site is less than 90 %, and the site has operated for less than a year, no 'real' comparisons can be made to the objective values. The technical problems associated with The Crescent site are also apparent from the complete lack of correlation between mass concentrations at the two sites (Figure 3.7), which are less than 400 m apart.

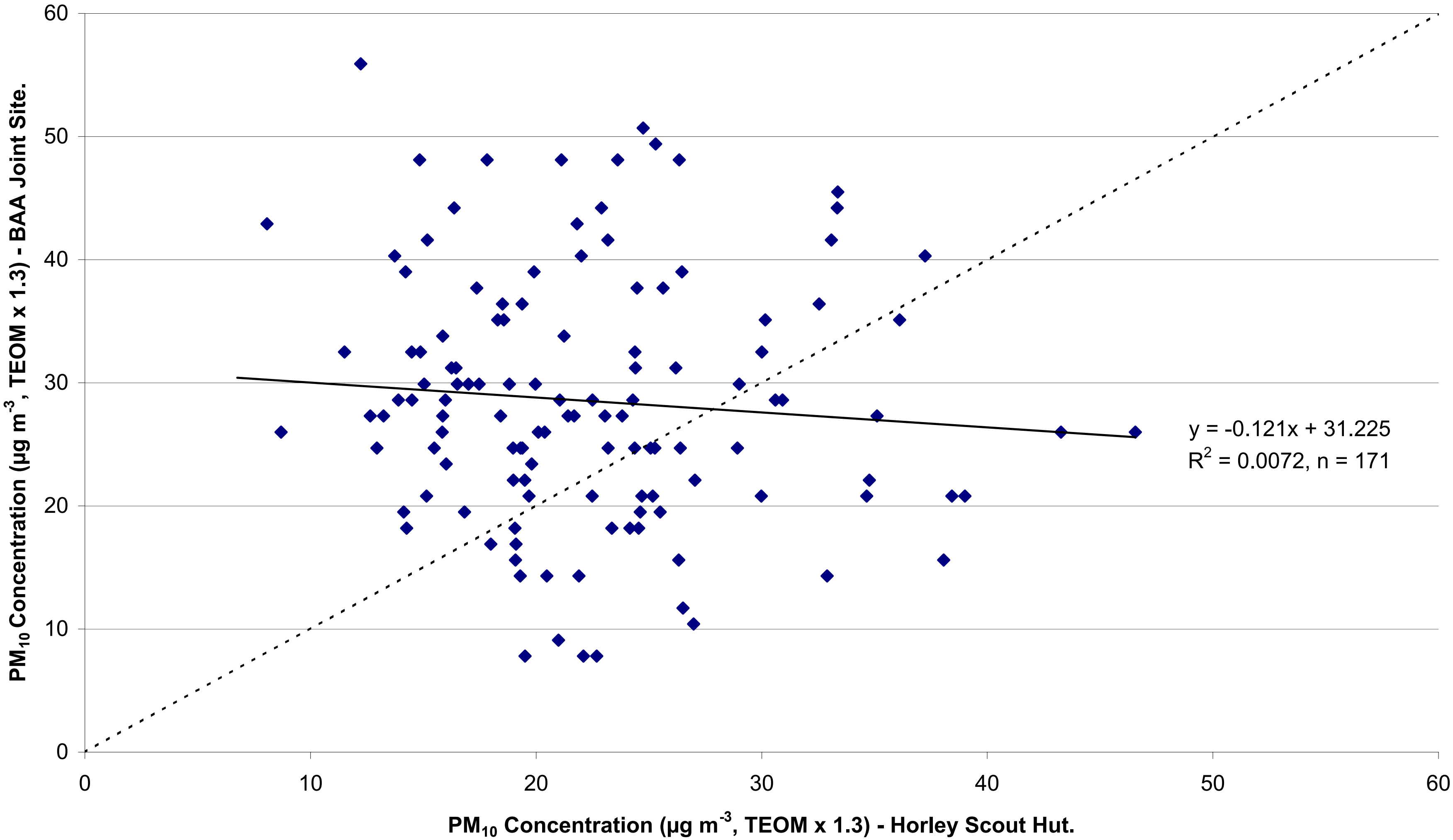
Figure 3.6: 2002 Mean Daily PM_{10} Concentrations in Horley (µg m^{-3}, TEOM x 1.3).



	Annual Mean	n>50	Max.	Min.	n	% Data Capture
BAA Joint Site	26.5	2	55.9	7.8	171	77.0
Scout Hut	23.2	6	63.9	6.7	365	100.0
Objective Values	40.0	<35	-	-	365	90.0

Mean daily values based on hourly averages where n>20.

Figure 3.7: Correlation between Daily PM_{10} Concentrations (µg m^{-3}, TEOM x 1.3) at the Two Horley Monitoring Sites (2002 data).



The technical guidance (DEFRA, 2003a) states that where there is relevant exposure within 500 m of an airport boundary, and where the airport passenger throughput exceeds 10 million passengers per annum, then a detailed assessment for PM_{10} is required. However, as the council has already examined the south Horley site in detail as part of the stage 3 assessment (AQC, 2001), and found that PM_{10} concentrations in the area will be below the 2004 objectives, a detailed assessment of Horley is not required.

However, it is recommended that:

i) PM_{10} monitoring in The Crescent continue for a further year given the problems to date, to confirm the findings of the stage 3 modelling that the PM_{10} concentrations in this area will meet the objective values.

ii) a detailed assessment is undertaken to assess the future impact of the airport on Horley should significant development of the site be confirmed before 2006/7.

3.7.3.2 PM_{10} Concentrations in the Borough and the Proposed 2010 Objective

There is no statutory requirement on the Council to assess PM_{10} concentrations in the Borough against the proposed 2010 objective. However, the aim of this section is to give 'advanced warning' of potential problem areas within the Borough. This section focuses mainly on traffic derived PM_{10}, as it is impossible to speculate on what industries may or may not locate in the Borough over the next 7 years. It has also been assumed that industry in the areas surrounding the Borough remains 'as is', although it is likely that increasingly stringent control measures will mean even smaller releases of PM_{10} than at present.

The 2010 PM_{10} concentrations at various major junctions and roads around the Borough were therefore calculated using the DMRB model, and the results are presented in Appendix A. The 10 highest areas are shown in Table 3.8. As can be seen from Table 3.8 the Rushworth Road / A217 site and the M25 Ashcombe Road site both fail to meet the proposed 2010 objective of an annual average concentration of 20 $\mu g\ m^{-3}$, and also the exceedence objective of less than 7 days over 50 $\mu g\ m^{-3}$, based on fixed 24 hour means. However, while the remainder of the sites examined meet the objective for less than 7 days over 50 $\mu g\ m^{-3}$, several fail to meet the objective of an annual average concentration of 20 $\mu g\ m^{-3}$. Out of the 74 receptors examined, only 32 of the sites had annual average concentrations below 20 $\mu g\ m^{-3}$.

Table 3.8 also demonstrates that even the site with the lowest of the modelled PM_{10} concentrations (18.9 µg m^{-3}) was less than 10 % below the annual concentration objective. The concentrations in Table 3.8 are calculated from estimated background PM_{10} concentrations in 2010, road traffic predictions for 2010, and estimated improvements in PM_{10} emissions from vehicles by 2010. Thus the uncertainty associated with the calculated concentrations is likely to exceed 10 %, and so potentially a far higher number of sites in the Borough would be likely to exceed the 2010 annual objective concentration.

When the regional background PM_{10} concentrations across the Borough are plotted as isopleth maps in 2004 and 2010 (Figure 3.8), i.e. PM_{10} present in the air regardless of the traffic in the Borough, it is apparent that the 'regional' contribution in 2004 is around 20 - 21 µg m^{-3} - roughly half of the annual average objective value for 2004. However, while the regional background concentration decreases slightly by 2010, this now represents a minimum of 87 % of the proposed annual average objective concentration, and for a large number of the sites in Reigate and Banstead over 90 % of the modelled PM_{10} concentration in 2010. Thus by 2010 the actions that the Council can take to comply with the objective value will at best only bring about very small changes in the measured PM_{10} mass concentration.

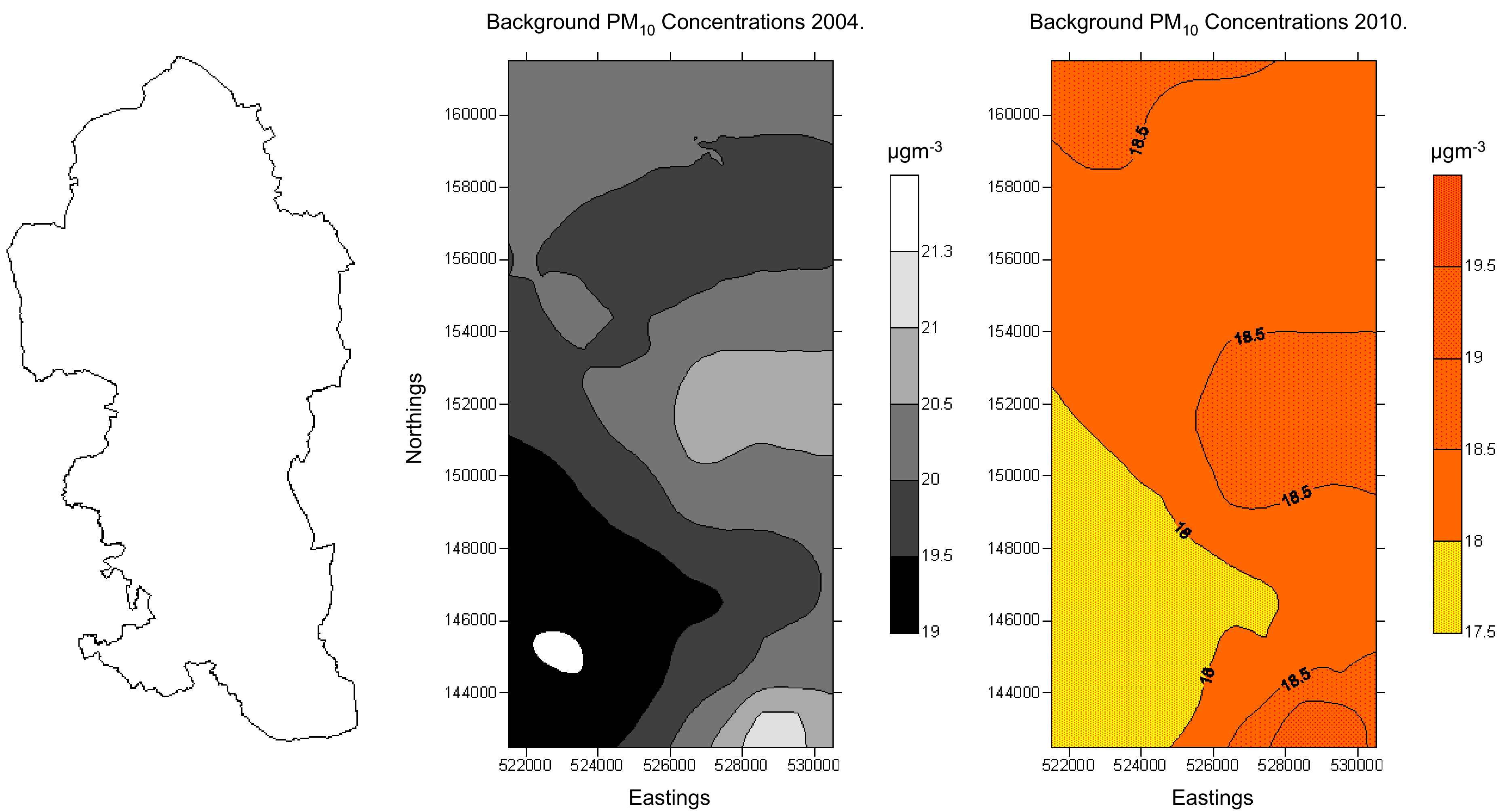


Figure 3.8: Regional / Background PM_{10} Concentrations in 2004 and 2010 in Reigate and Banstead.

3.7.4 Conclusions and Recommendations

PM_{10} concentrations in the Borough are generally below the 2004 objective values. However, a single site on the SE corner of the junction between Rushworth Road and the A217 requires a detailed assessment with respect to exceedences of the 50 $\mu g\ m^{-3}$ objective.

As there have been no significant changes since the stage 3 assessment in traffic flows south of Horley, and in the operation of Gatwick airport, a detailed assessment of PM_{10} with respect to the 2004 objective is not required. However, a detailed assessment will be required for the southern half of Horley with respect to the 2004 objective should any significant changes take place at Gatwick airport.

Analysis of the predicted PM_{10} concentrations within the Borough due to road traffic in 2010, indicate that a number of sites are likely to exceed the proposed 2010 objective for the annual average concentration. However, the regional background particle concentration across the Borough in 2010 is likely to represent nearly 90 % of annual average 2010 objective value, and thus the Councils ability to effect large changes in the concentrations of PM_{10} to achieve the objective value will be limited.

As the assessment of the 2010 objective is not a statutory requirement, it is not proposed at this stage that a detailed assessment is carried out to examine PM_{10} concentrations with respect to the 2010 objective, as emissions factors for traffic, and traffic count predictions are prone to change over such a long time frame. However, it is proposed that when a new Part A or B industrial process which emits PM_{10} locates in the Borough, that the environmental impact statement examines the emissions with respect to both the 2004 and proposed 2010 objective values.

4.0 Conclusions

The updating and screening assessment procedure indicates that the air quality in Reigate and Banstead will meet and in most cases is considerably lower than the Government objective values for carbon monoxide, benzene, 1,3 butadiene, lead and sulphur dioxide, and therefore there is no need to proceed to a detailed assessment of these pollutants.

Nitrogen dioxide concentrations in the Borough in general also meet or are below the Government objectives for the appropriate year. However, for the following sites a detailed assessment of nitrogen dioxide concentrations is required:

i) the property on the SE corner of the junction of Rushworth Road and the A217, as the site is predicted to breach the 2005 objective value.

ii) M25 with a view to narrowing the AQMA.

iii) M23 and properties on the A217 with a view to narrowing the AQMAs / revoking them.

iv) The southern area of Horley to better define the extent of the AQMA.

PM_{10} concentrations throughout the Borough are generally below the 2004 objective values. However, a detailed assessment is required for a single site at the SE corner of the junction of the A217 and Rushworth Road, with respect to the number of exceedences of the 50 $\mu g\ m^{-3}$ 24 hour fixed average value.

Although there are no statutory requirements for the Council to examine the 2010 PM_{10} objectives, it is predicted that a number of sites within the Borough will fail to meet the proposed annual average objective for PM_{10}. At these sites and elsewhere in the Borough around 90 % of the measured PM_{10} concentration will derive from the regional background concentration, over which the council has little control. At this stage a detailed assessment of PM_{10} concentrations in relation to road traffic against the proposed 2010 objectives is not considered appropriate. This decision is based on the fact that the 2010 objective values are still only proposals, and as emissions factors and predicted traffic counts are more likely to change over a 6 year period than the 3 year period between the 2007 detailed assessment and the proposed 2010 objective date.

<u>Appendix A.</u>

DMRB Modelling Results.

Receptor	Location or Junction	Year	CO Annual mean (mgm^{-3})	Benzene Annual mean (μgm^{-3})	1,3-butadiene Annual mean (μgm^{-3})	NO_x Annual mean (μgm^{-3})	NO_2 Annual mean (μgm^{-3})	PM_{10} Annual mean (μgm^{-3})	PM_{10} Days > 50 μgm^{-3}
1	A217/A2022	2003	0.44	0.76	0.40	71.8	32.8		
2	A217/A2022	2003	0.39	0.68	0.34	63.2	30.9	Only assessed for	
3	A217/A2022	2003	0.34	0.60	0.26	51.4	28.1	2004 & 2010	
4	A217/B2221	2003	0.50	0.80	0.41	77.7	34.0		
5	A217/B2221	2003	0.52	0.81	0.42	80.3	34.5		
6	A217/A240	2003	0.47	0.78	0.48	83.1	34.8		
7	A217/A240	2003	0.46	0.76	0.46	80.9	34.4		
8	A217/A240	2003	0.56	0.86	0.60	106.0	39.0		
9	A217 / B2032 (Bons.Dr.)	2003	0.30	0.49	0.22	49.7	27.6		
10	A217 / B2032 / B2220	2003	0.39	0.61	0.34	73.8	33.1		
11	A217 / B2032 / B2220	2003	0.43	0.65	0.39	82.7	34.8		
12	A217 nr M25	2003	0.38	0.64	0.44	73.9	32.6		
13	A217 / M25	2003	0.27	0.42	0.22	44.6	25.8		
14	A217 / M25	2003	0.33	0.60	0.51	70.3	31.8		
15	A217 / M25	2003	0.28	0.42	0.20	45.1	25.9		
16	A217 / Rushworth Road	2003	0.88	1.05	0.97	152.1	47.2		
17	A25 Castlefield Rd / A25 Church St	2003	0.53	0.70	0.44	80.7	35.3		
18	A25 Church St after Bancroft Road	2003	0.52	0.74	0.46	77.7	34.7		
19	Corner A25 Church St & A21 Bell St	2003	0.44	0.59	0.37	76.6	34.5		
20	A25 Reigate High Street	2003	0.43	0.59	0.36	76.4	34.4		
21	A217 / A2044	2003	0.36	0.49	0.26	58.2	29.1		
22	A217 / A2044	2003	0.37	0.50	0.27	59.8	29.4		
23	A217 / A2044	2003	0.49	0.66	0.41	78.1	33.3		
24	A217 / A2044	2003	0.41	0.63	0.39	63.6	30.3		
25	A240 / A2022 / B291	2003	0.44	0.69	0.34	68.9	32.5		
26	A240 / A2022 / B291	2003	0.44	0.70	0.36	73.0	33.4		
27	A240 / A2022 / B291	2003	0.47	0.72	0.38	82.9	35.4		
28	A240 / A2022 / B291	2003	0.44	0.69	0.34	72.0	33.2		
29	A240 / A2022 / B291	2003	0.52	0.78	0.44	91.5	37.1		
30	A240 / B2221	2003	0.43	0.67	0.33	69.1	32.3		
31	A240 / B2221	2003	0.44	0.69	0.37	79.2	34.4		
32	A240 / B2221	2003	0.47	0.72	0.41	84.7	35.5		
33	A240 / B2221	2003	0.48	0.75	0.45	87.2	36.0		
34	B290 near junction B2221	2003	0.34	0.75	0.24	53.1	28.7		
35	B290 near junction B2221	2003	0.38	0.79	0.27	59.4	30.3		
36	A2022 / B2218 / B2217	2003	0.50	0.86	0.57	100.9	38.5		
37	A2022 / B2218 / B2217	2003	0.41	0.72	0.40	76.5	33.8		
38	A2022 / B2218 / B2217	2003	0.50	0.83	0.49	87.1	35.9		
39	A2022 / B2218 / B2217	2003	0.51	0.83	0.50	93.8	37.2		
40	A2022 / B2218 / B2217	2003	0.40	0.74	0.46	76.9	33.9		
41	A240 / B284	2003	0.37	0.62	0.30	64.9	31.5		
42	A240 / B284	2003	0.37	0.60	0.26	56.5	29.6		
43	A23 / M23	2003	0.34	0.48	0.26	67.9	32.9		
44	A23 / M23	2003	0.38	0.52	0.31	86.1	36.7		
45	A23 / M23	2003	0.37	0.52	0.32	83.6	36.2		
46	A23 / M23	2003	0.34	0.49	0.27	69.2	33.1		
47	A23 / M23	2003	0.35	0.51	0.30	74.2	34.2		
48	A23 / M23	2003	0.35	0.56	0.37	69.9	33.3		
49	A23 / M23	2003	0.37	0.52	0.28	75.0	34.7		
50	A23 / School Hill	2003	0.44	0.60	0.36	86.0	37.4		
51	A23 / School Hill	2003	0.44	0.59	0.36	86.3	37.4		
52	A23 / A242	2003	0.37	0.53	0.29	69.7	34.2		
53	A23 / A242	2003	0.46	0.62	0.37	83.5	37.1		
54	A23 / A242	2003	0.47	0.63	0.38	84.2	37.3		

Receptor	Location or Junction	Year	CO Annual mean (mgm^{-3})	Benzene Annual mean (μgm^{-3})	1,3-butadiene Annual mean (μgm^{-3})	NO_x Annual mean (μgm^{-3})	NO_2 Annual mean (μgm^{-3})	PM_{10} Annual mean (μgm^{-3})	PM_{10} Days > 50 μgm^{-3}
55	A23 / Princess Way	2003	0.46	0.66	0.39	76.6	34.5		
56	A23 / A2044	2003	0.39	0.52	0.31	73.0	32.8		
57	A23 / B2036	2003	0.39	0.54	0.31	72.5	33.7		
58	A23 / B2036	2003	0.43	0.55	0.31	71.8	33.6		
59	A23 / B2036	2003	0.48	0.62	0.37	82.4	35.8		
60	A23 / B2036	2003	0.41	0.54	0.31	72.3	33.7		
61	A23 / B2036	2003	0.37	0.49	0.27	64.4	31.9		
62	A23 / A217	2003	0.35	0.50	0.26	58.8	30.4		
63	A23 / A217	2003	0.36	0.53	0.30	64.2	31.7		
64	A242 / A25	2003	0.45	0.63	0.37	76.5	34.5		
65	A242 / A25	2003	0.48	0.66	0.39	77.0	34.6		
66	A242 / A25	2003	0.44	0.60	0.34	70.0	33.1		
67	A25 Hatchlands Rd	2003	0.45	0.63	0.34	70.8	33.4		
68	A25 Reigate Road	2003	0.45	0.65	0.38	75.2	34.5		
69	M25 (Ashcmb Rd / Glade Hse)	2003	0.48	1.05	1.21	143.6	46.8		
70	M25 (Ashcmb Rd / Glade Hse)	2003	0.35	0.65	0.56	83.0	36.4		
71	M25 / M23	2003	0.27	0.40	0.17	48.6	28.8		
72	M25 / M23	2003	0.27	0.39	0.16	46.5	28.2		
73	M25 / M23	2003	0.31	0.47	0.28	61.1	32.0		
74	M25 / M23	2003	0.30	0.44	0.22	59.0	31.5		

Receptor	Name	Year	CO Annual mean (mgm^{-3})	Benzene Annual mean (μgm^{-3})	1,3-butadiene Annual mean (μgm^{-3})	NO_x Annual mean (μgm^{-3})	NO_2 Annual mean (μgm^{-3})	PM_{10} Annual mean (μgm^{-3})	PM_{10} Days > 50 μgm^{-3}
1	A217/A2022	2004	0.39	0.69	0.36	69.3	32.0	23.2	9
2	A217/A2022	2004	0.35	0.63	0.30	60.7	30.1	22.2	7
3	A217/A2022	2004	0.31	0.55	0.23	49.6	27.4	20.9	5
4	A217/B2221	2004	0.44	0.72	0.35	73.0	32.8	23.8	10
5	A217/B2221	2004	0.45	0.73	0.36	75.3	33.3	24.1	10
6	A217/A240	2004	0.42	0.69	0.41	77.9	33.6	24.1	10
7	A217/A240	2004	0.41	0.68	0.39	76.0	33.2	23.9	10
8	A217/A240	2004	0.49	0.77	0.51	98.9	37.5	26.7	17
9	A217 / B2032 (Bons.Dr.)	2004	0.27	0.45	0.20	47.8	26.8	20.4	4
10	A217 / B2032 / B2220	2004	0.35	0.55	0.29	69.3	31.9	22.7	8
11	A217 / B2032 / B2220	2004	0.38	0.59	0.33	77.3	33.5	23.6	9
12	A217 nr M25	2004	0.34	0.58	0.38	69.7	31.5	22.8	8
13	A217 / M25	2004	0.25	0.40	0.19	43.0	25.2	20.0	3
14	A217 / M25	2004	0.30	0.54	0.45	66.7	30.8	22.3	7
15	A217 / M25	2004	0.25	0.39	0.17	42.4	25.0	19.9	3
16	A217 / Rushworth Road	2004	0.76	0.91	0.81	138.9	45.0	33.3	41
17	A25 Castlefield Rd / A25 Church St	2004	0.47	0.63	0.38	77.3	34.4	24.6	12
18	A25 Church St after Bancroft Road	2004	0.35	0.49	0.28	65.9	31.9	22.7	8
19	Corner A25 Church St & A21 Bell St	2004	0.40	0.55	0.33	73.4	33.5	23.8	10
20	A25 Reigate High Street	2004	0.41	0.56	0.34	75.9	34.1	24.0	10
21	A217 / A2044	2004	0.32	0.45	0.23	55.3	28.2	21.7	6
22	A217 / A2044	2004	0.34	0.47	0.24	58.2	28.8	22.1	6
23	A217 / A2044	2004	0.42	0.59	0.34	72.8	32.0	24.1	10
24	A217 / A2044	2004	0.36	0.56	0.33	59.7	29.2	22.5	7
25	A240 / A2022 / B291	2004	0.39	0.63	0.30	66.2	31.7	23.0	8
26	A240 / A2022 / B291	2004	0.40	0.64	0.31	69.7	32.4	23.4	9
27	A240 / A2022 / B291	2004	0.42	0.66	0.33	77.5	34.1	24.0	10
28	A240 / A2022 / B291	2004	0.39	0.64	0.30	67.9	32.1	23.0	8
29	A240 / A2022 / B291	2004	0.46	0.71	0.38	86.8	35.9	25.3	13
30	A240 / B2221	2004	0.38	0.61	0.29	65.5	31.3	23.0	8
31	A240 / B2221	2004	0.39	0.63	0.32	74.4	33.2	23.6	9
32	A240 / B2221	2004	0.41	0.66	0.35	79.8	34.3	24.3	11
33	A240 / B2221	2004	0.43	0.68	0.39	82.2	34.8	24.8	12
34	B290 near junction B2221	2004	0.31	0.70	0.21	51.1	28.0	21.0	5
35	B290 near junction B2221	2004	0.34	0.74	0.24	56.9	29.5	21.7	6
36	A2022 / B2218 / B2217	2004	0.44	0.78	0.49	95.0	37.1	25.7	14
37	A2022 / B2218 / B2217	2004	0.38	0.68	0.37	73.3	32.9	23.5	9
38	A2022 / B2218 / B2217	2004	0.44	0.75	0.43	83.0	34.9	24.8	12
39	A2022 / B2218 / B2217	2004	0.45	0.75	0.43	88.7	36.0	25.2	13
40	A2022 / B2218 / B2217	2004	0.36	0.68	0.40	72.7	32.8	23.2	9
41	A240 / B284	2004	0.33	0.57	0.27	62.0	30.6	22.1	6
42	A240 / B284	2004	0.33	0.56	0.23	54.1	28.8	21.5	5
43	A23 / M23	2004	0.32	0.46	0.25	73.7	33.9	22.8	8
44	A23 / M23	2004	0.34	0.48	0.28	83.7	35.9	23.8	10
45	A23 / M23	2004	0.33	0.48	0.29	80.9	35.4	23.5	9
46	A23 / M23	2004	0.30	0.45	0.25	67.5	32.5	22.0	6
47	A23 / M23	2004	0.32	0.47	0.27	72.6	33.6	22.5	7
48	A23 / M23	2004	0.31	0.52	0.33	68.2	32.7	22.2	7
49	A23 / M23	2004	0.33	0.48	0.25	71.6	33.7	22.5	7
50	A23 / School Hill	2004	0.39	0.54	0.31	81.6	36.2	23.8	10
51	A23 / School Hill	2004	0.39	0.54	0.31	82.0	36.3	23.9	10
52	A23 / A242	2004	0.33	0.49	0.25	66.4	33.2	22.1	7
53	A23 / A242	2004	0.40	0.56	0.32	80.0	36.2	23.9	10
54	A23 / A242	2004	0.41	0.57	0.33	80.9	36.3	24.1	10

Receptor	Name	Year	CO Annual mean (mgm^{-3})	Benzene Annual mean (µgm^{-3})	1,3-butadiene Annual mean (µgm^{-3})	NO_x Annual mean (µgm^{-3})	NO_2 Annual mean (µgm^{-3})	PM_{10} Annual mean (µgm^{-3})	PM_{10} Days > 50 µgm^{-3}
55	A23 / Princess Way	2004	0.41	0.59	0.33	72.6	33.4	23.7	9
56	A23 / A2044	2004	0.35	0.47	0.28	69.6	31.8	22.8	8
57	A23 / B2036	2004	0.35	0.49	0.27	68.8	32.7	22.5	7
58	A23 / B2036	2004	0.38	0.51	0.27	68.8	32.7	22.9	8
59	A23 / B2036	2004	0.43	0.56	0.32	78.5	34.7	24.1	10
60	A23 / B2036	2004	0.37	0.49	0.27	69.3	32.8	22.9	8
61	A23 / B2036	2004	0.33	0.46	0.23	61.8	31.1	22.0	6
62	A23 / A217	2004	0.31	0.47	0.23	56.4	29.6	21.5	5
63	A23 / A217	2004	0.33	0.49	0.26	61.6	30.9	22.0	6
64	A242 / A25	2004	0.40	0.57	0.32	73.1	33.5	23.6	9
65	A242 / A25	2004	0.42	0.59	0.34	73.7	33.6	23.8	10
66	A242 / A25	2004	0.39	0.55	0.30	67.3	32.2	23.0	8
67	A25 Hatchlands Rd	2004	0.40	0.57	0.30	67.6	32.5	23.2	8
68	A25 Reigate Road	2004	0.40	0.59	0.33	71.9	33.6	23.5	9
69	M25 (Ashcmb Rd / Glade Hse)	2004	0.43	0.93	1.06	134.3	45.1	28.5	22
70	M25 (Ashcmb Rd / Glade Hse)	2004	0.31	0.59	0.49	78.8	35.3	22.9	8
71	M25 / M23	2004	0.25	0.38	0.15	47.0	28.2	19.9	3
72	M25 / M23	2004	0.26	0.39	0.17	50.6	29.1	20.2	4
73	M25 / M23	2004	0.28	0.44	0.25	58.8	31.2	21.1	5
74	M25 / M23	2004	0.27	0.41	0.20	57.1	30.8	20.9	5

Receptor	Name	Year	**CO** Annual mean (mgm^{-3})	**Benzene** Annual mean (μgm^{-3})	**1,3-butadiene** Annual mean (μgm^{-3})	**NO_x** Annual mean (μgm^{-3})	**NO_2** Annual mean (μgm^{-3})	**PM_{10}** Annual mean (μgm^{-3})	**PM_{10}** Days > 50 μgm^{-3}
1	A217/A2022	2005	0.35	0.64	0.32	67.6	31.4		
2	A217/A2022	2005	0.32	0.58	0.27	58.8	29.5	Only assessed for	
3	A217/A2022	2005	0.28	0.52	0.21	48.0	26.8	2004 & 2010	
4	A217/B2221	2005	0.39	0.66	0.31	69.3	31.8		
5	A217/B2221	2005	0.41	0.67	0.32	71.4	32.3		
6	A217/A240	2005	0.37	0.63	0.36	73.8	32.5		
7	A217/A240	2005	0.37	0.62	0.35	72.0	32.2		
8	A217/A240	2005	0.43	0.70	0.45	93.2	36.3		
9	A217 / B2032 (Bons.Dr.)	2005	0.25	0.42	0.18	46.1	26.2		
10	A217 / B2032 / B2220	2005	0.32	0.51	0.26	65.8	30.9		
11	A217 / B2032 / B2220	2005	0.34	0.54	0.29	73.1	32.4		
12	A217 nr M25	2005	0.31	0.53	0.34	66.4	30.6		
13	A217 / M25	2005	0.23	0.37	0.18	41.6	24.6		
14	A217 / M25	2005	0.27	0.50	0.41	63.7	30.0		
15	A217 / M25	2005	0.23	0.37	0.16	41.1	24.5		
16	A217 / Rushworth Road	2005	0.66	0.81	0.69	127.9	43.1		
17	A25 Castlefield Rd / A25 Church St	2005	0.42	0.58	0.34	74.6	33.6		
18	A25 Church St after Bancroft Road	2005	0.32	0.47	0.26	64.5	31.4		
19	Corner A25 Church St & A21 Bell St	2005	0.36	0.51	0.29	70.6	32.7		
20	A25 Reigate High Street	2005	0.35	0.51	0.28	68.6	32.3		
21	A217 / A2044	2005	0.29	0.42	0.20	52.9	27.4		
22	A217 / A2044	2005	0.31	0.44	0.21	55.6	28.1		
23	A217 / A2044	2005	0.38	0.53	0.30	68.5	30.9		
24	A217 / A2044	2005	0.32	0.51	0.28	56.6	28.3		
25	A240 / A2022 / B291	2005	0.35	0.59	0.27	64.0	31.0		
26	A240 / A2022 / B291	2005	0.36	0.59	0.28	67.2	31.7		
27	A240 / A2022 / B291	2005	0.37	0.61	0.29	73.1	32.9		
28	A240 / A2022 / B291	2005	0.35	0.59	0.26	64.6	31.1		
29	A240 / A2022 / B291	2005	0.41	0.65	0.34	83.0	34.9		
30	A240 / B2221	2005	0.35	0.57	0.26	62.5	30.4		
31	A240 / B2221	2005	0.35	0.59	0.28	70.4	32.2		
32	A240 / B2221	2005	0.37	0.61	0.32	75.8	33.3		
33	A240 / B2221	2005	0.38	0.63	0.34	78.1	33.8		
34	B290 near junction B2221	2005	0.28	0.66	0.19	49.3	27.4		
35	B290 near junction B2221	2005	0.31	0.70	0.22	54.8	28.8		
36	A2022 / B2218 / B2217	2005	0.40	0.71	0.44	90.3	36.0		
37	A2022 / B2218 / B2217	2005	0.35	0.63	0.33	70.2	32.1		
38	A2022 / B2218 / B2217	2005	0.39	0.69	0.39	79.8	34.0		
39	A2022 / B2218 / B2217	2005	0.40	0.69	0.38	84.8	35.0		
40	A2022 / B2218 / B2217	2005	0.32	0.63	0.36	69.4	31.9		
41	A240 / B284	2005	0.30	0.54	0.24	58.8	29.7		
42	A240 / B284	2005	0.30	0.53	0.21	52.0	28.1		
43	A23 / M23	2005	0.29	0.43	0.23	71.7	33.2		
44	A23 / M23	2005	0.30	0.44	0.26	82.1	35.4		
45	A23 / M23	2005	0.30	0.45	0.27	79.0	34.7		
46	A23 / M23	2005	0.28	0.42	0.23	66.3	32.0		
47	A23 / M23	2005	0.29	0.44	0.25	71.6	33.2		
48	A23 / M23	2005	0.28	0.48	0.31	66.9	32.2		
49	A23 / M23	2005	0.30	0.44	0.23	69.0	32.9		
50	A23 / School Hill	2005	0.35	0.50	0.28	78.1	35.2		
51	A23 / School Hill	2005	0.35	0.51	0.28	78.5	35.3		
52	A23 / A242	2005	0.30	0.45	0.22	63.6	32.3		
53	A23 / A242	2005	0.36	0.52	0.29	77.2	35.3		
54	A23 / A242	2005	0.37	0.53	0.29	78.3	35.6		

Receptor	Name	Year	CO Annual mean (mgm^{-3})	Benzene Annual mean (μgm^{-3})	1,3-butadiene Annual mean (μgm^{-3})	NO_x Annual mean (μgm^{-3})	NO_2 Annual mean (μgm^{-3})	PM_{10} Annual mean (μgm^{-3})	PM_{10} Days > 50 μgm^{-3}
55	A23 / Princess Way	2005	0.37	0.55	0.29	69.4	32.5		
56	A23 / A2044	2005	0.32	0.44	0.25	67.0	31.1		
57	A23 / B2036	2005	0.31	0.46	0.24	65.9	31.8		
58	A23 / B2036	2005	0.34	0.48	0.26	71.6	33.1		
59	A23 / B2036	2005	0.38	0.53	0.31	80.1	34.8		
60	A23 / B2036	2005	0.33	0.46	0.24	66.4	31.9		
61	A23 / B2036	2005	0.30	0.43	0.21	59.6	30.4		
62	A23 / A217	2005	0.28	0.44	0.21	54.5	29.0		
63	A23 / A217	2005	0.30	0.46	0.24	59.6	30.2		
64	A242 / A25	2005	0.36	0.52	0.29	70.4	32.7		
65	A242 / A25	2005	0.38	0.55	0.30	71.1	32.8		
66	A242 / A25	2005	0.35	0.51	0.27	64.9	31.5		
67	A25 Hatchlands Rd	2005	0.36	0.53	0.27	64.9	31.7		
68	A25 Reigate Road	2005	0.36	0.54	0.29	69.3	32.8		
69	M25 (Ashcmb Rd / Glade Hse)	2005	0.38	0.83	0.96	127.1	43.6		
70	M25 (Ashcmb Rd / Glade Hse)	2005	0.28	0.54	0.45	75.3	34.3		
71	M25 / M23	2005	0.23	0.36	0.14	45.5	27.6		
72	M25 / M23	2005	0.24	0.37	0.16	49.1	28.5		
73	M25 / M23	2005	0.25	0.41	0.23	56.8	30.5		
74	M25 / M23	2005	0.25	0.39	0.18	55.6	30.2		

Receptor	Name	Year	CO Annual mean (mgm^{-3})	Benzene Annual mean (μgm^{-3})	1,3-butadiene Annual mean (μgm^{-3})	NO_x Annual mean (μgm^{-3})	NO_2 Annual mean (μgm^{-3})	PM_{10} Annual mean (μgm^{-3})	PM_{10} Days > 50 μgm^{-3}
1	A217/A2022	2010	0.25	0.53	0.23	51.0	26.2	20.3	4
2	A217/A2022	2010	0.23	0.49	0.20	45.4	24.8	19.6	3
3	A217/A2022	2010	0.20	0.44	0.15	37.9	22.8	18.9	2
4	A217/B2221	2010	0.28	0.55	0.22	52.8	26.6	20.6	4
5	A217/B2221	2010	0.29	0.55	0.23	54.3	27.0	20.8	4
6	A217/A240	2010	0.27	0.53	0.26	55.5	27.0	20.6	4
7	A217/A240	2010	0.26	0.52	0.25	54.3	26.8	20.5	4
8	A217/A240	2010	0.32	0.58	0.33	67.9	29.7	21.9	6
8	A217/A240 using higher A217 link value	2010	0.32	0.58	0.35	73.1	30.8	22.3	7
9	A217 / B2032 (Bons.Dr.)	2010	0.17	0.36	0.13	36.3	22.3	18.5	2
10	A217 / B2032 / B2220	2010	0.22	0.43	0.19	50.0	25.8	19.8	3
11	A217 / B2032 / B2220	2010	0.24	0.45	0.22	55.1	27.0	20.3	4
12	A217 nr M25	2010	0.22	0.44	0.25	50.1	25.4	19.8	3
13	A217 / M25	2010	0.16	0.31	0.13	32.8	21.0	18.2	2
14	A217 / M25	2010	0.19	0.41	0.30	47.9	24.9	19.5	3
15	A217 / M25	2010	0.16	0.31	0.11	32.5	20.9	18.2	2
16	A217 / Rushworth Road	2010	0.50	0.67	0.51	91.9	35.1	25.2	13
17	A25 Castlefield Rd / A25 Church St	2010	0.31	0.50	0.27	58.9	28.6	21.3	5
18	A25 Church St after Bancroft Road	2010	0.18	0.33	0.12	37.7	23.3	18.6	2
19	Corner A25 Church St & A21 Bell St	2010	0.21	0.37	0.15	42.2	24.5	19.2	3
20	A25 Reigate High Street	2010	0.19	0.34	0.13	38.6	23.5	18.7	2
21	A217 / A2044	2010	0.21	0.35	0.15	41.4	23.2	19.3	3
22	A217 / A2044	2010	0.23	0.37	0.16	44.8	24.1	19.7	3
23	A217 / A2044	2010	0.27	0.44	0.23	53.1	26.1	20.7	4
24	A217 / A2044	2010	0.23	0.42	0.21	44.1	23.9	19.8	3
25	A240 / A2022 / B291	2010	0.25	0.49	0.19	48.0	25.7	20.1	4
26	A240 / A2022 / B291	2010	0.25	0.50	0.20	50.2	26.3	20.3	4
27	A240 / A2022 / B291	2010	0.27	0.51	0.21	56.3	27.7	20.8	4
28	A240 / A2022 / B291	2010	0.25	0.49	0.19	50.4	26.3	20.3	4
29	A240 / A2022 / B291	2010	0.30	0.54	0.24	60.6	28.7	21.4	5
30	A240 / B2221	2010	0.25	0.48	0.19	48.0	25.6	20.1	4
31	A240 / B2221	2010	0.25	0.49	0.20	52.7	26.7	20.4	4
32	A240 / B2221	2010	0.27	0.51	0.23	56.6	27.6	20.8	4
33	A240 / B2221	2010	0.28	0.53	0.25	57.9	27.9	21.0	5
34	B290 near junction B2221	2010	0.20	0.56	0.14	38.9	23.3	19.0	2
35	B290 near junction B2221	2010	0.22	0.58	0.15	42.8	24.3	19.4	3
36	A2022 / B2218 / B2217	2010	0.28	0.58	0.32	67.0	29.8	21.5	5
37	A2022 / B2218 / B2217	2010	0.25	0.52	0.24	53.3	26.8	20.3	4
38	A2022 / B2218 / B2217	2010	0.28	0.56	0.28	60.1	28.3	21.1	5
39	A2022 / B2218 / B2217	2010	0.29	0.56	0.28	63.7	29.1	21.3	5
40	A2022 / B2218 / B2217	2010	0.23	0.51	0.26	52.3	26.6	20.0	3
41	A240 / B284	2010	0.21	0.45	0.18	45.0	24.9	19.5	3
42	A240 / B284	2010	0.22	0.45	0.15	40.9	23.8	19.3	3
43	A23 / M23	2010	0.20	0.36	0.17	55.6	28.0	20.0	3
44	A23 / M23	2010	0.21	0.37	0.20	62.8	29.7	20.6	4
45	A23 / M23	2010	0.21	0.37	0.20	60.4	29.1	20.4	4
46	A23 / M23	2010	0.20	0.36	0.17	51.3	27.0	19.4	3
47	A23 / M23	2010	0.20	0.37	0.19	55.0	27.9	19.8	3
48	A23 / M23	2010	0.20	0.40	0.23	52.0	27.2	19.6	3
49	A23 / M23	2010	0.21	0.37	0.17	53.6	27.8	19.8	3
50	A23 / School Hill	2010	0.26	0.42	0.21	61.1	29.9	20.6	4
51	A23 / School Hill	2010	0.25	0.42	0.21	60.5	29.7	20.6	4
52	A23 / A242	2010	0.21	0.38	0.16	50.4	27.5	19.7	3
53	A23 / A242	2010	0.26	0.43	0.21	59.2	29.7	20.7	4

Receptor	Name	Year	CO Annual mean (mgm^{-3})	Benzene Annual mean (μgm^{-3})	1,3-butadiene Annual mean (μgm^{-3})	NO_x Annual mean (μgm^{-3})	NO_2 Annual mean (μgm^{-3})	PM_{10} Annual mean (μgm^{-3})	PM_{10} Days > 50 μgm^{-3}
54	A23 / A242	2010	0.26	0.43	0.21	60.2	29.9	20.8	4
55	A23 / Princess Way	2010	0.26	0.45	0.21	53.5	27.3	20.6	4
56	A23 / A2044	2010	0.23	0.36	0.18	50.7	25.9	19.9	3
57	A23 / B2036	2010	0.22	0.38	0.18	50.1	26.6	19.8	3
58	A23 / B2036	2010	0.25	0.39	0.17	51.0	26.8	20.1	4
59	A23 / B2036	2010	0.28	0.43	0.20	56.7	28.2	20.8	4
60	A23 / B2036	2010	0.24	0.38	0.18	50.8	26.8	20.1	3
61	A23 / B2036	2010	0.22	0.36	0.15	46.4	25.7	19.6	3
62	A23 / A217	2010	0.20	0.37	0.15	42.5	24.5	19.3	3
63	A23 / A217	2010	0.21	0.38	0.17	46.1	25.4	19.6	3
64	A242 / A25	2010	0.26	0.45	0.22	53.9	27.4	20.5	4
65	A242 / A25	2010	0.28	0.47	0.24	55.3	27.7	20.8	4
66	A242 / A25	2010	0.26	0.43	0.21	51.0	26.7	20.3	4
67	A25 Hatchlands Rd	2010	0.26	0.45	0.20	50.0	26.6	20.3	4
68	A25 Reigate Road	2010	0.26	0.47	0.22	53.7	27.6	20.6	4
69	M25 (Ashcmb Rd / Glade Hse)	2010	0.26	0.66	0.72	92.0	35.7	23.2	9
70	M25 (Ashcmb Rd / Glade Hse)	2010	0.20	0.41	0.26	55.5	28.3	20.0	3
71	M25 / M23	2010	0.16	0.31	0.10	36.9	23.8	18.2	2
72	M25 / M23	2010	0.17	0.32	0.11	39.6	24.5	18.4	2
73	M25 / M23	2010	0.18	0.35	0.17	44.8	26.0	18.9	2
74	M25 / M23	2010	0.18	0.33	0.13	44.1	25.8	18.9	2

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