AIR QUALITY IN LONDON 2000

THE EIGHTH REPORT OF THE LONDON AIR QUALITY NETWORK

Environmental Research Group
School of Health and Life Sciences
King's College London
December 2001

ACKNOWLEDGEMENTS AND CONTACTS

The London Air Quality Network is a unique and valuable resource whose continued development would not have been possible without the support of the local authorities in London and the Home Counties, the Association of London Government, London's Health Authorities and the Association of London Environmental Health Managers. The kind support of the Department of the Environment, Food and Rural Affairs and the Greater London Authority is also gratefully acknowledged.

The production of this report has truly been a team effort, which has been undertaken by staff who are both dedicated and committed to their work. Further information relating to this report (or related issues) can be gained through the following contacts.

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FOREWORD

KEN LIVINGSTONE – MAYOR OF LONDON

The annual trends of the major pollutants, indicated last year, appear to have largely continued through 2000. Annual mean network concentrations of both NO_X and NO_2 fell markedly. This is heartening as it shows that national strategies – particularly those for cleaner vehicles - are having an effect. The GLA, Government and the London borough's, through their work on local air quality management, predicted this reduction. NO_2 and PM_{10} are the two pollutants that currently exceed the National Air Quality Objectives. National policies will not be enough for the objectives to be met everywhere in London by the respective target dates and my Air Quality Strategy will set out policies to further reduce emissions in London. My officers will work with major London partners, principally the London boroughs to achieve further emission reductions.

The other pollutants CO, SO_2 and PM_{10} also decreased further during 2000, which is good news for air quality. Annual mean O_3 rose further during 2000, this is a cause for concern as it is not included in local air quality management. The EU are planning to deal with this pollutant on a European scale, involving all member states. The effects of these policies should be seen over the coming years.

Since the inception of the GLA in July 2000 I have published two of my strategies – Transport and Economic Development. I plan to publish my Air Quality Strategy this summer and the other five will follow. The next year will see the implementation of many policies to improve air quality, through my strategies and through London borough action plans. The data collected by ERG will help to assess their effectiveness. Road transport is the greatest source of NO_X and PM_{10} - it has been estimated that more people have their lives prematurely shortened from the fumes from road traffic than are actually killed in accidents. Road transport is also where most impact on emissions can be made.

My work to improve London's public transport network is happening apace. Bus fares, which rose by 18% between 1986 and 2000 have been frozen for the past 2 years. The total kilometres driven are at their highest since 1965 and total bus passengers increased by 6% last year to their highest level since 1975, all of which is fantastic news. This coupled with continuing investment to reduce emissions will make an impact on road transport emissions.

I will also set emissions targets for the other fleets controlled or operated by the GLA 'family'. These include London's tourist buses and police and fire vehicles. I am seeking to share information throughout London - success, good news as well as pitfalls - to ensure the full utilisation of cleaner vehicles. My congestion charging proposals will be a start in tackling London's congested streets. This is one of a raft of street management measures that will aid essential traffic flow. The route for Cross Rail, a railway line linking east and west London, is being looked at now by Transport for London. This is one of my priorities for long term improvements to London's public transport and will be one more tool that encourages less car use.

I am pleased that ERG is continuing to collate air pollution data for London. Its quality and standard is an essential tool for London's policy makers. It is important that as much available, good quality, information is presented together and I was heartened to see that data from the Government run sites are also included for the first time in this year's report.

INTRODUCTION

FRANK J KELLY - PROF. OF ENVIRONMENTAL HEALTH & DIRECTOR OF ERG

Welcome to the eighth annual report of the London Air Quality Network (LAQN). This report builds upon the four quarterly reports published during 2000. Since its inception in 1993 the London Air Quality Network has developed into the largest and most comprehensive regional monitoring network in Europe. Not content with this success I am happy to report that during 2000 the LAQN expanded further with increases in both the number, and quality, of some existing sites.

The LAQN is managed by the Air Quality Monitoring group led by Gary Fuller in the Environmental Research Group (ERG) at King's College London. The information in this report, together with its predecessors, is enhanced by input from the ERG's Air Quality Management group. The combined and complementary expertise of the individuals in these groups is further evident in the new LAQN website www.erg.kcl.ac.uk/home.asp. This excellent resource has summaries of air pollution across the LAQN and a number of tools to allow the user to analyse and plot the data. We hope that this resource will be of real benefit to Londoner's with an interest in air quality.

The data in the current report provide a unique overview of air quality in London during 2000 and, for comparison, in recent years. These data are of benefit to all those involved in air quality issues in London. The report, which includes data on eight different pollutants, is important both as a stand-alone document for comparison with other cities and as part of the ongoing annual air pollution record for London. We hope that this publication will provide a vital resource for anyone interested in air quality matters, especially those who are working at local and national levels or are developing policies to help reduce the level of air pollution in the UK.

On the health front, there are still major gaps in our knowledge regarding the most active or detrimental components of air pollution. Further development of the LAQN, through both expansion in poorly covered areas and in the range of pollutants monitored, will provide researchers with an improved basis with which to identify those pollutants, or combinations of pollutants, which put our health at most risk.

During recent months important steps have been taken to further integrate ERG into King's College London. In September 2001 ERG became a founding partner in an Air Pollution & Health initiative and plans are in place to bring ERG personnel together with other air pollution investigators on the Waterloo campus by September 2002. The combined expertise of the enlarged group will provide exciting new opportunities for research on the consequences of London's air quality. Moreover, bringing together the individuals who monitor air pollution with those who investigate, in human terms, the consequences of bad air quality will hopefully provide a vibrant working environment and help accelerate our understanding of the health consequences of air pollution.

During 2000 London did not experience the significant pollution incidents measured during recent years. Medium term trends indicate improvements in the concentrations of many pollutants. However, London clearly still suffers from major air quality problems and attainment of the Air Quality Strategy Objectives will be very challenging in many parts of the Capital. The existence of the LAQN, and its further development, will play an important role in our ability to alert those who are particularly sensitive to bad air quality. Indeed, the recent launch of the website mentioned above which is 'searchable by postcode' is an excellent example of how the LAQN is of benefit to Londoners. Furthermore, the LAQN will be an essential instrument for monitoring the impact of the measures in the Mayor's Air Quality Strategy and action being taken at a Borough level.

Hence, although containing some encouraging information, this report highlights how much more must be done at all levels from the individual, local councils and Government to combat the problem of air pollution. It is imperative that we all work together to provide a solution to the problem. The LAQN is an excellent example of such a working partnership between local authorities and academia.

EXECUTIVE SUMMARY

This report summarises the results of the air pollution monitoring carried out by the London Air Quality Network (LAQN) during 2000.

During 2000 the LAQN continued to expand with the addition of twelve monitoring sites.

For the first time, the LAQN Annual Report contains analysis of measurements from the London sites directly funded by the Department of the Environment, Food and Rural Affairs (DEFRA).

Network annual mean concentrations have been analysed for the period November 1996 to November 2001.

- Network annual mean NO_2 has declined by around 10% and NO_X concentrations have fallen by 26%.
- Network annual mean O_3 peaked during 2000, with a maximum increase of 30%. The network annual mean fell sharply during the end of 2000 with provisional data from 2001 suggesting an overall rise of 15%.
- Network annual mean CO, SO_2 and PM_{10} show marked overall decreases. Annual mean concentrations during 2000 and 2001 have been relatively stable.

Each of the pollutants monitored by the LAQN during 2000 have been compared to the Air Quality Strategy (AQS) objectives (DETR 2000a, DETR 2000b).

- The annual mean objective for NO_2 was exceeded at the majority of kerbside and roadside sites. The objective was also exceeded at many inner London background sites and those in west London. Around one third of the area of Greater London exceeded the objective.
- The ‘incident’ based objective for NO_2 was exceeded at kerbside sites at Marylebone Road, Redbridge 2 and Redbridge 3. The objective was also exceeded at the roadside sites Kensington & Chelsea 3 and Hammersmith & Fulham.
- The CO objective was exceeded at the kerside site Redbridge 2.
- All LAQN sites met the objective for SO_2.
- The O_3 objective was exceeded at seven outer London sites.
- The PM_{10} AQS incident based objective was exceeded at nine sites.
- The annual mean objective for PM_{10} was exceeded at the kerbside site in Marylebone Road and at the roadside site Enfield 2.

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AIR QUALITY IN 2000

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1.1 Background

The purpose of this report is to review air quality in London during 2000. Measurements have been analysed with specific reference to the Air Quality Strategy (AQS) objectives (DETR, 2000a, DETR 2000b). Full details of the sites in the London Air Quality Network (LAQN) in 2000 are presented in Appendix 1 and the detailed monitoring results are presented in Appendix 3.

The LAQN was formed in 1993 to co-ordinate and improve air pollution monitoring in London. At the end of November 2001, thirty-one London Boroughs were supplying data to the LAQN. Increasingly, these data are being supplemented with measurements from local authorities around London, thereby allowing an overall perspective of air pollution in South East England. The LAQN is facilitated by the Association of London Government on behalf of the thirty-three London Boroughs and is operated and managed by the Environmental Research Group (ERG) at King's College London. The core LAQN activities are funded by the ERG itself. The ERG is contracted by the Department of the Environment, Food and Rural Affairs (DEFRA) to maintain sixteen of the LAQN sites as affiliate sites to the UK Automatic Urban and Rural Network (AURN). This DEFRA support assists the operation of the overall LAQN.

1.2 Network Changes

Twelve monitoring sites joined the LAQN during 2000. Other sites received equipment enhancements. The principle site changes are listed in Appendix 1.

The combined London, Hertfordshire & Bedfordshire and Kent Networks produce a detailed perspective of air pollution in London and the Home Counties. This perspective is unique within the UK and is an increasingly important resource to quantify air pollution in London, supporting the Boroughs and the GLA in meeting the challenges of the UK Air Quality Strategy. The location of the LAQN sites and those surrounding London are shown in Figure 1.

For the first time, analysis of LAQN measurements has been augmented by measurements from the directly funded DEFRA sites in London. These six sites provide further information concerning pollution in central and west London. Hourly and 15 minute mean measurements from these sites have been obtained from the DEFRA National Air Quality Archive and included within the LAQN database.

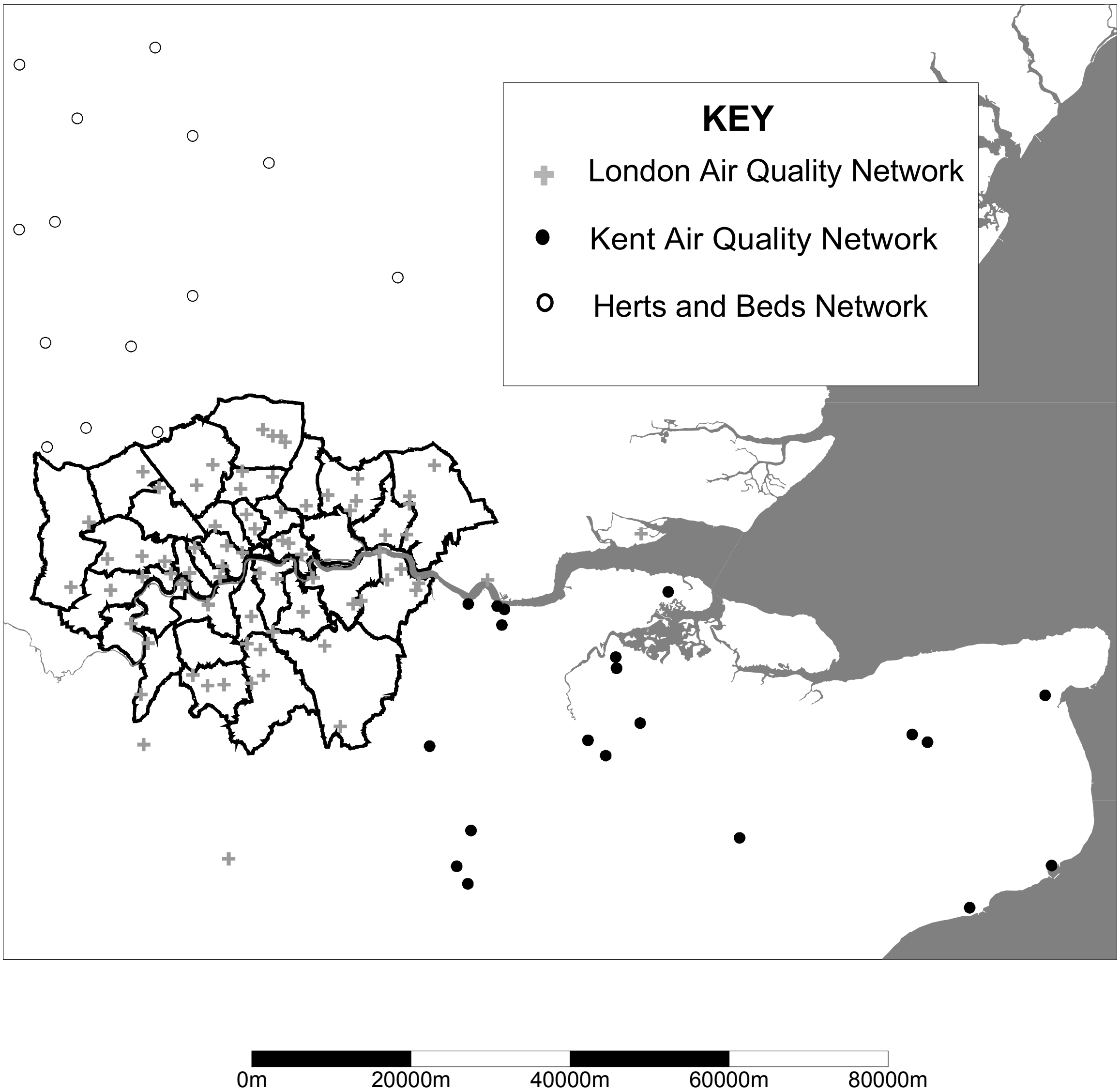

Figure 1 Location of LAQN Monitoring Sites and those in the Neighbouring Hertfordshire & Bedfordshire and Kent Networks.

The LAQN web site has been updated and relaunched, assisted by sponsorship from the Environment Agency. The new site has graphical summaries of air pollution across the LAQN, details of the monitoring sites, background information about air pollution and tools to allow the user to analyse and plot measurement data. The new Internet site, shown in

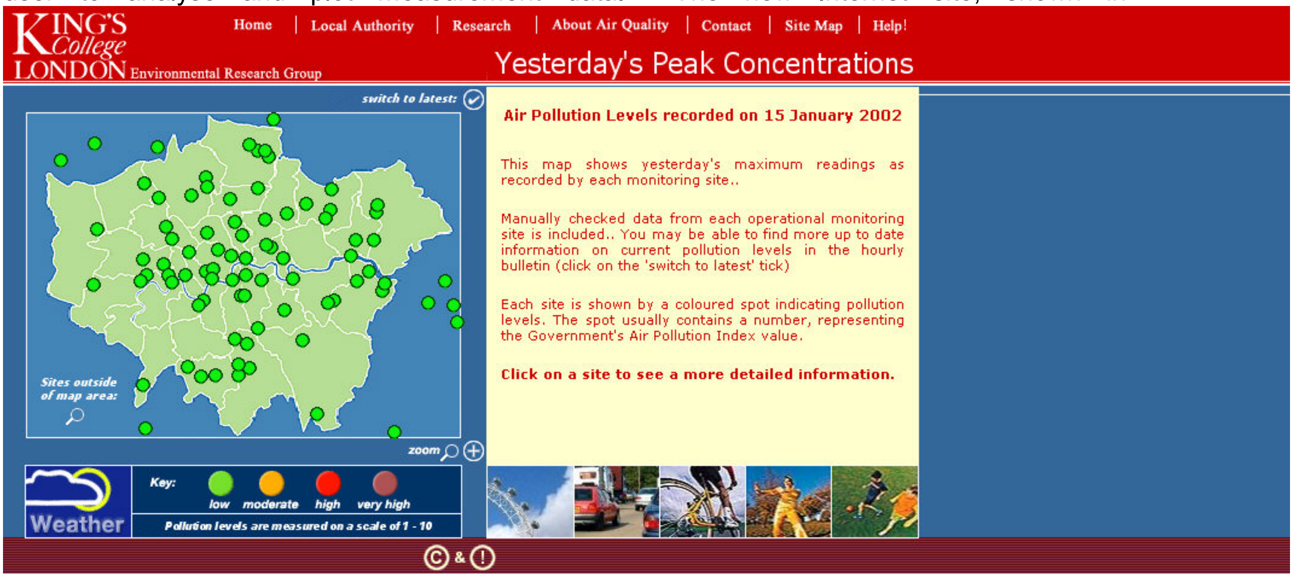

Figure **2**, may be found at www.erg.kcl.ac.uk/home.asp.

Figure 2 The New LAQN Web Site

1.3 Discussion of Results

1.3.1 Measurement Uncertainty and Presentation

Comparisons of 2000 results with national and international guidelines and standards are shown in Appendix 3.

When examining pollution measurements it is important to consider the location of the monitoring site e.g. kerbside, urban background, rural, etc., and the data quality. The site type and quality assurance standard for each site are listed in Appendix 1. Sites are divided into three quality standards. Data from sites affiliated to the Automatic Urban and Rural Network (AURN) and London Standard sites have traceabilty to national metrological standards, whereas for the locality standard sites there is insufficient information to demonstrate such traceability.

No scientific measurement is absolutely accurate or absolutely precise. The combination of accuracy and precision is termed the uncertainty. In order to place results in context, the uncertainty associated with each result has to be considered. Estimates of the uncertainty associated with air quality measurement are discussed in the 1996 LAQN Annual Report (SEIPH-ERG, 1996). This suggests that a working uncertainty of around 10 % (2σ) should be considered when discussing high values and long-term means of CO, NO_2 and SO_2 measured at London Standard sites. This is justified on the basis of both mathematical modelling and equipment performance tests. However, due to the statistical distribution of the data, a 10 % uncertainty in measurements does not imply a 10 % uncertainty in the number of exceedences of an objective. The calculation of uncertainty in the number of exceedences has to be based on an analysis of the dataset for each individual site. Error bars have been used to indicate the range of uncertainty in the figures below. There is some justification for a lower uncertainty of around 5 % for O_3 measurements. The uncertainty associated with the measurement of PM_{10} is more complex and is discussed below.

Data are subject to two quality assurance processes. Initially, data are validated when they are collected using the best calibration and instrument performance information available at the time. Data are retrospectively examined during the ratification process, using long term instrument histories and the results of further quality checks. Hence the final ratified data in this report for 2000 will differ from those initially published via our fax and Email dissemination services, on the internet and in Quarterly Reports.

The final and definitive data sets for the AURN affiliated sites will be published by DEFRA.

Each of the pollutants monitored by the LAQN in 2000 is discussed below in terms of their spatial distribution and in comparison with the AQS objectives. Many objectives require data representative of the whole year. If insufficient data were available (i.e. a data capture of less than 75 % for the whole year), then comparison with the objective was not possible. This, for example, may be the case for sites installed during the year.

1.3.2 Relative Results 1995 to 2000

During 2000 there were no major pollution incidents as seen in previous years. For example, during 1991, 1994 and 1997 London experienced significant winter pollution incidents. Further, a prolonged secondary particulate episode occurred during 1996 and the hot summer of 1995 produced substantial photochemistry.

Data from November 1995 to November 2001 have been analysed to place the results from 2000 in context. Annual means from November 1996 have been calculated, at monthly intervals, in an attempt to eliminate seasonal effects. Note that the mean value for a particular date represents that for the preceding 12 months e.g. the value calculated for November 1996 represents the mean between November 1995 and November 1996. To provide a perspective across the network as a whole, the mean from each of the long term sites have been averaged to produce a LAQN network mean, normalised to 100 % for each pollutant as at November 1996 to illustrate relative change. Measurements from roadside and background sites have been used. However, due to data availability, a different set of sites has been used for each pollutant. Four sites have been used for the PM_{10} calculation, five for CO, six for O_3 and SO_2, and twelve for NO_X and NO_2. (NO_X is the sum of NO and NO_2). It should be noted that data from 2001 are provisional and subject to ratification. The annual means are shown in Figure 3 and Figure 4.

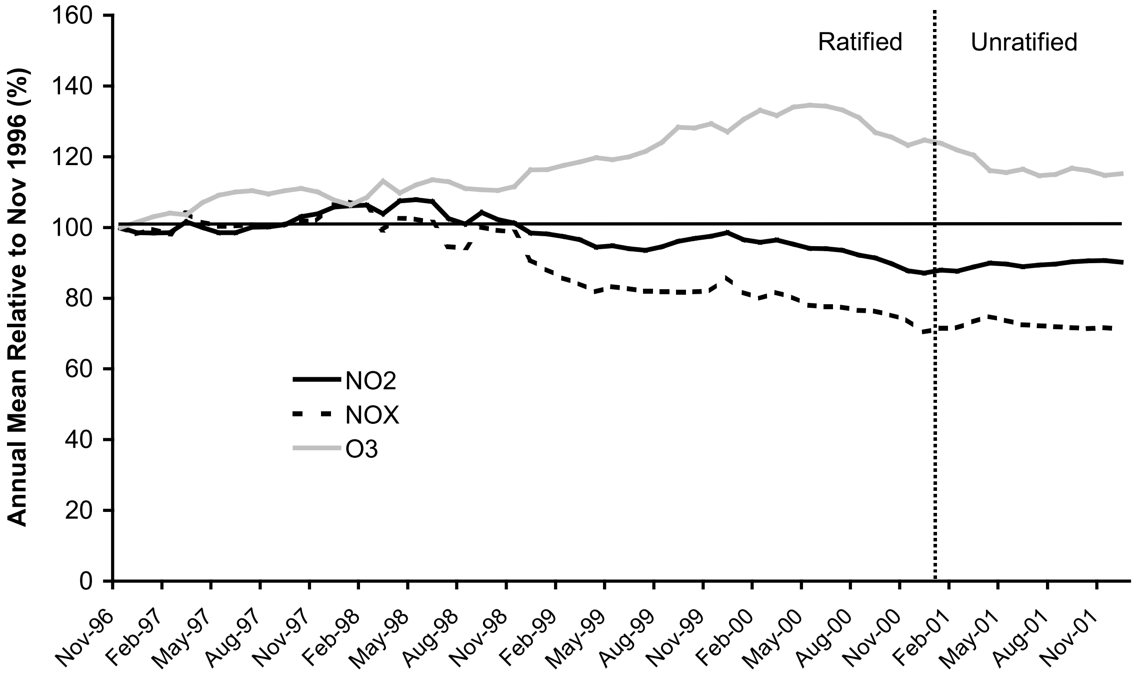

Figure 3 Relative Annual LAQN Mean for O_3, NO_X and NO_2

Figure 3 shows a fall of around 28 % in the NO_X concentration over the period November 1996 to November 2001. This is very likely the result of reduced NO_X emissions due to technological changes in the vehicle fleet. The effects of pollution incidents during autumn 1997 can also be seen in the NO_X concentration, causing a rise in concentration at this time and a consequential fall during autumn 1998 as this incident drops from the rolling annual mean. NO_X concentrations declined during 2000 although provisional data suggests a relative stability in NO_X concentrations during 2001.

LAQN annual mean NO_2 initially shows a rise due to pollution incidents in autumn 1997. The NO_2 mean fell during 1998 only to rise again during 1999. Previous analysis of the network annual mean NO_2 has not shown any significant trend. However during 2000 NO_2 concentrations show a substantial decline of around 11 %. As a consequence there has been around a 10 % reduction in annual mean NO_2 concentration during the period November 1996 to November 2001. This will be encouraging to air quality managers. It is difficult to determine the proportion of the NO_2 reduction that is due to emissions reduction and the proportion that is due to favourable metrological conditions; the exceptionally unsettled conditions during autumn 2000 for instance.

The O_3 concentration in Figure 3 shows an overall rise of 15% during the period November 1996 to November 2001. The network annual mean O_3 peaked during 2000 at over 30% above the November 1996 level. However, LAQN annual mean O_3 declined substantially during the latter part of 2000. Provisional results suggest stability during 2001.

Figure 4 shows that LAQN annual means for CO, SO_2 and PM_{10} fell from November 1996 to late 1999. The annual means appear stable during 2000 and provisional results for 2001 show a slight increase.

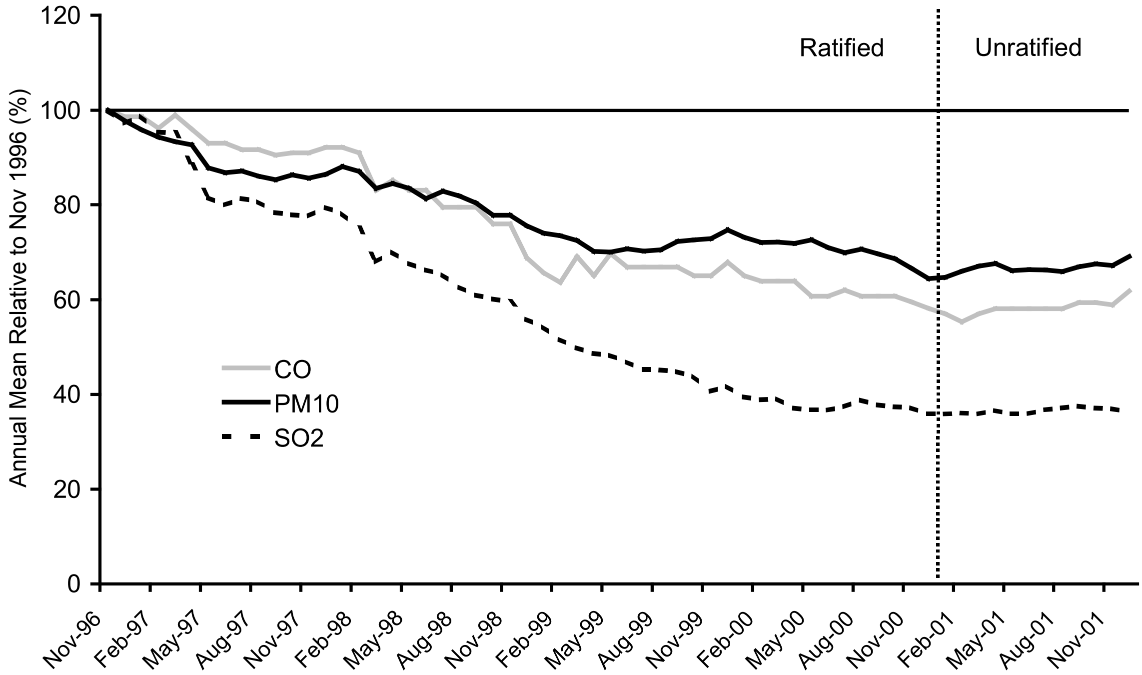

Figure 4 Relative Annual LAQN Mean CO, SO_2 and PM_{10}

1.3.3 Nitrogen Dioxide

NO_2 is largely a secondary pollutant formed by the oxidation of NO. In the LAQN area, road transport is the dominant source of NO_X. This is reflected in the general distribution of NO_2, with the highest concentrations in 2000 being measured at roadside and central London locations. Lower concentrations were observed at background, suburban and rural areas.

The AQS stipulates two objectives for NO_2: an annual mean of 21 ppb and an incident based objective of 104.6 ppb (hourly mean) not to be exceeded more than 18 times per year. The annual mean NO_2 concentration across London for 2000 is shown in Figure 5. The map is based on a calculated emissions inventory for 2000 and the meteorology and atmospheric chemistry experienced in London in 1996. It is likely that predicted NO_2 concentrations are overestimated around Heathrow due to uncertainties in the NO_X emissions at the airport. Elsewhere there are slight differences between the mapped results and those measured at the individual background monitoring sites, although these are within the variation that would be expected for individual sites and are within the limits of measurement uncertainty.

Figure 5 shows two main concentration centres focused on central London and the area around Heathrow Airport. The NO_2 objective is exceeded at almost all areas in inner London. The measurements alongside roads in central London are almost twice the objective. The objective is also exceeded along trunk roads in outer London, along the M25 and along main roads in the suburban Boroughs. Elevated background concentrations can also be seen around the trunk road network and in suburban 'town' centres such as Kingston, Sutton, and Croydon.

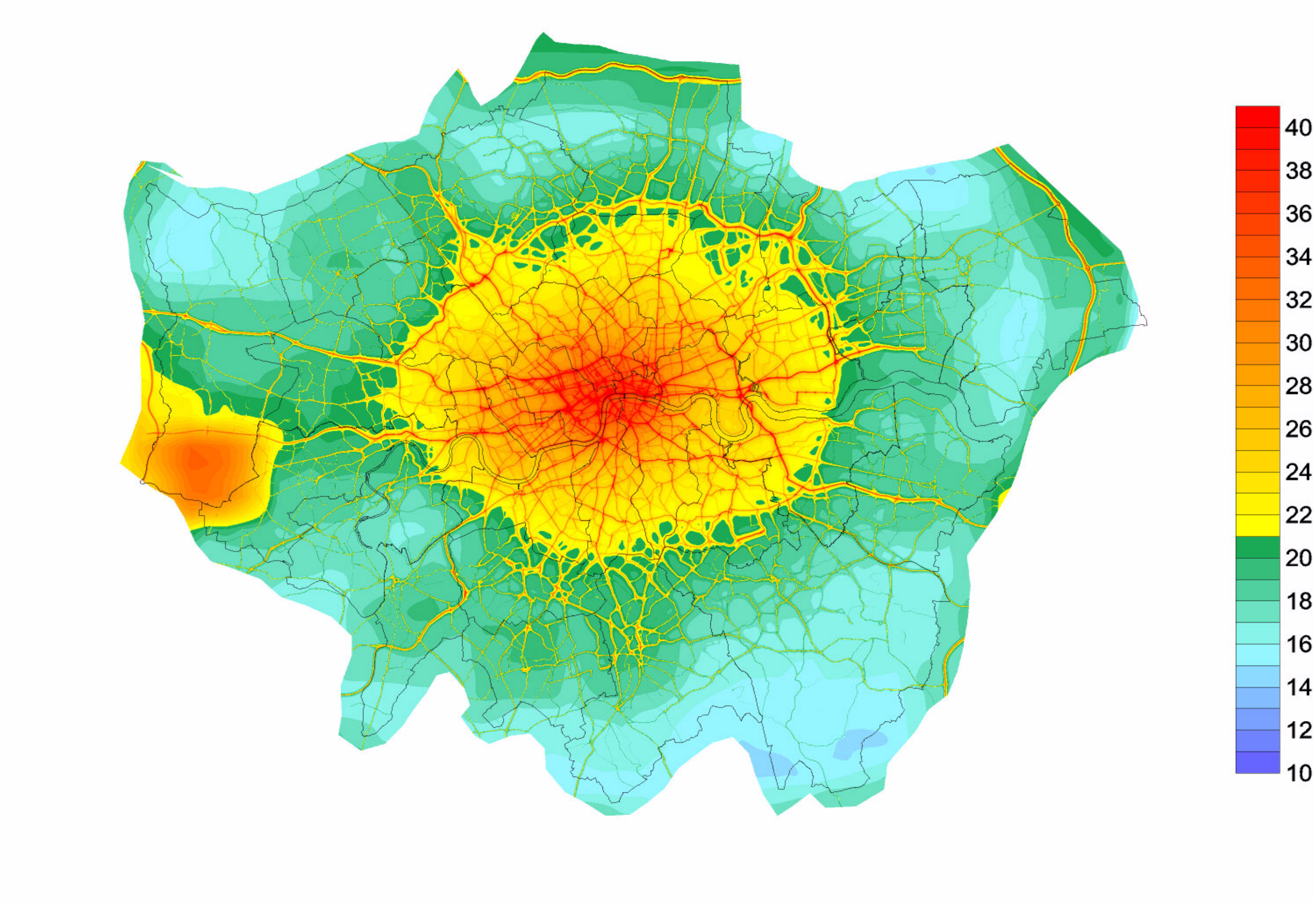

Figure 5 Predicted Annual Mean Background NO_2 Concentrations (ppb) (2000)

Figure 6 and Figure 7 show the annual mean NO_2 at the background sites across the network. The distribution of annual means reflects that in Figure 4. The highest annual means were measured at the Bloomsbury site in central London (31ppb) and at Heathrow (29ppb). Background sites execeeding the objective are largely in inner and west London.

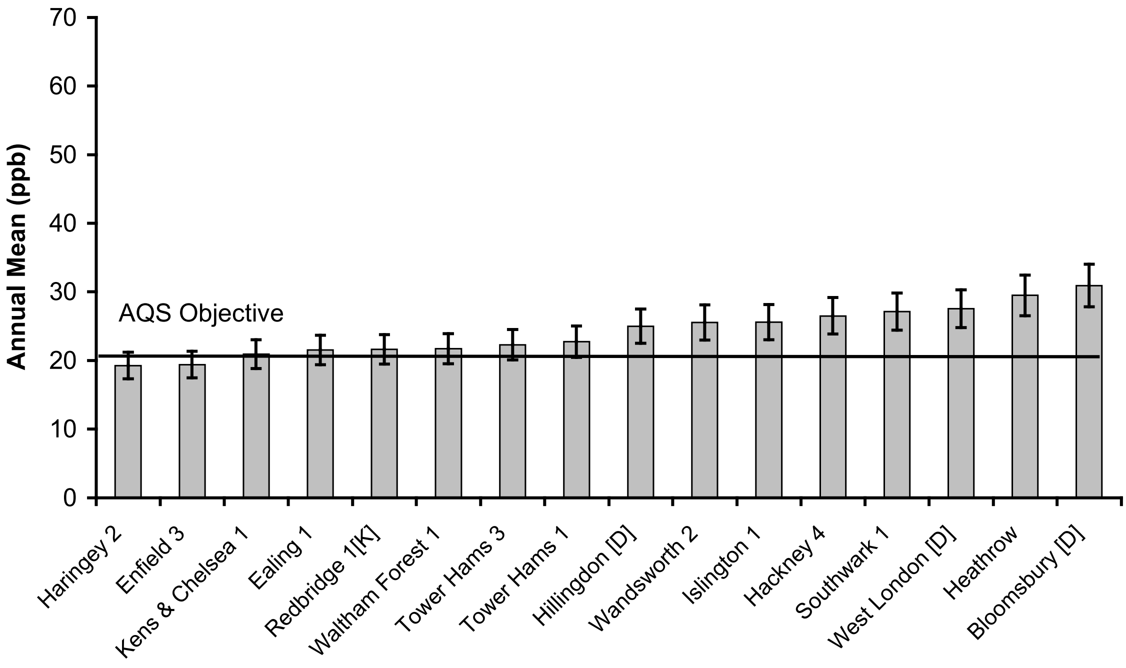

Figure 6 Background Annual Mean NO_2 (2000)

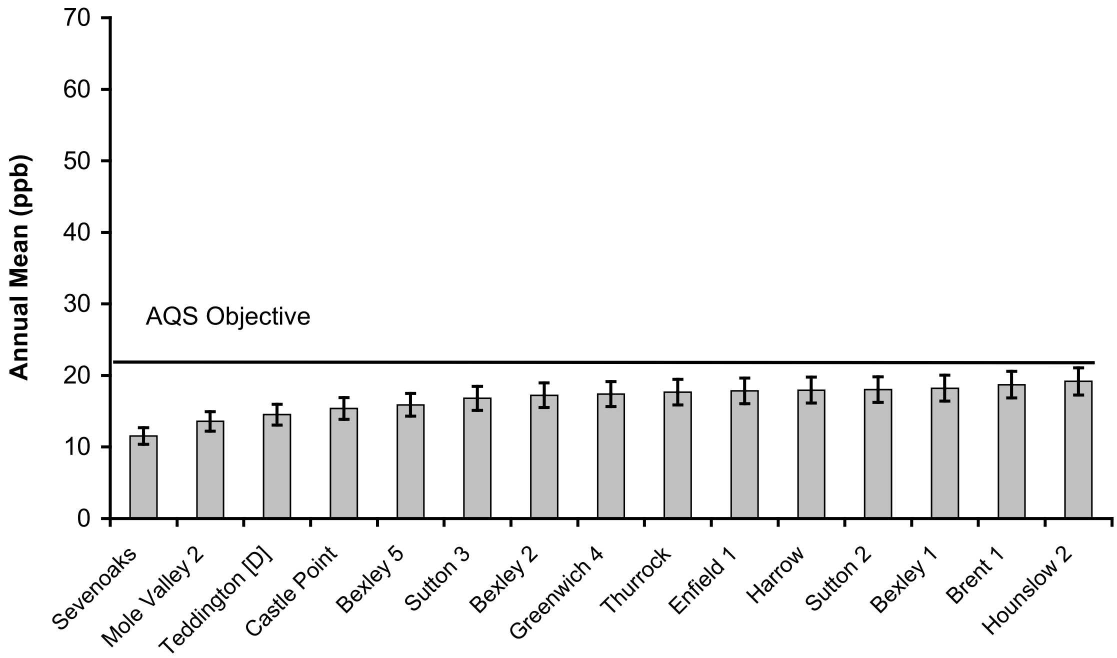

Figure 7 Background Annual Mean NO_2 (2000)

The annual mean NO_2 at kerbside and roadside sites is shown in Figure 8 and Figure 9. The highest annual mean NO_2 was measured at the Redbridge 2 site, which is located on a traffic island in the middle of a busy junction where public exposure is transient. With the exception of the outer London sites Croydon 2 and Sutton 1, all kerbside and roadside sites exceeded the AQS annual mean objective.

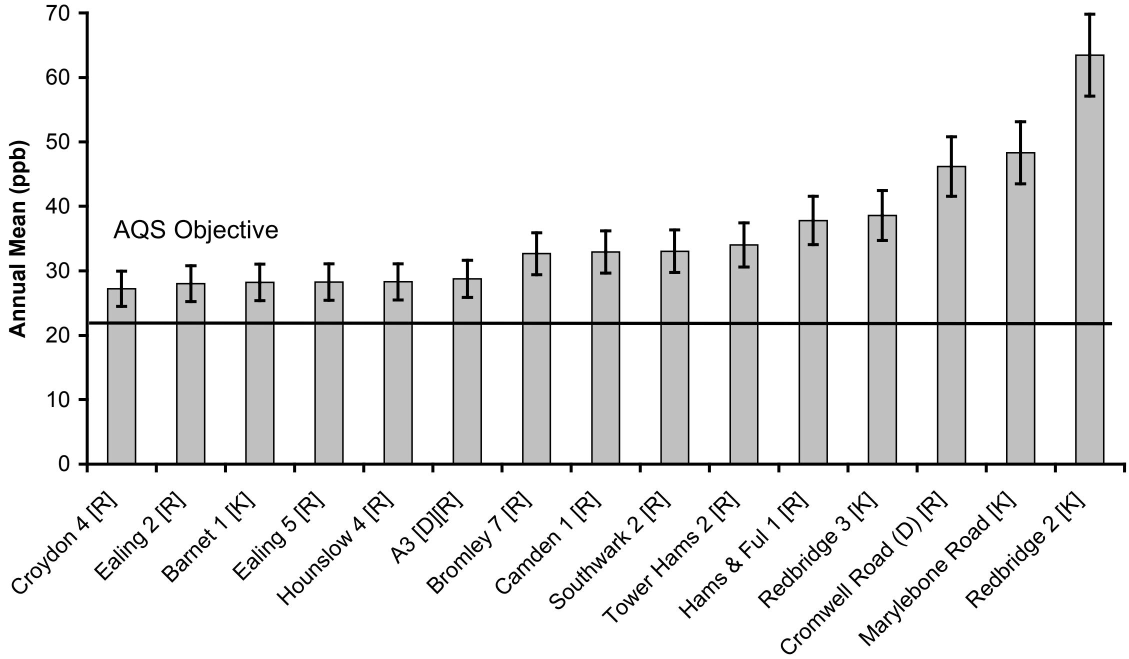

Figure 8 Kerbside and Roadside Annual Mean NO_2 (2000)

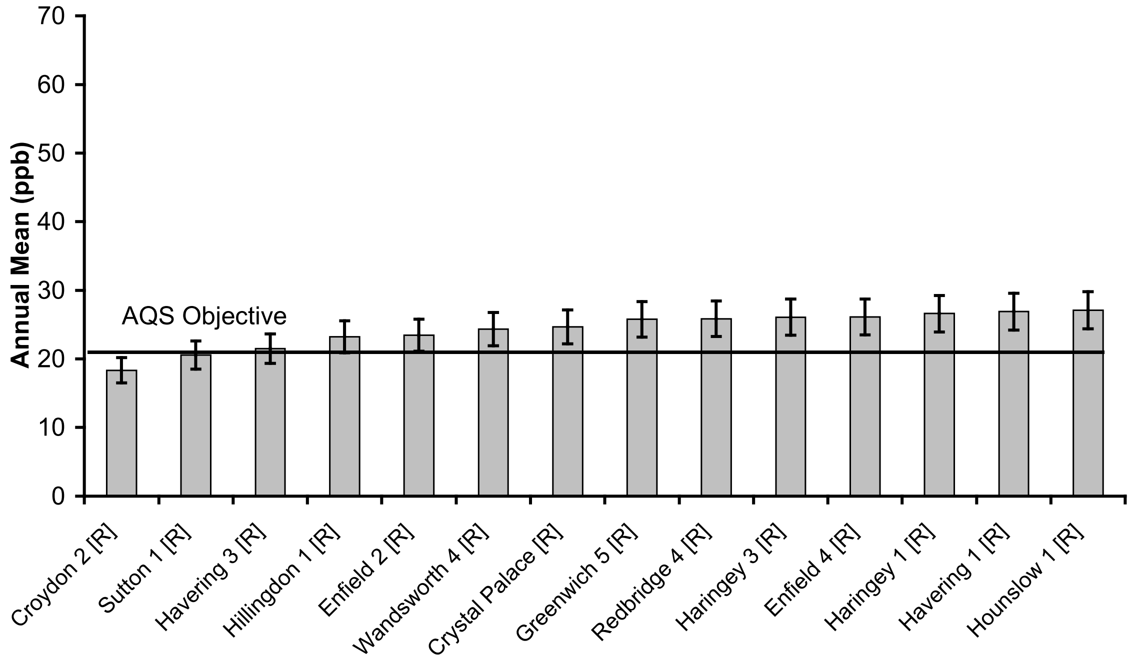

Figure 9 Kerbside and Roadside Annual Mean NO_2 (2000)

The AQS also has an incident based objective for NO_2. Measurements during 2000 are compared to this objective in Figure 10 for the sites that approached the objective during the year. The kerbside site Redbridge 2 measured 845 exceedences. This site is located on a traffic island in the middle of a busy junction where public exposure is transient. The objective was also exceeded at the kerbside sites at Marylebone Road and Redbridge 3 and at the roadside sites Kensington & Chelsea 3 and Hammersmith & Fulham.

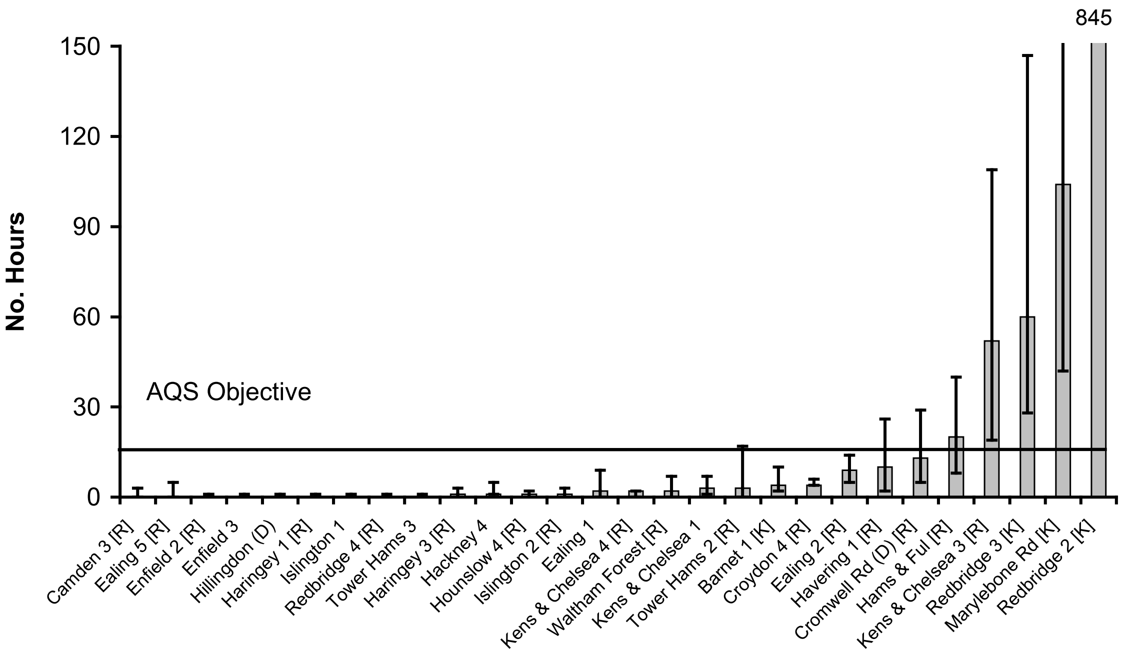

Figure 10 AQS incidence based Objective for NO_2 (2000)

1.3.4 Carbon Monoxide

CO emissions within the LAQN area are dominated by road transport sources.

The highest rolling 8-hour means were measured at kerbside and roadside sites with the AQS Objective of 10 ppm being exceeded at the kerbside site Redbridge 2 on 9 occasions over 5 separate days. This site is located on a traffic island in the centre of a busy junction. Results from this site and from the Bromley kerbside site (now closed) suggest that CO concentrations close to busy, congested junctions may be higher than previously thought (SEIPH-ERG, 1999; Lonsdale *et al*, 1998).

1.3.5 Sulphur Dioxide

The distribution of SO_2 concentrations in 2000 provides further evidence of the influence of both road traffic and industrial point sources. Road traffic sources are the main factor influencing annual mean concentrations, whereas industrial point sources produce short term high values due to plume grounding. This is discussed in Air Quality in London in 1995, The Third Report of the London Air Quality Network (SEIPH-ERG, 1996). The annual mean concentrations of SO_2 do not vary to any significant degree over the network.

The AQS objective for SO_2, based on 35 exceedences of a 15 minute mean of 100 ppb, was not approached at any site in the network. The two LAQN sites in Essex, Thurrock and Castle Point, measured eight and two exceedences respectively.

1.3.6 Ozone

O_3 is a seasonal pollutant with the highest concentrations being measured during the summer months. It is also a regional pollutant, with episodes extending over many hundreds of kilometres. O_3 exhibits significant local variation caused by the scavenging effect of NO close to NO_X emission sources, e.g. at the roadside. Exceedences of health-based standards are therefore not expected at roadside and kerbside sites and O_3 monitoring is not generally undertaken in these locations. Results from the LAQN are shown in Figure 11.

The AQS has an objective of 50 ppb, measured as a rolling 8 hour mean which should not be exceeded on more than 10 days per year. The AQS objective was exceeded at 7 background sites in outer London and in towns in the southeast. Six further sites measured a possible exceedence within the limits of uncertainty. These are shown in Figure 11.

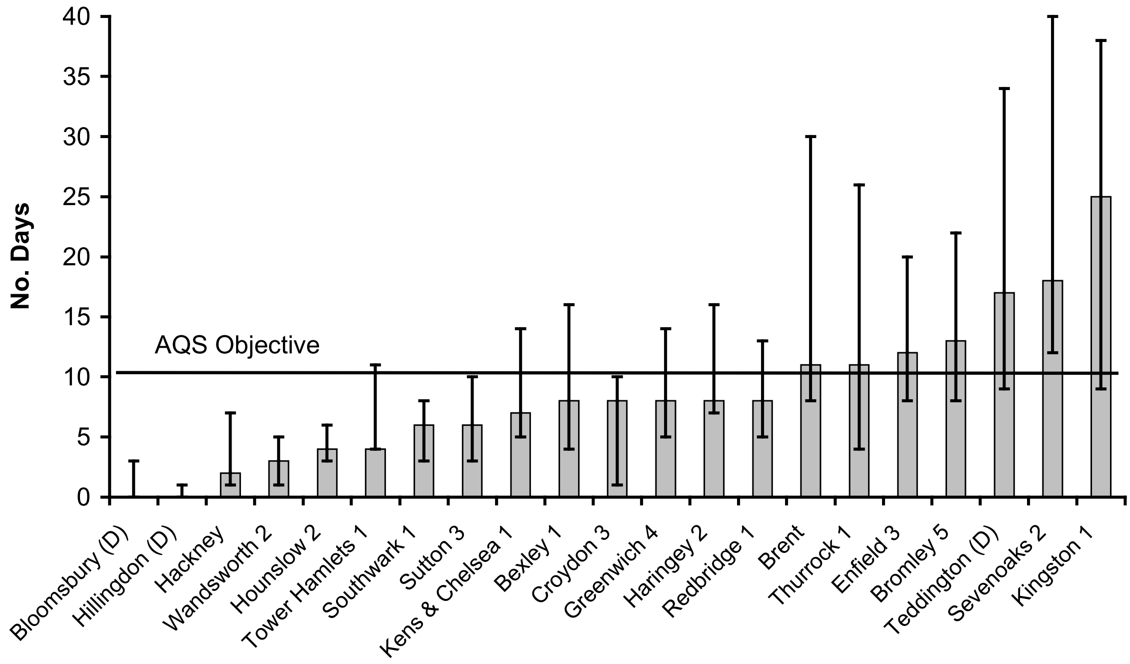

Figure 11 AQS O_3 Objective (2000)

1.3.7 PM_{10}

There are two AQS objectives for PM_{10}. These are in line with the EU Daughter Directive Stage 1 Limit Value for PM_{10}. The AQS has an incident based objective of 50 μgm^{-3}, measured as a daily mean, not to be exceeded on more than 35 days per year, and an annual mean objective of 40 μgm^{-3}.

PM_{10} poses many measurement challenges. Rather than comprising of a single defined chemical compound, like CO or SO_2 for example, the composition of PM_{10} varies with location, time of year and during episodes. PM_{10} can be considered to comprise; primary particulates (mainly emitted from local sources), secondary particulates (mainly from distant sources), and coarse particulates whose origin can be local or further afield. The variation in composition affects each measurement technique differently and therefore each measurement technique produces systematically different results. The EU Daughter Directive is based on a 'gravimetric' method where PM_{10} is collected on a filter that is then weighed in a laboratory (CEN, 1998). There is ample evidence to suggest that the most common measurement methodology employed in the UK, the Tapered Element Oscillating Microbalance (TEOM) produces a result lower than the 'gravimetric' method (APEG, 1999; Green 1999, Green *et al*., 2000). DETR (1999) suggests that a correction factor of 1.3 be applied to TEOM results for comparison to the AQS Objective. TEOM results from 2000, calculated on this basis, are shown in Figure 12 to Figure 17.

Beta attenuation monitors (BAM) are also used on the LAQN to measure PM_{10}. BAM instruments are shown in black in Figure 12 to Figure 17. Research at Marylebone Road (Green, 1999) sought to compare the results from TEOM, 'gravimetric' and BAM instruments. The BAM instrument tested produced higher results than the 'gravimetric' method at this location during the test period. However, no correction factor has been applied to the BAM measurements. Due to these methodological differences it has not been possible to make an uncertainty estimate for PM_{10} measurements.

During 2000 the PM_{10} AQS incident based objective was exceeded at nine sites. This is shown in Figure 12 to Figure 14.

The annual mean AQS objective is shown in Figure 15 and Figure 16. The AQS annual mean objective was exceeded at the kerbside site Marylebone Road and at the roadside site Enfield 2.

Several sites were affected by local PM_{10} sources during 2000. The Bexley 4 site was regularly affected by PM_{10} arising from vehicles accessing nearby industrial sites. Brief local incidents were measured at Crystal Palace due to removal of road markings, at Croydon 4 due to road and tram works, at Croydon 3 due to brick cutting and at Sevenoaks 2 due to a burning car.

Other notable PM_{10} events during 2000 include a episode during March caused by Saharan dust (Ryall *et al* 2001) and Bonfire Night.

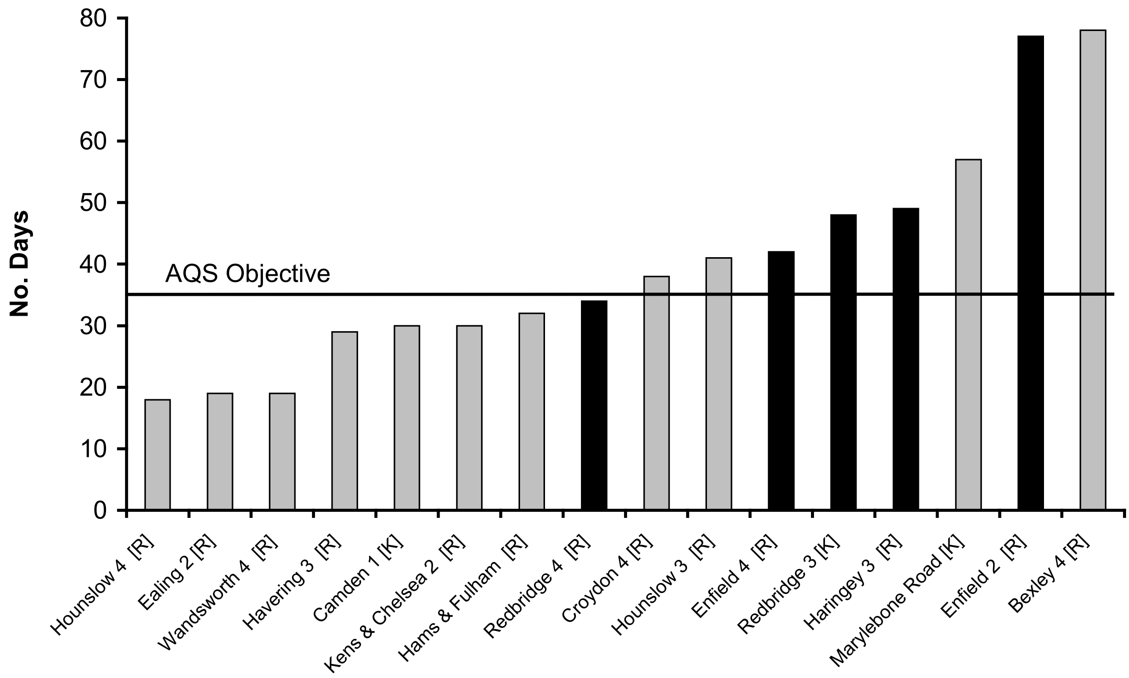

Figure 12 AQS incident based objective for PM_{10} at road and kerbside sites (2000). BAM sites are shown in black.

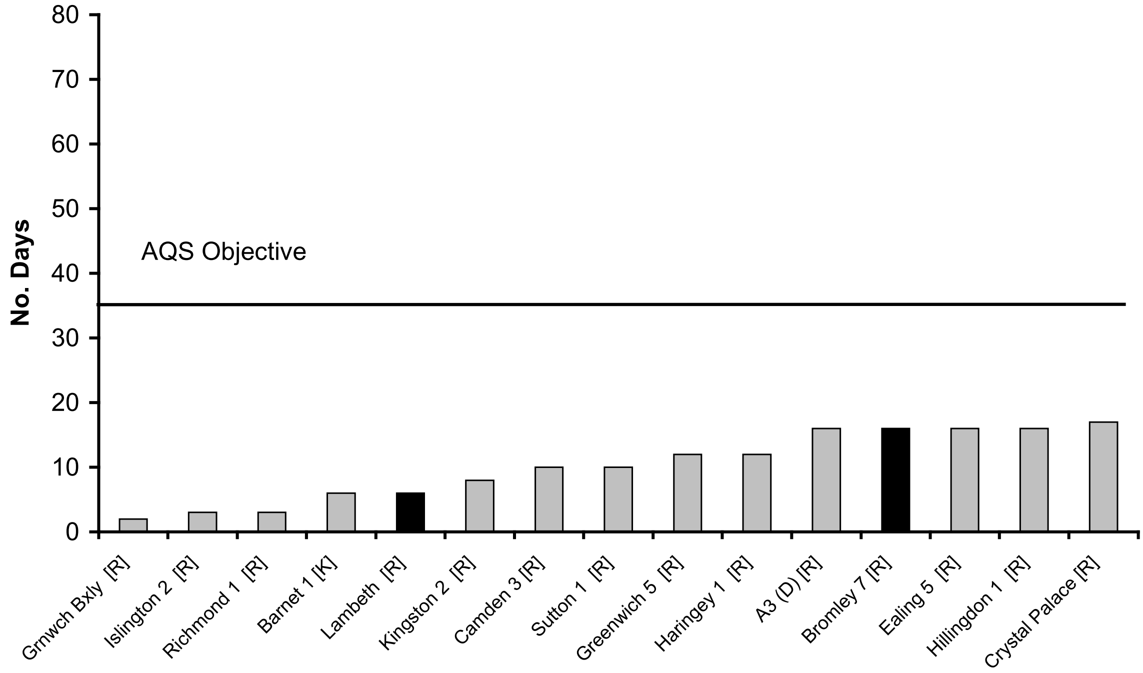

Figure 13 AQS incident based objective for PM_{10} at road and kerbside sites (2000). BAM sites are shown in black.

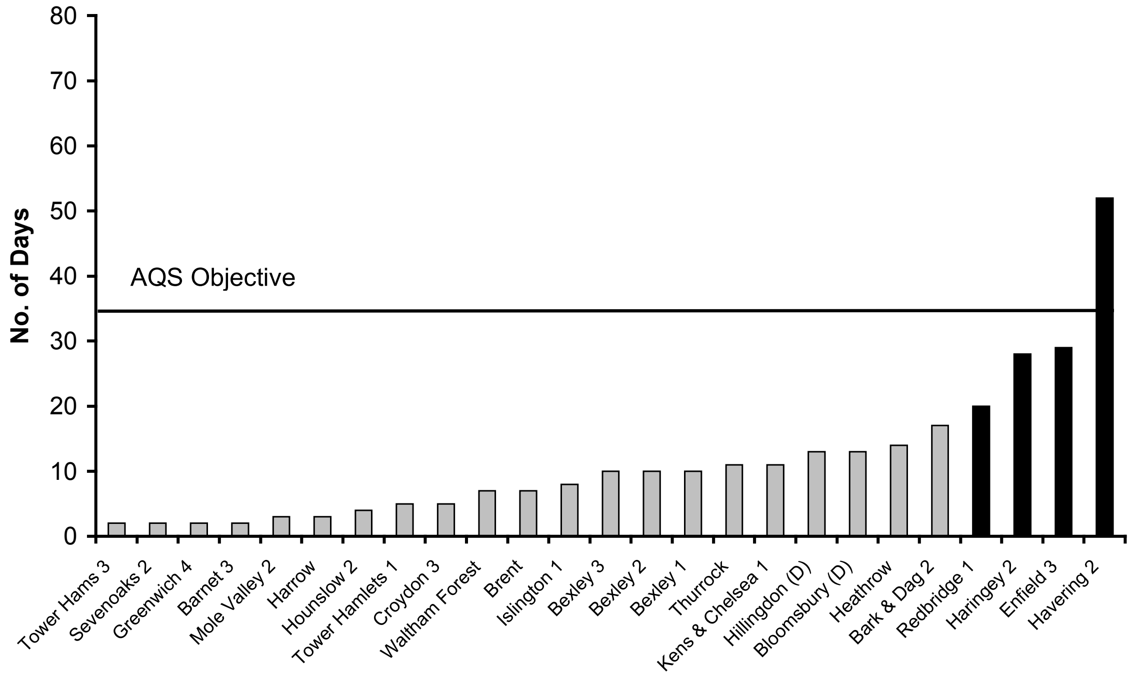

Figure 14 AQS incident based objective for PM_{10} at background sites (2000). BAM sites are shown in black.

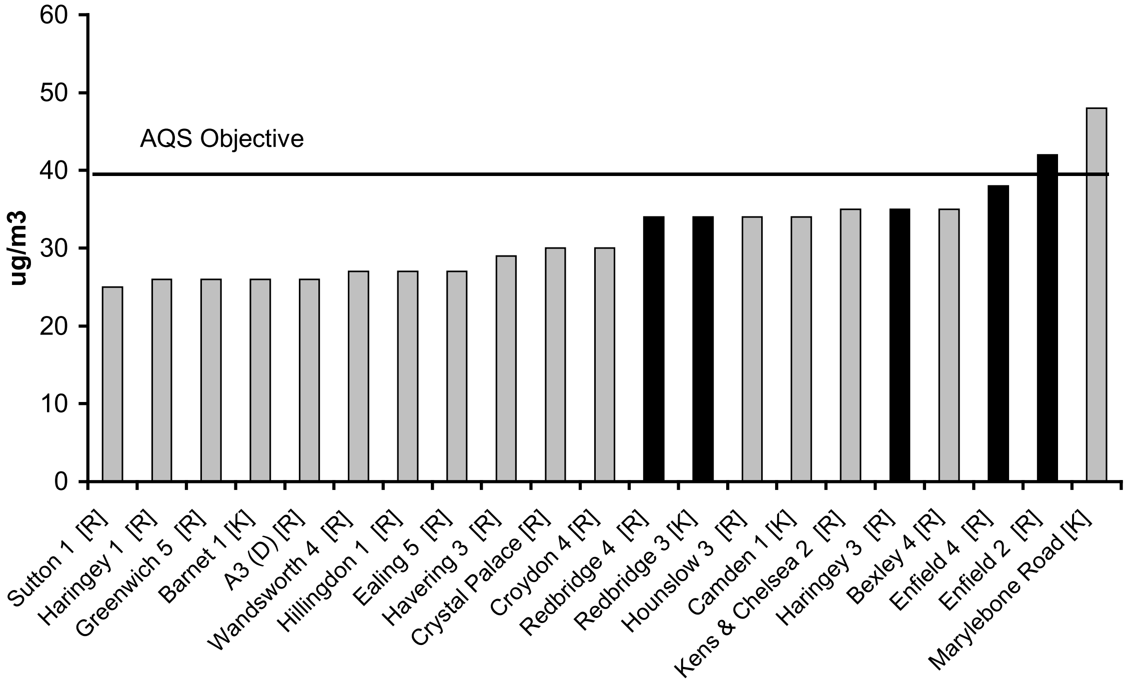

Figure 15 AQS PM_{10} annual mean objective at kerbside and roadside sites (2000).

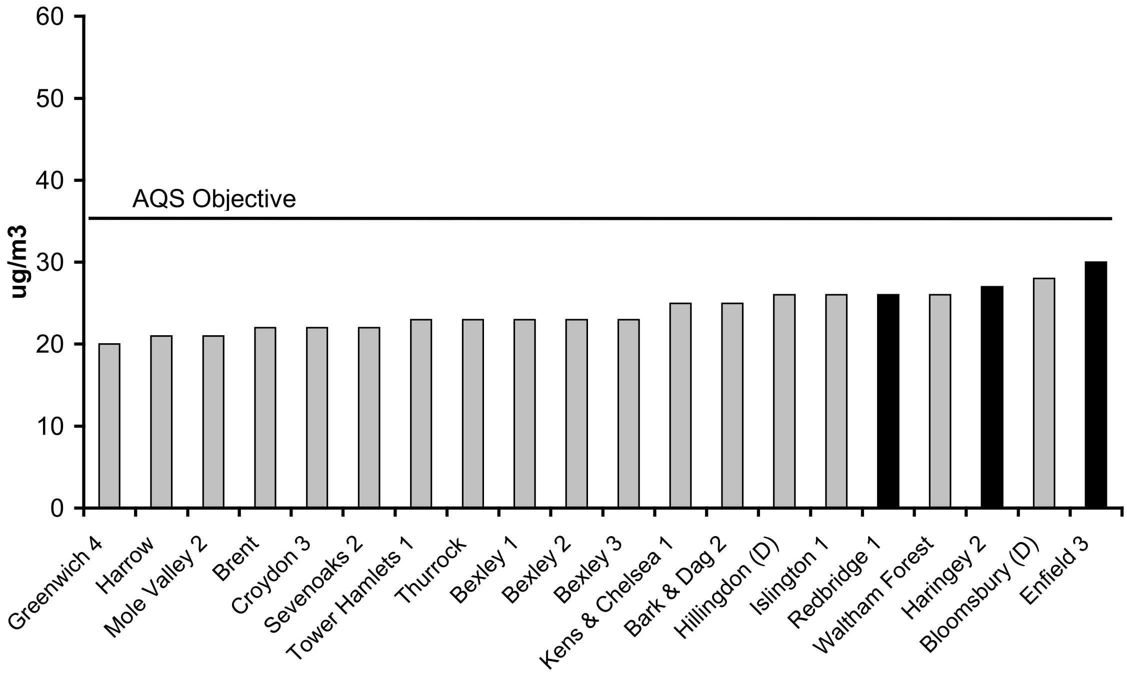

Figure 16 AQS PM_{10} annual mean objective at background sites (2000)

1.3.8 $PM_{2.5}$

$PM_{2.5}$ is a finer fraction of PM_{10}. $PM_{2.5}$ is not currently included in the AQS. The Expert Panel on Air Quality Standards have recently considered $PM_{2.5}$ and concluded that health evidence does not justify a separate $PM_{2.5}$ standard at this time. However, measurements of $PM_{2.5}$ are essential to the understanding of PM_{10}. Co-located measurements of PM_{10} and $PM_{2.5}$ are especially useful providing valuable data for modelling PM_{10} in London and South East England (Fuller *et al* 2002). These are undertaken at several sites in the LAQN including the roadside sites Bromley 7 and

Ealing 2, the kerbside site at Marylebone Road, and at the suburban sites at Bexley 2 and Bexley 3. Co-located measurements are also undertaken at Bloomsbury and $PM_{2.5}$ is measured at Hackney. The ratio of $PM_{2.5}$ to PM_{10} at each site is shown in Figure 17. The majority of PM_{10} measured at each site is $PM_{2.5}$, ranging between 65 % at rural Medway Stoke (Kent Air Quality Monitoring Network) to 77 % at the BAM roadside site Bromley 7.

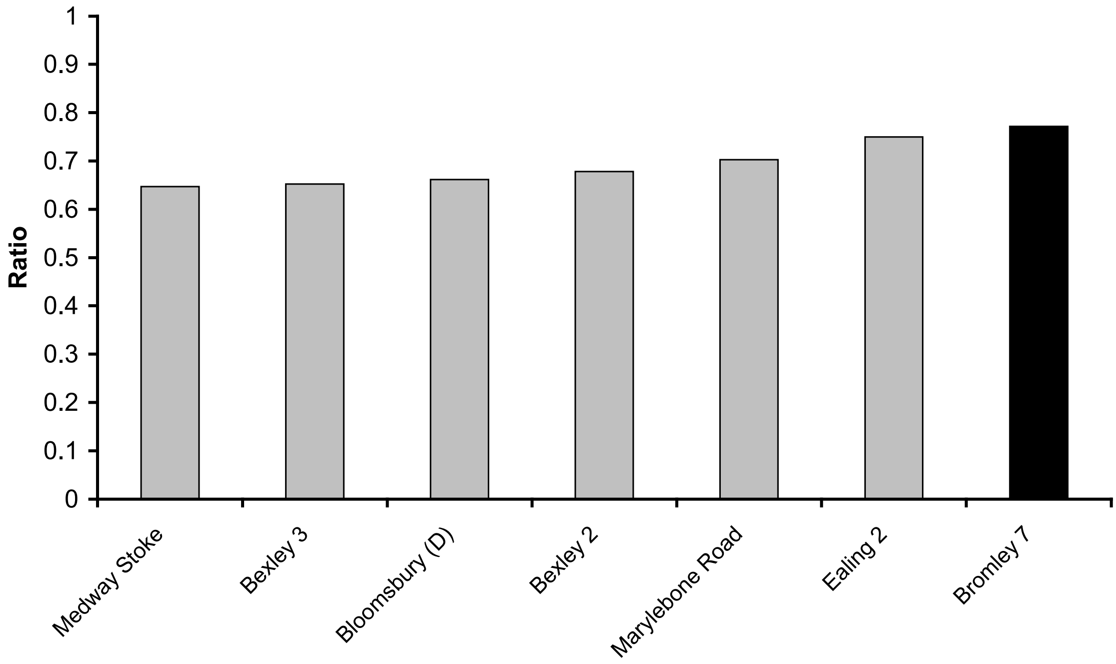

Figure 17 Ratio of Annual Mean $PM_{2.5}$ to PM_{10} (2000).

1.3.9 Benzene and 1,3 Butadiene

The AQS contains objectives for the annual mean concentration of these substances. The main atmospheric source of benzene is the distribution and combustion of petrol, whereas 1,3 butadiene is mainly derived from petrol combustion. Both benzene and 1,3 butadiene are measured at the kerbside at Marylebone Road and at the roadside at Tower Hamlets 2. During 2000 the annual means were below the AQS objectives for 2003. Both pollutants are also measured at the National Hydrocarbon Network monitoring sites in central London and at Eltham (co-located with the Greenwich 4 site). The AQS objectives for benzene and 1,3 butadiene were comfortably met at both sites for 2000.

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LAQN MONITORING SITES 2000

APPENDIX 1: LAQN MONITORING SITES 2000

A.1.0. Details of Monitoring Sites

The following tables detail the pollution monitoring sites in the London Air Quality Network at the end of 2000. The start date of each site is shown along with the pollutants monitored and the data quality. In some cases a monitoring site was not operating during 2000. The availability of data from a site is indicted in the data column in the tables below.

Sites are divided into a number of categories dependent on their location;

- Kerbside sites are those with sampling locations within 1m of the kerbside and with a sampling height of 3m or less.
- Roadside sites are those with sampling locations within 1-5m for the roadside and with a sampling height of 3m or less.
- Urban background sites are located to represent pollution conditions in the centre of an urban area. Sampling locations are away from the influence of individual pollution sources; 25m from major roads for example.
- Suburban sites are typical of residential locations on the edge of a build up area. Sampling locations are away from the influence of individual pollution sources; 25m from major roads for example.

A.1.1 Kerbside Sites

	Start	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$	Data	Quality
Barnet 1	Dec 98		•			**T**		**Yes**	∗∗
Bromley 4	Feb 96	Closed Jul 1998							
Camden 1	Apr 96		•			**T**		**Yes**	∗∗ **A1**
Marylebone Road	Jun 97	•	•	•	•	**TG**	•	**Yes**	∗∗ **A1**
Redbridge 2	Dec 99	•	•					**Yes**	∗
Redbridge 3	Dec 99		•			**B**		**Yes**	∗

Key: T =TEOM, B=Beta Attenuation, G= Gravimetric, ∗Locality Standard, ∗∗Traceability to National Standards
A1= Affiliated to UK AURN – Ratified Data supplied to LAQN by NPL - final data set published by DEFRA
A2= Affiliated to UK AURN – final data set published by DEFRA

A.1.2 Roadside Sites

	Start	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$	Data	Quality
Bexley 4	May 99					**T**		**Yes**	**
Bromley 7	July 98	●	●			**B**	**B**	**Yes**	*/**A1
Camden 3	Apr 00		●			**T**		**Yes**	**
Croydon 2	Sept 94		●					**Yes**	**
Croydon 4	Sept 99		●	●		**T**		**Yes**	**
Croydon 5	Oct 00		●					**Yes**	**
Crystal Palace	Oct 99	●	●	●		**T**		**Yes**	**
Ealing 2	Sept 96	●	●			**T**	**T**	**Yes**	**
Ealing 4	Dec 98	Closed Mar 99							
Ealing 5	Mar 99		●	●		**T**		**Yes**	**
Enfield 2	Jan 98	●	●			**B**		**Yes**	**
Enfield 4	Mar 00		●	●		**B**		**Yes**	**
Greenwich 5	Sept 97		●			**T**		**Yes**	*
Greenwich Bexley	Oct 00		●			**T**	**T**	**Yes**	**
Hams & Fulham 1	Aug 99		●			**T**		**Yes**	**
Haringey 1	Dec 94		●	●		**T**		**Yes**	** A1
Haringey 3	Apr 99		●	●		**B**		**Yes**	**
Havering 1	Dec 95		●					**Yes**	**
Havering 3	Dec 98		●	●		**T**		**Yes**	**
Hillingdon 1	Sept 99		●			**T**		**Yes**	**
Hounslow 1	Apr 93	●	●		(●)			**Yes**	** A1
Hounslow 3	Mar 99					**T**		**Yes**	**
Hounslow 4	Aug 99		●	●		**T**		**Yes**	**
Islington 2	Jul 00	●	●			**T**		**Yes**	**
Ken&Chelsea 2	May 98					**T**		**Yes**	**
Ken&Chelsea 3	Mar 00		●					**Yes**	**
Ken&Chelsea 4	Sep 00		●					**Yes**	**

Key: T =TEOM, B=Beta Attenuation, G= Gravimetric, *Locality Standard, **Traceability to National Standards
A1= Affiliated to UK AURN – Ratified Data supplied to LAQN by NPL - final data set published by DEFRA
A2= Affiliated to UK AURN – final data set published by DEFRA

A.1.2 Roadside Sites (continued)

	Start	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$	Data	Quality
Kingston 2	Apr 96		●			**T**		**No**	∗∗
Lambeth 1	Sep 00		●	●		**B**		**Yes**	∗
Redbridge 4	Dec 99	●	●	●		**B**		**Yes**	∗
Richmond 1	Jun 00		●			**T**		**Yes**	∗∗
Southwark 2	Oct 94	●	●	●				**Yes**	∗∗ **A1**
Sutton 1	May 95	●	●	●		**T**		**Yes**	∗∗ **A1**
Tower Hamlets 2	Mar 94	●	●					**Yes**	∗∗ **A1**
Wandsworth 1	Sept 94	Closed Mar 1996							
Wandsworth 4	Feb 98	●	●			**T**		**Yes**	∗∗
Westminster 2	Jun95	Last data 1995							

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A.1.3 Urban Background Sites

	Start	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$	Data	Quality
Barnet 2	Aug 00		●			**T**		**Yes**	**
Barnet 3	Aug 00		●			**T**		**Yes**	**
Brent	Aug 95	●	●	●	●	**T**		**Yes**	** A2
Bromley 1	Jan 93	Closed Feb 96							
Castle Point	May 96		●	●				**Yes**	**
Croydon 3	May 96				●	**T**		**Yes**	**
Ealing 1	Mar 95	(●)	●	●	●			**Yes**	**
Enfield 3	Nov 98	●	●	●	●	**B**		**Yes**	**
Greenwich 4	Sept 93		●	●	●	**T**		**Yes**	** A1
Hackney	Oct 93	●	●		●		**T**	**Yes**	*/**A1
Heathrow	Mar 99	●	●			**T**		**Yes**	**
Hillingdon (O)	Oct 94	Last Data Apr 95							
Ken&Chelsea 1	Mar 95	●	●	●	●	**T**		**Yes**	**A1
Islington 1	Sep 94	(●)	●			**T**		**Yes**	**
Lewisham	Jan 95		●	●	●			**Yes**	**A1
Redbridge 1	Dec 99		●		●	**B**		**Yes**	*
Sevenoaks 2	Feb 98	●	●	●	●	**T**		**Yes**	**
Southwark 1	Mar 93	●	●	●	●			**Yes**	**A1
Thurrock	Feb 95	●	●	●	●	**T**		**Yes**	**A2
Tower Hamlets 1	Jan 94		●	●	●	**T**		**Yes**	**
Tower Hamlets 3	Oct 99		●	●		**T**		**Yes**	**
Waltham Forest	Jul 98		●	●		**T**		**Yes**	**
Wandsworth 2	Oct 94	●	●	●	●			**Yes**	**A1
Westminster 1	Jan 93	Last Data 1996							

Key: T =TEOM, B=Beta Attenuation, G= Gravimetric, *Locality Standard, **Traceability to National Standards
A1= Affiliated to UK AURN – Ratified Data supplied to LAQN by NPL - final data set published by DEFRA
A2= Affiliated to UK AURN – final data set published by DEFRA

A.1.4 Suburban Sites

	Start	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$	Data	Quality
Bark & Dag 1	Sep 1993		•	•				**Yes**	∗∗
Bark & Dag 2	Oct 99					**T**		**Yes**	∗∗
Bexley 1	Jan 93	•	•	•	•	**T**		**Yes**	∗**A2**
Bexley 2	Jan 98		•			**T**	**T**	**Yes**	∗∗
Bexley 3	Jan 98					**T**	**T**	**Yes**	∗∗
Bexley 5	Nov 99	•	•	•				**Yes**	∗∗
Brentwood 1	Aug 95	Last data Mar 1999							
Bromley 5	Mar 96				•			**Yes**	∗∗
Enfield 1	Jul 95		•					**Yes**	∗∗
Haringey 2	Apr 96		•		•	**B**		**Yes**	∗∗**A1**
Havering 2	Apr 98					**B**		**Yes**	∗
Harrow	Apr 99		•	•		**T**		**Yes**	∗∗
Hounslow 2	Apr 99		•	•	•	**T**		**Yes**	∗∗
Kingston 1	Mar 96				•			**Yes**	∗∗
Mole Valley 2	Apr 97		•			**T**		**Yes**	∗∗
Reigate & Bans 1	Jul 00		•			**T**		**Yes**	∗∗
Sutton 2	May 95		•					**Yes**	∗∗
Sutton 3	May 95		•		•			**Yes**	∗∗**A1**
Wandsworth 3	Oct 94			•	**(•)**			**Yes**	∗∗

A.1.5 Rural Sites

	Start	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$	Data	Quality
Mole Valley 1	Mar 96	Closed Mar 1999							
S'oaks Scudders H	Sept 95	Closed Sept 1997							

Key: T =TEOM, B=Beta Attenuation, G= Gravimetric, ∗Locality Standard, ∗∗Traceability to National Standards
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A2= Affiliated to UK AURN – final data set published by DEFRA

A.1.6 Principle Site Changes During 2000

- The Barnet 2 and 3 sites joined the LAQN during August. They are both urban background sites located respectively in Strawberry Vale and Finchley. Both sites monitor NO_X and PM_{10} (TEOM).

- The Camden 3 monitoring site was installed during April. The site monitors NO_X and PM_{10} (TEOM) in a roadside location on Shaftsbury Avenue. The site is innovatively located in a cylindrical advertising hoarding. The site is an important addition to the monitoring of roadside pollution in central London and forms part of Camden Council's ClearZone project.

- The Croydon 5 roadside site joined the network during October. The site is located on London Road in Norbury and monitors NO_X. The site was located on the basis of modelled air pollution as part of the Council's Review and Assessment process.

- The Greenwich Bexley roadside site was installed on the A2 during October. The site is jointly funded by the London Boroughs of Greenwich and Bexley, and is situated at their common border. The site monitors NO_X and PM_{10} (TEOM) with $PM_{2.5}$ (TEOM) installed during early 2001. This combination of monitoring means that the site will make a significant contribution to the understanding of particulate pollution across London.

- The Enfield 4 monitoring site joined the LAQN during March. The site is located in a roadside location. The site is close to an industrial estate, the Edmonton incinerator and the North Circular Road (A406). The site measures NO_X, SO_2 and PM_{10} (BAM).

- A SO_2 analyser was installed at the Harrow suburban site.

- The O_3 analyser at the roadside site Hounslow 1 was relocated to the suburban site Hounslow 2 during April. This will provide improved information regarding O_3 in west London.

- The Islington 2 roadside monitoring site was commissioned during July. The site is located adjacent to Holloway Road and monitors NO_X , CO and PM_{10} (TEOM).

- The LAQN's first Lambeth site joined the network during September. The site is located adjacent to the South Circular Road (A205) in north Streatham and monitors NO_X, SO_2 and PM_{10} (BAM).

- The Kensington and Chelsea 3 site was installed during March. The site is in a roadside location within the Harrods building in Knightsbridge. The site measures NO_X.

- The Kensington & Chelsea 4 NO_X monitoring site joined the LAQN during September. The site is located in the Old Chelsea Town Hall on the King's Road.

- The Kingston 2 monitoring site was temporarily shutdown during June and was out of action for the remainder of 2000.

- The LAQN expanded significantly to the south with the addition of a second site in Surrey. The Reigate and Banstead 1 site is located in a residential area in Horley immediately to the north of Gatwick Airport. The site is located in an area where the AQS Objectives are likely to be exceeded in 2005 due to a combination of road traffic and emissions from the airport itself. The site monitors NO_X and PM_{10} (TEOM).

- The Richmond 1 monitoring site joined the LAQN during June. The site is located at a roadside location in the north of the borough. The site monitors NO_X and PM_{10} (TEOM) and forms part of an expansion of Richmond Council's monitoring programme.

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DEFRA DIRECTLY FUNDED SITES

APPENDIX 2: DEFRA DIRECTLY FUNDED SITES

A.2.1 Roadside Sites

	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$
A3 (D)	●	●			T	
Cromwell Rd (D)	●	●	●		#	

A.2.2 Background Sites

	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$
Bloomsbury (D)	●	●	●	●	T	T
Hillingdon (D)	●	●	●	●	T	
Teddington (D)		●	●	●		
West London (D)	●	●				

 # Reported as LAQN site Kensington & Chelsea 2.
T = TEOM.

SUMMARY OF RESULTS

APPENDIX 3: SUMMARY OF MONITORING RESULTS

A.3.1 Carbon Monoxide

Where data capture for an analyser was less than 75 % a statistical comparison is shown in parenthesis. Where comparison with the objective cannot be made these results are marked not applicable (NA).

Carbon Monoxide	Data Capture %	Annual Mean (ppm)	Annual Max (h) (ppm)
Kerbside			
Marylebone Rd	95	2.0	8.5
Redbridge 2	88	2.8	14.4
Roadside			
A3 (D)	97	0.8	6.0
Bromley 7	90	0.9	6.2
Cromwell Rd (D)	98	1.2	5.2
Crystal Palace	96	1.1	7.4
Ealing 2	99	1.0	7.0
Enfield 2	86	0.7	10.2
Hounslow 1	96	0.8	6.8
Islington 2	45	1.3	9.1
Redbridge 4	93	0.8	8.3
Southwark 2	97	0.9	5.9
Sutton 1	89	0.7	5.4
Tower Hams 2	88	0.8	6.1
Wandsworth 4	92	0.7	5.9

Carbon Monoxide	Data Capture %	Annual Mean (ppm)	Annual Max (h) (ppm)
Background			
Bloomsbury	95	0.6	6.3
Brent	98	0.4	9.5
Enfield 3	96	0.5	10.9
Hackney	90	0.6	9.4
Heathrow	97	0.6	6.1
Hillingdon (D)	90	0.5	8.1
Kens & Chelsea 1	94	0.3	5.9
Sevenoaks 2	96	0.2	5.3
Southwark 1	96	0.5	4.9
Thurrock	96	0.2	6.2
Wandsworth 2	92	0.7	5.9
West London (D)	97	0.3	4.6
Suburban			
Bexley 1	86	0.4	4.4
Bexley 5	93	0.4	4.9

Carbon Monoxide	Exceedence of AQS Objective Max Rolling 8h Mean >10ppm	Days Moderate Pollution or Above
Kerbside		
Marylebone Rd	No / 0	0
Redbridge 2	Yes / 9	5
Roadside		
A3 (D)	No / 0	0
Bromley 7	No / 0	0
Cromwell Rd (D)	No / 0	0
Crystal Palace	No / 0	0
Ealing 2	No / 0	0
Enfield 2	No / 0	0
Hillingdon (D)	No / 0	0
Hounslow 1	No / 0	0
Islington 2	NA / 0	0
Redbridge 4	No / 0	0
Southwark 2	No / 0	0
Sutton 1	No / 0	0
Tower Hams 2	No / 0	0
Wandsworth 4	No / 0	0
West London (D)	No / 0	0
Background		
Brent	No / 0	0
Enfield 3	No / 0	0
Hackney	No / 0	0
Heathrow	No / 0	0
Kens & Chelsea 1	No / 0	0
Sevenoaks 2	No / 0	0
Southwark 1	No / 0	0
Thurrock	No / 0	0
Wandsworth 2	No / 0	0
Suburban		
Bexley 1	No / 0	0
Bexley 5	No / 0	0

A.2.2 Nitrogen Dioxide

Where data capture for an analyser was less than 75 % a statistical comparison is shown in parenthesis. Where comparison with the objective cannot be made these results are marked not applicable (NA).

Nitrogen Dioxide	Data Capture %	Annual Mean (ppb)	Annual Max (h) (ppb)
Kerbside			
Barnet 1	96	28	132
Camden 1	95	33	86
Marylebone Road	96	48	156
Redbridge 2	89	63	197
Redbridge 3	97	39	220

Nitrogen Dioxide	Data Capture %	Annual Mean (ppb)	Annual Max (h) (ppb)
Roadside			
A3 (D)	96	29	73
Bromley 7	82	33	88
Camden 3	34	37	103
Cromwell Rd (D)	93	46	204
Croydon 2	94	18	57
Croydon 4	95	27	142
Croydon 5	23	29	91
Crystal Palace	96	25	73
Greenwich 5	98	26	85
Greenwich Bexley	20	22	65
Ealing 2	94	28	149
Ealing 5	83	28	104
Enfield 2	93	23	101
Enfield 4	78	26	89
Hams & Fulham 1	82	38	157
Haringey 1	88	27	104
Haringey 3	94	26	107
Havering 1	85	27	136
Havering 3	98	22	85
Hilingdon 1	98	23	92
Hounslow 1	96	27	79
Hounslow 4	75	28	113
Islington 2	46	34	105
Kens & Chelsea 3	73	39	770
Kens & Chelsea 4	25	45	109

Nitrogen Dioxide	Data Capture %	Annual Mean (ppb)	Annual Max (h) (ppb)
Roadside			
Kingston 2	41	24	72
Lambeth 1	26	32	76
Redbridge 4	93	26	99
Richmond 1	46	20	70
Southwark 2	89	33	81
Sutton 1	87	21	81
Tower Hamlets 2	91	34	110
Wandsworth 4	99	24	81

Nitrogen Dioxide	Data Capture %	Annual Mean (ppb)	Annual Max (h) (ppb)
Background			
Barnet 2	36	22	74
Barnet 3	37	23	76
Bloomsbury (D)	96	31	90
Brent	97	19	88
Castle Point	89	15	79
Ealing 1	97	22	112
Enfield 3	94	19	100
Greenwich 4	97	17	64
Hackney	90	26	125
Heathrow	97	29	93
Hillingdon (D)	98	23	92
Islington 1	93	26	97
Ken & Chelsea 1	96	21	116
Lewisham	43	27	64
Redbridge 1	94	22	84
Sevenoaks 2	98	12	57
Southwark 1	96	27	73
Teddington (D)	98	15	71
Thurrock	92	18	84
Tower Hamlets 1	84	23	93
Tower Hamlets 3	94	22	100
Waltham Forest	94	22	113
Wandsworth 2	97	26	94
West London (D)	97	28	83

Nitrogen Dioxide	Data Capture %	Annual Mean (ppb)	Annual Max (h) (ppb)
Suburban			
Bark & Dag 1	70	15	85
Bexley 1	96	18	65
Bexley 2	94	17	71
Bexley 5	95	16	64
Enfield 1	92	18	79
Haringey 2	93	19	84
Harrow	96	18	85
Hounslow 2	97	19	74
Mole Valley 2	97	14	56
Reigate & Bans 1	38	18	52
Sutton 2	98	18	74
Sutton 3	91	17	66

Nitrogen Dioxide	Exceedence of Air Quality Strategy Objectives			
	Annual Mean >21ppb	Annual Mean >40 ug/m3	105ppb (200ug/m3) not to be exceeded on more than 18 hours	Days Moderate Pollution or Above
Kerbside				
Barnet 1	Yes / 28	Yes / 53	No / 4	0
Camden 1	Yes / 33	Yes / 63	No / 0	0
Marylebone Road	Yes / 48	Yes / 92	Yes / 104	1
Redbridge 2	Yes / 63	Yes / 120	Yes / 849	31
Redbridge 3	Yes / 39	Yes / 74	Yes / 60	1

Nitrogen Dioxide	Exceedence of Air Quality Strategy Objectives			
	Annual Mean >21ppb	Annual Mean >40 ug/m3	105ppb (200ug/m3) not to be exceeded on more than 18 hours	Days Moderate Pollution or Above
Roadside				
A3 (D)	Yes / 29	Yes / 55	No / 0	0
Bromley 7	Yes / 33	Yes / 63	No / 0	0
Camden 3	NA / 37	NA / 71	NA / 0	0
Cromwell Rd (D)	Yes / 46	Yes / 88	No / 13	1
Croydon 2	No / 18	No / 34	No / 0	0
Croydon 4	Yes / 27	Yes / 52	No / 4	0
Croydon 5	NA / 29	NA / 55	No / 0	0
Crystal Palace	Yes / 25	Yes / 48	No / 0	0
Greenwich 5	Yes / 26	Yes / 50	No / 0	0
Greenwich Bexley	NA / 22	NA / 42	NA / 0	0
Ealing 2	Yes / 28	Yes / 53	No / 9	0
Ealing 5	Yes / 28	Yes / 53	No / 0	0
Enfield 2	Yes / 23	Yes / 44	No / 0	0
Enfield 4	Yes / 26	Yes / 50	No / 0	0
Hams & Fulham 1	Yes / 38	Yes / 73	Yes / 20	1
Haringey 1	Yes / 27	Yes / 52	No / 0	0
Haringey 3	Yes / 26	Yes / 50	No / 1	0
Havering 1	Yes / 27	Yes / 52	No / 10	0
Havering 3	Yes / 22	Yes / 42	No / 0	0
Hillingdon 1	Yes / 23	Yes / 44	No / 0	0
Hounslow 1	Yes / 27	Yes / 52	No / 0	0
Hounslow 4	Yes / 28	Yes / 53	No / 1	0
Islington 2	NA / 34	NA / 65	NA / 1	0
Kens & Chelsea 3	NA / 39	NA / 74	Yes / 52	2
Kens & Chelsea 4	NA / 45	NA / 86	NA / 1	0

Nitrogen Dioxide	Exceedence of Air Quality Strategy Objectives			
	Annual Mean >21ppb	Annual Mean >40 ug/m3	105ppb (200ug/m3) not to be exceeded on more than 18 hours	Days Moderate Pollution or Above
Roadside				
Kingston 2	NA / 24	NA / 46	NA / 0	0
Lambeth 1	NA / 32	NA / 61	NA / 0	0
Redbridge 4	Yes / 26	Yes / 50	No / 0	0
Richmond 1	NA / 20	NA / 38	NA / 0	0
Southwark 2	Yes / 33	Yes / 63	No / 0	0
Sutton 1	No / 21	No / 40	No / 0	0
Tower Hamlets 2	Yes / 34	Yes / 65	No /3	0
Wandsworth 4	Yes / 24	Yes / 46	No / 0	0

Nitrogen Dioxide	Exceedence of Air Quality Strategy Objectives			
	Annual Mean >21ppb	Annual Mean >40 ug/m3	105ppb (200ug/m3) not to be exceeded on more than 18 hours	Days Moderate Pollution or Above
Background				
Barnet 2	NA / 22	NA / 42	NA / 0	0
Barnet 3	NA / 23	NA / 44	NA / 0	0
Bloomsbury (D)	Yes / 31	Yes / 59	No / 0	0
Brent	No /19	No / 36	No / 0	0
Castle Point	No / 15	No / 29	No / 0	0
Ealing 1	Yes / 22	Yes / 42	No / 2	0
Enfield 3	No / 19	No / 36	No / 0	0
Greenwich 4	No / 17	No / 32	No / 0	0
Hackney	Yes / 26	Yes / 50	No / 1	0
Heathrow	Yes / 29	Yes / 55	No / 0	0
Hillingdon (D)	Yes / 23	Yes / 44	No / 0	0
Islington 1	Yes / 26	Yes / 50	No / 0	0
Ken & Chelsea 1	No / 21	No / 40	No / 3	0
Lewisham	NA / 27	NA / 52	NA / 0	0
Redbridge 1	Yes / 22	Yes / 42	No / 0	0
Sevenoaks 2	No / 12	No / 23	No / 0	0
Southwark 1	Yes / 27	Yes / 52	No / 0	0
Teddington (D)	No / 15	No / 29	No / 0	0
Thurrock	No / 18	No / 34	No / 0	0
Tower Hamlets 1	Yes / 23	Yes / 44	No / 0	0
Tower Hamlets 3	Yes / 22	Yes / 42	No / 0	0
Waltham Forest	Yes / 22	Yes / 42	No / 2	0
Wandsworth 2	Yes / 26	Yes / 50	No / 0	0
West London (D)	Yes / 28	Yes / 53	No / 0	0

Nitrogen Dioxide	Exceedence of Air Quality Strategy Objectives			
	Annual Mean >21ppb	Annual Mean >40 ug/m3	105ppb (200ug/m3) not to be exceeded on more than 18 hours	Days Moderate Pollution or Above
Suburban				
Bark & Dag 1	NA / 15	NA / 29	NA / 0	0
Bexley 1	No / 18	No / 34	No / 0	0
Bexley 2	No / 17	No / 32	No / 0	0
Bexley 5	No / 16	No / 31	No / 0	0
Enfield 1	No / 18	No / 34	No / 0	0
Haringey 2	No / 19	No / 36	No / 0	0
Harrow	No / 18	No / 34	No / 0	0
Hounslow 2	No / 19	No / 36	No / 0	0
Mole Valley 2	No / 14	No / 27	No / 0	0
Reigate & Bans 1	NA / 18	NA / 34	NA / 0	0
Sutton 2	No / 18	No / 34	No / 0	0
Sutton 3	No / 17	No / 32	No / 0	0

A.2.3 Ozone

Where data capture for an analyser was less than 75 % a statistical comparison is shown in parenthesis. Where comparison with the objective cannot be made these results are marked not applicable (NA).

Ozone	Data Capture %	Annual Mean (ppb)	Annual Max (h) (ppb)
Kerbside			
Marylebone Road	98	7	48
Background			
Bloomsbury (D)	97	11	54
Brent	98	19	77
Croydon 3	94	18	63
Ealing 1	97	14	53
Enfield 3	94	18	78
Greenwich 4	98	18	70
Hackney	87	15	64
Hillingdon (D)	98	11	56
Kens & Chelsea 1	94	17	67
Lewisham	39	11	40
Redbridge 1	97	17	66
Sevenoaks 2	95	22	77
Southwark 1	96	15	65
Teddington (D)	98	22	75
Thurrock	96	19	79
Tower Hamlets 1	99	16	63
Wandsworth 2	96	12	59
Suburban			
Bexley 1	98	18	73
Bromley 5	79	24	74
Haringey 2	98	16	74
Hounslow 2	56	15	68
Kingston 1	93	22	93
Sutton 3	99	18	63

Ozone	AQS Objective 50ppb (8h avg) exceeded on more than 10 days	Days Moderate Pollution or Above
Kerbside		
Marylebone Road	No / 0	0
Urban Background		
Bloomsbury (D)	No / 0	3
Brent	Yes / 11	34
Croydon 3	No / 8	11
Ealing 1	No / 0	3
Enfield 3	Yes / 12	23
Greenwich 4	No / 8	19
Hackney	No / 2	9
Hillingdon (D)	No / 0	3
Kens & Chelsea 1	No / 7	18
Lewisham	NA / 0	0
Redbridge 1	No / 8	16
Sevenoaks 2	Yes / 18	38
Southwark 1	No / 6	11
Teddington (D)	Yes / 17	37
Thurrock	Yes / 11	24
Tower Hamlets 1	No / 4	12
Wandsworth 2	No / 3	6
Suburban		
Bexley 1	No / 8	20
Bromley 5	Yes / 13	26
Haringey 2	No / 8	20
Hounslow 2	NA / 4	8
Kingston 1	Yes / 25	45
Sutton 3	No / 6	14

A.2.4 PM_{10}

Where data capture for an analyser was less than 75 % a statistical comparison is shown in parenthesis. Where comparison with the objective cannot be made these results are marked not applicable (NA).

PM_{10}	Instrument Type	Data Capture %	Annual Mean (μgm^{-3})	Annual Max (h) (μgm^{-3})
Kerbside				
Barnet 1	**T**	89	20	215
Camden	**T**	97	26	175
Marylebone Road	**T**	98	37	693
Redbridge 3	**B**	97	34	327

T =TEOM, B=Beta Attenuation.

PM_{10}	Instrument Type	Data Capture %	Annual Mean (μgm^{-3})	Annual Max (h) (μgm^{-3})
Roadside				
A3 (D)	**T**	98	20	142
Bexley 4	**T**	97	27	329
Bromley 7	**B**	86	25	191
Camden 3	**T**	38	25	187
Croydon 4	**T**	96	23	446
Crystal Palace	**T**	96	23	1870
Ealing 2	**T**	69	22	175
Ealing 5	**T**	91	21	285
Enfield 2	**B**	92	42	238
Enfield 4	**B**	62	38	250
Greenwich 5	**T**	97	20	161
Greenwich Bexley	**T**	20	18	150
Hams & Fulham 1	**T**	89	26	195
Haringey 1	**T**	93	20	185
Haringey 3	**B**	96	35	171
Havering 3	**T**	95	22	201
Hillingdon 1	**T**	92	21	144
Hounslow 3	**T**	99	26	234
Hounslow 4	**T**	78	23	181
Islington 2	**T**	45	25	169
Kens and Chelsea 2	**T**	97	27	535
Kingston 2	**T**	46	21	127
Lambeth	**B**	24	33	471
Redbridge 4	**B**	92	34	203
Richmond 1	**T**	53	18	179
Sutton 1	**T**	91	19	138
Wandsworth 4	**T**	99	21	2108

T =TEOM, B=Beta Attenuation.

PM_{10}	Instrument Type	Data Capture %	Annual Mean (μgm^{-3})	Annual Max (h) (μgm^{-3})
Background				
Barnet 2	**T**	20	16	55
Barnet 3	**T**	37	18	154
Bloomsbury (D)	**T**	97	21	128
Brent	**T**	98	17	153
Croydon 3	**T**	96	17	980
Enfield 3	**B**	85	30	338
Greenwich 4	**T**	92	15	197
Heathrow	**T**	97	21	148
Hillingdon (D)	**T**	98	20	207
Islington 1	**T**	98	20	187
Kens & Chelsea 1	**T**	95	19	163
Redbridge 1	**B**	94	26	368
Sevenoaks 2	**T**	90	17	1346
Tower Hamlets 1	**T**	97	18	121
Tower Hamlets 3	**T**	94	15	117
Thurrock	**T**	93	18	258
Waltham Forest	**T**	91	19	134
Suburban				
Bark & Dag 2	**T**	99	19	153
Bexley 1	**T**	97	18	287
Bexley 2	**T**	97	18	251
Bexley 3	**T**	93	18	215
Haringey 2	**B**	94	27	166
Harrow	**T**	92	16	184
Hounslow 2	**T**	97	17	242
Havering 2	**B**	77	40	824
Mole Valley 2	**T**	90	16	195
Reigate & Bans 1	**T**	44	16	196

T =TEOM, B=Beta Attenuation.

AQS Objectives			
PM_{10}	35 Days Daily Average >50µgm^{-3}	Annual Mean >40µgm^{-3}	Days Moderate Pollution or Above*
	(TEOM *1.3, BAM *1)	(TEOM *1.3, BAM *1)	
Kerbside			
Barnet 1	No / 6	No / 26	3
Camden 1	No / 30	No / 34	5
Marylebone Road	Yes / 157	Yes / 48	80
Redbridge 3	Yes / 48	No / 34	(76)

*DEFRA bands are for PM_{10} as measured by TEOM instruments. Results using other instruments cannot be compared directly and are shown in parenthesis.

PM$_{10}$	AQS Objectives: 35 Days Daily Average >50μgm^{-3} (TEOM *1.3, BAM *1)	AQS Objectives: Annual Mean >40μgm^{-3} (TEOM *1.3, BAM *1)	Days Moderate Pollution or Above#
Roadside			
A3 (D)	No / 16	No / 26	2
Bexley 4	Yes / 78	No / 35	77
Bromley 7	No / 16	No / 25	(30)
Camden 3	NA / 10	NA / 33	2
Croydon 4	Yes / 38	No / 30	18
Crystal Palace	No / 17	No / 30	3
Ealing 2	No / 19	No / 29	6
Ealing 5	No / 16	No / 27	5
Enfield 2	Yes / 77	Yes / 42	(113)
Enfield 4	NA / 42	NA / 38	(62)
Greenwich 5	No / 12	No / 26	4
Greenwich Bexley	NA / 2	NA / 24	1
Hams & Fulham	No / 32	No / 34	11
Haringey 1	No / 12	No / 26	6
Haringey 3	Yes / 49	No / 35	(76)
Havering 3	No / 29	No / 29	13
Hillingdon 1	No / 16	No / 27	2
Hounslow 3	Yes / 41	No / 34	18
Hounslow 4	No / 18	No / 30	6
Islington 2	NA / 3	NA / 26	1
Kens & Chelsea 2	No / 30	No / 35	16
Kingston 2	NA / 8	NA / 28	0
Lambeth	NA / 6	NA / 33	(11)
Redbridge 4	No / 34	No / 34	(58)
Richmond 1	NA / 3	NA / 23	1
Sutton 1	No / 10	No / 25	0
Wandsworth 4	No / 19	No / 27	5

#DEFRA bands are for PM$_{10}$ as measured by TEOM instruments. Results using other instruments cannot be compared directly and are shown in parenthesis.

	AQS Objectives		
PM_{10}	35 Days Daily Average >50µgm^{-3} (TEOM *1.3, BAM *1)	Annual Mean >40µgm^{-3} (TEOM *1.3, BAM *1)	Days Moderate Pollution or Above#
Background			
Barnet 2	NA / 0	NA / 21	0
Barnet 3	NA / 2	NA / 23	2
Bloomsbury (D)	No / 13	No / 28	1
Brent	No / 7	No / 22	3
Croydon 3	No / 5	No / 22	2
Enfield 3	No / 29	No / 30	(47)
Greenwich 4	No / 2	No / 20	1
Heathrow	No / 14	No / 28	7
Hillingdon (D)	No / 13	No / 26	2
Islington 1	No / 8	No / 26	4
Kens & Chelsea 1	No / 11	No / 25	3
Redbridge 1	No / 20	No / 26	(32)
Sevenoaks 2	No / 2	No / 22	0
Tower Hamlets 1	No / 5	No / 23	3
Tower Hamlets 3	No / 2	No / 20	2
Thurrock	No / 11	No / 23	3
Waltham Forest	No / 7	No / 26	5
Suburban			
Bark & Dag 2	No / 17	No / 25	4
Bexley 1	No / 10	No / 23	4
Bexley 2	No / 10	No / 23	5
Bexley 3	No / 10	No / 23	5
Haringey 2	No / 28	No / 27	(45)
Harrow	No / 3	No / 21	3
Hounslow 2	No / 4	No / 22	0
Havering 2	Yes / 52	Yes / 40	(84)
Mole Valley 2	No / 3	No / 21	0
Reigate & Bans 1	NA / 0	NA / 21	0

#DEFRA bands are for PM_{10} as measured by TEOM instruments. Results using other instruments cannot be compared directly and are shown in parenthesis.

A.2.5 $PM_{2.5}$

$PM_{2.5}$	Instrument Type*	Data Capture %	Annual Mean (μgm^{-3})	Annual Max (h) (μgm^{-3})
Roadside				
Bromley 7	**B**	86	19	174
Ealing 2	**T**	98	16	190
Marylebone Rd	**T**	89	26	330
Background				
Hackney	**T**	97	16	130
Suburban				
Bexley 2	**T**	75	12	127
Bexley 3	**T**	80	12	200

Key: T =TEOM, B=Beta Attenuation.

A.2.6 Sulphur Dioxide

Where data capture for an analyser was less than 75 % a statistical comparison is shown in parenthesis. Where comparison with the objective cannot be made these results are marked not applicable (NA).

Sulphur Dioxide	Data Capture %	Annual Mean (ppb)	Annual Max (h) (ppb)
Kerbside			
Marylebone Road	95	5	43
Roadside			
Cromwell Rd (D)	97	3	22
Croydon 4	81	4	48
Crystal Palace	92	3	47
Ealing 5	78	3	51
Enfield 4	76	4	41
Haringey 1	91	4	36
Haringey 3	86	3	44
Havering 3	99	2	36
Hounslow 4	76	2	37
Lambeth	24	3	31
Redbridge 4	92	4	62
Southwark 2	86	2	35
Sutton 1	87	3	42

Sulphur Dioxide	Data Capture %	Annual Mean (ppb)	Annual Max (h) (ppb)
Background			
Bloomsbury (D)	97	4	70
Brent	98	2	38
Castle Point	97	4	80
Ealing 1	98	3	24
Enfield 3	96	3	40
Greenwich 4	93	2	63
Hillingdon (D)	98	4	33
Kens & Chelsea 1	96	2	34
Lewisham	44	2	19
Sevenoaks 2	98	1	47
Southwark 1	95	3	45
Teddington (D)	97	2	44
Tower Hamlets 1	92	2	36
Tower Hamlets 3	92	4	43
Thurrock	96	3	91
Waltham Forest	94	3	59
Wandsworth 2	81	2	46
Suburban			
Bark & Dag 1	69	2	48
Bexley 1	98	2	70
Bexley 5	95	3	73
Harrow	79	2	39
Hounslow 2	97	2	50
Wandsworth 3	89	2	34

Sulphur Dioxide	AQS Objective 100ppb (266ug/m3) (15min avg) not to be exceeded on more than 35 occasions	Days Moderate Pollution or Above
Kerbside		
Marylebone Road	No / 0	0
Roadside		
Cromwell Rd (D)	No / 0	0
Croydon 4	No / 0	0
Crystal Palace	No / 0	0
Ealing 5	No / 0	0
Enfield 4	No / 0	0
Haringey 1	No / 0	0
Haringey 3	No / 0	0
Havering 3	No / 0	0
Hounslow 4	No / 0	0
Lambeth	NA / 0	0
Redbridge 4	No / 0	0
Southwark 2	No / 0	0
Sutton 1	No / 0	0

Sulphur Dioxide	AQS Objective 100ppb (266ug/m3) (15min avg) not to be exceeded on more than 35 occasions	Days Moderate Pollution or Above
Background		
Bloomsbury (D)	No / 0	0
Brent	No / 0	0
Castle Point	No / 2	2
Ealing 1	No / 0	0
Enfield 3	No / 0	0
Greenwich 4	No / 0	0
Kens & Chelsea 1	No / 0	0
Lewisham	NA / 0	0
Sevenoaks 2	No / 0	0
Southwark 1	No / 0	0
Teddington (D)	No / 0	0
Tower Hamlets 1	No / 0	0
Tower Hamlets 3	No / 0	0
Thurrock	No / 8	4
Waltham Forest	No / 0	0
Wandsworth 2	No / 0	0
Suburban		
Bark & Dag 1	NA / 0	0
Bexley 1	No / 0	0
Bexley 5	No / 0	0
Harrow	No / 0	0
Hounslow 2	No / 0	0
Wandsworth 3	No / 0	0

King's College London

University of London

Air Quality Strategy Objectives

UK Air Quality Information System

APPENDIX 4: AIR QUALITY STRATEGY OBJECTIVES & UK AIR QUALITY INFORMATION SYSTEM

The following objectives are set out in the Air Quality Regulations 2000 for the purposes of Local Air Quality Management.

Pollutant	Objective		Date to be achieved by
	Concentration	Measured as	
Benzene	16.25 $\mu g/m^3$ (5 ppb)	Running Annual Mean	31 Dec 2003
1, 3 Butadiene	2.25 $\mu g/m^3$ (1 ppb)	Running Annual Mean	31 Dec 2003
Carbon Monoxide	11.6 $\mu g/m^3$ (10 ppb)	Running 8 hour mean	31 Dec 2003
Lead	0.5 $\mu g/m^3$ 0.25 $\mu g/m^3$	Annual Mean Annual Mean	31 Dec 2003 31 Dec 2008
Nitrogen Dioxide (provisional)	200 $\mu g/m^3$ (105 ppb) not to be exceeded more than 18 times a year 40 $\mu g/m^3$ (21 ppb)	1 hour mean Annual Mean	31 Dec 2005 31 Dec 2005
Particles (PM_{10})	50 $\mu g/m^3$ not to be exceeded more than 35 times a year 40 $\mu g/m^3$	24 hour mean Annual Mean	31 Dec 2004 31 Dec 2004
Sulphur Dioxide	350 $\mu g/m^3$ (132 ppb) not to be exceeded more than 24 times a year 125 $\mu g/m^3$ (47 ppb) not to be exceeded more than3 times a year 266 $\mu g/m^3$ (100 ppb) not to be exceeded more than 35 times a year	1 hour mean 24 hour mean 15 minute mean	31 Dec 2004 31 Dec 2004 31 Dec 2005

The following objectives are not included in the Air Quality Regulations 2000 for the purposes of Local Air Quality Management.

Pollutant	Objective		Date to be achieved by
	Concentration	Measured as	
Objectives for the protection of human health			
Ozone (provisional)	100 $\mu g/m^3$ (50 ppb) not to be exceeded more than 10 times per year	Daily maximum of running 8 hour mean	31 Dec 2005
Objectives for the protection of vegetation and ecosystems			
Nitrogen Oxides (assuming NO_X is taken as NO_2)	30 $\mu g/m^3$ (16 ppb)	Annual mean	31 Dec 2000
Sulphur Dioxide	20 $\mu g/m^3$ (8 ppb) 20 $\mu g/m^3$ (8 ppb)	Annual Mean Winter Mean (1 Oct- 31 Mar)	31 Dec 2000 31 Dec 2000

DETR, 2000; The Air Quality Strategy for England, Scotland, Wales and Northern Ireland.

DETR, 2000; Air Quality Regulations 2000.

The 'descriptors' applied to air pollution concentrations are defined by the UK Air Quality Information system.

Pollutant / Band	LOW	MODERATE	HIGH	VERY HIGH
Air Quality Index	**1 -3**	**4-6**	**7-9**	**10**
Sulphur Dioxide	below 100ppb, averaged over 15 minutes	100ppb, averaged over 15 minutes	200ppb, averaged over 15 minutes	400ppb, averaged over 15 minutes
Ozone	below 50ppb, as an 8 hour running average	50ppb, as an 8 hour running average or 50ppb averaged over one hour	90 ppb, averaged over one hour	180 ppb, averaged over one hour
Carbon Monoxide	below 10 ppm, as an 8 hour running average	10 ppm, as an 8 hour running average	15 ppm, as an 8 hour running average	20 ppm, as an 8 hour running average
Nitrogen Dioxide	below 150 ppb, averaged over one hour	150 ppb, averaged over one hour	300 ppb, averaged over one hour	400 ppb, averaged over one hour
PM_{10} Particles (by TEOM)	below 50 ug/m^3, as a 24 hour running average	50 ug/m^3, as a 24 hour running average	75 ug/m^3, as a 24 hour running average	100 ug/m^3, as a 24 hour running average