LONDON WIDE ENVIRONMENT PROGRAMME

Nitrogen Dioxide Diffusion Tube Annual Report 2004

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Clients

London Borough of Barnet
London Borough of Brent
London Borough of Bexley
London Borough of Camden
London Borough of Croyden
Corporation of London
London Borough of Greenwich
London Borough of Harrow
London Borough of Hillingdon
London Borough of Hounslow
London Borough of Hammersmith & Fulham
London Borough of Newham
Royal Borough of Kensington & Chelsea
London Borough of Richmond Upon Thames
City of Westminster

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Executive Summary

Casella Stanger has undertaken the London-Wide Environment Programme (LWEP) since 1986. The LWEP consists of the monitoring, analysis and reporting of key environmental indicators throughout the Greater London region. This report addresses one of these indicators – nitrogen dioxide (NO_2).

Nitrogen dioxide has been regarded as a one of the main pollutants that needs to be targeted due to high road traffic emission levels in London. London Boroughs have a statutory duty to regularly review and assess air quality. This process is coupled with the Greater London Authority's air quality management schemes that are outlined in the Mayor's strategy, and which takes an over-arching view on London-wide air quality issues. Subsequent air quality management schemes that are to be introduced indicate the necessity for monitored nitrogen dioxide monitoring data on a city-wide scale in order to estimate the effect on a spatial and temporal basis. The LWEP is principally provided as a service for the London Boroughs.

In 2004 diffusion tubes were located at 298 monitoring sites over fifteen boroughs. Annual average NO_2 concentrations that were above the 40 $\mu g/m^3$ Air Quality Objective where recorded at 36 urban background and 150 roadside sites; this is a reduction of 13% compared to the previous year. Results from the 2004 survey indicate an average 4% decrease in NO_2 concentrations at background sites, and an average 1% increase in roadside sites compared to 2003.

The geographical spread shows higher concentrations in central parts of London and a lower concentration further away from the city centre. A few hot spots are identified in boroughs on the outskirts of the city.

Long-term linear trend analysis continues to display a downward trend in annual mean NO_2 concentrations at urban background and an upward trend in roadside sites for the majority of participating Boroughs.

CONTENTS

1 INTRODUCTION

The London-Wide Environment Programme (LWEP) has been managed by Casella Stanger since 1986, following on from the Company's origins in the Greater London Council's Scientific Services Department.

The LWEP has been an on-going programme consisting of the monitoring, analysis and reporting of key environmental indicators throughout the Greater London region. One of the more important components is the monitoring of nitrogen dioxide (NO_2) by passive diffusion tubes. This is a cost-effective method for assessing the spatial and temporal distribution of NO_2 as well as identifying hotspots in an urban environment.

In recent years it has proven to be a useful tool for local authorities in screening and baseline surveys, particularly with regards to the Review and Assessment of air quality for local air quality management (Part IV of the Environment Act 1995). Additionally, the Greater London Authority (GLA) has been given an important role to play in the air quality management of the City by virtue of the London Air Quality Strategy that must be taken into consideration by the local authorities when carrying out their statutory duties.

In year 2004 a total of fifteen London Boroughs participated in the nitrogen dioxide London-Wide Environment Programme:

- London Borough of Barnet
- London Borough of Bexley
- London Borough of Brent
- London Borough of Camden
- Corporation of London
- London Borough of Croydon
- London Borough of Greenwich
- London Borough of Hammersmith & Fulham
- London Borough of Harrow
- London Borough of Hillingdon
- London Borough of Hounslow
- Royal Borough of Kensington & Chelsea
- London Borough of Newham
- London Borough of Richmond-upon-Thames
- City of Westminster

1.1 Objectives

The overall objective of this report is to provide subscribing local authorities with an overview of the NO_2 concentrations recorded as part of the LWEP NO_2 Diffusion Tube Survey in 2004 and to view these results in the broader context of regulatory requirements and previous monitoring data.

This overall objective will be met by:

- Outlining the reasons for undertaking the monitoring of ambient levels of NO_2;
- Outlining relevant existing and future legislative air quality requirements;
- Detailing the NO_2 sampling methods employed by Casella Stanger in undertaking the LWEP NO_2 Diffusion Tube Survey, including the quality assurance and quality control procedures;
- Identifying the geographical spread of annual mean NO_2 concentration of participating boroughs at background and roadside sites within Greater London;
- Assessing the long-term trend in NO_2 concentrations recorded as part of the LWEP NO_2 Diffusion Tube Survey since 1986;
- Reporting the annual mean NO_2 concentrations at each site, for all participating boroughs in 2004 and to place these results in the context of other results gathered since 1993;
- Undertaking analysis of the results to assess trends in pollution at background and roadside classes for each participating borough;
- Identifying the elevation in NO_2 concentrations at roadside sites when compared to background levels in each participating borough;
- Validation of nitrogen dioxide diffusion tubes through the analysis of results from tubes co-located at automatic analysers in London.

2 FORMATION, SOURCES AND EFFECTS OF NO_2

2.1 Formation of atmospheric nitrogen dioxide

NO_2 is generated naturally and by man-made activities. NO_2 can be emitted directly (known as primary NO_2) or can form during a series of chemical reactions in the atmosphere involving NO_x (NO + NO_2) and ozone (referred to as secondary NO_2.) NO_2 can, in turn, act as a future source of oxygen in the formation of ozone under photochemical conditions. Due to the nature of the formation of NO_2 in the atmosphere, there is often an inverse relationship between concentrations of ozone and NO_2.

Combustion processes are the main anthropogenic source of NO_x emissions. These include road transport, power generation, and various high-temperature industrial processes.

The concentration of NO_2 in the atmosphere at any given location is influenced by a number of factors. These including the magnitude and proximity of NO_x emissions sources, the proportion of NO_x directly emitted as NO_2, the chemistry leading to the generation and destruction of NO_2, and meteorological conditions that affect the dispersion and accumulation of NO_2. During the winter months, anti-cyclonic weather systems often result in stable, cold weather conditions, which along with oxidation by atmospheric oxygen often produce pollution episodes. The product of such conditions is thought to be responsible for the extremely high NO_2 concentrations recorded over London in December 1991, when levels peaked at over 803.5 $\mu g\ m^{-3}$ in the evening rush hour. During the summer, increased temperatures and solar radiation serve to increase the rate of photochemical reactions in the atmosphere. The higher the concentration of NO_2 , the more oxygen is available for the production of ozone leading to a general decrease in occurrence of NO_2 when compared to the winter months.

2.2 Emission sources

Emissions inventories are an important means of quantifying emissions of NO_x from different sources at different times. The greatest contributor of nitrogen oxides (NO_x) in the UK is road transport. Fossil-fuelled power stations contributed around a quarter of the total NO_x in the same year, whilst the remainder came from a variety of sources including industry and domestic activity.

Estimates indicate that 49% of total NOx emissions were produced by road transport in 2000[1]. Heavy-duty vehicles currently emit 43% of NOx emissions from UK road transport, however these estimates are based on limited emissions tests on these vehicles. There has been an approximate 34% reduction in NO_x emission from road transport between 1990 and 2000 due to improvements in engine design and fitting of three-way catalysts and progressively stricter European vehicle emission standards for petrol cars. The contribution of road transport to NO_x emissions in urban areas is generally higher than the national average. In London 68% of NO_x emissions originate from road transport.

[1] Nitrogen Dioxide in the UK, AQEG, 2004

There is evidence thar significant amounts of NO_2 are emitted directly from the tail pipe of diesel vehicles, with levels possibly as high as 25% of total NO_X emissions.[2] Primary emissions of NO_2 will be particularly significant for slow-moving buses and large HGVs, as well as diesel vans and taxis in the centre of towns and cities. The increasing sale of diesel cars in the UK should also be considered when assessing future NO_2 concentrations in urban areas. Attention should be given to catalytic regeneration traps introduced to mitigate particulate emissions in diesel vehicle exhaust, as this technology has been associated with primary NO_2 emissions.

2.3 Health effects

Medical and epidemiological evidence suggests that nitrogen dioxide may have both acute and chronic effects on health.

Experimental evidence has shown that NO_2 probably exerts its biological damage by oxidation, with the primary toxic effect occurring in the respiratory system. Susceptible groups include young children, asthmatics and people with chronic respiratory diseases. It has also been shown that individuals sensitive to allergens will show a significant response to high concentrations of NO_2. Whilst there have been recorded responses in the susceptible groups listed, it has been demonstrated that individuals not suffering from respiratory disease will be, by-and-large, unaffected by air pollution episodes.

At present, there are still uncertainties concerning the effects of NO_2 exposure over a longer time scale; this is due to the wide range of modifying influences on the behaviour of a single pollutant. It is difficult statistically to separate the impacts on health of NO_2 from those of other pollutants. During the December 1991 episode, particles were also recorded at high levels. It is probable that a synergistic combination of pollutants gives rise to detrimental health effects, as opposed to individual pollutants acting alone. Research conducted at St Bartholomew's Hospital in London showed that exposure of asthmatics to high SO_2 and NO_2 levels in combination can increase the subject's response to airborne allergens. Many studies estimating the chronic effects of NO_2 use unquantified and indirect measures of exposure, though these studies do suggest that the effects of NO_2 exposure are significant.

[2] Source: AQEG (2003) Nitrogen Dioxide in the United Kingdom (Draft for Consultation)

3 POLICY FRAMEWORK

3.1 Standards and Objectives

Air quality standards relevant to NO_2 concentrations have undergone change, both nationally and on a European level. For Europe, the First Air Quality Daughter Directive(1999/30/EC) sets out limits for annual mean and hourly mean NO_2 concentrations and aims to achieve the objectives by 1st January 2010.

Table 1 Air Quality Objectives for nitrogen dioxide in first Daughter Directive

	Concentration	Measured as	Achievement Date
Hourly	200 μg m³ not to be exceeded more than 18 times a year	1 hour mean	1 January 2010
Annual	40 μg m³	Annual mean	1 January 2010

Air quality standards relevant to the UK are found in The Air Quality Strategy for England, Scotland, Wales and Northern Ireland[3] (AQS). The document was published in January 2000, superseding the earlier National Air Quality Strategy[4] (NAQS) published in March 1997, and provides a revised framework for reducing air pollution at national and local levels from a wide range of emission sources. The AQS sets out two Air Quality Objectives (AQOs), one hourly and one annual (Table 2), and are in line with those set in the European Directive, although an earlier date for the objectives to be achieved (of 31st December 2005) has been set.

Table 2 Air Quality Objectives for nitrogen dioxide in AQS

	Concentration	Measured as	Achievement Date
Hourly	200 μg m³ not to be exceeded more than 18 times a year	1 hour mean	31 December 2005
Annual	40 μg m³	Annual mean	31 December 2005

The standards for the eight pollutants covered by the strategy are underpinned by recommendations made by the Government's Expert Panel on Air Quality Standards (EPAQS). The objective levels have been based on medical and scientific evidence of how each pollutant affects human health. Factors such as economic efficiency, practicability, technical feasibility and time-scale have also been taken into consideration by the government when setting the final objective values. Objectives for NO_2 are prescribed in the Regulations for the purpose of Local

[3] DETR (2000) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland - Working together for Clean Air"
[4] DoE (1997) The United Kingdom National Air Quality Strategy

Air Quality Management (LAQM) and thus have direct relevance to the diffusion tube network in London.

LAQM is at the heart of the AQS. Local authorities are charged with reviewing current air quality and assessing whether the relevant AQO will be achieved by the target date. Those authorities that conclude that one or more of the objectives are unlikely to be achieved, will be obliged to declare Air Quality Management Areas (AQMAs) and draw up action plans of how to reduce air pollution. Most London boroughs are declaring AQMAs on the prediction that the annual mean AQO for NO_2 will not be met by the end of 2005.

3.2 The Greater London Authority

The Greater London Authority (GLA), created under the Greater London Authority Act 1999 assumed its responsibilities on 3 July 2000. It was created to give London it's own decision making authority, which is in line with the Government's wider environmental, transport, economic and planning objectives.

As a result, the Mayor has significant decision-making abilities being charged, amongst other things, with the responsibility for the London-wide environment and a duty to promote the health of Londoners. The Mayor has a duty to develop an air quality management strategy, in consultation with the London Boroughs, to deliver improvements to air quality in London. The Strategy for London is required to include proposals and policies from the National AQS as well as any other proposals and policies that the Mayor considers appropriate. The Mayor's Air Quality Strategy was published in September 2003, and states that meeting targets for NO_2 is the primary concern of the strategy.

The strategy recognises that road traffic is the primary cause of air pollution in London and is consequently linked to other relevant strategies and measures taken by Transport for London (TfL), the Greater London Authority, and the London Development Agency (LDA). TfL in particular will be instrumental in tackling this problem by means of measures to reduce traffic, promote cleaner technology, and reduce current emissions and by promoting and adopting alternative fuels. New schemes such as a congestion-charging zone around London and the anticipated Low Emission Zone are likely to lead to environmental benefits. In addition to road traffic, commercial and domestic space heating is another significant source of NO_2 though measures needed to reduce this emission source are yet uncertain. Long-term monitoring of NO_2 by diffusion tubes with its geographical spread across London will assist in determining the effect of a number of these policies in the future.

4 NO_2 DIFFUSTION TUBE MONITORING

4.1 Diffusion tubes

Diffusion tubes are simple and inexpensive passive sampling devices that have become a widely used monitoring devices in the UK for measuring ambient NO_2 concentrations. The samplers are composed of an acrylic tube that can be sealed at both ends. One end of the tube contains two stainless steel mesh discs coated with triethanolamine (TEA) that adsorbs NO_2 to produce a nitrite salt that can be determined by colorimetry. Once the inlet cap is removed exposure begins, and a concentration gradient is established within the tube resulting in molecular diffusion takes place towards the TEA-coated grid. After exposure the total quantity of gas transferred along the tube is determined by chemical analysis, commonly ultra violet spectrometry.

There are a number of different diffusion tube preparation methods in use by laboratories in the UK. The difference relates to the way in which the metal grids are coated with TEA. The methods currently in use are 50% TEA in acetone, 50% TEA in water and 10% TEA in water.

4.2 Performance of diffusion tubes

NO_2 diffusion tubes are an indicative monitoring technique commonly exploited to investigate the temporal and spatial trends in NO_2 concentrations. These devices do not perform to the same accuracy as the automatic chemiluminescent analyser, that is identified by the EU as the reference methods of measurement for nitrogen dioxide. Numerous studies have been undertaken to explore the factors affecting diffusion tube performance. These have focused on exposing diffusion tubes alongside chemiluminescence monitors. The results have observed that measurements by diffusion tubes over-estimate (positive bias) or underestimate (negative bias) the true ambient NO_2 concentrations. The various mechanisms[5] that have been proposed to explain the over- and under-estimation of NO_2 concentrations by diffusion tubes include:

Over-estimation of ambient NO_2 concentrations

- Higher wind speeds can generate turbulence in the entrance of the diffusion tube causing a shortening of the diffusion tube length.
- Reduced NO_2 photolysis in the tube by the blocking of UV light by the tube material.
- Interference effects of the secondary particulate compound peroxyacteyl nitrate (PAN).

Under-estimation of ambient NO_2 concentrations

- Insufficient extraction of nitrite from the grids
- Increased exposure time that is thought to cause the degradation of absorbed nitrite over time.

The factors[6] that have been suggested to influence diffusion tube performance are:

- The laboratory preparing and analysing the tubes
- The exposure interval – weekly, 2-weekly or monthly
- Time of year

[5] Air Quality Expert Group: Report on Nitrogen Dioxide in the United Kingdom, 2004,Appendix 1
[6] Compilation of Diffusion Tube Co-location Studies Carried out by Local Authorities, 2002, Air Quality Consultants

- The exposure setting – sheltered or exposed
- The exposure location – roadside or background
- The tube preparation method
- The exposure concentration and NO_2/NO_x ratio

4.3 Bias adjustment factors

The fact that diffusion tube measurements exhibit a bias compared to the reference method needs to be taken into consideration when results are to be compared with air quality standards and objectives. DEFRA's Technical Guidance LAQM.TG(03) advises local authorities to examine the bias associated with their diffusion tubes and then apply an adjustment factor to the annual mean, if required, as part of their Review and Assessment of air quality. Co-location studies are recommended (for a minimum period of nine months) where diffusion tubes are exposed in triplicate concurrently with an automatic monitoring site.

In circumstances where local authorities do not have the opportunity to carry out a co-location study a default factor should be applied. Air Quality Consultants has established a spreadsheet on the Review and Assessment website[7] representing default bias correction factors complied from co-location studies carried out by local authorities at roadside and background sites throughout the UK. Default bias correction factors are available for a number of UK laboratories and the key tube preparation methods.

4.4 LWEP monitoring programme

A total of 298 monitoring sites were active in the LWEP diffusion tube programme during 2004. The locations of the diffusion tubes are chosen by each authority to reflect the likely exposure of the public to concentrations of nitrogen dioxide. All monitoring site have been classified as either roadside (0-20m) or background (>20m) depending on the distance from the road. The number of tubes exposed in each borough at the discretion of each local authority involved in the monitoring programme. As NO_2 concentrations in London are mainly attributable to road transport, thus results in a strong bias towards roadside sites as opposed to background sites.

4.4.1 Diffusion tube preparation and analysis

The diffusion tubes employed in the LWEP programme are prepared and analysed by UKAS accredited Gradko International Ltd. Diffusion tubes are prepared using the 50% v/v triethanolamine with acetone method and analysed using UV spectrometry. The diffusion tubes are labelled, and kept refrigerated in plastic bags prior to and after exposure.

As results from the LWEP are incorporated into the UK Nitrogen Dioxide Diffusion Tube Survey, the tubes are exposed for a four-to five-week period, consistent with the national survey. Adherence to the changeover dates is important to enable as valid an inter-comparison as possible between boroughs.

[7] http://www.uwe.ac.uk/aqm/review/diffusiontube300905.xls

4.4.2 Quality assurance and quality control

The EU Daughter Directive sets data quality objectives for nitrogen dioxide along with other pollutants. Under the Directive, annual mean NO_2 concentration data derived from diffusion tube measurements must demonstrate an accuracy of $\pm$25 % to enable comparison with the Directive air quality standards for NO_2.

In order to ensure that NO_2 concentrations reported are of a high calibre, strict performance criteria need to be met through the execution of quality assurance and control procedures. As mentioned earlier number of factors have been identified as influencing the performance of diffusion tubes including the laboratory preparing and analysing the tubes and the tube preparation method. Quality assurance and control procedures are therefore an integral feature of any monitoring programme, ensuring that uncertainties in the data are minimised and allowing the best estimate of true concentrations to be determined.

Gradko International Ltd conducts rigorous quality control and assurance procedures in order to maintain the highest degree of confidence in their laboratory measurements. These are discussed in more detail below.

Workplace Analysis Scheme for Proficiency (WASP)

Gradko International Ltd participates in the Health and Safety Laboratory WASP[8] NO_2 diffusion tube scheme on a monthly basis. This is a recognised performance-testing programme for laboratories undertaking NO_2 diffusion tube analysis as part of the UK NO_2 monitoring network. The scheme is designed to help laboratories meet the European Standard EN482[9]. The laboratory performance for each month of 2004 was rated 'good' which signifies a high level of accuracy for laboratory measurements.

Network Field Inter-comparison Exercise

Gradko International Ltd also takes part in the NO_2 Network Field Inter-comparison Exercise, operated by NETCEN, which complements the WASP scheme in assessing sampling and analytical performance of diffusion tubes under normal operating conditions. This involves the regular exposure of a triplet of tubes at an Automatic Urban Network site (AUN) site. These site that employ continuous chemiluminescent analysers to measure NO_2 concentrations. Of particular interest is the bias of the diffusion tube measurement relative to the automatic analyser that gives an indication of accuracy. NETCEN have established performance criteria for participating laboratories in line with the EU 1st Daughter Directive requirement for indicative monitoring techniques as the 95% confidence interval of the annual mean bias should not exceed $\pm$ 25%.

In conjunction with this, a measure of precision is determined by comparing the triplet co-located tube measurements commonly referred to as the coefficient of variation (CoV). This value is useful for assessing the uncertainty of results due to sampling and analytical techniques. The NETCEN performance for precision is that the mean coefficient of variation for the full year should not exceed 10%.

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8 Health and Safety Executive, Workplace Analysis Scheme for Proficiency

9 European Committee for Standardisation (CEN) Workplace Atmospheres, General requirements for the performance of procedures for the chemical measurement of chemical agents, EN482, Brussels, CEN 1994.

The Field Inter-comparison Exercise has historically generated the bias and precision results for each laboratory on an annual basis. This changed in 2004 to results being reported on a monthly basis. This enables a full year's inter-comparison against the NETCEN performance criteria to be carried, as shown in Table 3. The results below indicate that Gradko International Ltd diffusion tubes are well within the performance targets set by NETCEN.

Table 3 Summary of NO_2 Network Field Inter-comparison Results, 2004

Annual Mean Bias		Precision	
NETCEN Performance Target	Gradko Annual Mean Bias	NETCEN Performance Target	Gradko Precision
±25%	7%	10%	6.9%

Gradko International Ltd perform blank exposures that serve as a quality control check on the tube preparation procedure. All results are blank subtracted before they are issued to the relevant Borough.

Casella Stanger conduct an 'in-house' co-location study to establish an LWEP bias adjustment factor based on triplicate NO_2 diffusion tubes sampling concurrently located with a continuous analysers for a number of local authorities. This is discussed in more detail in Chapter 9.

5 OVERVIEW OF RESULTS

5.1 Current year results

Table 4 shows summary statistics for the 298 diffusion tube sites operating in the 2004 LWEP Diffusion Tube Network. Background concentrations elevate to a maximum of 54.2 μg/m^3 and roadside concentrations to 127.7 μg/m$^{3.}$ A total number of 186 sites exceeded the 2005 air quality objective, of which 81% are roadside monitoring sites. Annual mean NO_2 concentrations across all sites reveal a slight reduction at background sites (4%) and minor increase (1%) at roadside location sites compared to 2003. The number of sites failing to meet the 2005 air quality objective has decreased by 15% in 2004 compared to the previous year.

Table 4 Summary statistics for all LWEP diffusion tubes monitoring sites 2004

Site Type	Number of Sites	Annual Mean NO_2 Concentration Ranges (μg/m^3)	Annual Mean NO_2 Concentration (μg/m^3)	Number of AQO Exceedences
Background	103	16.1 – 54.2	37.2	36
Roadside	195	24.0 - 127.7	52.4	150

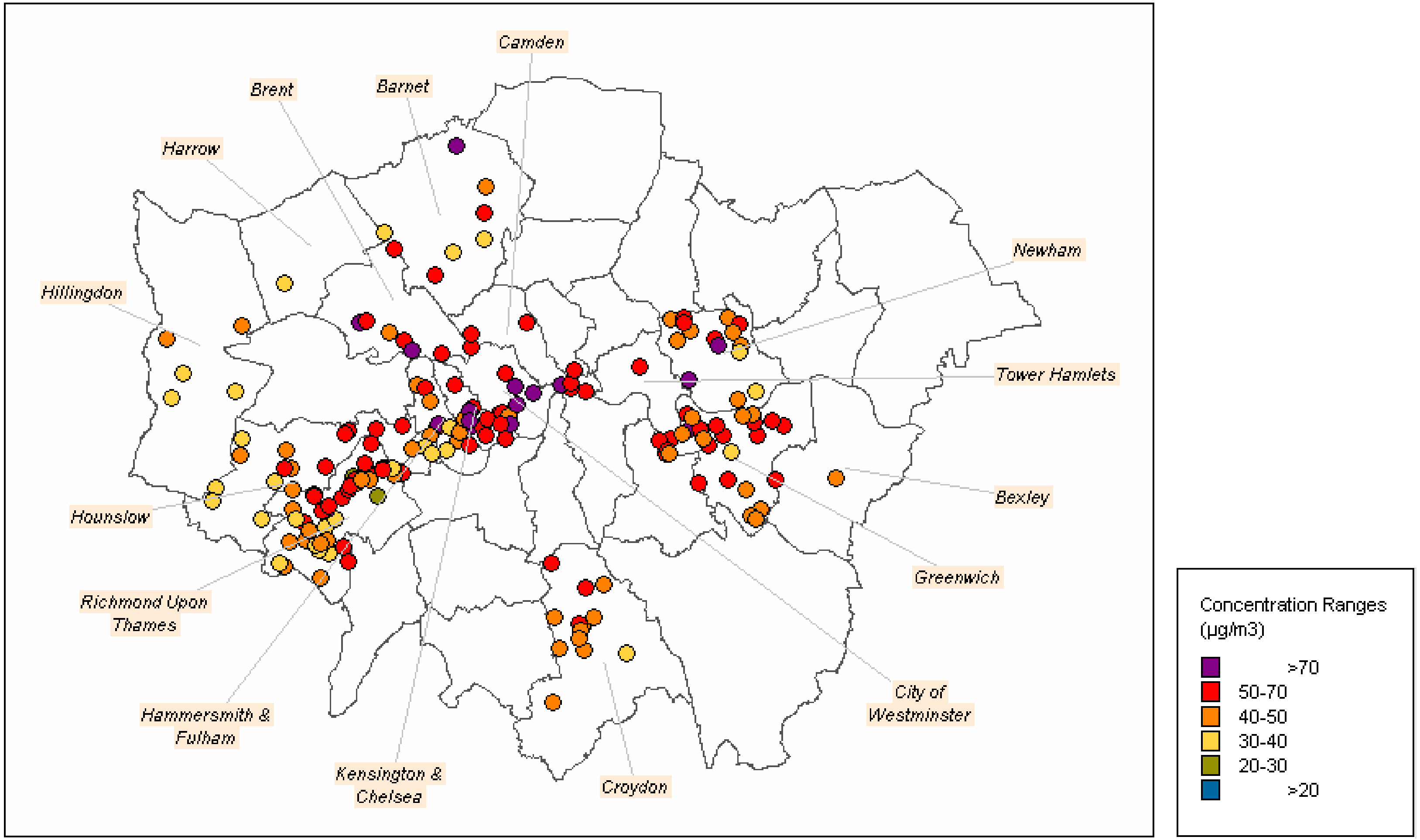
5.2 Geographical spread of nitrogen dioxide concentrations

Maps 1 and 2 show the geographical spread of the annual mean concentrations for the nitrogen dioxide diffusion tube survey across London for 2004. The maps include data only from Boroughs that are part of the London Wide Environment Programme for nitrogen dioxide.

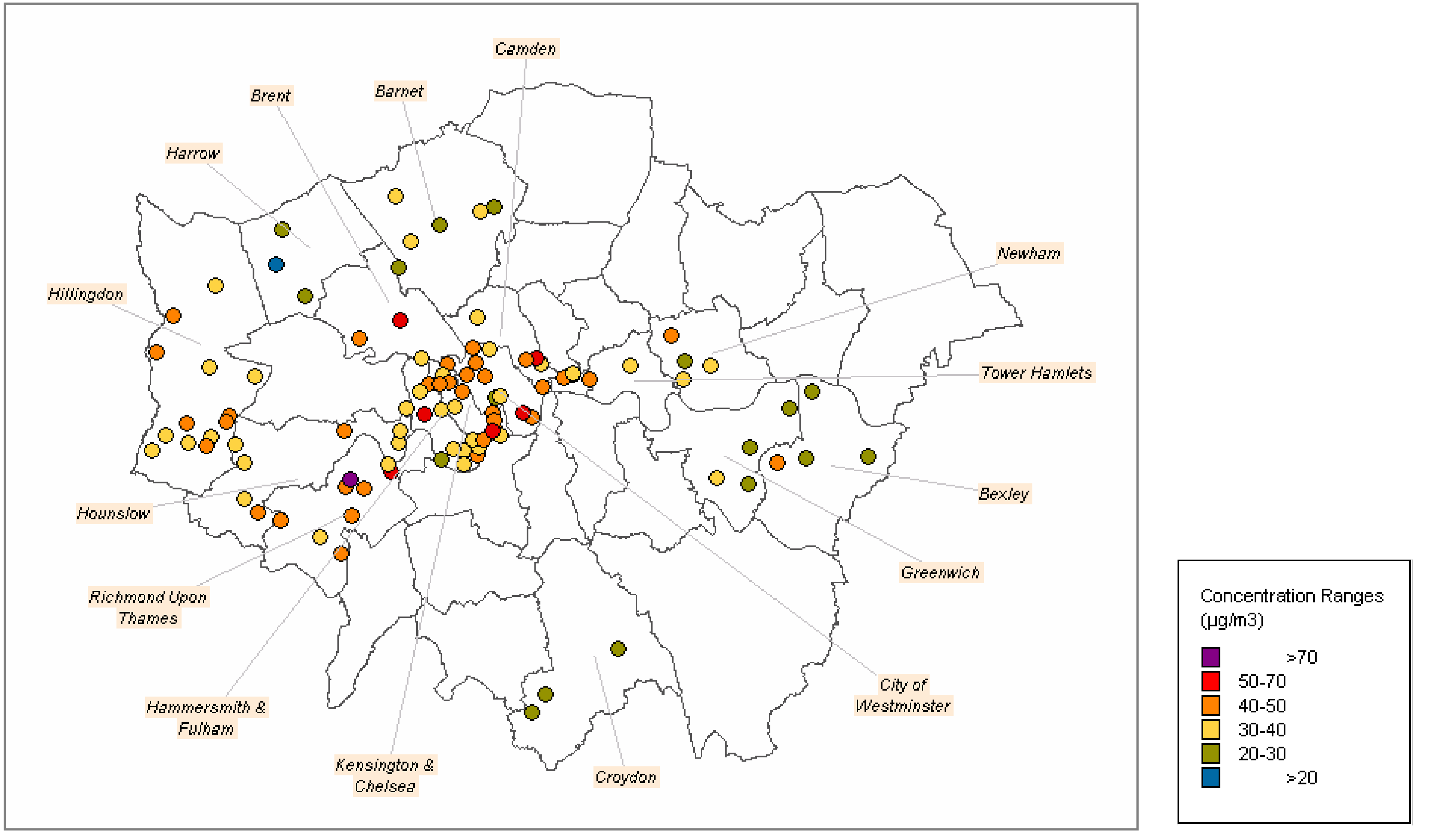
The higher NO_2 levels are concentrated around central parts of London while further away from the centre, the levels tend to decrease. The NO_2 concentration at background sites is predominantly recorded an annual mean in the 30-40 μg/m^3 range uniformly spread throughout London. The highest background annual mean concentrations are clustered within central London. The geographical spread of annual mean NO_2 concentrations at roadside sites is predominantly recorded in the 51-59 μg/m^3 concentration range. The centre of London maintains the highest levels of roadside NO_2 reaching with annual means recording over 70 μg/m^3.

A few boroughs situated away from the city experienced annual mean concentration in the higher concentration bandings at both background and roadside locations. These may indicate local pollution hot spots.

Map 1 Annual Mean Roadside NO_2 Concentrations, 2004



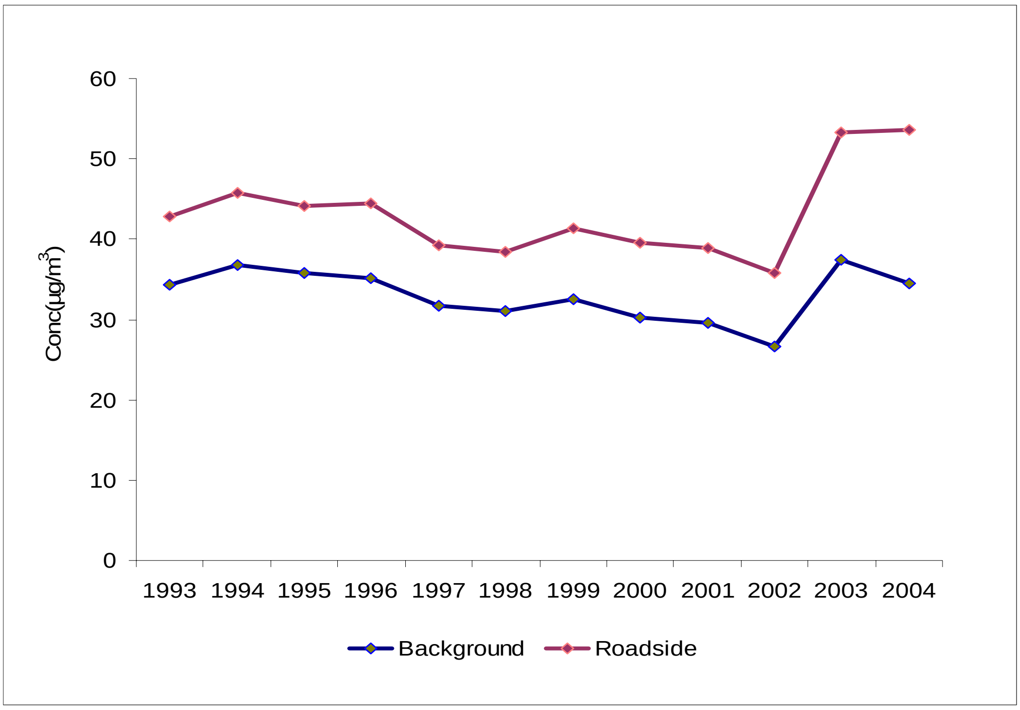
Map 2 Annual Mean Background NO_2 Concentrations, 2004



5.3 Long term trends

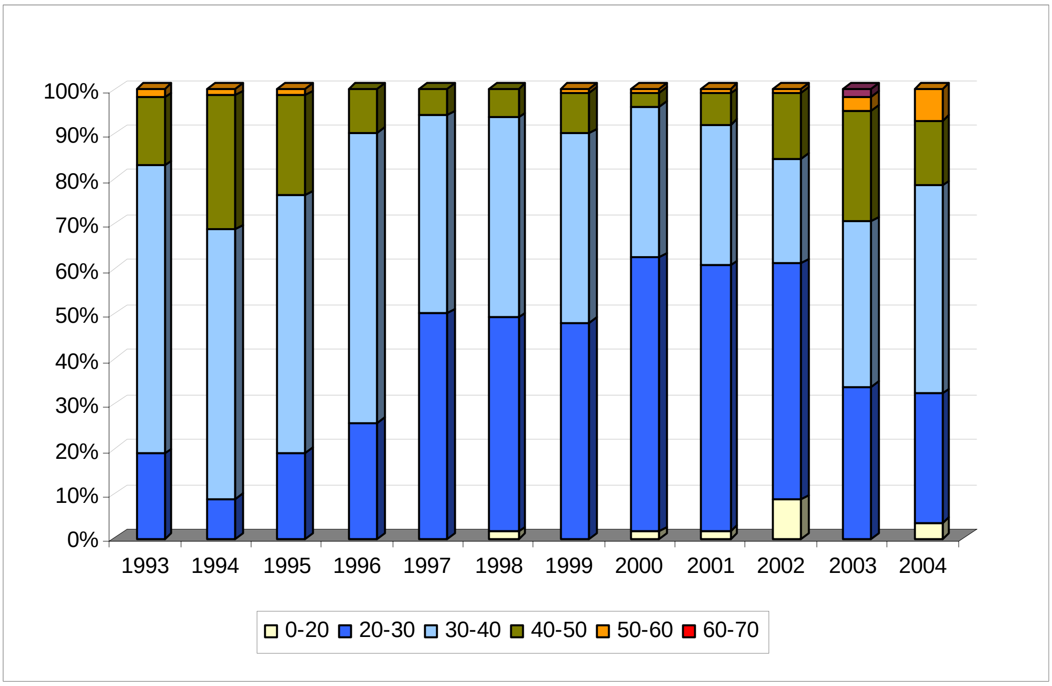
This report relies on results from eleven sites to establish long-term trends in annual mean NO_2 concentrations recorded at both background and roadside sites from 1986 to the present date. The introduction of the UK Nitrogen Dioxide Diffusion Tube Survey in 1993 and the resultant increase in exposure time from 2 to 4/5 weeks showed a distinct change in long-term concentrations. The extension in exposure time had the effect of decreasing NO_2 concentrations. In order to strengthen the comparability and representation of long-term trends, data have been collated from diffusion tube sites over a complete data set from 1993 to the present year. This subsequently provides a much larger data set comprising of a total of sixty one sites covering both roadside and background locations. Overall, this improves the inter-year and site comparability of NO_2 concentrations over the past ten years.

Figure 1 Long-term annual mean NO_2 concentrations at selection of background and roadside sites in London.



Long-term background and roadside sites follow very similar trends, and indicate a gradual decline in annual mean NO_2 concentration between 1993 and 2002. In 2003 a distinct increase in annual NO_2 concentration is recorded at both site types, attributed to poor meteorological conditions. Roadside NO_2 concentrations increase marginally in 2004 to reach their highest level over the monitoring period. Background sites however show a sharp decrease in annual mean NO_2 concentration in 2004.

Figure 2 Frequency Distribution of Annual Mean Background NO_2 Concentrations, 1993-2004

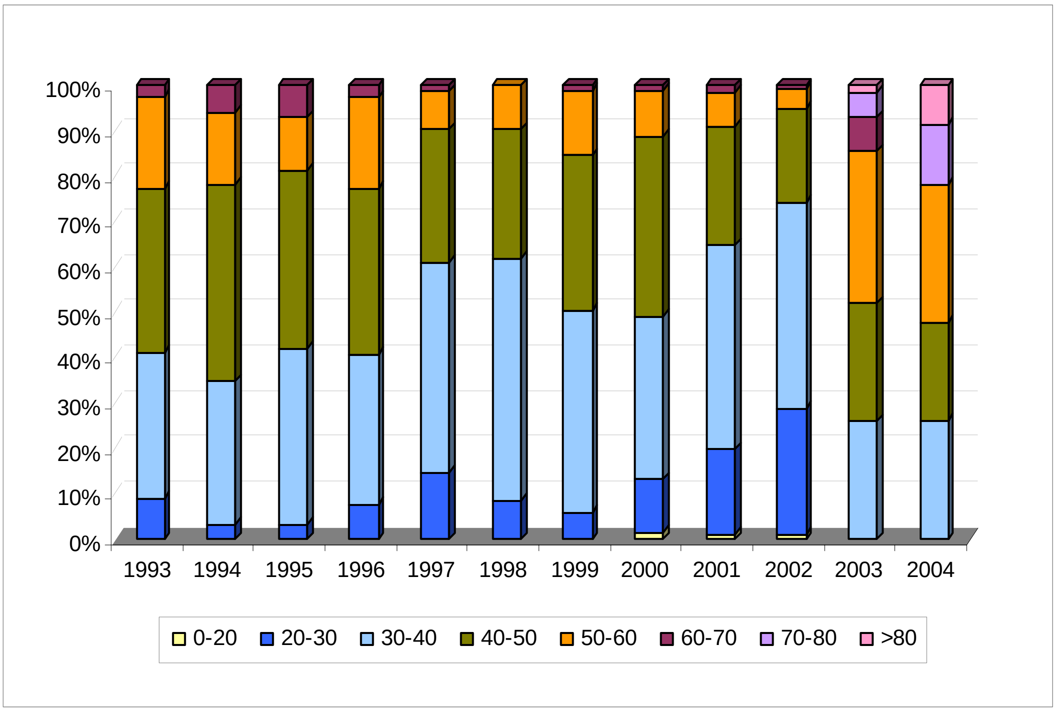


In the early part of the programme the largest percentage of annual mean NO_2 concentrations where present in the 30-40 µg/m^3 banding. Approximately 5% of sites recorded concentration in the 50-60 µg/m^3 banding. From 1997 to 2002 there is a clear variation in the frequency of each banding. Annual mean NO_2 concentrations in the 50-60 µg/m^3 and 40-50 µg/m^3 banding reduce by approximately 50%. Annual mean NO_2 concentrations recorded in the 20-30 µg/m^3 range gradually increase over this period. In 1998 annual mean NO_2 concentrations drop for the first time to below 20 µg/m^3, and continue to be recorded in this banding over the next four years. In 2002 annual mean NO_2 concentrations illustrate a change in the proportion of each concentration banding.

The 20-30 µg/m^3 banding are the most frequently recorded concentrations at London sites. The frequency distribution for background sites in 2003 stands out from the previous years with an obvious shift in the proportion of each banding. A new high concentration range of 60-70 µg/m^3 has been introduced with the loss of the very low concentration banding of 0-20 µg/m^3. The highest percentage of background annual mean NO_2 levels are recorded in the 30-40 µg/m^3 concentration range.

In 2004, there are no longer any concentrations falling within the 60-70 µg/m^3 range. The 50-60 µg/m^3 has almost doubled since the previous year and the 40-50 µg/m^3 banding has reduced in size. The 0-20 µg/m^3 band has reappeared with a small percentage of the results falling within this range. In 2004, the highest percentage of results are recorded within the 30-40 µg/m^3 banding.

Figure 3 Frequency Distribution of Annual Mean Roadside NO_2 Concentrations, 1993-2004



Between 1993 and 1996 the highest percentage of annual mean NO_2 concentrations at roadside were present in the 40-50 μg/m^3 concentration banding. Approximately 10% of sites recorded concentrations over 60 μg/m^3 and a very low number showed concentration in the 20-30 μg/m^3 banding.

A reduction in the frequency of annual mean roadside NO_2 concentrations in the >60μg/m^3, 50-60 μg/m^3 and 40-50 μg/m^3 bands are apparent from 1997 onwards. An elevation in sites recording concentrations in the 30-40 μg/m^3 band occurs in 1997 remaining at this frequency over the next 5 years. Between 2000 and 2002 sites begin to record concentrations >20 μg/m^3. In 2002 roadside sites recording in the banding of 20 to 30 μg/m^3 show a sharp increase, whereas sites recording the higher bandings decline. The annual mean NO_2 concentration at roadside sites is mainly in the 30-40 μg/m^3 banding.

A distinct change in the proportion of each concentration banding takes place in 2003 reflecting the sizeable elevation in NO_2 levels. The highest percentage of roadside annual mean NO_2 concentrations is recorded in the 50-60 μg/m^3. This reflects an approximate 20 μg/m^3 elevation in concentration compared with 2002.

In 2004, the percentage of results falling into the 30-40 and the 40-50 μg/m^3 bands is almost identical to 2003. There are now no results falling within the 60-70 μg/m^3 band. The two new bandings, introduced in 2003, have both increased in size. There appears to be a marginally higher percentage of roadside annual mean NO_2 concentrations recorded in the 50-60 μg/m^3 range than the 40-50 μg/m^3 range. Annual mean concentrations in the 70 to 80 μg/m^3 and >80 μg/m^3 have increased in 2004.

The frequency distributions for both site categories indicate that in 2004 a greater proportion of NO_2 concentrations are associated with the higher concentration bandings.

6 DATA ANALYSIS

6.1 Introduction

Prior to analysing the results, the entire year's data set for each local authority was validated for outliers and spurious results. Two screening procedures where adopted for this task. Firstly, monthly mean NO_2 concentrations recording under 5 μg/m^3 where removed. Secondly, monthly mean NO_2 concentrations for each diffusion tube site falling outside two standard deviations of the annual mean concentration where rejected. Only diffusion tube sites with at least nine months of validated monitoring data were then used for further analysis and reporting.

6.2 Data analysis

2004 Mean Values

Bar charts have been created showing the 2004 annual mean NO_2 concentration recorded at each site included in the LWEP survey. The sites have been classified by distance from the nearest major road into background and roadside. Appendix 1 lists the NO_2 concentration for all the roadside and background sites in each borough. Sites that have exceeded the 40 μg/m^3 2005 air quality objective have been highlighted.

Site Time Series

Time series plots have been created for sites with over eight years of continuous monitoring data. Each time series plot contains data for sites as grouped by their site class.

6.3 Analysis of results

Trend Analysis by Site Class

Monitoring sites with a minimum of eight years continuous data were first identified. Individual concentrations are grouped by site class to provide an arithmetic mean for each site class. The mean annual class concentrations have been plotted and a simple linear trend model applied to assess whether concentrations have generally risen or fallen at background, and roadside locations within each Borough.

Roadside Elevation

Annual mean background concentrations were subtracted from annual mean roadside concentrations to calculate the elevation above background NO_2 concentration. This may provide an indication of the level of NO_2 being received at roadside locations from road transport sources.

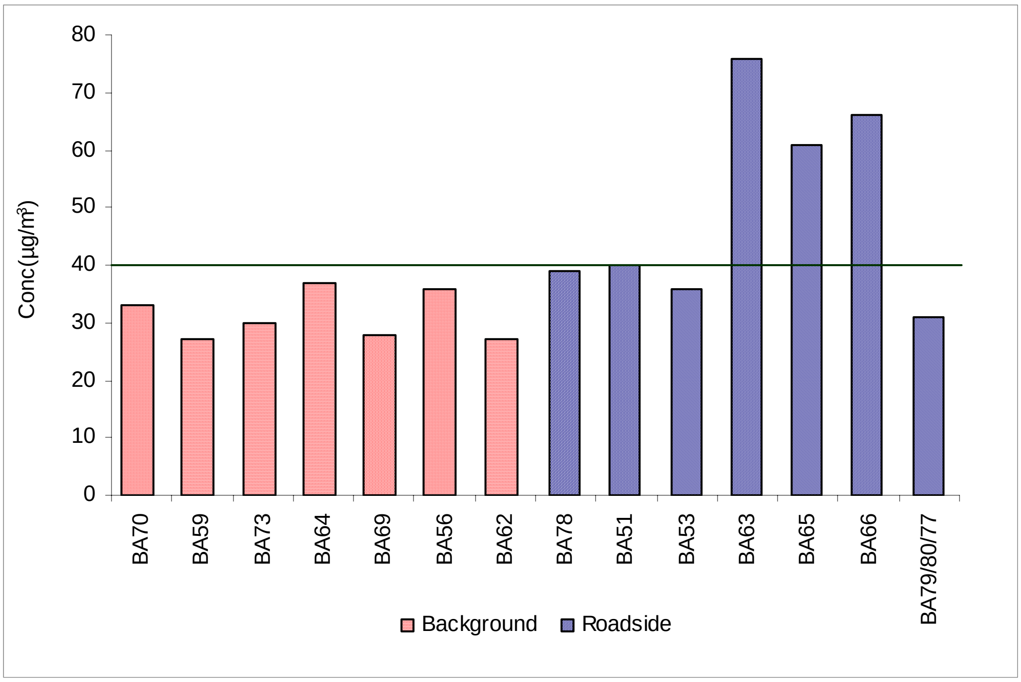
Sites were only included in the calculation of annual mean concentrations for each site class if consistent and valid data were available. Any sites with 1 or more years of absent or invalid data were not used.

7 REPORTING OF RESULTS – PARTICIPATING BOROUGHS

7.1 London Borough of Barnet

Annual Mean Values

Figure 4 Barnet Background and Roadside Annual Mean NO_2 Concentrations, 2004



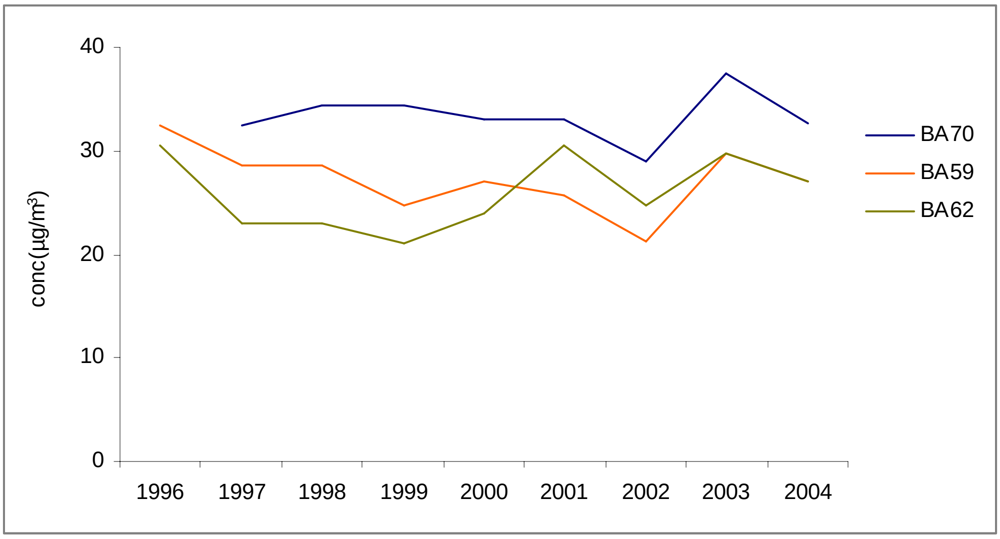
Barnet exposed diffusion tubes at 14 monitoring sites in 2004, a reduction of seven sites[10] compared to the previous year. The data capture for Barnet in 2004 was 89%.

Background concentrations vary between 27.0 and 37.0 $\mu g/m^3$. Roadside concentrations range between 31 and 76 $\mu g/m^3$. The 2005 air quality objective was exceeded at sites BA63, BA65 and BA66 representing 21% of the sites.

[10] Discontinued sites: BA67, BA67, BA62, BA61, BA52, BA71, BA60, BA72, BA74, BA75

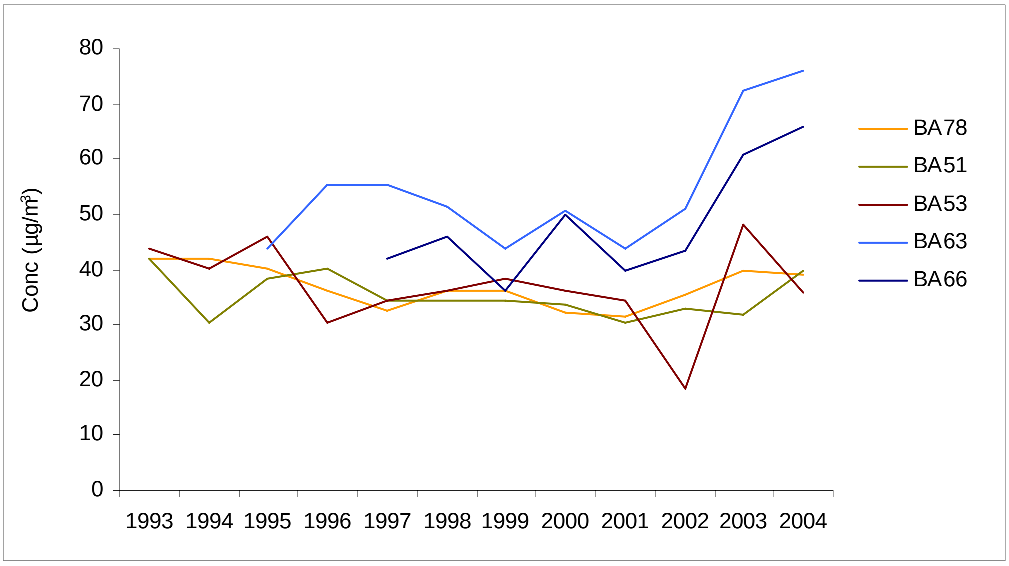
Time Series

Figure 5 Barnet Background Time Series, 1996-2004



BA70 generally records the highest annual mean background concentrations throughout the period of monitoring. From 1997 to 2001, concentrations monitored at this site are consistently around 33 $\mu g/m^3$. There is a marked decrease in concentrations monitored at this site in 2002 followed by marked increase in 2003. Concentrations monitored at BA70 are exceeded on only one occasion, at BA64 in 2002. Concentrations monitored at background sites fluctuate between 21 $\mu g/m^3$ and 37.4 $\mu g/m^3$ between 1996 and 2004. All background monitoring sites show a decrease in annual mean NO_2 concentration in 2004 of approximately 5% compared to 2003.

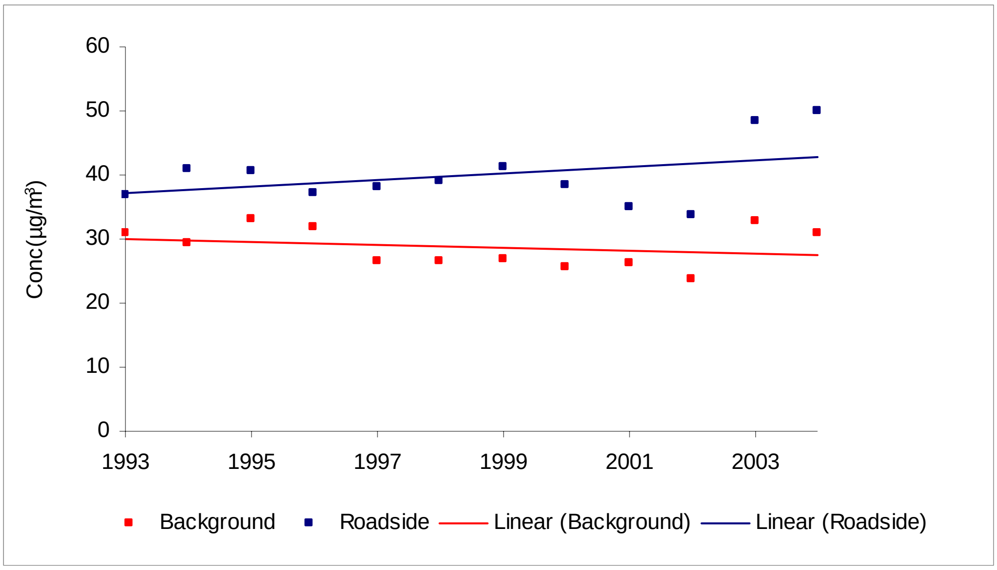
Figure 6 Barnet Roadside Time Series, 1993-2004



BA63 records the highest roadside NO_2 concentrations since 1996. There is a marked increase in roadside concentrations at all sites in 2003. In 2004 NO_2 concentrations continue to rise by 4%. Only BA78 and BA66 record a decrease in annual mean NO_2 concentration.

Trend Analysis

Figure 7 Barnet Background and Roadside Trend Analysis, 1993-2004



Long-term background annual mean NO_2 concentrations display a downward trend, decreasing by 8% between 1993 and 2004. Long-term roadside annual mean NO_2 concentrations display an upward trend over this period, increasing by 16% over the same period.

Roadside Elevation

Table 5 Barnet Elevation Above Background NO_2 Concentration µg/m³

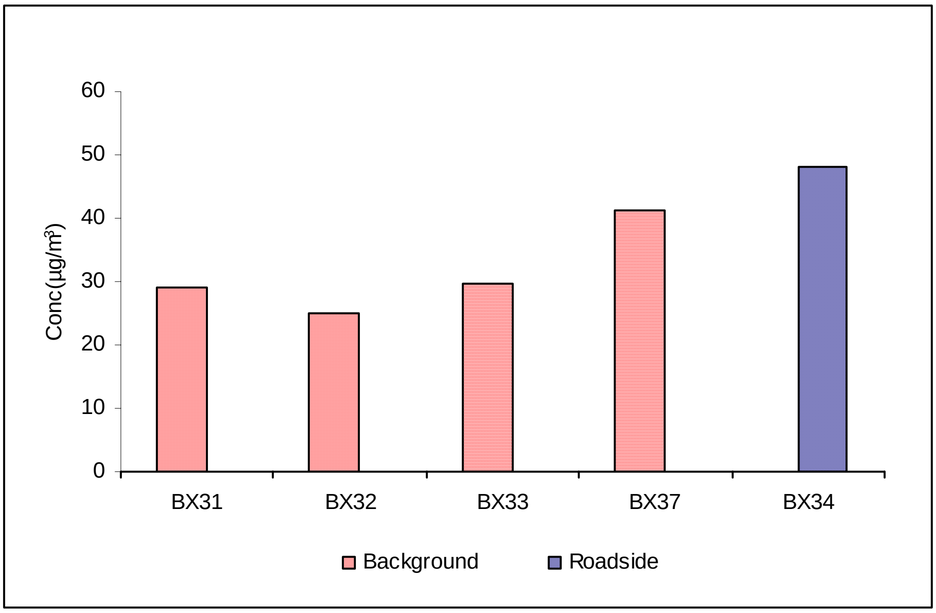
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
11.5	7.5	5.6	11.6	12.4	14.5	12.8	8.8	9.9	15.6	19.0

The roadside elevation in NO_2 concentration drops by almost 50% between 1994 and 1996, then gradually increases over the next 3 years. After a reduction in 2000 and then 2001, the elevation above background concentration continues to rise to its current level of 19.0 µg/m^3.

7.2 London Borough of Bexley

Annual Mean Values

Figure 8 Bexley Background and Roadside Annual Mean NO_2 Concentrations, 2004

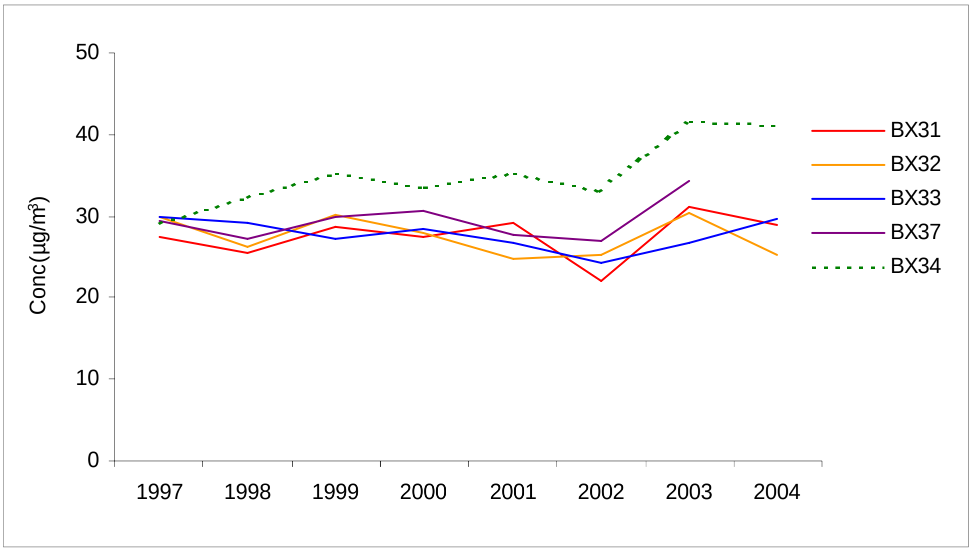


Bexley exposed diffusion tubes at seven monitoring locations in 2004, with no changes in sites numbers compared to the previous year. The data capture for Bexley in 2004 was 81%. The annual mean NO_2 concentrations for BX35 and BA36 have not been reported this year as the 75% data capture criterion was not fulfilled at these locations. The results can be viewed in Appendix 1.

Background concentrations vary between 25.1 and 41.1 $\mu g/m^3$. The single roadside concentration reported is 48.2 $\mu g/m^3$. The 2005 air quality objective was exceeded at two monitoring locations; this is a slight increase since the previous year.

Time Series

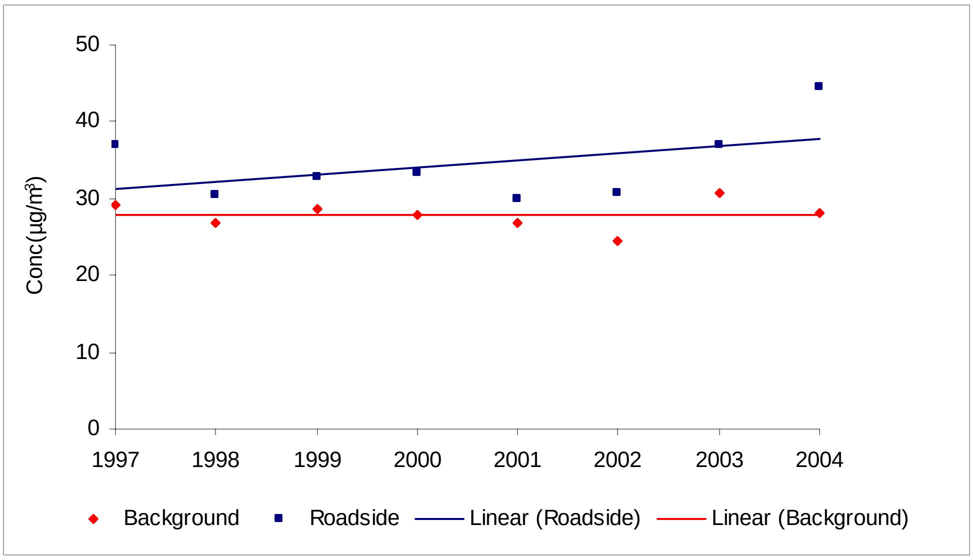
Figure 9 Bexley Background and Roadside Time Series, 1997-2004



Background concentrations are generally very similar throughout the period of monitoring. BX31 shows the greatest variation with a distinct decrease in 2002 followed by a marked increase in 2003. BX33 continues to show a minor increase in annual mean NO_2 concentration in 2004, where as BX31 and BX32 indicate a 9% drop in NO_2 levels compared to 2003. The annual mean NO_2 concentrations at BX34 show a very minor reduction in 2004.

Trend Analysis

Figure 10 Bexley Background and Roadside Trend Analysis, 1997-2004



Long-term background annual mean NO_2 concentrations remain relatively constant at just under 30 µg/m^3. Long-term roadside annual mean NO_2 concentrations display an upward trend over this period, increasing by 20%.

Roadside Elevation

Table 6 Bexley Elevation Above Background NO_2 Concentration μg/m³

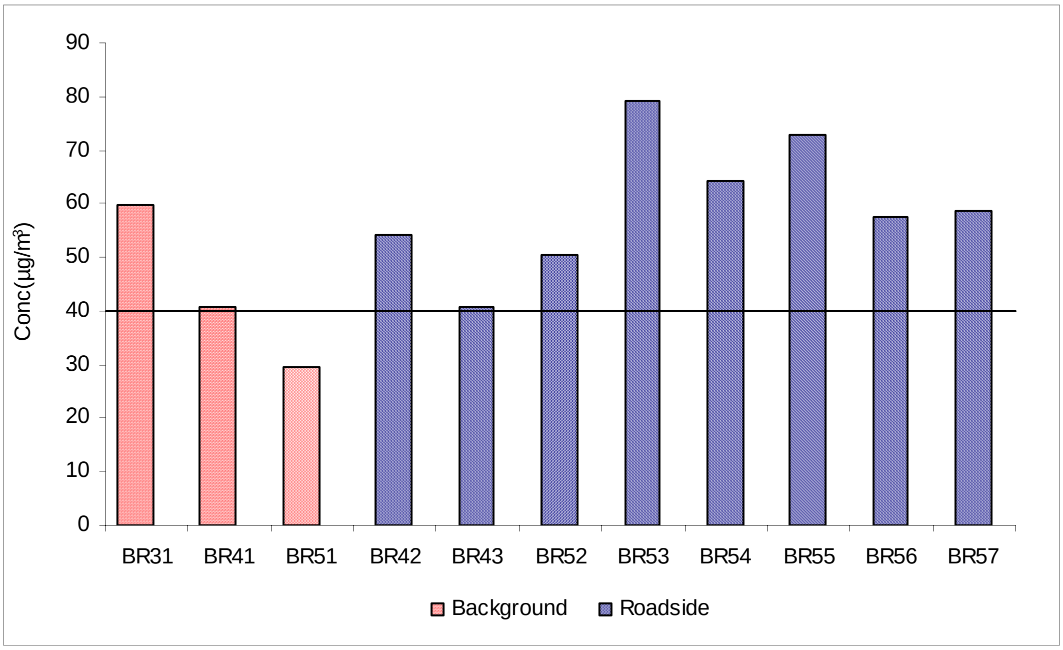
1997	1998	1999	2000	2001	2002	2003	2004
8.0	3.7	4.3	5.5	3.0	6.2	6.5	16.6

The roadside elevation in NO_2 concentration drops by almost 50% between 1997 and 2001, doubles in 2002 and continues rise slightly in 2003. The roadside elevation concentration shows a marked increase 2004, reaching the highest level over the eight-year monitoring period.

7.3 London Borough of Brent

Annual Mean Values

Figure 11 Brent Background and Roadside Annual Mean NO_2 Concentrations, 2004

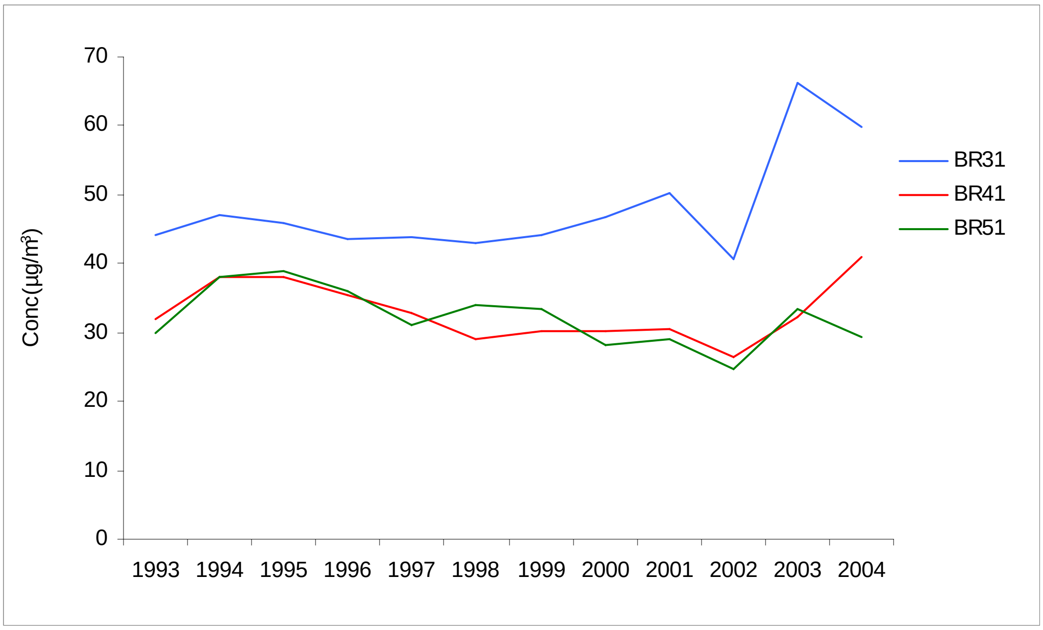


Brent exposed diffusion tubes at 12 monitoring location in 2004, with no change in site numbers compared to the previous year. The data capture for this year was 90%. Annual mean NO_2 concentration for BR58 has not been reported as the 75% data capture criterion was not fulfilled at this location.

Background concentrations vary between 29.3 and 59.8 $\mu g/m^3$. Roadside concentrations range between 40.8 and 79.2 $\mu g/m^3$. The 2005 air quality objective was exceeded at 90% of the borough's monitoring sites; identical to last year.

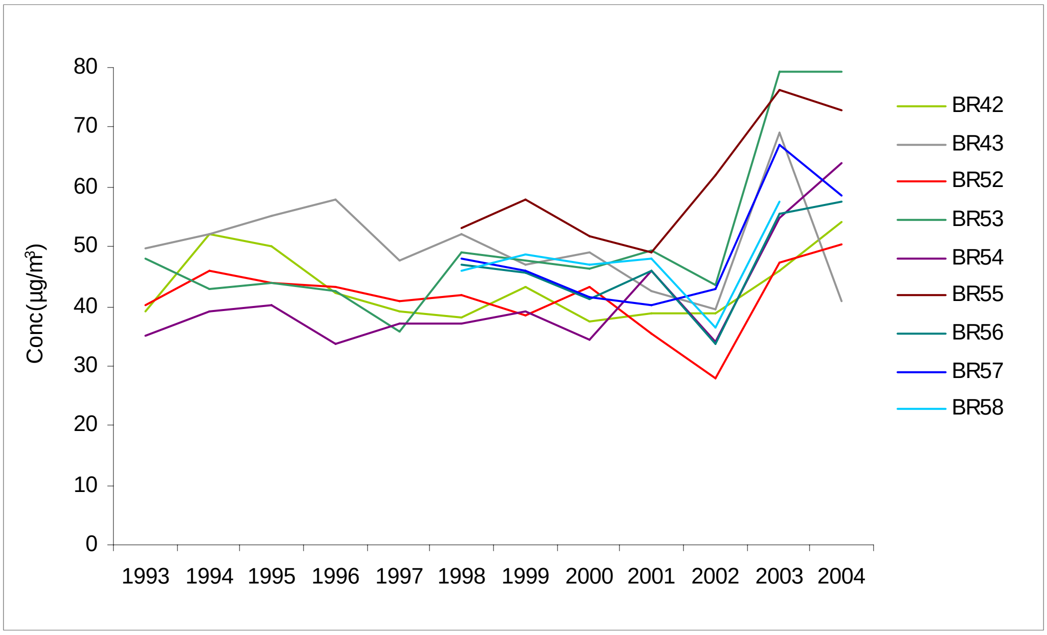
Time Series

Figure 12 Brent Background Time Series, 1993-2004



The annual mean concentration monitored at BR31 is consistently greater than the concentrations monitored at the other background sites. Background concentrations at B41 and BR51 are generally very similar up to 2003. In 2004, there is a marked increase in the monitored concentration at BR41 and a noticeable decrease at BR51 and BR31. Compared with last results, annual mean NO_2 levels at background sites in 2004 reduce by 2%.

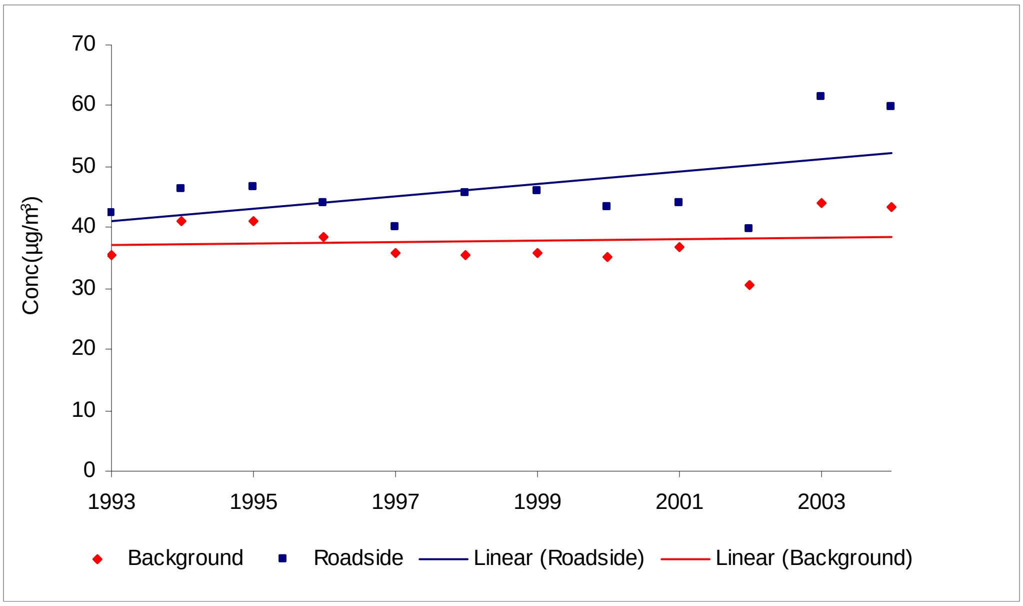
Figure 13 Brent Roadside Time Series, 1993-2004



Concentrations at roadside location fluctuate between 1993 and 2002 with no obvious trend. NO_2 concentrations increase at all sites in 2003. In 2004, the concentrations decrease at all roadside sites except BR41, BR42 and BR43. Site BR43 shows the most significant drop in NO_2 concentration. Comparing the annual mean NO_2 mean levels at roadside sites between 2003 and 2004, there has been an overall reduction of 3%.

Trend Analysis

Figure 14 Brent Background and Roadside Trend Analysis, 1993-2004



Long-term background annual mean NO_2 concentrations remain approximately constant at just under 40 µg/m^3 from 1993 to 2004. Long-term roadside annual mean NO_2 concentrations display an upward trend over this period, increasing by 27%.

Roadside Elevation

Table 7 Brent Elevation Above Background NO_2 Concentration µg/m^3

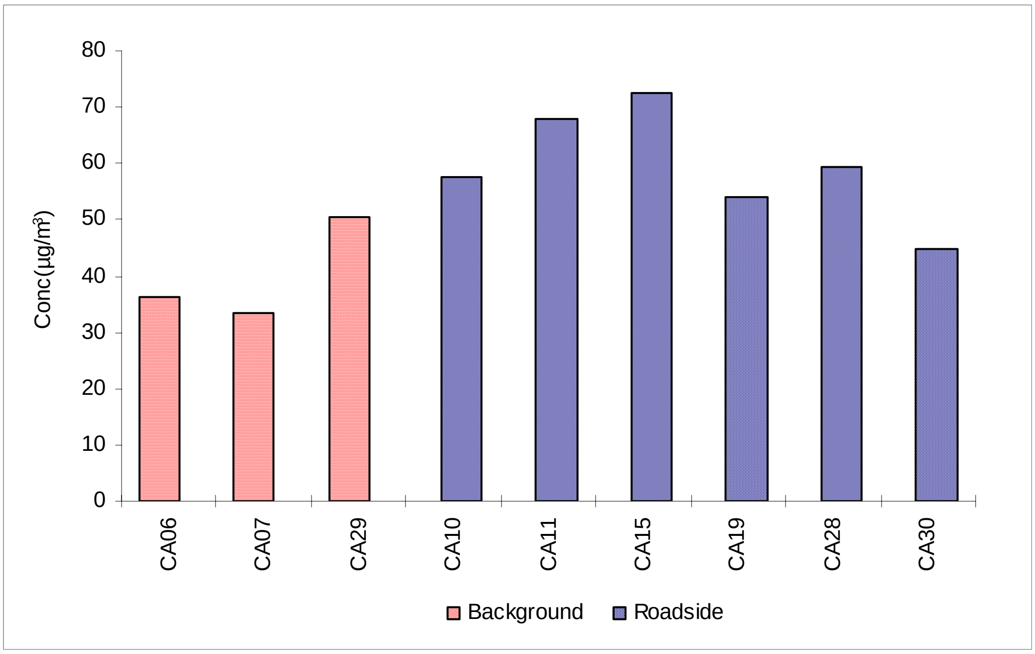
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
5.4	5.6	5.5	4.2	10.4	10.1	8.5	7.3	9.2	11.9	16.4

The roadside elevation in NO_2 concentration remains virtually constant between 1994 and 1996. The concentration decreases in 1997 but then more than doubles to the 1998 level. The roadside elevation in NO_2 concentration falls until 2001 then begins to rise over the next four years reaching its highest value to date of 16.4 µg/m^3 in 2004.

7.4 London Borough of Camden

Annual Mean Values

Figure 15 Camden Background and Roadside Annual Mean NO_2 Concentrations, 2004



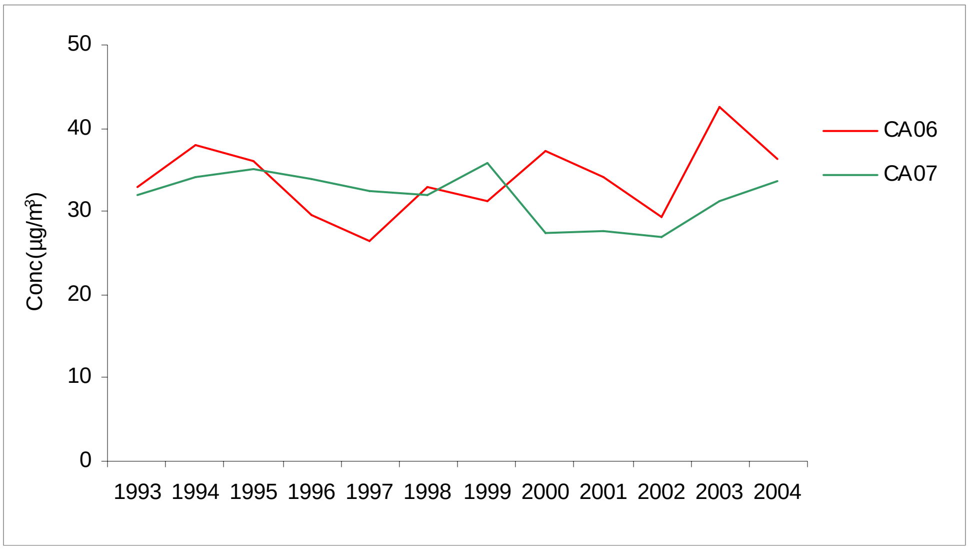
Camden exposed diffusion tubes at 23 monitoring locations in 2004, with sixteen sites of these sites discontinued[11] during the year. The data capture for this year was 79%. The annual mean NO_2 concentrations for the redundant sites, and CA04 have not been reported as the 75% data capture criterion was not fulfilled at these locations.

Background concentrations vary between 33.6 and 50.5 $\mu g/m^3$. Roadside concentrations range between 44.9 and 72.6 $\mu g/m^3$. The 2005 air quality objective was exceeded at seven sites representing 78% of the total number of sites, a reduction from exceedences at 90% of sites recorded last year.

[11] Discontinued diffusion tube sites: CA1, CA5, CA11, CA15, CA27, CA3, CA10, CA21, CA22, CA23, CA24, CA25, CA32, CA33, CA35, CA36.

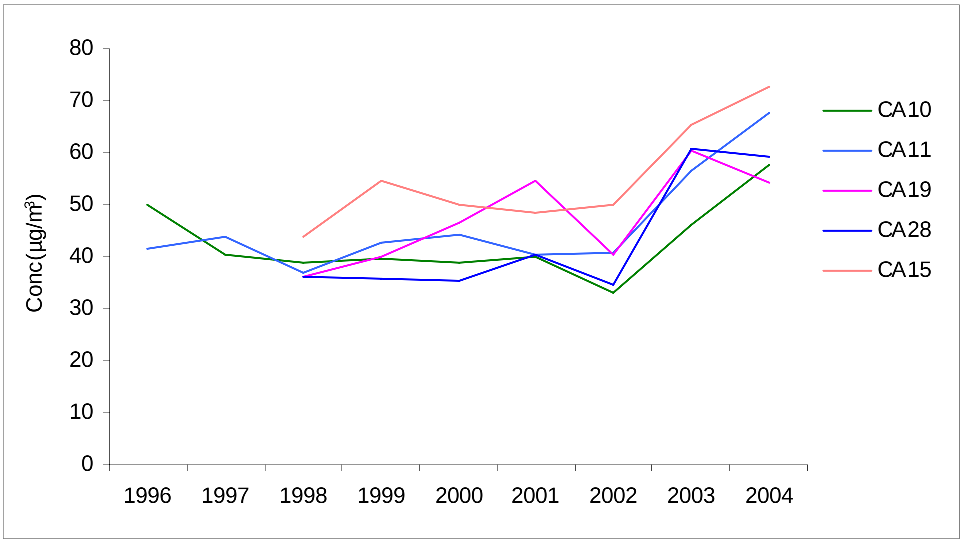
Time Series

Figure 16 Camden Background Time Series, 1993-2004



CA07 maintains a stable level of NO_2 up to 1998 after which concentrations decrease until 2002. Concentrations have continued to rise at this location since 2002. Concentrations at the background site CA06 have fluctuated throughout the period. Comparing the mean of the concentrations monitored at background sites between 2003 and 2004, there has been a reduction of 3%.

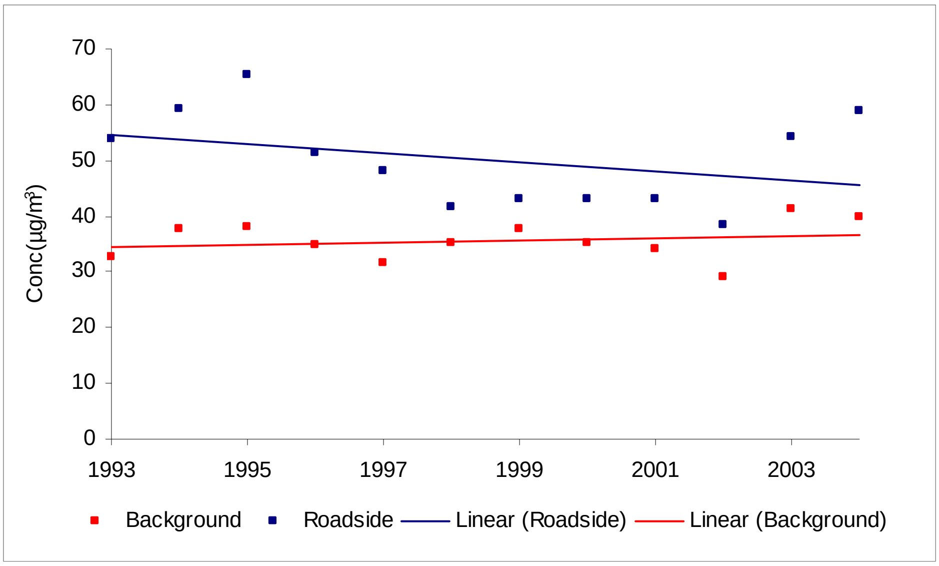
Figure 17 Camden Roadside Time Series, 1996-2004



Concentrations monitored at the roadside sites fluctuate between 1996 and 2002. The concentrations increase at all sites in 2003. In 2004, annual mean NO_2 concentrations show a minor elevation at all long term roadside sites except CA28. Comparing the mean of the concentrations monitored at background sites between 2003 and 2004, there has been an increase of 9%.

Trend Analysis

Figure 18 Camden Background and Roadside Trend Analysis, 1993-2004



Long-term background annual mean NO_2 concentrations display a positive trend with levels increasing by 7% between 1993 and 2004. Concentrations monitored at roadside sites are decreasing. Since 1993, levels have decreased by 16%.

Roadside Elevation

Table 8 Camden Elevation Above Background NO_2 Concentration µg/m³

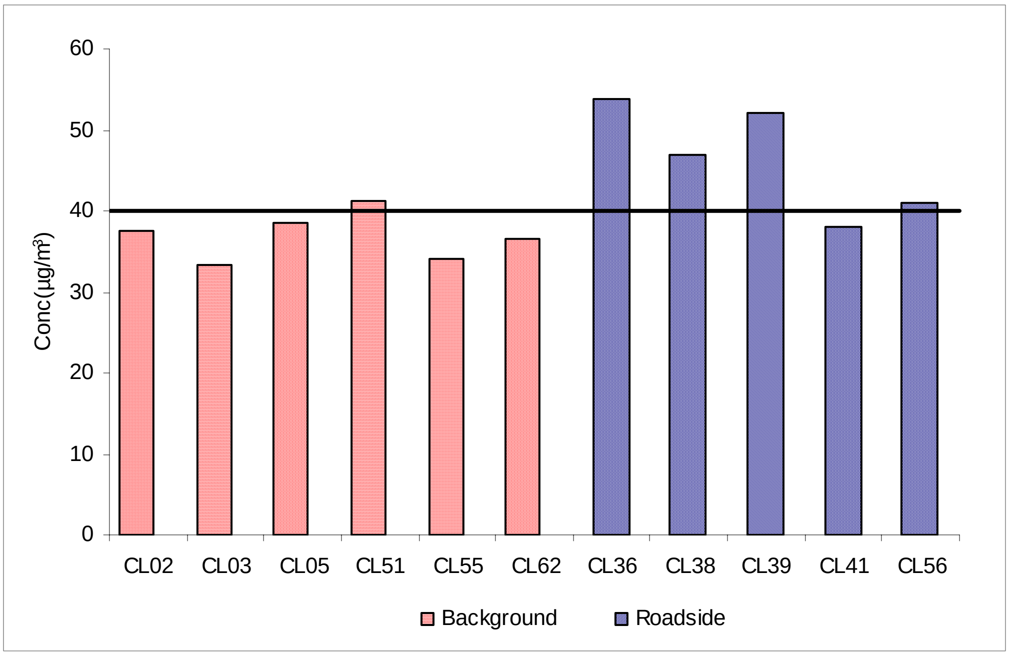
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
21.7	27.3	16.6	16.5	6.3	5.5	8.1	9.1	6.3	13.4	19.0

A steady reduction in roadside elevation is apparent from 1996 to 2000. In 2003, concentrations doubled when compared with the previous year. Concentration levels have continued to increase in 2004.

7.5 Corporation of London

Annual Mean Values

Figure 19 Corporation of London Background and Roadside Annual Mean NO_2 Concentrations, 2004

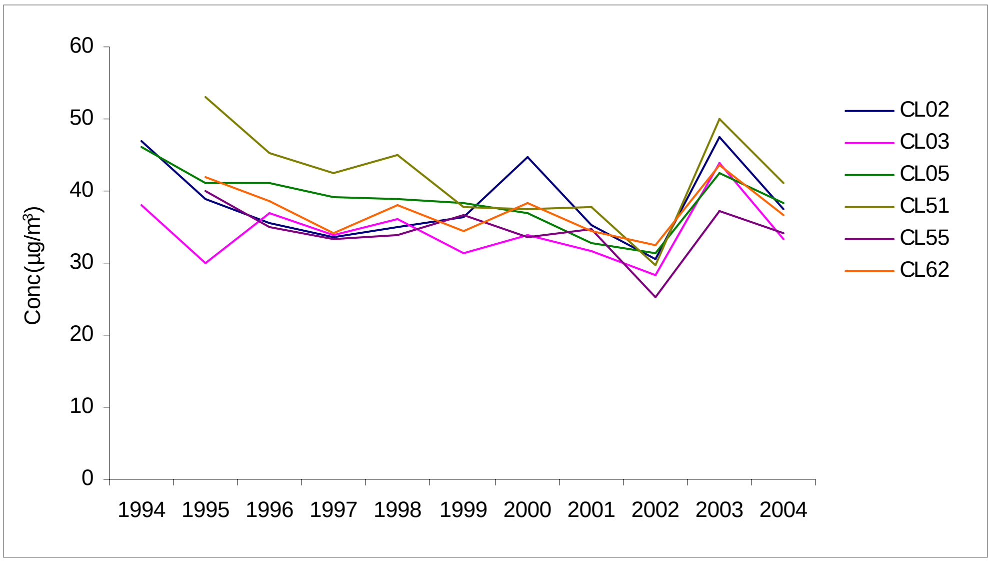


Corporation of London exposed diffusion tubes 11 monitoring locations in 2004, with no change in site numbers compared to the previous year. The data capture for this year was 98%.

Background concentrations vary between 33.3 and 41.1 µg/m^3. Roadside concentrations range between 38.1 and 53.8 µg/m^3. The 2005 air quality objective was exceeded at five monitoring sites, representing 45% of the total number of sites. This represents a fifty-percentage reduction in exceedances compared to last year.

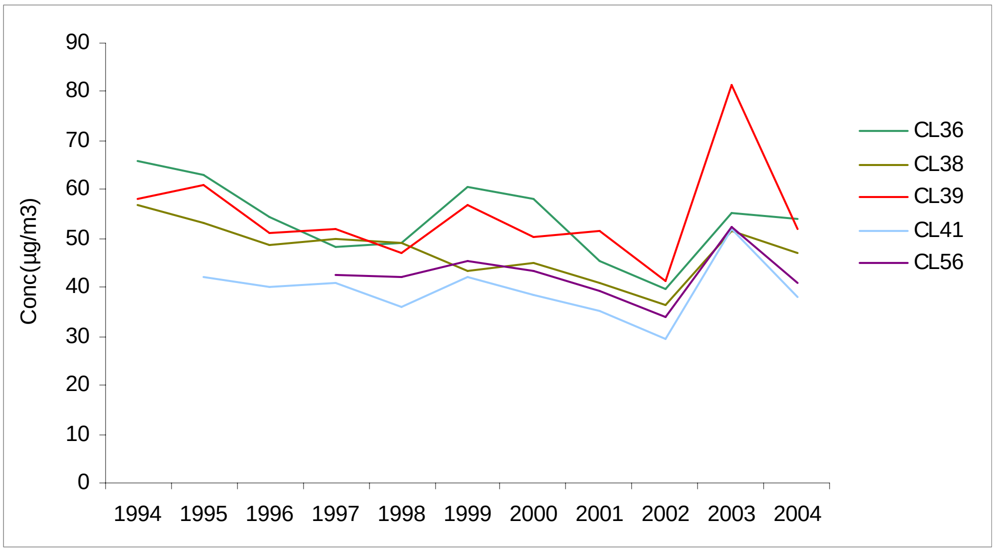
Time Series

Figure 20 Corporation of London Background Time Series, 1994-2004



Long-term background concentrations do not follow any particular trend prior to 2002. The graph shows that the annual concentration rose in 2003 at all sites. This was followed by a reduction in concentrations at all sites in 2004. Comparing the mean of the concentrations monitored at background sites between 2003 and 2004, there has been a reduction of 16%.

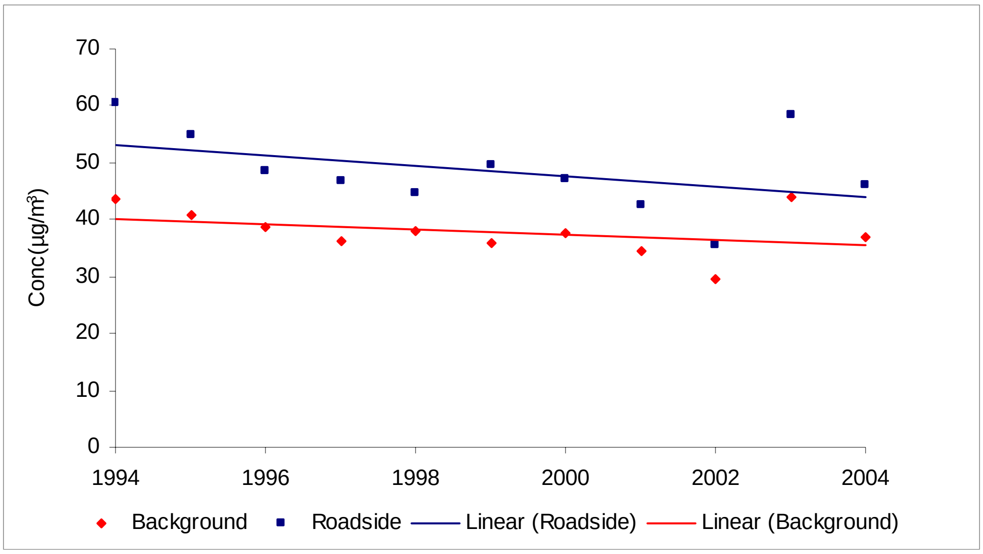
Figure 21 Corporation of London Roadside Time Series, 1994-2004



These observations are also applicable to the roadside concentrations. Concentrations decrease at all sites in 2002, increase in 2003 and fall once more in 2004. The peak concentration in 2003 at CL39 is particularly high at 81.6 $\mu g/m^3$. The steep decrease in concentration at this site in 2004 brings it close to the level recorded at CL36. Comparing the mean of the concentrations monitored at roadside sites between 2003 and 2004, there has been a reduction of 21%.

Trend Analysis

Figure 22 Corporation of London Background and Roadside Trend Analysis, 1994-2004



Background annual mean NO_2 concentrations continue to display a downward trend decreasing by 17% between 1994 and 2004. Roadside annual mean NO_2 concentrations continue to display a downward trend decreasing by 12% between 1994 and 2004.

Roadside Elevation

Table 9 Corporation of London Elevation Above Background NO_2 Concentration µg/m³

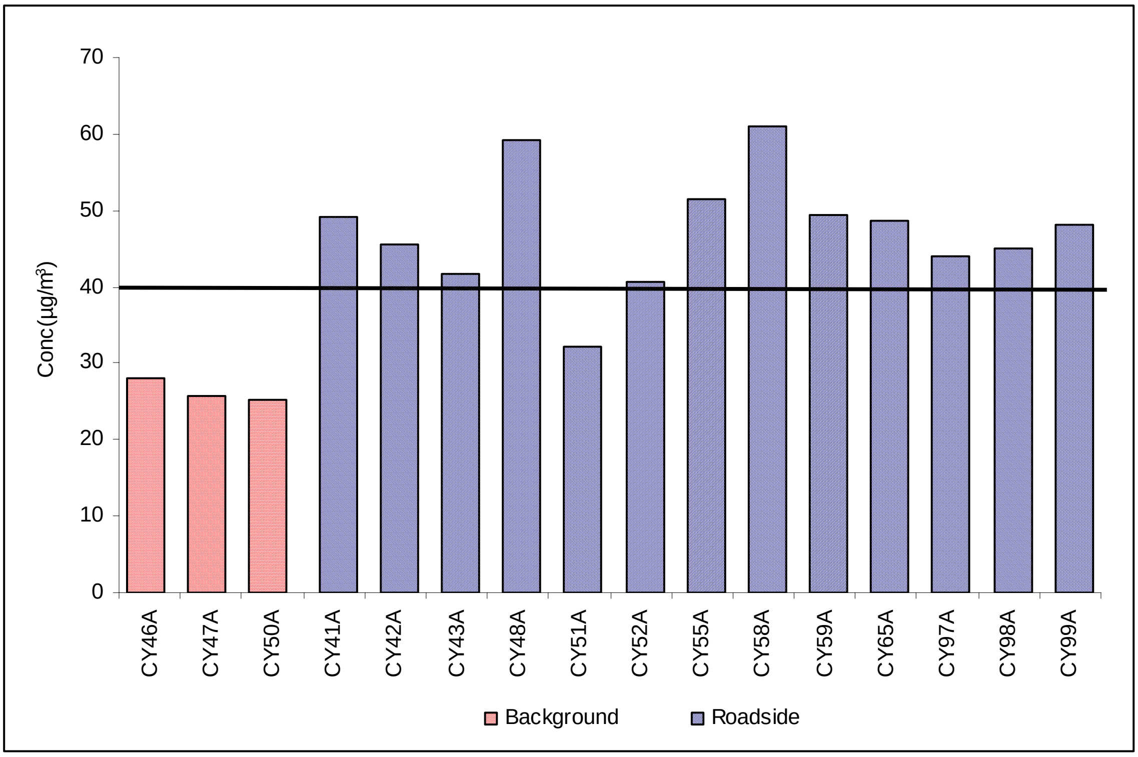
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
16.7	13.9	9.8	10.6	6.8	13.9	9.5	8.0	5.7	14.4	9.0

The roadside elevation fluctuates over the eleven-year monitoring period peaking in 1994, 1999 and 2003. The roadside elevation concentration shows a marked reduction in 2004.

7.6 London Borough of Croydon

Annual Mean Values

Figure 23 Croydon Background and Roadside Annual Mean NO_2 Concentrations, 2004



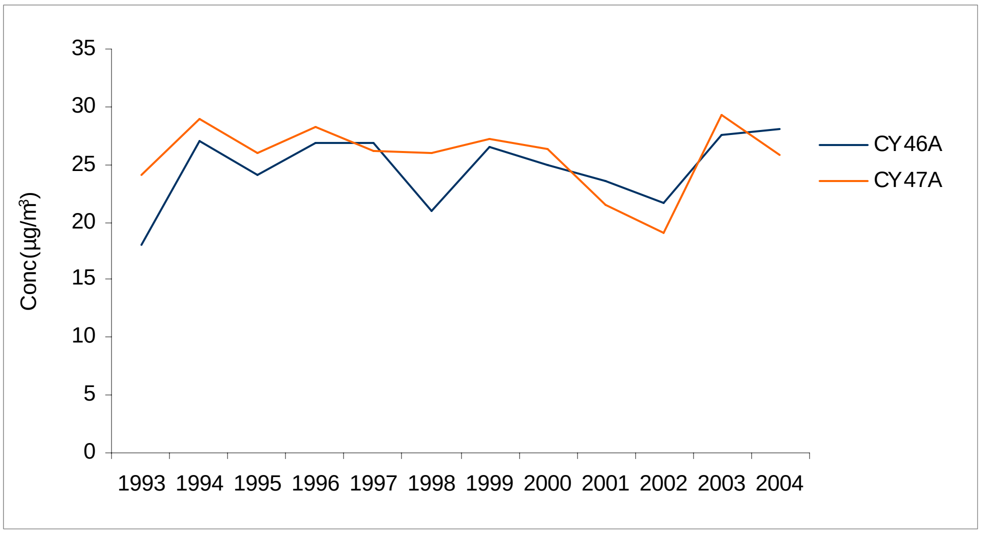
Croydon exposed diffusion tubes at 24 monitoring locations in 2004, with six of these sites discontinuing during the year[12]. The data capture this year was 88%. The annual mean results for the discontinued sites, as well as CY64 and CY56, have not been reported due to their low data capture.

Background concentrations vary between 25.1 and 28.1 µg/m^3. Roadside concentrations range between 30.2 and 61.0 µg/m^3. The 2005 air quality objective was exceeded at ten roadside sites, representing 60% of all monitoring sites. This is a reduction compared to last year where 70% of sites recording concentrations over 40 µg/m^3.

[12] Discontinued diffusion tube sites: CY57, CY60, CY61, CY62, CY63, CY66

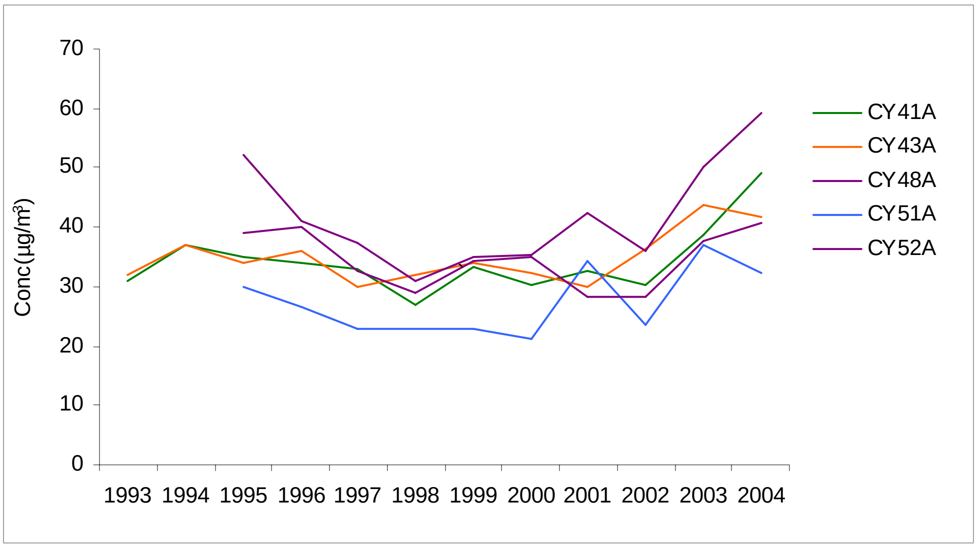
Time Series

Figure 24 Croydon Background Time Series, 1993-2004



Background concentrations monitored at CY46A and CY47A are similar. Monitored concentrations increased in 2003 at both sites. When compared with 2003 concentrations, the monitored concentration in 2004 at CY46A slightly increased whereas the monitored concentration at CY47A showed a marked decrease. Comparing the mean of the concentrations monitored at background sites between 2003 and 2004, there has been a reduction of 7%.

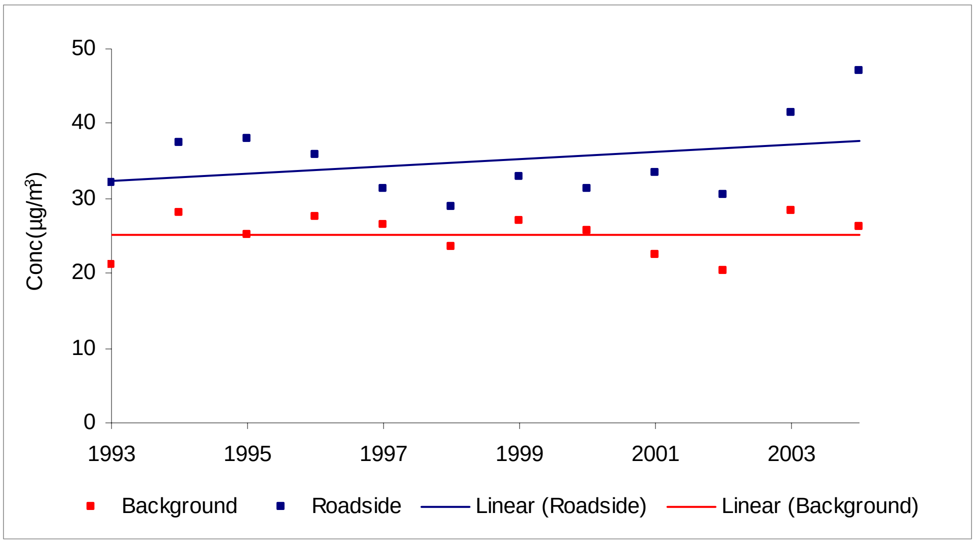
Figure 25 Croydon Roadside Time Series, 1993-2004



CY48A and CY51A follow similar trends prior to 2004. Concentrations monitored in 2004 vary with some sites monitoring concentrations at higher levels compared with 2003 and some lower. Comparing the mean of the concentrations monitored at roadside sites between 2003 and 2004, there has been a reduction of less than 1%.

Trend Analysis

Figure 26 Croydon Background and Roadside Trend Analysis, 1993-2004



Long-term background annual mean NO_2 concentrations remain relatively constant at around 25 µg/m^3 from 1993 to 2004. Long-term roadside annual mean NO_2 concentrations display a positive trend between 1993 and 2004.

Roadside Elevation

Table 10 Croydon Elevation Above Background NO_2 Concentration µg/m^3

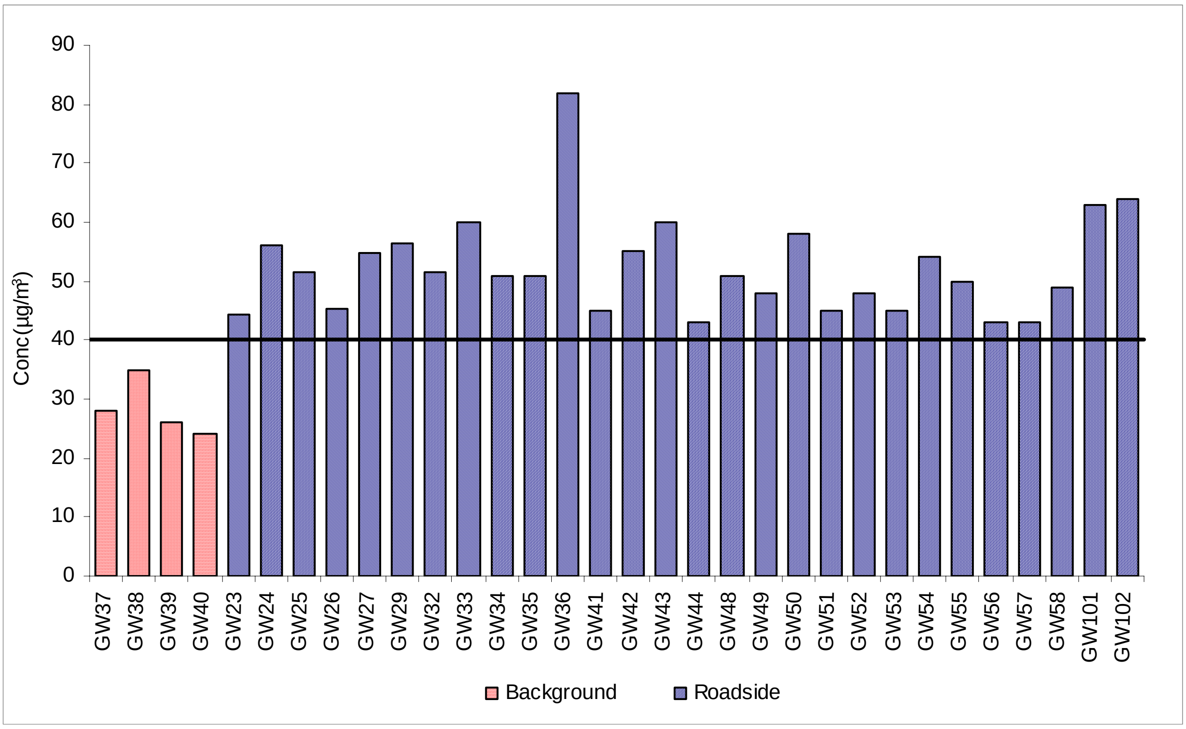
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
9.3	13.0	8.2	4.8	5.3	6.1	5.6	10.8	10.0	13.1	20.7

There has been much variation in the elevations above background NO_2 concentrations since 1994. The roadside elevation in NO_2 concentration rises by approximately fifty percent in 2001 and 2002 with further increases over the following two years. In 2004 the roadside elevation in NO_2 concentration reaches the highest level over the eleven year monitoring period.

7.7 London Borough of Greenwich

Annual Mean Values

Figure 27 Greenwich Background and Roadside Annual Mean NO_2 Concentrations, 2004

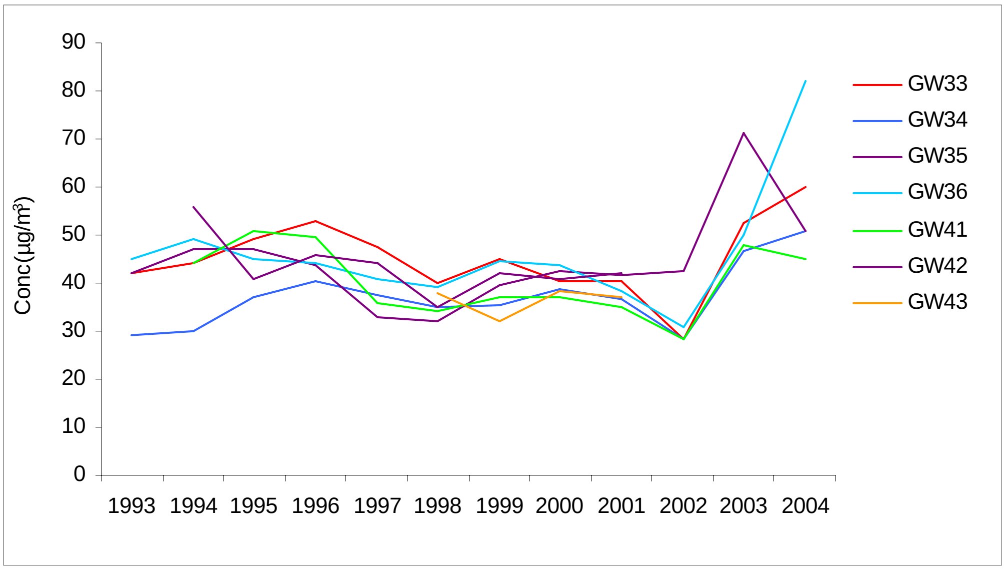


Greenwich exposed diffusion tubes at 33 monitoring location in 2004, introducing one new site GW45. The data capture for this year was 91%. The annual mean NO_2 concentration for GW45 has not been reported due to its low data capture.

Background concentrations vary between 24.1 and 34.8 $\mu g/m^3$. Roadside concentrations range between 43.0 and 82.0 $\mu g/m^3$. The 2005 air quality objective was exceeded at 28 monitoring sites, representing 88% of the total number of sites. This is an identical number of exceedances as 2003.

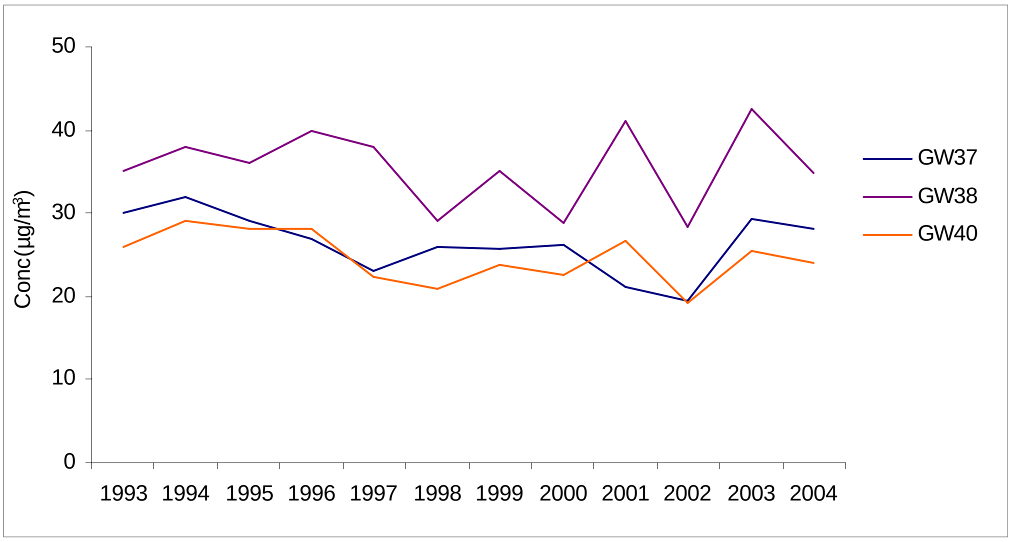
Time Series

Figure 28 Greenwich Background Time Series, 1993-2004



The background concentrations monitored at GW37 are consistently higher than those monitored at GW38 and GW40. The concentrations fluctuate throughout the period. Concentrations at GW38 and GW40 are closely aligned throughout the period. Annual mean background NO_2 concentrations decrease at all sites in 2002, increase in 2003 and fall once more in 2004. Comparing the mean of the concentrations monitored at background sites between 2003 and 2004, there has been a reduction of 21%.

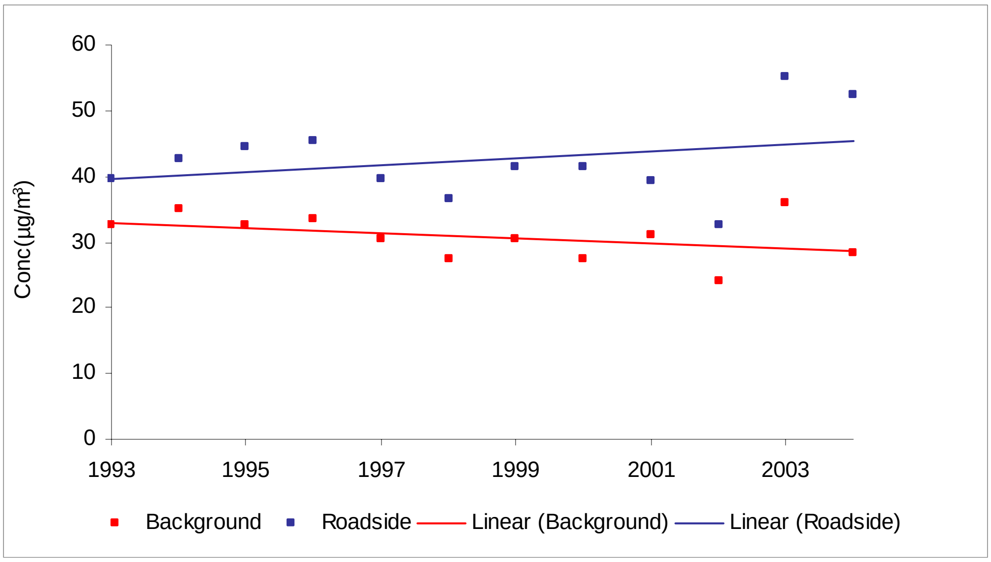
Figure 29 Greenwich Roadside Time Series, 1993-2004



NO_2 levels at roadside sites have fluctuated between 1993 and 2002. There is a marked decrease in concentration at the majority of sites in 2002, the only exception being GW35. Comparing the mean of the concentrations monitored at roadside sites between 2003 and 2004, there has been a reduction of 5%.

Trend Analysis

Figure 30 Greenwich Background and Roadside Trend Analysis, 1993-2004



Long-term background annual mean NO_2 concentrations display an increasing trend of 15% between 1993 and 2004. Long-term roadside annual mean NO_2 concentrations show a decreasing trend of 14% over the same period.

Roadside Elevation

Table 11 Greenwich Elevation Above Background NO_2 Concentration (µg/m³)

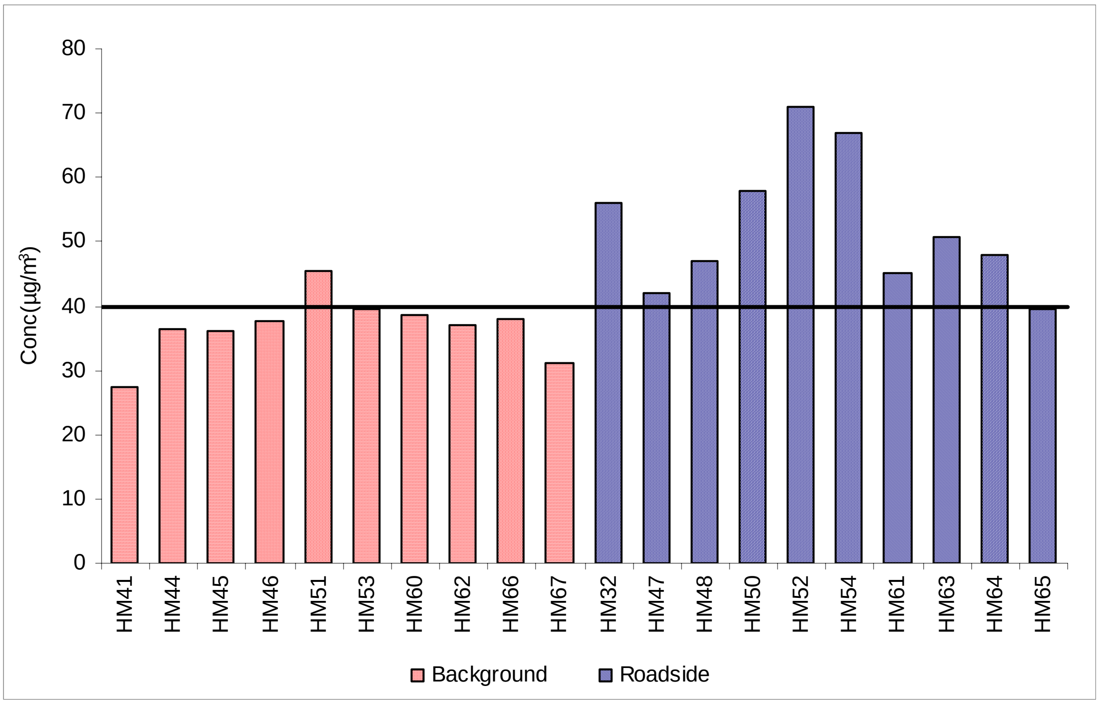
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
7.5	12.0	11.8	9.1	9.0	10.9	13.8	8.0	8.6	19.3	24.1

The elevation above background NO_2 concentration decreases between 1995 and 1998 and then rises to 2000. There is a marked decrease in 2001 after which, elevations rise to their highest value in 2004.

7.8 London Borough of Hammersmith and Fulham

Annual Mean Values

Figure 31 Hammersmith and Fulham Background and Roadside Annual Mean NO_2 Concentrations, 2004

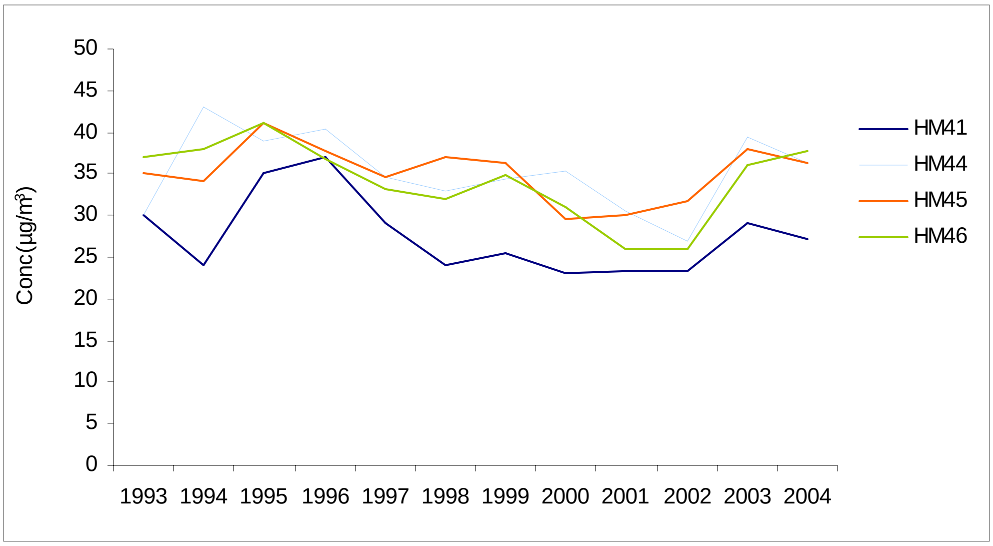


Hammersmith and Fulham exposed diffusion tubes at 20 monitoring locations in 2004, with no revision in site numbers compared to the previous year. The data capture for this year was 90%.

Background concentrations vary between 27.2 and 45.4 µg/m^3. Roadside concentrations range between 39.6 and 70.8 µg/m^3. The 2005 air quality objective was exceeded at ten monitoring sites representing 50% of the authority's sites, identical to last year

Time Series

Figure 32 Hammersmith and Fulham Background Time Series, 1993-2004



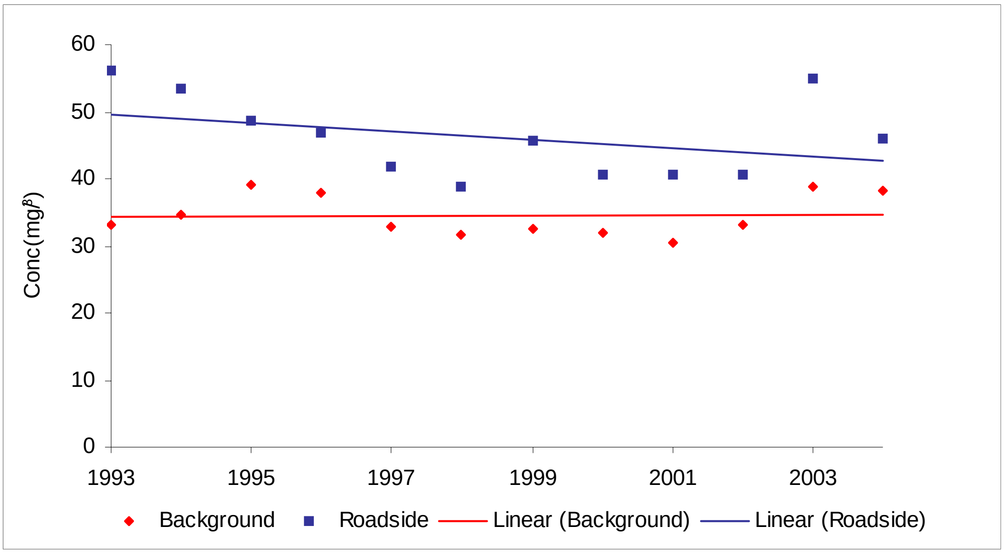
The long-term data show annual mean background NO_2 level to be lowest at HM41. After peaking in 1996 the NO_2 concentration gradually decreases, remaining relatively constant from 2000 onwards. Annual mean NO_2 concentrations at HM44, HM45 and HM46 fluctuate over the ten-year monitoring period. Mean NO_2 levels decrease at HM44 and HM46 post 2000, whereas at HM45 a steady increase is evident. In 2003 all background diffusion tube sites experience a rise in annual mean NO_2 concentrations. In 2004, there is a decrease in monitored concentrations at HM41, HM44, and HM45. Concentrations at HM46 increase in 2004. Comparing the mean of the concentrations monitored at background sites between 2003 and 2004, there has been a reduction of 2%.

Figure 33 Hammersmith and Fulham Roadside Time Series, 1993-2004

HM32 records the highest roadside mean NO_2 concentration between 1993 and 2004, peaking in 1994, 1999 and 2003. The annual mean NO_2 concentration at HM48 remains fairly constant from 1997 to 1999. Between 2000 and 2001 a reduction in concentration takes place followed by a small rise in 2002. HM47 indicates a gradual decrease in NO_2 concentration between 1995 and 2002. HM32, HM47 and HM48 all record a marked increase in annual mean NO_2 concentration in 2003. Concentrations fall in 2004 at HM32 and HM48. Comparing the mean of the concentrations monitored at roadside sites between 2003 and 2004, there has been a reduction of 16%.

Trend Analysis

Figure 34 Hammersmith and Fulham Background and Roadside Trend Analysis, 1993-2004



Long-term background annual mean NO_2 concentrations display a slight positive trend. Long-term roadside annual mean NO_2 concentrations display a downward trend reducing by 14% between 1993 and 2004.

Roadside Elevation

Table 12 Hammersmith and Fulham Elevation Above Background NO_2 Concentration μg/m³

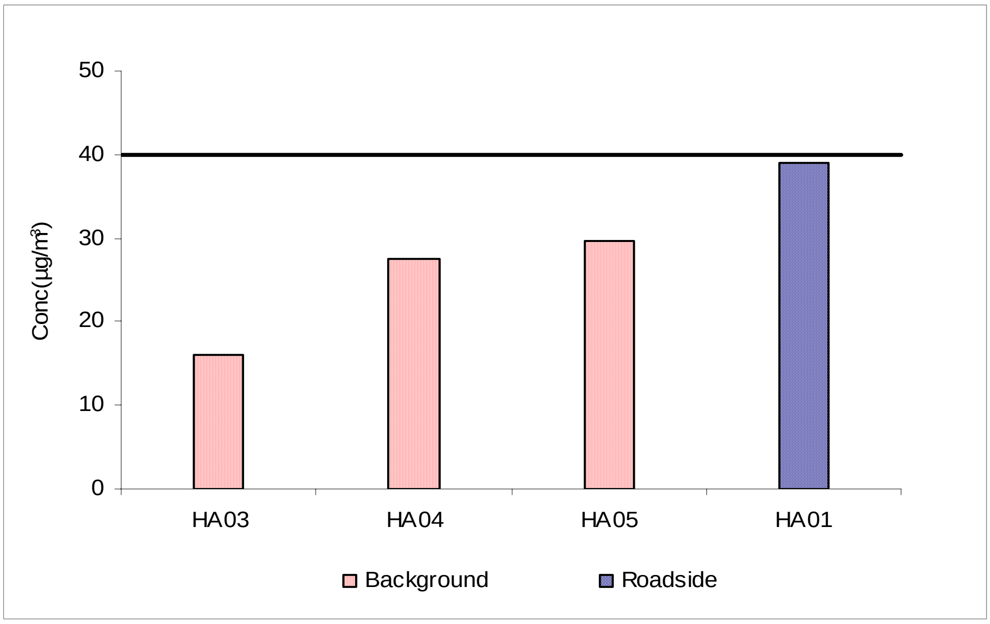
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
18.8	9.5	8.9	8.9	7.2	12.9	8.8	10.4	7.6	16.2	15.3

The roadside elevation in NO_2 concentration decreases by more than 50% between 1994 and 1998. After 1998, the elevation fluctuates until 2003 and 2004 when concentrations show limited variability. In 2004 the roadside elevation exhibits a minor reduction in concentration.

7.9 London Borough of Harrow

Annual Mean Values

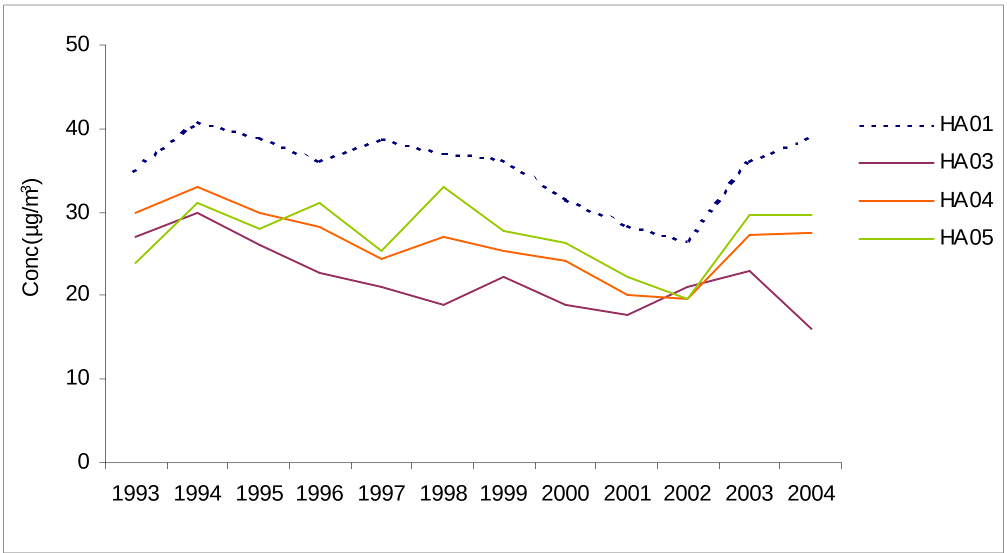
Figure 35 Harrow Background and Roadside Annual Mean NO_2 Concentrations, 2004



Harrow exposed diffusion tubes at 4 monitoring locations in 2004, with no revisions to site numbers compared to the previous year. The data capture for this year was 72%. Background concentrations vary between 16.1 and 29.6 µg/m^3. The roadside concentration is 39.0 µg/m^3. The 2005 air quality objective was not exceeded in 2004, identical to last year.

Time Series

Figure 36 Harrow Background and Roadside Time Series, 1993-2004

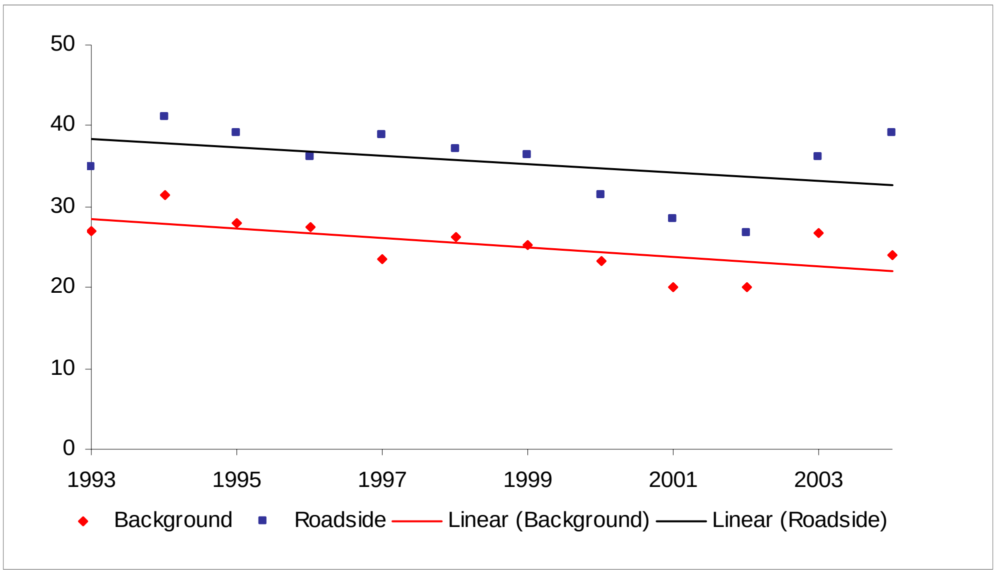


Background concentrations at HA03 and HA04 follow a similar pattern. HA05 displays a rolling trend with the mean NO_2 concentration showing a continual reduction from 1998 to 2002. In 2003 all background sites experience a rise in annual mean. There is a slight increase in concentrations at HA04 and HA05 in 2004, but a marked decrease at HA03. Concentrations at HM46 increase in 2004. Comparing the mean of the concentrations monitored at background sites between 2003 and 2004, there has been a reduction of 10%.

At roadside site, HA01, indicates a gradual decrease in NO_2 concentration after 1994 with this becoming more apparent from 1999 onwards. A sharp rise in annual mean NO_2 concentration takes place in 2003. The concentration in 2004 is 8% greater than the concentration in 2003.

Trend Analysis

Figure 37 Harrow Background and Roadside Trend Analysis, 1993-2004



Long-term background and roadside annual mean NO_2 concentrations display a decreasing trend between 1993 and 2004. Background concentrations reduce by 15% and roadside concentrations reduce by 23%.

Roadside Elevation

Table 13 Harrow Elevation Above Background NO_2 Concentration µg/m³

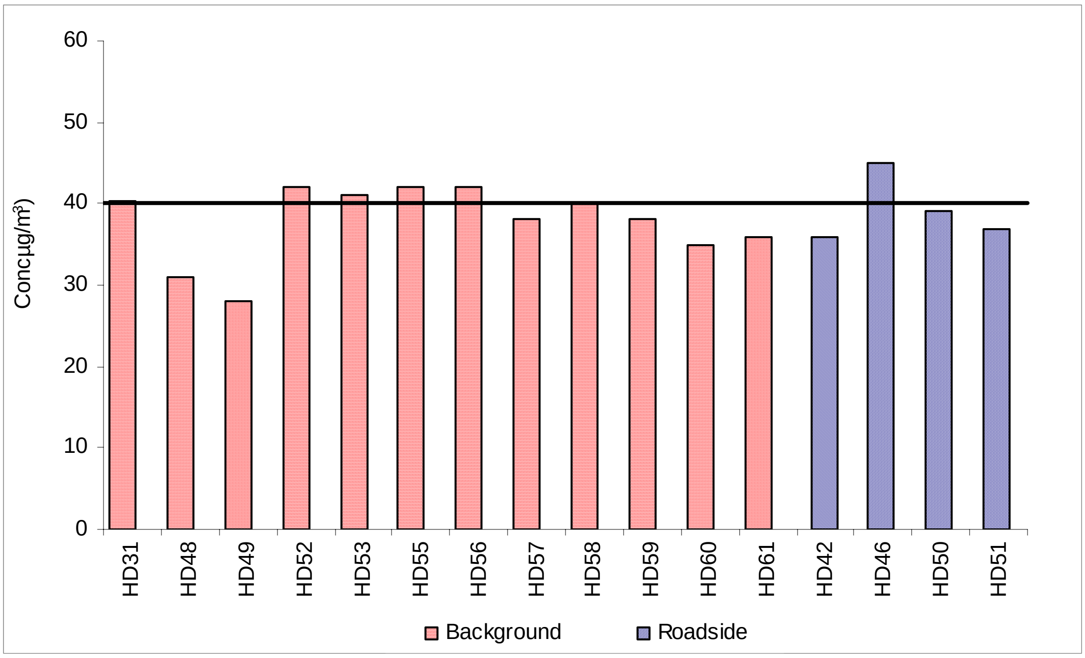
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
9.7	11.0	8.7	15.1	10.7	11.3	8.4	8.5	6.6	9.5	15.0

The roadside elevation in NO_2 concentration drops by almost 50% between 1997 and 1998, then gradually increases by approximately 1 µg/m^3 over the next three years. Between 2000 and 2002 the roadside decreases and then gradually rise in 2003 and 2004.

7.10 London Borough of Hillingdon

Annual Mean Values

Figure 38 Hillingdon Background and Roadside Annual Mean NO_2 Concentrations, 2004



Hillingdon exposed diffusion tubes at 25 monitoring locations in 2004, introducing five new monitoring sites[13]. The data capture for this year 2004 was 72%. The annual mean NO_2 concentrations for the new monitoring sites, as well as HD41, HD43, HD47 and HD54, have not been reported as the 75% data capture criterion was not fulfilled at these locations.

Background concentrations vary between 28.0 and 42.0 $\mu g/m^3$. Roadside concentrations range between 36.0 and 45.0 $\mu g/m^3$. The 2005 air quality objective was exceeded at six monitoring sites representing 38% of the total number of sites. This is a reduction compared to last year when 60% of sites recorded over 40 $\mu g/m^3$.

[13] New diffusion tube sites: HD62, HD63, HD64, HD65 and HD66.

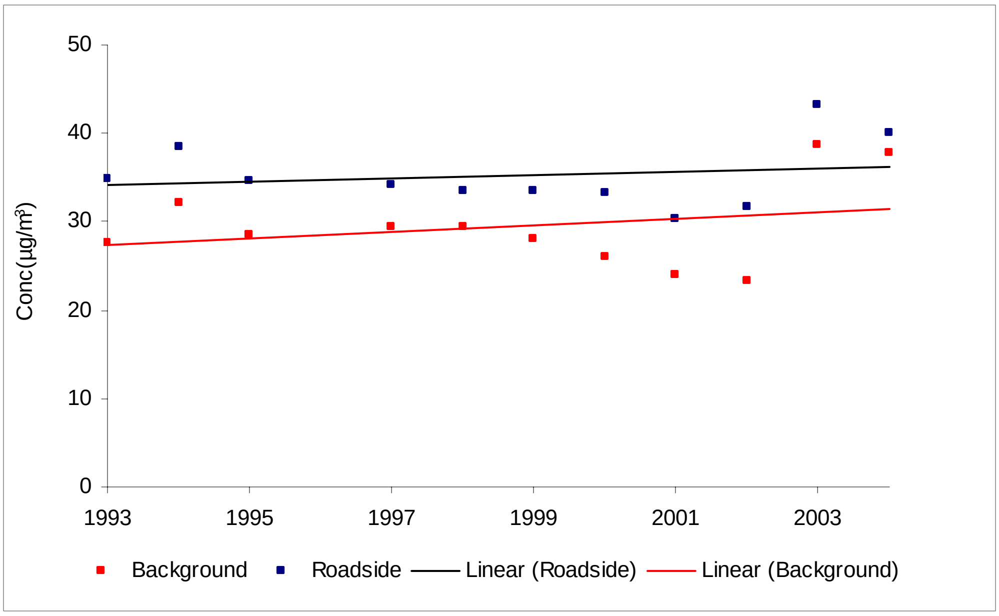
Time Series

Figure 39 Hillingdon Background and Roadside Time Series, 1993-2004

The background concentration monitored at HD31 continually varies between 1993 and 2004 as does the roadside concentration monitored at HD42. There is a marked increase in 2003 at both locations followed by a decrease in 2004. When comparing the background concentration at HD31 in 2004 with 2003, there has been a 2% decrease. When comparing the roadside concentration at HD42 in 2004 with 2003, there has been a 7% decrease.

Trend Analysis

Figure 40 Hillingdon Background and Roadside Trend Analysis, 1993-2004



Long-term background annual mean NO_2 concentrations display a positive trend increasing by 6% from 1993 to 2004. Long-term roadside annual mean NO_2 concentrations display a positive trend increasing by 22% from 1993 to 2004.

Roadside Elevation

Table 14 Hillingdon Elevation Above Background NO_2 Concentration µg/m³

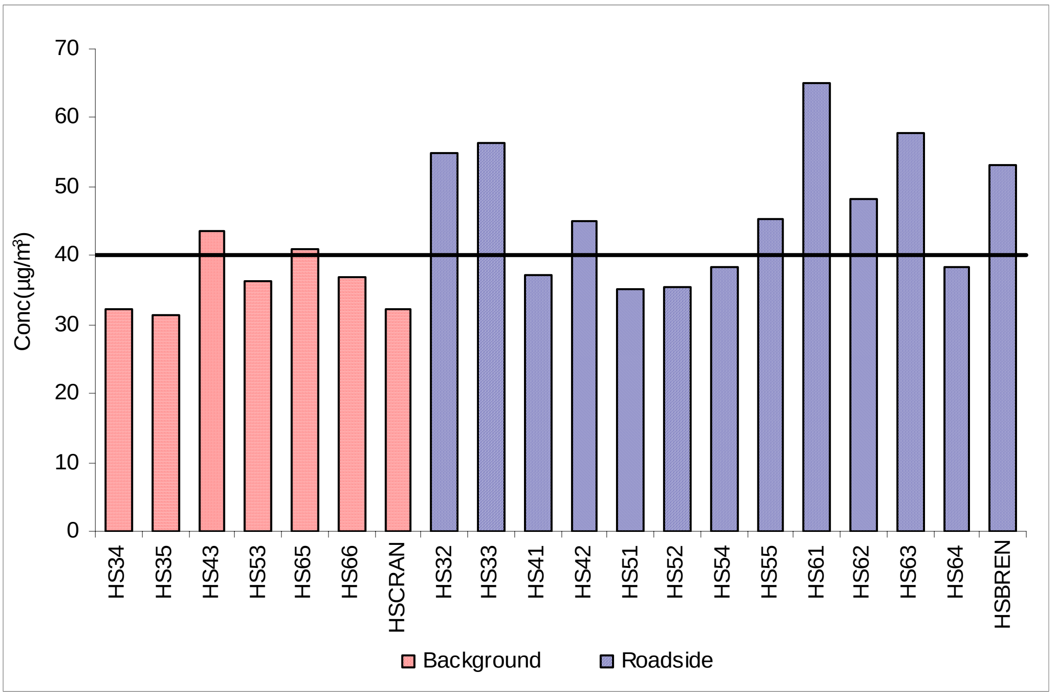
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
6.5	6.0		4.8	4.0	5.4	7.1	6.3	8.4	4.5	2.2

The roadside elevation in NO_2 concentration varies throughout the period. The elevation reduces by 50% in 2004 dropping to its lowest concentration over the eleven-year monitoring period.

7.11 London Borough of Hounslow

Annual Mean Values

Figure 41 Hounslow Background and Roadside Annual Mean NO_2 Concentrations, 2004

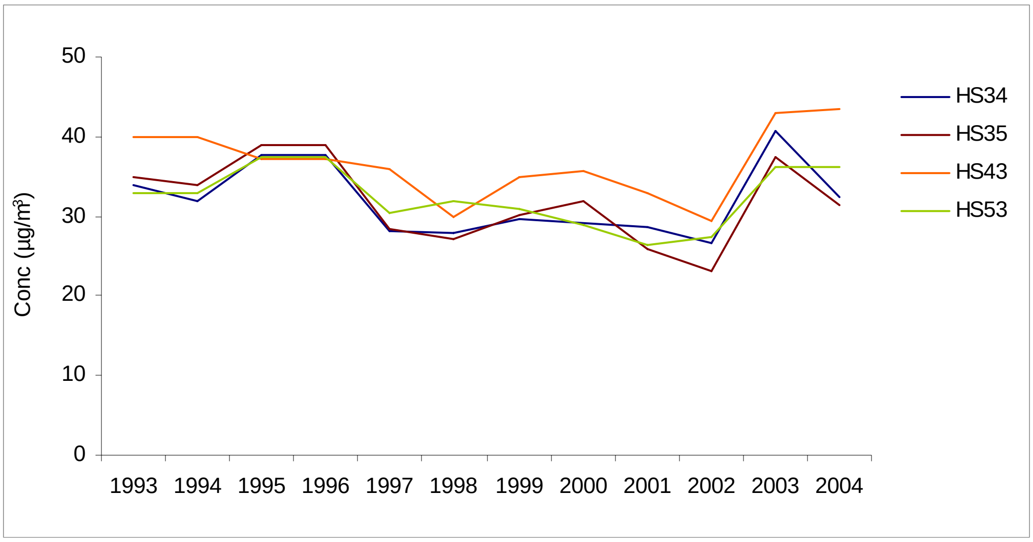


Hounslow exposed diffusion tubes at 21 monitoring location in 2004, with no revision in site numbers compared to the previous year. The data capture this year was 97%.

Background concentrations vary between 31.4 and 43.5 µg/m^3. Roadside concentrations range between 35.0 and 65.0 µg/m^3. The 2005 air quality objective was exceeded at ten monitoring sites representing 50% of the total number of sites. This is a reduction compared to last year, where 60% of the site recorded over 40 µg/m^3.

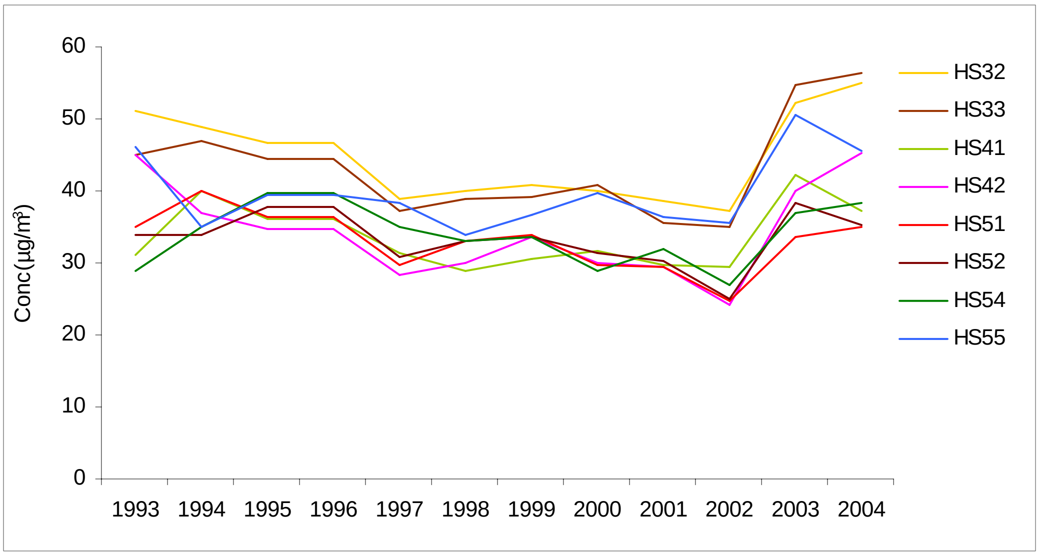
Time Series

Figure 42 Hounslow Background Time Series, 1993-2004



The time series reveals HS53, HS43 and HS34 to follow an identical trend from 1993 to 1997. Following a small peak in 1998, HS53 reflects a gradual decrease in NO_2 concentration until 2001, after which the concentration rises slightly. NO_2 concentration at HS34 rise between 1997 and 1999 but then begins to steadily decrease. HS35 shows a similar trend, with NO_2 concentrations falling earlier in 2000. The annual mean NO_2 concentration at HS43 shows a gradual decrease from 1993 to 1998. NO_2 concentrations at all sites show a minor rise from 1998 to 2000 and then begin to descend over the next two years. Background concentrations increase between 2002 and 2003 at all locations. In 2004, a decrease in concentrations is monitored at HS34 and HS35. A slight increase is monitored at HS43 and HS53. Comparing the mean of background concentrations monitored in 2004 with 2003, there is a 9% reduction.

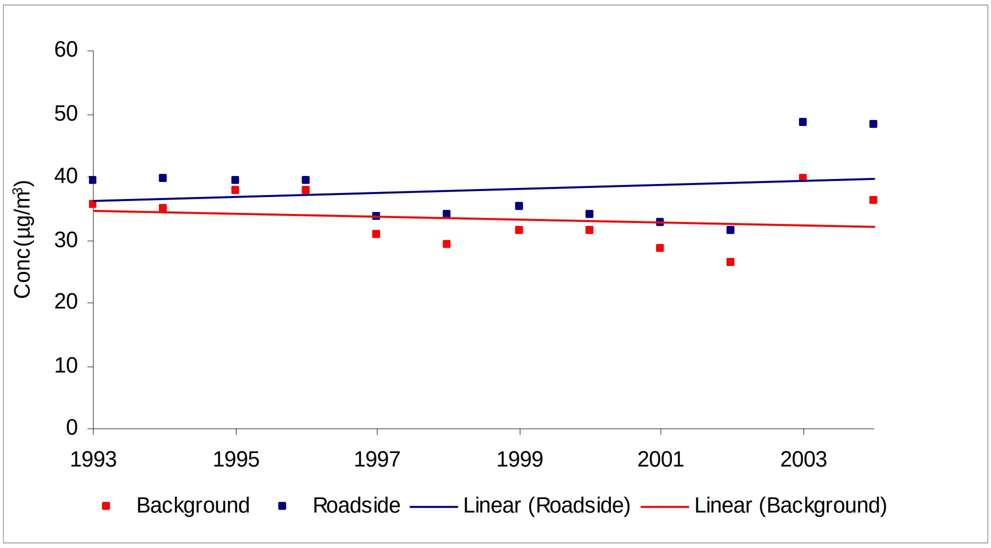
Figure 43 Hounslow Roadside Series, 1993-2004



HS32 and HS33 follow near identical trends with a gradual decrease in NO2 concentrations between 1994 and 2002. With the exception of HS55, the remaining sites reflect a similar rolling pattern peaking in 1996 and 1999, then falling sharply in 1997 and 2002. In 2003 all roadside sites experience a sharp elevation in annual mean NO_2 concentration. 50% of sites recorded their highest long-term concentrations in 2003. In 2004, annual mean NO_2 concentrations increased at seven roadside sites. Comparing the mean of roadside concentrations monitored in 2004 with 2003, there is a reduction of less than 1%.

Trend Analysis

Figure 44 Hounslow Background and Roadside Trend Analysis, 1993-2004



Long-term background annual mean NO_2 concentrations show a decreasing trend. Between 1993 and 2004, concentrations have decreased by 8%. Long-term roadside annual mean NO_2 concentrations show a positive trend. Between 1993 and 2004, concentrations have increased by 9%.

Roadside Elevation

Table 15 Hounslow Elevation Above Background NO_2 Concentration µg/m³

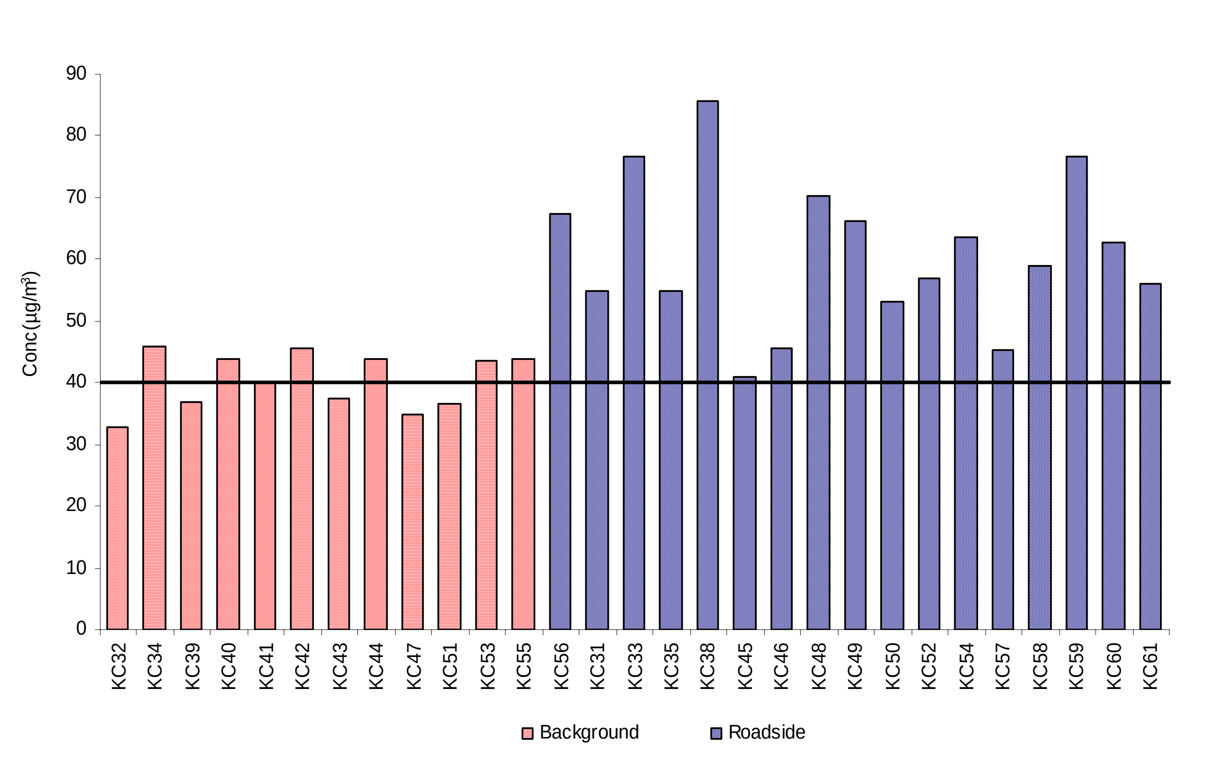
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
4.9	1.6	1.6	2.9	4.6	3.9	2.6	4.3	5.1	11.5	12.0

The elevation above background NO_2 concentration increased by over 50% in 2003 compared with all previous years. The elevation continued to increase in 2004.

7.12 London Borough of Kensington and Chelsea

Annual Mean Values

Figure 45 Kensington and Chelsea Background and Roadside Annual Mean NO_2 Concentrations, 2004

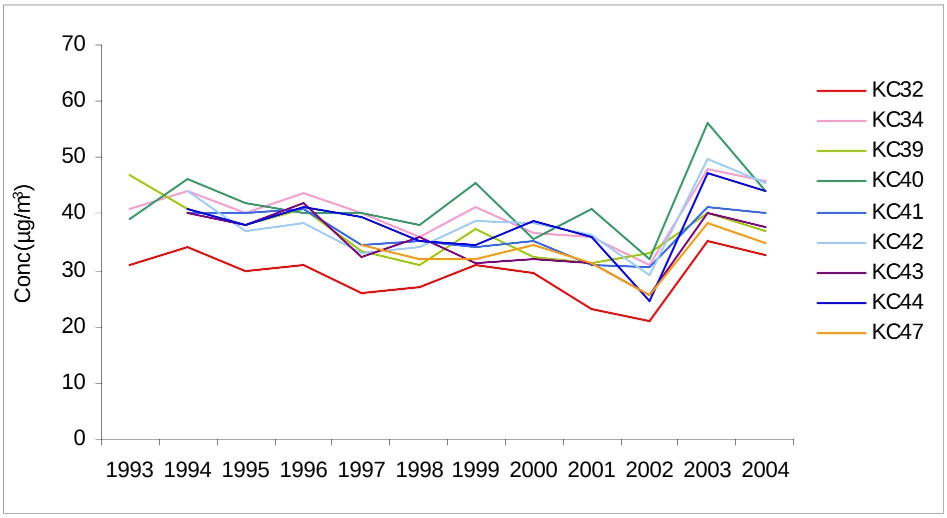


Kensington and Chelsea exposed diffusion tubes at 29 monitoring locations in 2004, with no change in site numbers compared to the previous year. The data capture for this year was 97%.

Background concentrations vary between 32.8 and 45.6 µg/m^3. Roadside concentrations range between 40.8 and 85.6 µg/m^3. The 2005 air quality objective was exceeded at 24 monitoring sites representing 83% of the total number of sites. This is a decrease compared to last year when 90% of monitoring sites recorded over 40 µg/m^3.

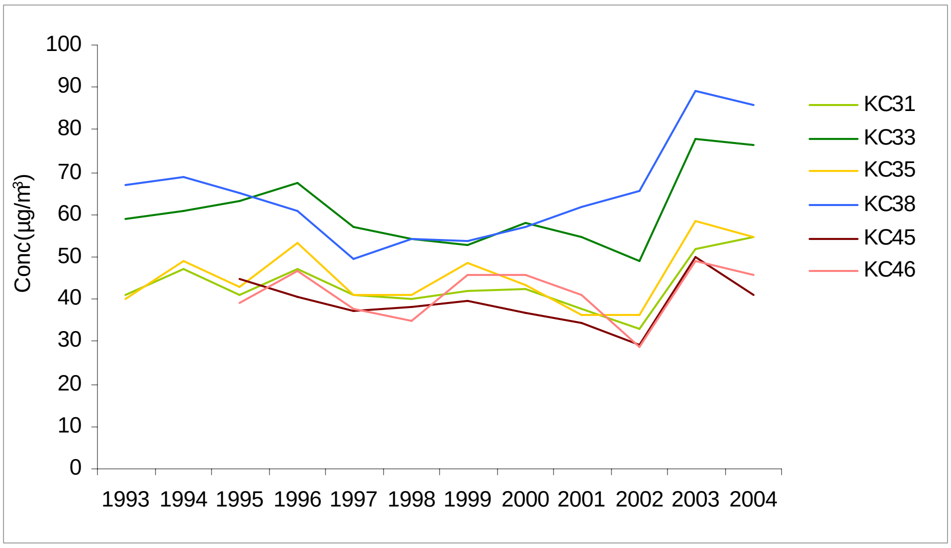
Time Series

Figure 46 Kensington and Chelsea Background Time Series, 1993-2004



All background sites appear to follow a similar rolling trend between 1993 and 2004. KC32 maintains the lowest annual mean NO_2 concentration over this monitoring period. From 2001 to 2002 all background sites except KC39 experience a decrease in annual mean NO_2concentration. An abrupt rise in NO_2 concentration takes place at all sites in 2003 with KC32, KC34 and KC40 recording their highest concentrations over the eleven-year monitoring period. Background sites have experienced an obvious growth in NO_2 concentration in 2003. Concentrations fall in 2004 at all sites except KC51 where there is a small increase. There is an 8% reduction of annual mean NO_2 concentrations between 2003 and 2004.

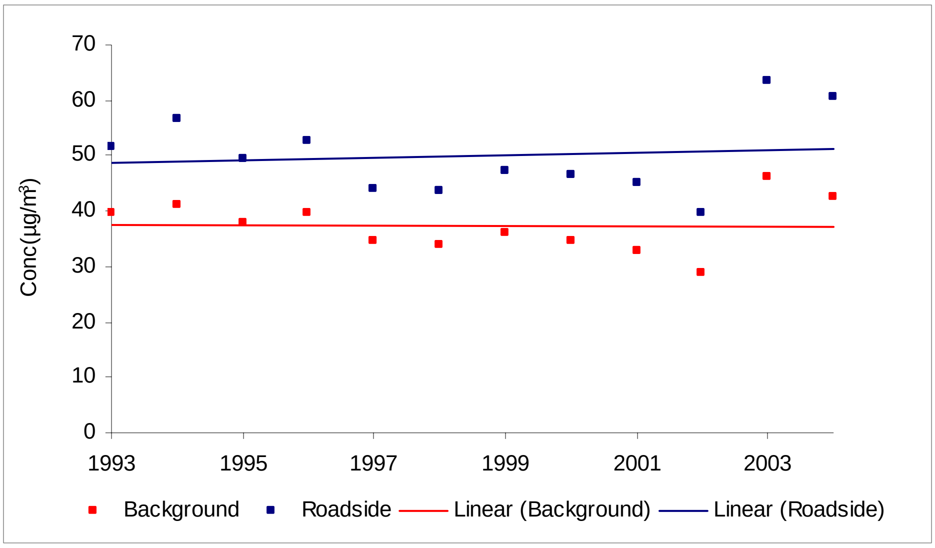
Figure 47 Kensington and Chelsea Roadside Time Series, 1993-2004



KC33 and KC38 clearly show the highest NO_2 concentrations between 1993 and 2003. KC38 is the only site to show a gradual increase in NO_2 concentration, taking place between 1997 and 2003. The NO_2 concentration at KC33 reveals a gradual reduction from 1997 to 2002. The NO_2 concentrations at the remaining sites fluctuate over the eleven-year monitoring period. Between 2002 and 2003 all roadside concentrations record an appreciable rise in NO_2 concentrations. Comparing the mean of the concentrations monitored at roadside sites between 2003 and 2004, there is a reduction of 5%.

Trend Analysis

Figure 48 Kensington and Chelsea Background and Roadside Trend Analysis, 1993-2004



Long-term background annual mean NO_2 concentrations show a decreasing trend. Between 1993 and 2004, concentrations have decreased by 2%. Long-term roadside annual mean NO_2 concentrations show a positive trend. Between 1993 and 2004, concentrations have increased by 5%.

Roadside Elevation

Table 16 Kensington and Chelsea Elevation Above Background NO_2 Concentration µg/m³

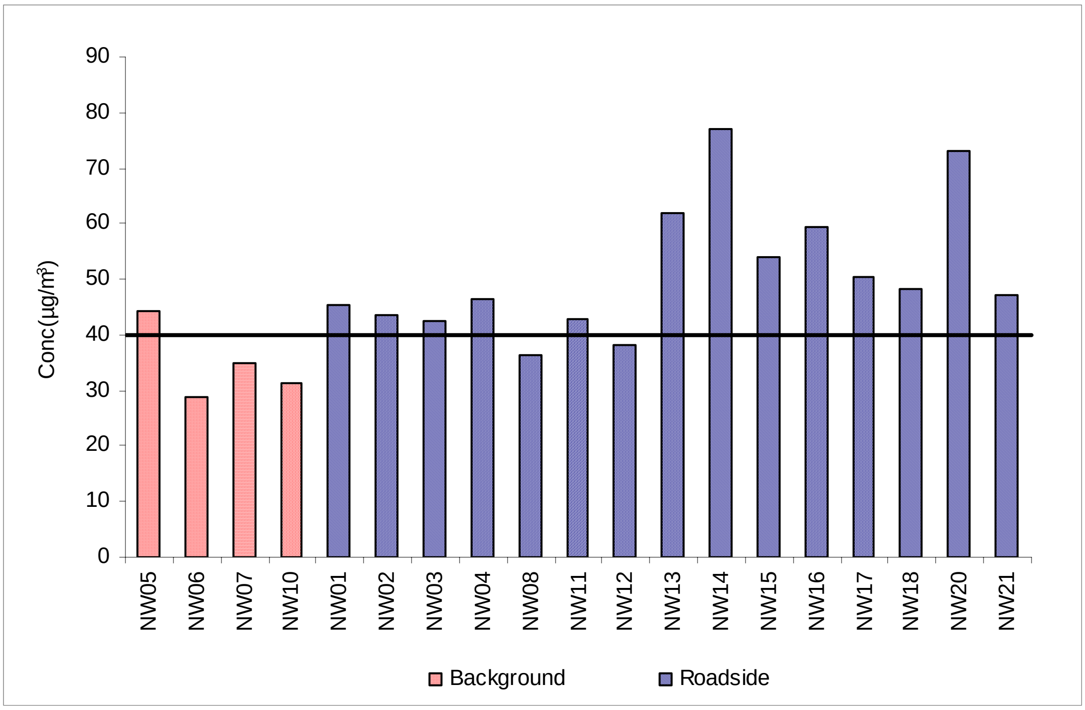
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
15.3	11.5	12.9	9.2	9.9	11.0	11.9	12.2	10.6	17.3	20.4

The elevation above background concentration fluctuates around 11 µg/m3 between 1994 and 2002. However, in 2003 this increases by 7 µg/m^3. The elevation continues to increase in 2004, reaching the highest long-term concentration.

7.13 London Borough of Newham

Annual Mean Values

Figure 49 Newham Background and Roadside Annual Mean NO_2 Concentrations, 2004

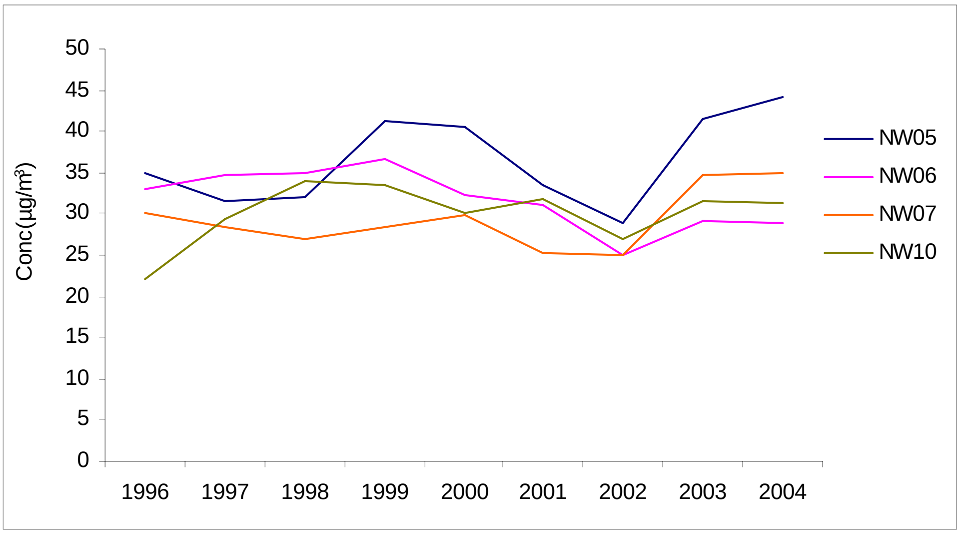


Newham exposed diffusion tubes at 20 monitoring locations in 2004, with no change in site numbers compared to the previous year. The data capture this year was 88%. The annual mean concentration for NH19 has not been reported due to the low data capture for this location.

Background concentrations vary between 28.8 and 44.3 $\mu g/m^3$. Roadside concentrations range between 36.2 and 77.2 $\mu g/m^3$. The 2005 air quality objective was exceeded at 14 monitoring sites representing 74% of the total number of sites. This represents an increase compared to last year when 65% of sites recorded over 40 $\mu g/m^3$.

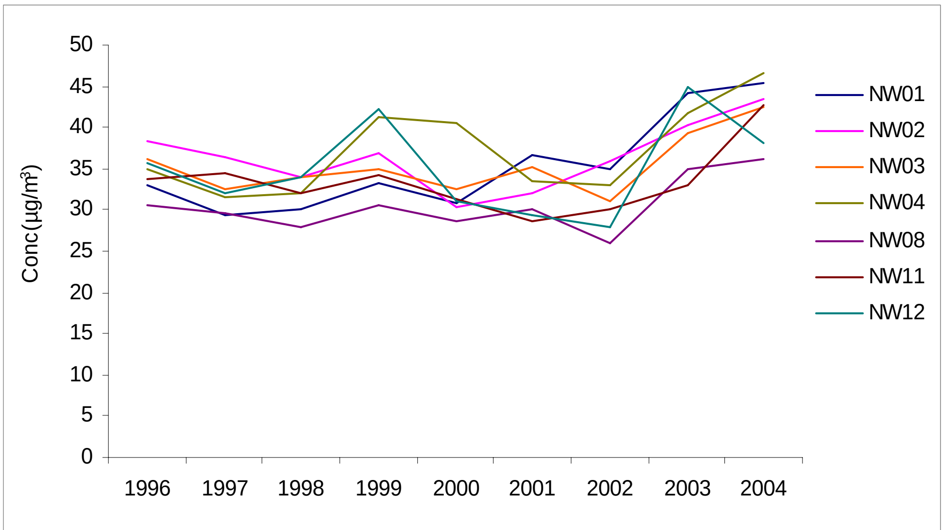
Time Series

Figure 50 Newham Background Time Series, 1996-2004



NW05 and NW07 follow similar patterns, with annual mean NO_2 concentrations progressively decreasing between 2000 and 2002. From 1999 onwards NW05 records the highest NO_2 concentrations. A noticeable increase in annual mean NO_2 concentration takes place in 2003 at sites NW05 and NW07. Sites NW06 and NW10 display a comparable trend from 1997 onwards. Annual mean concentrations at both sites fall sharply in 2000 and 2002, then increase slightly in 2003. In 2004, the annual mean concentrations decrease slightly at all background sites except NW05, where the concentration increases. Comparing the mean of the concentrations monitored at roadside sites between 2003 and 2004, there has been an increase of 2%.

Figure 51 Newham Roadside Time Series, 1996-2004

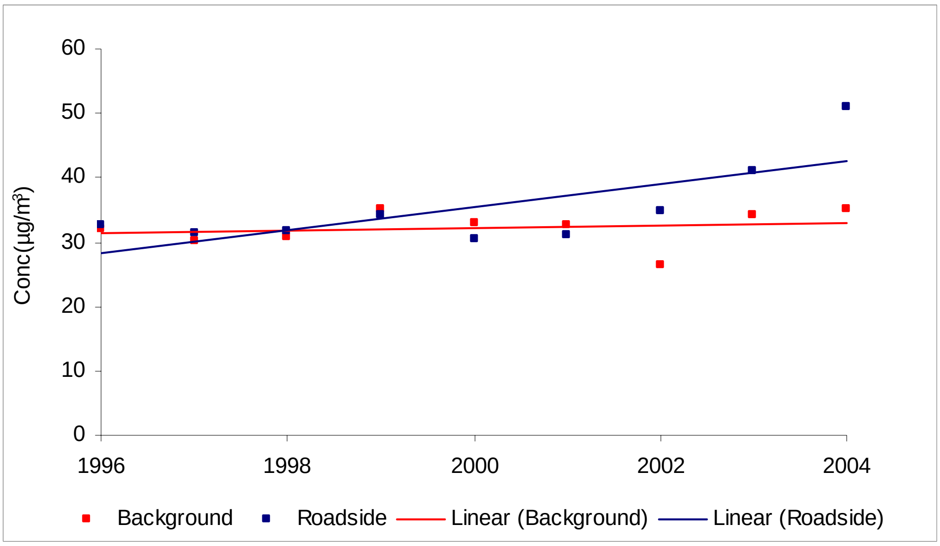


Roadside site NO_2 concentrations appear to follow one another fairly closely. NO_2 levels appear to peak in 1999 and 2003. Annual mean concentrations show a distinct increase from 2002 to 2003 at all roadside sites. Annual mean concentrations increased at all roadside locations except

NW12 where the concentration decreased. Comparing the mean of the concentrations monitored at roadside sites between 2003 and 2004, there has been an increase of 25%.

Trend Analysis

Figure 52 Newham Background and Roadside Trend Analysis, 1996-2004



Long-term background annual mean NO_2 concentrations show a decreasing trend. Between 1993 and 2004, concentrations have decreased by 1%. Long-term roadside annual mean NO_2 concentrations show a positive trend. Between 1993 and 2004, concentrations have increased by 4%.

Roadside Elevation

Table 17 Newham Elevation Above Background NO_2 Concentration µg/m³

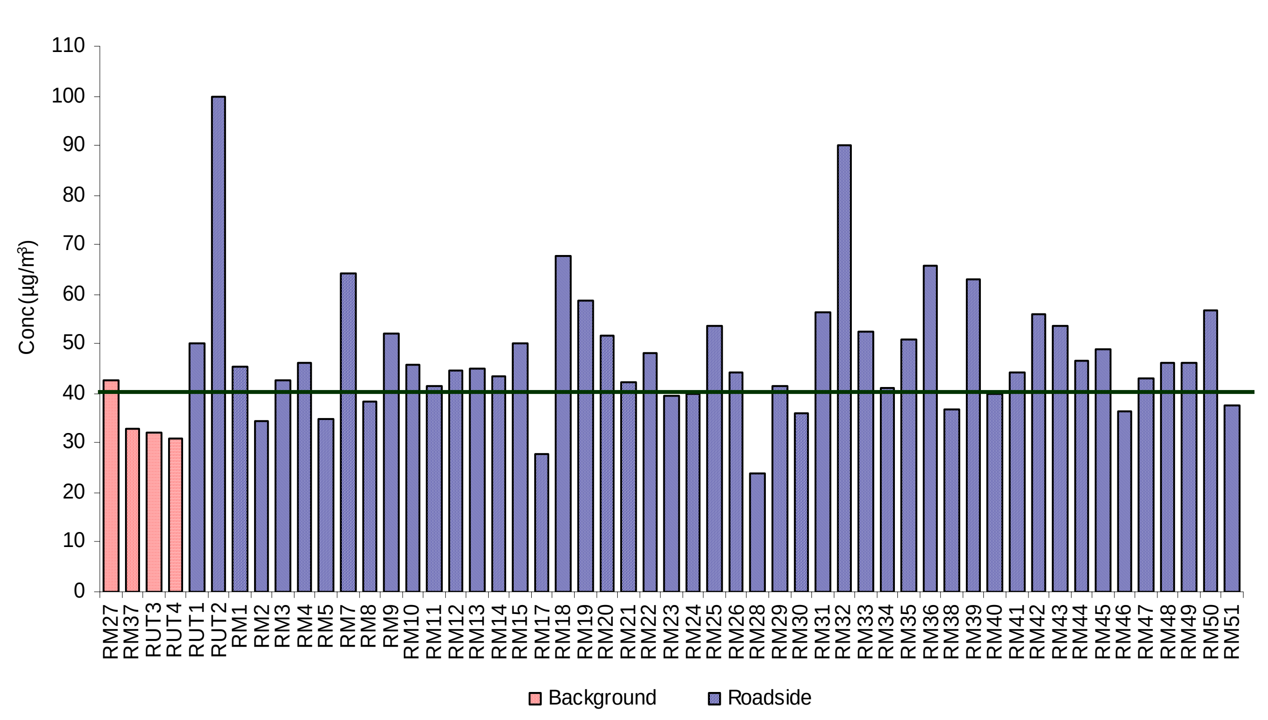
1996	1997	1998	1999	2000	2001	2002	2003	2004
0.5	1.3	0.9	-1.0	-2.3	-1.5	8.6	11.2	16.0

Between 1996 and 2001 the roadside elevation concentration is extremely low. Between 1999 and 2001 background concentrations rises above roadside concentrations. This pattern changes from 2002 onwards with the roadside elevation significantly increasing reaching its highest level in 2004.

7.14 London Borough of Richmond Upon Thames

Annual Mean Values

Figure 53 Richmond Upon Thames Background and Roadside Annual Mean NO_2 Concentrations, 2004

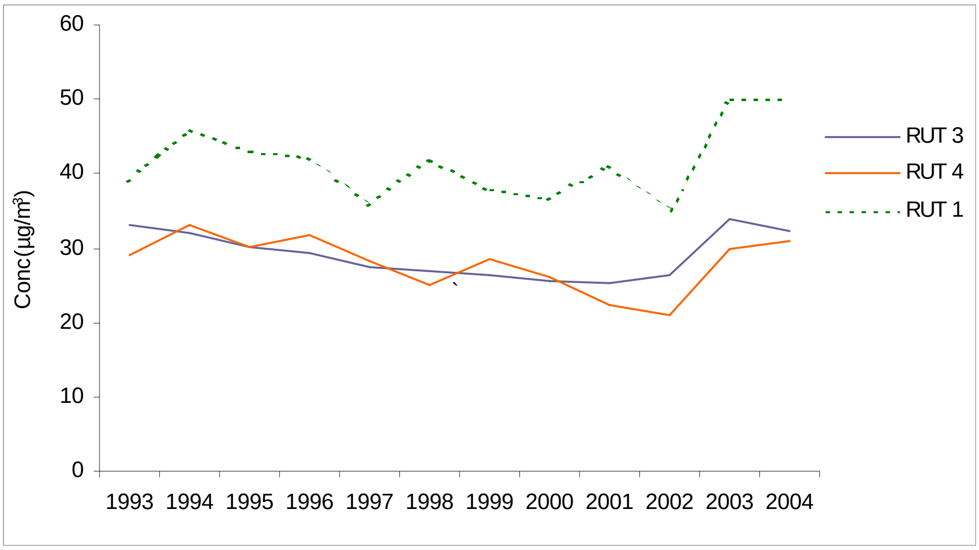


Richmond Upon Thames exposed diffusion tubes at 57 monitoring locations in 2004, with no changes in site numbers compared to the previous year. The data capture for this year was 97%.

Background concentrations vary between 27.7 and 31.0 µg/m³. Roadside concentrations range between 24.0 and 100.0 µg/m³. The 2005 air quality objective was exceeded at 42 diffusion tube sites representing 74% of monitoring locations. This represents a decrease compared to last year when 84% sites recorded over 40 µg/m³.

Time Series

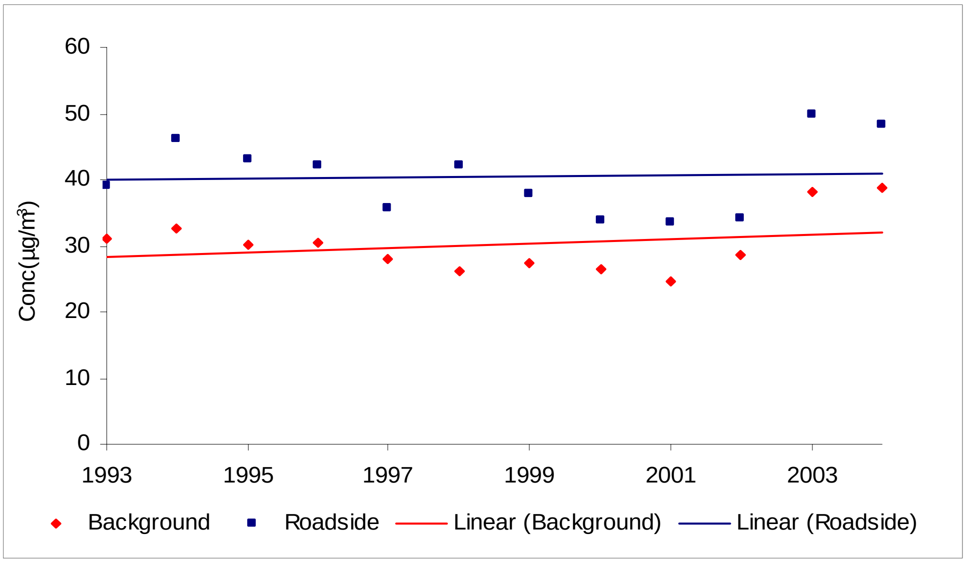
Figure 54 Richmond Upon Thames Background and Roadside Time Series, 1993-2004



Background concentrations at RUT3 show a gradual reduction from 1993 to 2002. After a minor rise in 2002 NO_2 concentrations increase sharply in 2003. RUT4 shows gradual decrease in NO_2 concentration from 1996 to 2002. This trend is interrupted in 2003 by a distinct elevation in NO_2 concentration. Annual mean NO2 concentrations at RUT1 decline from 1994 to 1996 and proceed to fluctuate slightly over the next seven years. A distinct increase in concentration takes place in 2003 with levels reaching 50.2 µg/m3. In 2004, there have been small changes in concentration at each site.

Trend Analysis

Figure 55 Richmond Upon Thames Background and Roadside Trend Analysis, 1993-2004



Long-term background annual mean NO_2 concentrations show a positive trend. Between 1993 and 2004, concentrations have increased by 1%. Long-term roadside annual mean NO_2 concentrations remain virtually constant at around 40 µg/m^3.

Roadside Elevation

Table 18 Richmond Upon Thames Elevation Above Background NO_2 Concentration µg/m³

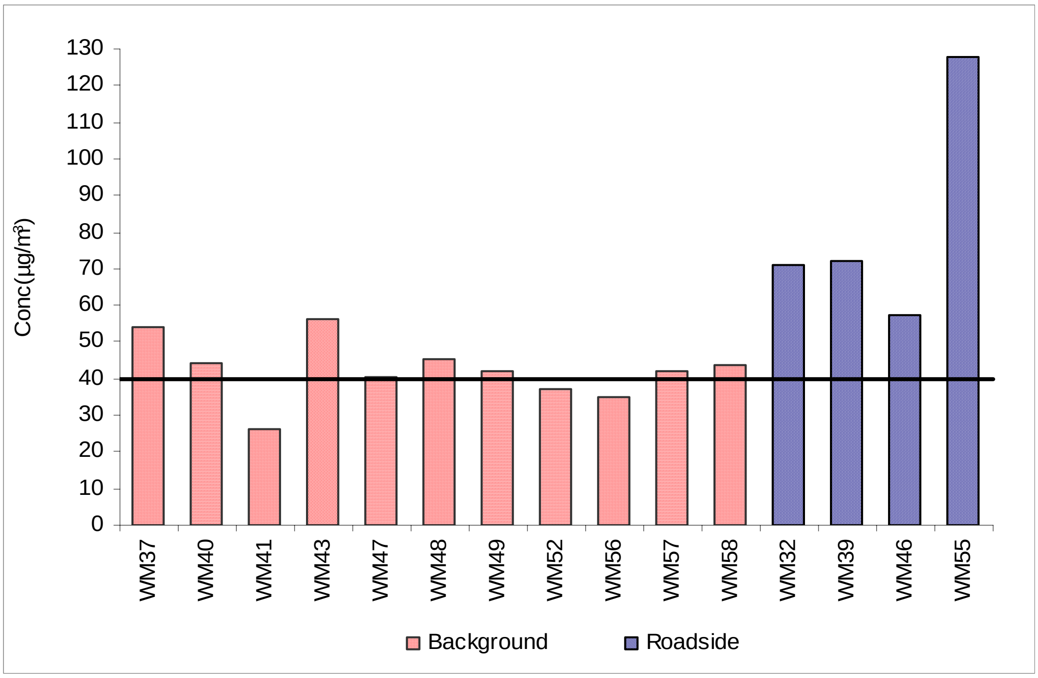
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
13.5	13.0	11.7	7.9	16.0	10.4	7.7	8.8	5.7	11.5	9.4

The roadside elevation concentration fluctuates between 1993 and 2002, showing a sharp peak in 1998 at 16 µg/m³ then falling sharply over the next four years. In 2003 there is an approximate two-fold increase in the NO_2 elevation above background concentration. This however decreases by 3µg/m³ in 2004.

7.15 London Borough of Westminster

Annual Mean Values

Figure 56 Westminster Background and Roadside Annual Mean NO_2 Concentrations, 2004

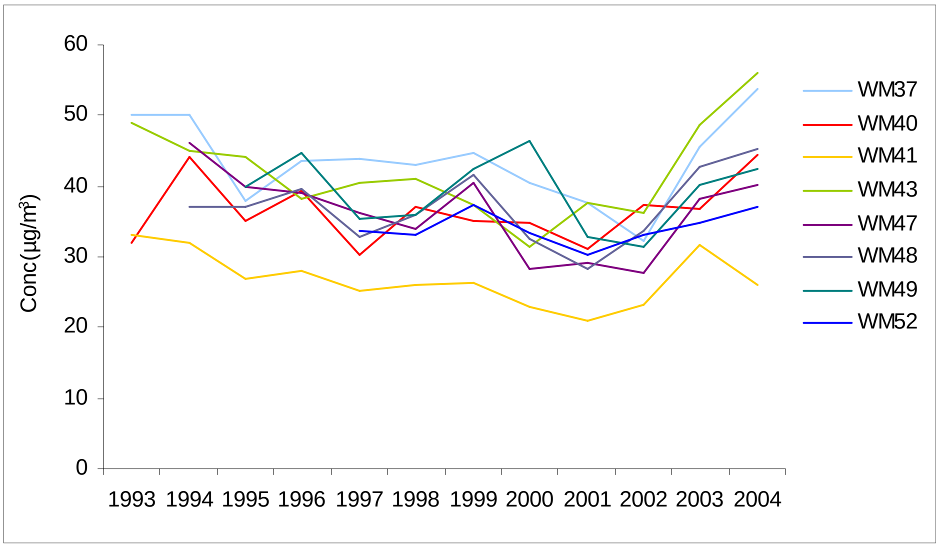


Westminster exposed diffusion tubes at 19 monitoring locations in 2004, with no revision in site numbers compared to the previous year. The data capture for this year was 87%. %. The annual mean NO_2 concentrations for WM36, WM53 and WM 54 have not been reported due to the low data capture for these locations.

Background concentrations vary between 26.0 and 56.2 µg/m^3. Roadside concentrations range between 57.3 and 128.0 µg/m^3. The 2005 air quality objective was exceeded at twelve monitoring sites representing 80% of the total number of sites. This is an increase compared to last year when 60% of the sites recorded over 40 µg/m^3.

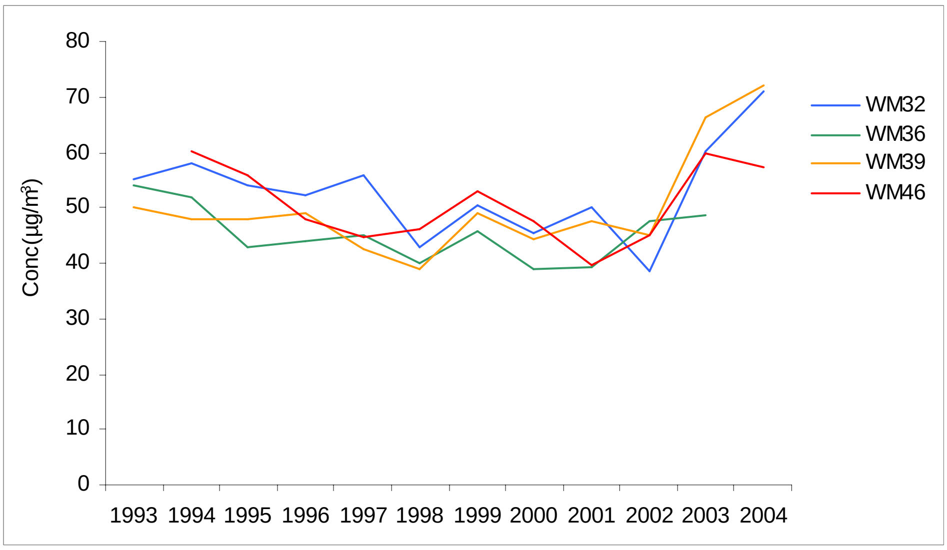
Time Series

Figure 57 Westminster Background Time Series, 1993-2004



WM41 records the lowest annual mean NO_2 concentration over the eleven-year monitoring period. The NO_2 concentration at this site remains fairly uniform between 1996 and 1999. Over the next two years concentrations decrease but start to rise from 2001 onwards. A fluctuation in NO_2 concentration can be seen at the other background sites. All background locations, with the exception of WM40, experience a noticeable increase in annual mean NO_2 concentration in 2003. In 2004, concentrations continue to increase at all sites except WM41. Comparing the mean of the concentrations monitored at background sites between 2003 and 2004, there has been an increase of 7%.

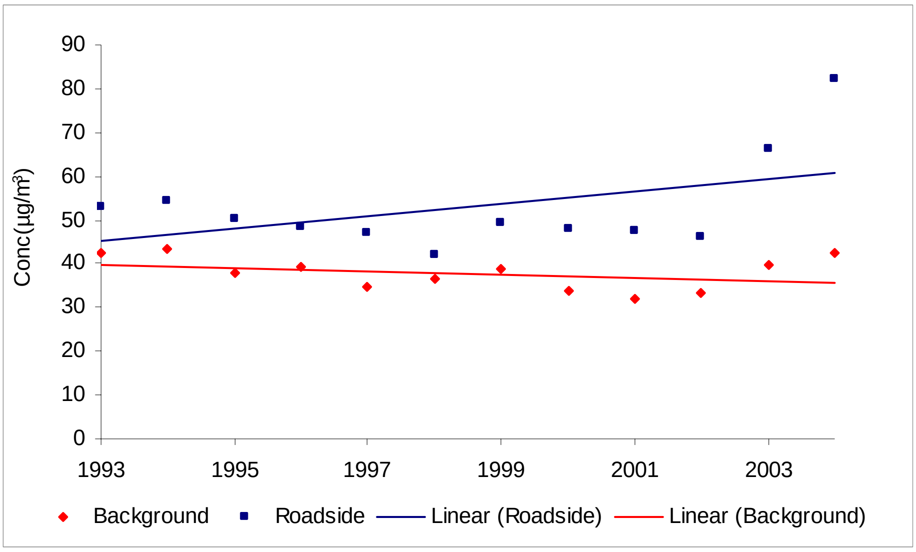
Figure 58 Westminster Roadside Time Series, 1993-2004



All roadside sites display a rolling trend in annual mean NO_2 concentration. Between 2002 and 2003 the NO_2 concentration rises by 52% at WM32, WM36 and WM39. WM36 records a minor rise in NO_2 concentration. Comparing the mean of the concentrations monitored at roadside sites between 2003 and 2004, there has been an increase of 24%.

Trend Analysis

Figure 59 Westminster Background and Roadside Trend Analysis, 1993-2004



Long-term background annual mean NO_2 concentrations show a decreasing trend. Between 1993 and 2004, concentrations have decreased by 10%. Long-term roadside annual mean NO_2 concentrations show a positive trend. Between 1993 and 2004, concentrations have decreased by 35%.

Roadside Elevation

Table 19 Westminster Elevation Above Background NO_2 Concentration µg/m³

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
11.2	12.3	9.1	12.4	5.6	10.8	14.2	15.8	12.8	26.6	39.8

The elevation above background NO_2 concentration fluctuates between 1993 and 2002 around 10µg/m^3. The lowest concentration is recorded in 1998 where a drop of just over 50% takes place. In 2003 there is a two-fold increase in roadside elevation concentration. Concentrations increase in 2004 reaching the highest level of the period.

8 DIFFUSION TUBE CO-LOCATION STUDY

This chapter examines the results of triplicate diffusion tubes that have been co-located with a continuous NOx analyser operated at eight London authorities who participate in the LWEP nitrogen dioxide monitoring network. The mean bias correction factor derived from this study is intended to aid those local authorities that do not have the facilities to allow the calculation of their own correction factor. The study additionally aims to show compliance with EU Daughter Directive data quality objectives.

8.1 Co-location monitoring sites

Thirteen monitoring sites have been selected for this co-location study all of which operate as part of the Automatic Urban and Rural Network (AURN) or London Air Quality Network (LAQN). These sites are operated on behalf of DEFRA by Central Management and Coordination Units (CMCU) which are either Kings ERG (responsible for LAQN) or Casella Stanger (responsible for AURN). The sites are summarised in Table 20. Recognised QA/QC procedures for calibration and data ratification of the continuous monitoring data are performed by NETCEN.

Triplicate diffusion tube NO_2 results associated with each monitoring site were averaged, and the annual mean NO_2 concentration compared to the equivalent concentration measured by the co-located continuous NOx analyser over the twelve-month period. Monthly continuous NO_2 data for each monitoring site has been retrieved from the Air Quality Archive.[14] Continuous analyser monthly mean results containing less than 75% data capture have been omitted to ensure a comparative and robust data set.

Table 20 Co-location monitoring sites details

Monitoring Site Name	Network	CMCU	Site Classification
Brent 1, Kingsbury	AURN	Casella Stanger	Urban Background
Bloomsbury, AURN	AURN	Casella Stanger	Urban Center
Croydon, London Road	LAQN	Kings ERG	Roadside
Greenwich 5, Trafalgar Road	LAQN	Kings ERG	Roadside
Greenwich 7, Blackheath	AURN	Casella Stanger	Roadside
Hillingdon 1, South Ruislip	LAQN	Kings ERG	Roadside
Hillingdon, AURN	AURN	Casella Stanger	Suburban
Hillingdon 2, Hospital			Roadside
Hounslow 1, Brentford	LAQN	Kings ERG	Roadside
Hounslow 2, Cranford Avenue	LAQN	Kings ERG	Suburban
Kensington 2, Cromwell Road	AURN	Casella Stanger	Roadside
Kensington 1, North Kensington			Urban Background
Richmond 2, Barnes Wetland Centre	LAQN	Kings ERG	Suburban

[14] http://www.airquality.co.uk/archive/index.php

8.2 Results

Table 21 Bias adjustment factor and %bias of LWEP Co-location Study 2004

Co-Location Site	Annual Mean NO_2 Concentration (µg/m³)		Correction Factors	
	Diffusion Tube	Continuous Monitor	Adjustment Factor (A)	% Bias (B)
Kensington 1, North Kensington	34.9	38.6	1.10	-10
Kensington 2, Cromwell Road	63.6	79.6	1.25	-20
Brent 1, Kingsbury	29.3	30.1	1.00	-1
Bloomsbury, AURN	50.5	59.0	1.17	-14
Croydon, London Road	51.5	63.7	1.24	-19
Hounslow 4, Chiswick High Road	65.0	68.9	1.06	-6
Hounslow 1, Brentford	32.3	48.6	0.91	-9.5
Hillingdon, AURN	40.3	44.5	1.10	-9
Hillingdon 1, South Ruslip	45.0	52.3	1.16	-14
Hillingdon 2, Hospital	39.5	41.1	1.04	-4
Greenwich 5, Trafalgar Road	43.0	45.4	1.06	-5
Greenwich 7, Blackheath	49.0	51.2	1.05	-4
Richmond 2, Barnes Wetland Center	33.0	39.6	1.20	-17
	Mean Bias Adjustment Factor		**1.10**	
	Overall % Bias			**-9**

The bias adjustment factor ranges between 0.91 and 1.24 for the thirteen monitoring sites participating in the co-location study. The bias adjustment factor varies at background and roadside sites. The 2004 LWEP mean bias adjustment factor is calculated at 1.10. (This is the identical value identified on the Air Quality Consultant spread sheet as the default value for Gradko diffusion tube prepared with 50% TEA with acetone method for 2004). The percentage bias figures show that diffusion tubes under-read NO_2 concentrations between 1 and 17% when compared to the reference method of the continuous NOx analyser. The overall percentage bias for 2004 is -9, representing a minor improvement in the relationship between the two monitoring techniques compared to last year.

The variation in the mean bias adjustment factors over the past four years can be seen in Table 22. As can be seen in Table 22 the mean % bias and bias adjustment factor results for 2003 and 2004 are clearly lower than those calculated in the preceding years Gradko Internationally Ltd have been contacted with regards to the recent reduction in bias adjustment factors. The laboratory has guaranteed that no modifications have taken place with any of their preparation or analytical procedures during this year.

Table 22 Mean correction factor and %bias from LWEP Studies 2001-2004.

Year	Mean Bias Adjustment Factors	Mean % Bias
2001	1.37	-26
2002	1.35	-26
2003	1.11	-10
2004	1.10	-9

When the mean bias adjustment factor of 1.10 is applied to the raw diffusion tube NO_2, the number of sites showing exceedences increases. NO_2 concentrations above 36 $\mu g/m^3$ will exceed the 2005 AQO; monitoring sites reporting NO_2 concentrations in excess of this concentration are highlighted in Appendix 1.

9 CONCLUSION

In 2004, annual mean NO_2 concentration at background monitoring sites experienced a 4% reduction compared to 2003, where as roadside sites showed a minor 1% increase. A total of 186 monitoring sites exceeded the 2005 Air Quality Objective of 40 $\mu g/m^3$, representing 62% of diffusion tube monitoring sites. The long-term trend analysis continues to indicate a general decrease in concentrations of NO_2 over time at background sites whereas roadside sites reveal an increase. A summary of the results for background and roadside sites is as follows:

- The annual mean background NO_2 concentration was 37.2 $\mu g/m^3$ with results predominantly recorded in the 30-40 $\mu g/m^3$ concentration ranges.

- 36 background sites exceeded the 2005 air quality objective, this is reduction of 25% compared to the previous year.

- The annual mean roadside NO_2 concentration was 52.4 $\mu g/m^3$ with results predominantly recorded in the 50-60 $\mu g/m^3$ concentration ranges.

- 150 roadside sites exceeded the 2005 air quality objective, this is a 11% reduction compared to the previous year.

Analysis of the roadside elevation is intended to provide an indication of the contribution of road traffic to total NO_2 concentrations. Contribution from road traffic to annual average NO_2 concentrations has increased in eleven boroughs.

The LWEP co-location study has been extended to include the results from eight local authorities where triplicate diffusion tubes are concurrently situated with an automatic analyser. The results showed that the diffusion tubes used in this air quality programme under-read by 9%. This is well within the criterion of $\pm$25% set by the NETCEN inter-comparison exercise. The mean bias adjustment factor derived from the LWEP collocation study for 2004 was calculated as 1.10. If the LWEP bias adjustment factor is applied to the raw diffusion tube results reported in this report, the number of sites showing exceedences increases at both background and roadside sites.

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Appendix 1 Monthly and Annual Mean NO_2 Concentrations All Sites, 2004

Site Code = Site exceeding 2005 AQO
Site Code = Site likely to exceed the 2005 AQO if the 1.10 bias adjustment factor is applied
Annual Mean = Value not reported data capture <9 months
* = No monitoring data

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2004
Barnet	BA70	B	45.0	43.3	*	*	*	*	22.9	27.8	20.1	33.2	38.4	34.9	33.2
	BA59	B	33.6	34.4	30.8	27.9	20.6	9.8	*	20.2	20.0	26.1	33.7	36.2	**27**
	BA73	B	35.8	37.6	39.3	*	29.8	12.0	24.6	26.7	21.2	30.4	39.6	37.5	**30**
	BA64	B	54.6	40.9	34.5	35.0	29.1	15.5	*	35.6	28.4	38.2	45.6	46.7	**37**
	BA69	B	41.9	31.4	26.8	31.2	22.5	10.4	16.1	18.8	21.2	31.4	36.6	43.8	**28**
	BA56	B	*	41.6	47.5	33.1	42.2	15.9	37.7	39.8	28.2	*	42.0	*	**36**
	BA62	B	*	36.5	35.1	30.5	*	11.3	19.7	22.9	20.7	28.9	36.9	*	**27**
	BA78	R	44.6	*	44.3	43.1	38.5	17.6	33.0	35.0	35.1	40.3	53.1	46.7	**39**
	BA51	R	43.1	41.8	39.3	46.5	37.9	*	35.1	36.4	29.0	40.3	44.4	47.0	**40**
	BA53	R	42.2	39.2	26.7	*	39.9	13.2	33.6	39.5	31.7	42.6	41.8	44.4	**36**
	BA63	R	75.6	58.2	72.6	77.4	73.9	44.2	74.3	86.8	75.6	89.4	86.4	93.3	**76**
	BA65	R	48.4	*	71.8	70.9	67.0	26.7	63.9	69.5	52.9	69.2	67.3	67.8	**61**
	BA66	R	60.3	55.1	77.1	71.0	76.3		65.1	69.5	58.8	58.2	66.7	68.2	**66**
	BA79/80/77	R	37.5	31.1	33.8	34.6	27.3	9.5	26.1	30.2	25.3	36.9	39.5	41.5	**31**
Bexley	BX31	B	37.1	38.9	19.6	19.8	26.7	22.8	25.3	25.3	26.2	32.5	34.6	38.8	**29**
	BX32	B	35.6	24.1	23.7	0.6	29.3	22.9	15.1	27.2	24.5	32.1	33.4	33.4	**25**
	BX33	B	44.1	34.0	28.1	29.1	27.9	18.5	26.8	23.2	25.1	29.2	36.6	34.5	**29**
	BX37	B	33.3	49.4	*	31.5	49.8	36.8	41.4	*	35.7	34.1	51.2	47.4	**41**
	BX34	R	40.2	57.5	47.3	43.3	49.9	50.7	43.8	46.0	46.9	47.1	57.2	*	**48**
	BX35	R	38.7	37.1		35.8	37.2	*	45.8	31.7		18.7	40.4	*	35.7
	BX36	R	*	*	25.9	*	1.7	*	29.7	*	*	*	*	*	19.1

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2004
Brent	BR31	B	61.0	67.2	67.8	49.6	67.6	53.3	62.0	*	*	63.4	41.2	65.3	**60**
	BR41	B	*	*	36.5	50.5	54.4	38.2	24.8	32.0	*	47.7	33.6	50.1	**41**
	BR51	B	32.8	35.1	33.7	32.3	29.8	22.8	24.9	26.6	20.6	*	29.3	34.8	**29**
	BR42	R	53.5	72.3	53.6	59.7	68.0	46.4	*	45.7	41.3	*	46.8	55.5	**54**
	BR43	R	35.0	35.6	33.5	32.1	29.3	24.3	66.0	69.3	55.2	29.5	39.8	40.4	**41**
	BR52	R	46.0	52.7	48.9	55.0	46.1	62.1	42.4	50.3	40.4	*	55.7	56.4	**51**
	BR53	R	*	54.0	84.2	80.8	86.8	95.6	111.4	72.4	89.3	66.6	54.0	75.6	**79**
	BR54	R	65.2	60.5	67.8	50.0	47.5	47.3	57.6	65.5	73.1	53.0	106.9	74.3	**64**
	BR55	R	57.5	87.2	66.8	66.5	89.9	85.8	85.7	81.3	50.3	67.6	55.7	79.1	**73**
	BR56	R	56.9	66.5	73.8	59.6	44.9	57.3	55.7	60.6	51.2	54.2	47.1	62.4	**58**
	BR57	R	60.4	53.9	61.9	45.4	69.4	*	58.5	51.8	52.5	59.6	64.4	66.3	**59**
	BR58	R	67.9	65.3	64.3	*	*	*	62.7	*	71.2	70.5	61.8	73.3	**67.1**
Camden	CA06	B	*0.6*[15]	42.5	55.0	38.0	39.3	33.0	33.6	30.3	51.7	*	38.6		**36**
	CA07	B	41.6	*	36.0	*	28.1	19.2	20.2	27.1	48.0	29.3	39.8	46.4	**34**
	CA25	B	36.4	49.5	54.4	*	*	*	*	*	*	*	*	*	**47**
	CA29	B	62.0	59.2	65.0	54.0	51.0	42.1	37.1	41.1	51.6	44.1	48.2	*	**50**
	CA04	R	36.5	*	53.9	75.8		76.0	72.3	81.4	*	*	62.5	70.4	**66.1**
	CA19	R	51.6	38.9	*	67.0	71.4	43.0	40.9	44.9	*	60.1	56.3	66.6	**54**
	CA28	R	66.5	78.2	36.6	64.4	75.9	72.1	54.7	66.0	34.0	56.5	69.8	37.4	**59**
	CA30	R	55.1	58.6	52.1	29.5	51.5	34.8	39.0	43.7	35.3	43.0	45.3	51.3	**45**
City of London	CL36	R	68.7	55.2	46.0	64.2	67.6	78.1	67.0	59.7	66.7	58.8	50.1	61.6	**62**
	CL38	R	44.5	70.1	57.5	*	65.3	60.3	58.7	49.4	61.1	53.5	63.8	60.4	**59**
	CL39	R	96.2	99.4	100.6	83.1	114.6	101.6	88.9	99.1	102.0	87.3	98.8	91.6	**97**
	CL41	R	45.3	56.3	54.6	45.4	49.3	47.3	47.4	56.4	50.4	54.0	55.5	61.4	**52**
	CL56	R	56.3	67.8	69.0	55.1	58.9	41.6	39.9	43.9	46.5	42.5	52.1	56.2	**52**
	CL02	B	52.0	51.1	39.1	49.5	*	44.0	44.0	43.3	52.6	46.0	52.8	59.7	**49**
	CL03	B	47.8	53.4	50.0	45.9	39.4	53.3	37.1	42.6	38.1	42.6	49.3	52.2	**46**
	CL05	B	51.8	49.4	36.8	45.4	38.3	35.8	39.0	41.4	39.7	41.5	47.6	53.4	**43**
	CL51	B	63.1	51.7	69.0	52.8	50.0	40.8	41.7	45.1	47.6	59.4	48.2	58.9	**52**
	CL55	B	45.4	40.8	43.7	41.7	36.2	30.8	34.8	38.0	31.9	39.4	36.8	44.2	**39**
	CL62	B	38.8	49.4	49.4	45.9	43.2	39.5	38.9	39.6	39.2	9.9	44.9	48.6	**41**

[15] Results in italics are considered outliers and have not been included in the calculation of the annual mean concentration.

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2004
Croydon	CY46A	B	64.8	32.2	29.3	32.1	13.1	19.0	24.1	21.8	20.1	18.9	31.3	29.9	**28**
	CY47A	B	30.7	40.8	29.8	29.8	9.3	18.1	20.5	21.3	22.3	24.9	31.5	30.6	**26**
	CY50A	B	69.4	23.6	23.0	14.2	20.9	44.9	12.1	13.6	11.2	17.1	27.3	24.5	**25**
	CY41A	R	*	61.5	46.5	45.4	24.4	46.6	50.6	54.8	48.0	50.6	58.0	54.7	**49**
	CY42A	R	*	*	100.4	50.0	22.8	39.2	39.7	38.1	38.5	35.9	46.0	44.1	**45**
	CY43A	R	55.3	61.1	51.1	50.5	30.6	45.4	11.6	9.0	39.1	40.8	53.5	52.1	**42**
	CY48A	R	57.2	62.8	63.2	64.2	30.3	58.3	49.9	68.2	68.4	59.7	64.0	63.1	**59**
	CY51A	R	13.2	42.7	40.8	43.6	0.6	13.0	27.7	36.6	38.6	38.9	45.8	44.4	**32**
	CY52A	R	*	51.7	41.3	44.5	22.0	28.6	34.8	37.9	39.1	41.3	55.0	49.9	**41**
	CY55	R	40.8	60.5	58.4	48.4	33.4	49.8	53.6	54.1	54.1	55.1	56.8	52.6	**51**
	CY56	R	43.1	*	*	36.7	17.5	*	31.3	*	29.1	29.8	35.3	37.7	**32.5**
	CY58	R	*	61.0	63.1	64.7	30.9	0.28	56.7	61.7	64.0	67.4	97.4	47.9	**61**
	CY59	R	40.3	58.1	57.4	55.1	29.4	*	50.8	45.4	*	55.2	53.0	*	**49**
	CY64	R	*	54.1	48.2	45.5	*	48.6		45.7	*	*	*	*	**48.4**
	CY65	R	52.4	60.4	43.6	46.9	26.1	52.5	50.3	43.5	*	*	62.8	*	**49**
	CY97A	R	31.9	56.3	48.8	*	*	46.3	39.7	38.8	43.9	39.9	47.7	*	**44**
	CY98A	R	*	57.2	54.6	40.9	18.7	44.1	43.3	45.7	45.7	45.3	51.8	43.3	**45**
	CY99A	R	54.6	61.6	66.0	52.8	23.4	36.8	42.4	40.2	40.8	46.6	51.8	53.8	**48**
Greenwich	GW37	B	42.2	23.0	25.8	26.6	28.2	21.2	22.7	*	27.5	25.7	36.4	30.5	**28**
	GW38	B	29.7	43.3	38.8	23.0	47.9	29.7	32.6	*	25.2	35.8	40.9	35.5	**35**
	GW39	B	*	30.7	25.3	23.7	25.7	19.4	24.2	*	22.0	23.2	33.2	33.2	**26**
	GW40	B	29.2	33.4	20.8	17.9	21.5	18.2	19.0	*	19.5	21.9	34.5	28.8	**24**
	GW23	R	30.4	68.0	49.7	51.9	57.7	32.3	39.5	33.2	34.1	40.5	50.2	43.6	**44**
	GW24	R	43.8	69.9	62.1	59.1	63.5	55.9	57.0	51.4	48.6	49.1	62.3	49.6	**56**
	GW25	R	49.7	59.7	31.0	47.2	58.2	57.5	54.2	57.9	51.6	50.6	49.3	49.9	**51**
	GW26	R	40.5	56.5	43.2	36.7	53.8	46.6	45.0	46.6	35.2	41.4	56.3	42.1	**45**
	GW27	R	33.6	66.7	54.0	39.5	58.9	51.4	62.5	58.8	57.2	55.1	66.7	54.9	**55**
	GW29	R	63.2	65.0	33.2	45.9	53.9	65.3	61.6	*	51.9	56.7	65.5	56.6	**56**
	GW32	R	*	46.8	58.3	37.7	59.8	59.7	47.8	51.1	50.3	47.4	57.4	50.8	**52**
	GW33	R	44.6	61.7	66.4	59.2	79.0	59.4	59.7	59.7	57.7	54.1	60.4	52.2	**60**
	GW34	R	58.5	60.7	50.3	32.6	49.8	51.1	58.6	48.1	46.4	46.3	54.0	57.7	**51**
	GW35	R	84.1	84.8	91.1	72.5	92.0	87.4	79.0	76.3	85.0	71.8	80.0	74.6	**82**

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Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2004
Greenwich	GW36	R	70.3	57.5	53.3	50.5	50.5	52.7	49.6	*	49.1	57.1	69.6	60.3	**56**
	GW41	R	37.2	50.1	49.9	41.3	45.7	39.3	43.7	*	44.2	43.7	51.9	45.3	**45**
	GW42	R	43.2	59.8	59.6	62.0	66.9	48.5	39.1	*	51.9	55.4	53.3	61.8	**55**
	GW43	R	55.6	50.6	60.8	62.0	59.8	56.4	65.2	*	55.3	58.4	65.7	65.2	**60**
	GW44	R	31.6	62.5	37.7	37.2	54.5	45.9	39.1	*	48.7	38.7	43.0	37.8	**43**
	GW45	R	*	*	*	*	*	*	*	47.8	41.6	*	65.3	60.8	**54**
	GW48	R	51.1	62.3	58.1	52.8	49.4	44.7	41.4	*	41.9	47.1	54.9	56.7	**51**
	GW49	R	39.4	52.6	40.3	55.1	52.8	42.6	50.8	*	41.3	49.4	50.6	48.4	**48**
	GW50	R	45.1	54.3	40.2	58.1	50.7	58.2	53.3	*	75.2	59.2	65.2	76.0	**58**
	GW51	R	49.9	49.5	34.6	33.5	35.5	44.7	47.8	*	46.3	46.0	49.6	59.9	**45**
	GW52	R	42.9	57.6	50.8	50.5	47.5	43.7	54.2	*	42.4	39.5	50.9	50.3	**48**
	GW53	R	42.2	52.0	35.9	41.3	36.6	43.9	48.4	*	41.7	42.7	56.7	58.7	**45**
	GW54	R	52.6	59.4	66.4	55.1	57.2	41.6	51.5	*	47.0	54.7	53.8	56.7	**54**
	GW55	R	47.6	56.6	57.2	53.4	65.6	40.7	48.1	*	41.4	42.5	52.2	45.3	**50**
	GW56	R	43.1	50.7	42.7	46.4	46.0	43.3	34.0	*	33.0	35.1	54.3	49.4	**43**
	GW57	R	52.3	56.8	56.8	36.9	46.0	35.9	39.4	*	26.6	34.5	43.2	47.0	**43**
	GW58	R	51.4	52.8	45.6	43.1	51.7	44.9	*	*	*	46.3	49.5	52.3	**49**
	GW101	R	55.2	57.0	69.6	54.7	79.9	66.6	61.6	*	55.3	62.4	60.7	67.4	**63**
	GW102	R	61.8	70.0	77.6	67.0	76.9	66.4	54.2	*	50.8	51.6	66.3	66.6	**64**
Hammersmith & Fulham	HM32	R	62.4	56.4	29.3	47.6	70.9	57.7	60.5	*	60.7	59.7	63.2	50.7	**56**
	HM47	R	46.3	45.3	50.0	30.4	37.6	39.9	37.5	*	27.4	44.6	49.0	51.6	**42**
	HM48	R	63.2	30.0	55.2	31.4	52.3	44.1	47.9	*	36.9	47.2	51.2	59.3	**47**
	HM50	R	68.7	39.8	60.0	32.8		63.4	76.3	*	58.8	62.0	50.2	63.4	**58**
	HM52	R	86.5	33.4	77.4	71.8	70.6	80.0	60.5	*	87.7	69.1	65.4	76.6	**71**
	HM54	R	63.8	71.8	72.1	61.3	82.2	66.8	67.8	*	58.1	57.4	67.1	69.7	**67**
	HM61	R	52.8	49.3	53.3	31.9	46.2	37.6	42.8	*	33.8	42.5	54.6	54.3	**45**
	HM62	R	44.5	41.4	43.8	29.0	35.8	30.1	30.3	*	26.3	38.0	43.4	46.3	**37**
	HM64	R	55.7	47.3	52.0	34.2	48.4	47.1	46.2	*	47.6	43.1	56.6	55.2	**48**
	HM65	R	35.9	47.3	46.9	39.5	47.8	32.0	23.9	*	30.0	41.1	46.4	45.2	**40**
	HM41	B	29.0	34.6	35.9	23.8	26.6	16.3	19.1	*	21.4	25.7	35.2	32.1	**27**
	HM44	B	45.0	50.8	40.8	28.1	37.3	25.6	30.2	*	26.7	33.3	39.4	43.2	**36**
	HM45	B	38.5	30.4	47.7	28.1	38.0	30.6	28.5	*	28.4	37.0	42.2	48.9	**36**

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2004
Hammersmith & Fulham	HM46	B	33.1	43.7	47.1	35.7	34.0	27.0	28.5	*	*	34.7	48.5	44.5	**38**
	HM51	B	48.5	52.0	37.5	23.3	55.4	41.3	46.1	*	41.1	45.0	50.8	58.4	**45**
	HM53	B	45.2	43.1	49.9	31.4	42.0	29.5	33.8	*	32.7	36.9	46.6	43.1	**39**
	HM60	B	43.5	36.7	53.3	30.0	37.0	31.5	*	*	26.3	34.7	46.0	47.0	**39**
	HM63	B	38.8	56.4	34.3	40.9	70.9	56.5	54.2	*	*	49.3	55.9	51.3	**51**
	HM66	B	44.4	44.9	44.2	44.7	37.7	24.5	25.7	*	25.7	35.5	43.6	46.1	**38**
	HM67	B	33.8	23.7	40.8	23.3	34.5	20.2	25.7	*	26.7	32.2	41.0	41.8	**31**
Harrow	HA01	R	35.8	35.1	39.8	42.2	40.9	39.4	37.0	*	29.6	36.5	39.5	48.6	**39**
	HA03	B	17.0	17.2	24.8	13.5	15.1	13.2	14.1	*	10.8	13.8	18.1	19.4	**16**
	HA04	B	28.7	32.7	30.1	28.1	24.4	20.2	20.4	*	*	28.1	33.4	30.0	**28**
	HA05	B	27.6	25.3	37.7	33.9	30.1	19.8	22.9	*	22.2	29.9	38.0	38.4	**30**
Hillingdon	HD31	B	41.6	38.6	42.9	44.1	36.2	38.2	39.6	*	38.1	43.1	36.5	44.6	**40**
	HD41	B	24.2	32.1	31.0	27.5	*	28.6	*	*	23.5	*	*	*	28
	HD48	B	37.4	29.5	38.0	31.7	31.2	26.4	29.4	*	21.7	31.6	31.5	35.6	**31**
	HD49	B	*	31.5	36.4	29.2	27.3	35.3	25.0	*	21.4	30.9	29.7	37.1	**30**
	HD52	B	54.6	38.2	42.8	44.8	41.3	37.8	34.8	*	35.4	38.7	43.5	48.3	**42**
	HD53	B	46.7	29.5	36.4	40.7	*		39.7	*	36.9	44.0	47.9	50.1	**41**
	HD54?	B	*	*	*	*	*	33.5	*	*	*	*	*	*	**33**
	HD55	B	56.6	36.8	47.6	46.9	42.4	33.0	37.0	*	30.2	*	41.9	47.3	**42**
	HD56	B	51.5	50.2	45.5	45.0	36.6	37.8	35.7	*	22.4	*	42.9	48.7	**42**
	HD57	B	76.9	41.5	42.8	31.2	40.4	31.0	7.6		26.3	35.3	41.2	46.4	**38**
	HD58	B	45.3	34.2	48.2	46.9	37.4	33.3	38.4	*	33.5	*	43.3	*	**40**
	HD59	B	46.4	44.2	43.9	37.9	35.5	27.7	27.2	*	*	40.2	40.1	41.2	**38**
	HD60	B	40.2	38.9	39.3	37.7	35.5	23.8	33.3	25.9	*	*	39.4	38.6	**35**
	HD61	B	38.5	34.8	43.0	40.1	36.1	31.8	31.1	*	28.1	36.6	41.9	38.5	**36**
	HD66	B	*	*	*	*	*	*	*	*	25.3	35.0	39.1	35.4	34
	HD62	B	*	*	*	*	*	*	*	*	42.4	*	36.6	47.7	42

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2004
Hillingdon	HD42	R	24.2	36.8	43.4	40.2	40.0	34.2	34.8	*	29.6	*	39.6	*	**36**
	HD43	R	30.2		50.9	43.0	58.0	42.9	*	*	31.9	42.4	44.4	*	**43**
	HD46	R	42.5	52.6	51.6	54.1	45.3	20.3	45.2	*	34.6	45.2	49.8	52.5	**45**
	HD47	R	*	29.5			45.8	32.9	*	*	25.9	37.7	46.5	*	36
	HD50	R	*	42.2	35.8	39.6	37.3	32.4	35.4	*	28.6	40.6	46.0	48.2	**39**
	HD51	R	45.2	42.2	35.3	42.4	33.4	35.3	29.4	*	30.9	*	35.1	42.9	**37**
	HD63	R	*	*	*	*	*	*	*	*	25.8	36.0	36.0	34.8	33
	HD64	R	*	*	*	*	*	*	*	*	26.4	32.7	37.7	37.0	33
	HD65	R	*	*	*	*	*	*	*	*	*	34.5	37.8	37.8	36
Hounslow	HS34	B	35.0	37.9	33.3	37.1	38.1	24.6	31.2	31.7	27.5	25.9	36.4	28.8	**32**
	HS35	B	36.5	37.9	31.1	38.0	28.5	24.9	26.6	30.4	23.5	29.3	36.2	33.5	**31**
	HS43	B	47.3	39.2	61.9	52.2	52.1	39.4	39.5	35.9	30.2	30.4	48.5	45.1	**43**
	HS53	B	42.6	37.3	32.1	35.7	38.2	32.4	29.4	32.3	30.2	33.0	46.1	44.7	**36**
	HS65	B	45.6	40.2	40.9	42.4	45.4	37.9	39.5	45.9	29.1	38.0	45.9	41.3	**41**
	HS66	B	33.4	44.8	39.7	35.7	39.6	33.9	34.9	*	30.8	34.2	41.0	36.3	**37**
	HSCRAN	B	37.4	30.8	38.8	31.5	31.3	23.3	27.8	28.7	27.6	33.4	37.4	38.3	**32**
	HS32	R	42.8	53.6	61.9	60.9	50.2	56.0	51.4	66.5	49.8	53.6	55.2	56.5	**55**
	HS33	R	56.1	56.3	56.0	54.1	61.8	67.3	57.8	63.2	43.6	48.7	56.5	54.2	**56**
	HS41	R	41.1	35.6	42.7	36.6	48.4	35.3	34.4	34.2	24.7	35.4	43.3	35.3	**37**
	HS42	R	40.6	38.3	31.0	40.2	38.5	20.7	35.3	144.2	29.1	40.1	42.9	40.8	**45**
	HS51	R	43.7	36.1	40.4	32.0	37.6	28.5	30.3	30.4	26.9	29.6	45.1	39.6	**35**
	HS52	R	36.2	46.5	45.7	39.2	41.2	28.8	29.4	25.3	21.8	30.5	42.7	36.7	**35**
	HS54	R	42.8	27.6	44.4	42.0	43.7	32.9	34.4	39.6	33.6	34.8	44.4	40.3	**38**
	HS55	R	49.7	52.7	42.1	45.3	57.1	34.6	45.0	40.4	36.3	44.9	46.6	50.3	**45**
	HS61	R	66.5	59.8	62.4	71.5	75.8	61.4	61.6	62.6	*	62.8	*	*	**65**
	HS62	R	52.8	47.0		60.8	54.7	43.8	43.6	47.3	39.6	38.6	50.6	52.4	**48**
	HS63	R	64.0	56.2	57.4	*	63.2	61.0	62.4	63.0	46.8	49.2	57.9	55.0	**58**
	HS64	R	46.5	37.9	42.7	34.0	44.3	31.7	33.5	37.3	29.1	32.5	49.1	42.8	**38**
	HSCHIS	R	72.2	57.6	63.5	65.5	68.9	64.8	62.5	70.9	56.4	69.6	*	64.3	**65**
	HSBREN	R	57.3	55.1	56.4	55.8	59.5	50.3	52.7	50.3	43.9	46.4	57.5	44,17	**53**

CASELLA STANGER

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2004
Kensington & Chelsea	KC32	B	40.3	32.7	37.4	35.7	30.8	25.4	25.3	31.6	22.3	31.9	38.6	42.2	**33**
	KC34	B	51.9	47.1	*	57.3	47.6	37.7	39.2	44.6	38.5	41.7	50.2	50.2	**46**
	KC39	B	33.5	47.9	32.0	41.5	45.8	28.2	33.0	35.0	28.3	34.6	43.4	38.9	**37**
	KC40	B	43.6	48.3	48.7	36.8	36.1	38.9	44.6	47.8	47.3	48.1	41.0	45.9	**44**
	KC41	B	46.1	45.3	57.5	*	41.6	25.0	33.1	31.4	34.6	35.7	48.3	43.1	**40**
	KC42	B	66.0	38.4	58.1	27.4	41.2	35.9	41.9	40.9	45.8	41.6	53.5	56.1	**46**
	KC43	B	45.6	48.5	42.9	43.8	39.1	24.5	32.1	28.3	29.4	32.6	38.9	45.1	**38**
	KC44	B	53.8	60.4	51.6	34.4	42.6	38.6	39.1	39.4	35.1	36.7	50.2	44.6	**44**
	KC47	B	39.6	42.1	35.2	29.3	36.1	25.7	29.4	33.1	30.5	37.0	41.9	39.2	**35**
	KC51	B	46.9	43.1	40.8	36.7	38.9	27.5	27.6	28.6	32.4	31.0	44.9	41.7	**37**
	KC53	B	46.4	33.3	43.1	32.5	52.6	49.2	40.9	44.2	37.4	45.0	50.4	47.9	**44**
	KC55	B	14.5	48.2	42.6	*	44.3	33.1	*	46.2	62.5	40.4	55.1	51.9	**44**
	KC56	B	31.4	36.7	83.3	75.2	78.1	73.3	70.7	65.6	87.1	63.4	72.4	69.4	**67**
	KC31	R	58.7	49.9	58.7	36.6	71.9	49.9	63.4	54.3	50.8	55.5	58.4	51.2	**55**
	KC33	R	79.5	74.5	69.1	82.3	78.0	71.5	*	81.6	82.7	75.0	73.9	73.4	**77**
	KC35	R	64.5	46.6	46.5	46.0	51.8	65.9	60.7	70.2	50.1	52.2	50.5	51.7	**55**
	KC38	R	*	88.8	80.1	87.0	94.8	95.6	93.3	97.6	68.3	83.8	80.1	72.8	**86**
	KC45	R	37.8	43.5	28.8	45.7	44.6	39.3	39.7	46.8	35.7	*	*	46.6	**41**
	KC46	R	55.8	49.8	51.8	21.5	48.9	41.2	43.9	53.4	47.4	*	47.5	40.8	**46**
	KC48	R	93.6	55.2	68.3	72.6	74.3	68.1	73.6	73.9	59.4	65.5	74.4	63.9	**70**
	KC49	R	67.4	71.3	68.8	59.5	81.3	65.6	60.7	63.2	61.7	60.2	75.3	57.7	**66**
	KC50	R	45.9	51.7	57.5	52.3	56.1	44.5	57.1	47.3	57.0	52.5	58.1	56.7	**53**
	KC52	R	64.4	60.4	51.7	46.4	69.1	52.9	58.9	51.1	53.6	55.3	61.7	56.9	**57**
	KC54	R	62.0	60.1	66.1	83.8	67.1	63.4	64.5	65.9	51.9	50.5	60.5	66.8	**64**
	KC57	R	29.5	52.3	49.3	39.1	47.1	50.3	49.2	41.6	38.4	48.7	55.6	43.0	**45**
	KC58	R	21.0	74.6	64.4	64.0	70.1	57.6	64.5	63.3	49.8	43.4	72.7	61.6	**59**
	KC59	R	43.4	80.3	73.6	56.7	81.3	89.0	77.8	97.1	82.3	53.1	92.7	91.9	**77**
	KC60	R	77.4	64.2	74.8	55.1	70.4	60.9	63.9	64.4	46.9	55.0	61.8	59.1	**63**
	KC61	R	58.4	67.1	57.5	47.7	61.8	59.7	56.6	48.1	45.3	50.3	61.5	58.6	**56**

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2004
Newham	NH5	B	44.8	48.8	50.1	42.0	53.1	36.6	45.6	41.3	42.3	36.4	56.1	34.1	44
	NH6	B	32.0	32.1	31.0	29.4	25.8	21.5	23.8	26.7	24.9	26.7	34.6	37.1	29
	NH7	B	35.0	40.8	39.3	37.4	31.7	28.3	34.6	33.9	30.1	28.7	39.5	40.3	35
	NH10	B	35.9	32.3	37.3	14.7	34.9	32.7	21.0	31.5	*	34.8	*	38.0	31
	NH1	R	58.9	42.5	46.6	40.9	40.8	43.8	46.2	43.6	40.5	43.3	52.3	45.8	45
	NH2	R	48.5	45.1	44.9	45.4	40.5	37.0	37.0	47.0	42.7	44.0	40.8	48.2	43
	NH3	R	51.5	47.6	47.3	26.3	42.6	36.6	36.6	39.0	40.0	43.3	49.1	51.2	43
	NH4	R	62.5	50.7	49.9	29.4	50.2	39.2	44.9	44.2	45.3	*	50.3	45.6	47
	NH8	R	40.5	46.4	38.8	37.4	43.7	26.2	34.0	35.1	33.1	38.3	27.1	34.1	36
	NH11	R	*	41.4	39.6	33.7	37.8	32.6	35.9	42.9	47.0	46.0	64.4	48.4	43
	NH12	R	*	*0.62*	*	*2.30*	31.5	45.6	29.6	37.1	30.8	34.2	50.4	45.1	38
	NH13	R	*	57.7	59.9	50.0	61.0	70.2	68.8	63.9	64.1	66.1	70.3	47.9	62
	NH14	R	69.2	*	77.8	*	82.6	80.0	62.6	91.4	82.0	71.0	78.2	*	77
	NH15	R	65.1	55.7	58.2	40.0	55.1	49.3	43.8	*	*	50.4	64.1	58.3	54
	NH16	R	65.1	70.7	48.0	63.1	53.2	61.4	44.0	71.5	51.5	*	*	64.6	59
	NH17	R	59.0	60.0	46.6	57.9	44.8	45.2	41.4	52.2	*	43.7	53.2	*	50
	NH18	R	49.5	58.2	47.1	45.0	48.0	40.0	43.3	*	48.0	*	52.7	50.5	48
	NH19	R	76.4	50.9	48.2	67.1	54.4	*	*	*	*	*	63.6	63.3	*60*
	NH20	R	75.8	65.2	72.4	50.6	78.1	87.9	85.2	71.4	82.1	70.0	73.4	63.9	73
	NH21	R	43.8	57.8		53.7	55.9	41.6	42.9	37.1	37.5	44.3	53.6	49.4	47
Richmond	RM01	R	52.2	48.0	45.9	45.9	45.5	43.2	44.3	41.4	32.6	44.2	56.6	46.8	46
	RM02	R	32.9	45.6	38.6	38.6	29.0	29.3	22.2	35.3	27.3	30.8	47.9	37.0	35
	RM03	R	37.4	55.1	34.4	34.4	50.6	40.7	36.6	45.0	36.2	43.1	51.1	49.6	43
	RM04	R	40.7	53.3	50.9	50.9	54.9	37.6	36.6	45.3	35.7	44.1	57.7	47.9	46
	RM05	R	44.0	45.1	34.4	34.4	24.8	28.5	26.0	34.6	27.2	35.9	45.5	37.3	35
	RM06	B	40.2	53.4	43.6	43.6	70.0	45.7	46.6	52.8	40.2	44.7	44.4	51.3	48
	RM07	R	55.0	69.4	82.6	82.6	83.7	57.8	50.9	58.3	54.6	60.0	70.6	46.2	64
	RM08	R	44.8	49.8	33.5	33.5	44.2	31.7	28.8	34.6	31.3	37.6	47.8	42.4	38
	RM09	R	54.6	56.3	64.3	64.3	56.6	39.5	43.2	46.6	42.0	49.6	59.5	50.3	52
	RM10	B	56.8	51.0	52.3	52.3	40.4	35.9	37.7	*	39.8	42.1	47.0	47.0	46
	RM11	R	45.2	45.6	45.9	45.9	39.1	34.5	26.0	35.7	32.6	43.9	54.2	47.7	41

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2004
Richmond	RM12	R	30.9	53.3	47.3	47.3	53.3	38.3	30.5	48.4	36.2	49.3	55.0	45.6	**45**
	RM13	R	54.2	44.4	55.1	55.1	42.6	35.1	26.0	45.5	36.2	47.4	55.8	41.1	**45**
	RM14	R	51.4	*	41.3	41.3	*	36.7	37.7	39.0	42.9	53.4	*	47.7	**43**
	RM15	R	57.7	56.3	55.1	55.1	50.1	40.3	38.2	47.8	43.8	46.3	60.2	49.7	**50**
	RM16	B	54.4	52.7	41.3	41.3	40.6	38.0	32.8	39.8	36.2	36.3	59.4	45.5	**43**
	RM17	R	26.7	32.8	24.3	24.3	31.1	21.7	19.9	27.3	23.7	32.1	37.8	30.2	**28**
	RM18	R	56.0	74.9	68.8	68.8	83.7	72.1	66.5	66.0	53.0	60.1	80.6	62.1	**68**
	RM19	R	53.8	56.6	68.8	68.8	61.2	58.8	50.4	55.9	44.2	55.2	64.6	65.5	**59**
	RM20	R	51.4	52.7	42.7	42.7	56.0	57.0	44.3	56.9	42.4	*	64.5	59.2	**52**
	RM21	R	42.7	44.3	32.1	32.1	48.2	43.3	38.8	46.1	34.4	41.9	51.1	50.1	**42**
	RM22	R	43.9	52.7	41.3	41.3	47.0	33.2	42.7	50.6	47.6	56.6	59.0	61.5	**48**
	RM23	R	43.0	43.4	35.1	35.1	46.4	32.3	*	40.2	36.9	36.2	46.9	39.2	**40**
	RM24	R	43.2	41.6	36.3	36.3	44.4	34.2	*	37.7	33.1	39.2	48.3	47.0	**40**
	RM25	R	48.6	44.4	64.3	64.3	66.3	47.3	33.8	58.5	39.8	57.0	62.2	57.0	**54**
	RM26	R	56.8	61.6	39.0	39.0	35.1	39.2	36.0	49.0	33.1	40.3	57.0	46.5	**44**
	RM27	B	46.3	45.5	42.2	42.2	48.1	37.9	40.5	43.0	34.8	43.5	45.1	41.4	**43**
	RM28	R	41.8	26.1	21.1	21.1	26.3	14.9	12.7	18.8	18.8	26.0	29.9	30.9	**24**
	RM29	B	43.6	45.5	36.7	36.7	47.2	40.4	35.5	41.9	37.1	44.6	46.4	*	**41**
	RM30	R	34.8	40.5	41.3	41.3	47.8	25.7	28.3	27.6	28.1	36.9	42.9	*	**36**
	RM31	R	57.3	56.3	55.5	55.5	64.6	50.0	50.4	54.7	50.7	61.9	69.5	52.0	**57**
	RM32	R	84.5	82.4	101.0	101.0	94.2	69.7	77.6	110.5	78.0	103.5	86.3	94.0	**90**
	RM33	R	51.4	62.2	57.8	57.8	77.7	16.4	33.8	57.8	48.3	49.3	64.2	*	**52**
	RM34	R	41.9	48.0	39.9	39.9	43.7	58.4	28.8	35.8	30.8	36.6	47.3	42.3	**41**
	RM35	R	64.4	61.7	44.5	44.5	54.2	35.3	40.5	59.9	48.8	49.4	59.1	50.0	**51**
	RM36	B	63.6	69.3	55.1	55.1	85.0	43.3	70.9	91.6	54.4	57.0	77.2	65.4	**66**
	RM37	R	30.5	32.5	26.4	26.4	26.9	72.9	*	25.1	19.0	29.7	38.1	35.4	**33**
	RM38	R	37.2	42.7	40.9	40.9	40.6	32.5	24.9	29.7	33.0	34.9	45.9	38.8	**37**
	RM39	R	56.2	64.0	60.8	60.8	71.2	70.3	68.7	61.5	56.7	54.3	74.3	59.1	**63**
	RM40	R	39.5	36.1	45.9	45.9	42.2	34.4	28.8	30.3	35.7	41.1	50.5	48.7	**40**
	RM41	R	48.8	*	39.5	39.5	49.6	48.2	42.1	40.3	35.7	45.6	50.0	47.7	**44**
	RM42	R	40.7	61.8	68.8	68.8	76.2	38.8	43.2	62.4	44.2	66.6	55.8	46.6	**56**
	RM43	R	45.3	44.5	54.6	54.6	76.9	56.6	46.5	54.9	37.1	58.8	65.1	50.0	**54**

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2004
Richmond	RM44	R	44.4	46.0	34.0	34.0	60.9	55.0	39.9	41.2	38.0	47.4	59.6	59.1	**47**
	RM45	R	*	52.2	52.8	52.8	55.3	42.6	38.8	50.5	42.0	47.3	54.7	48.4	**49**
	RM46	R	44.3	53.4	37.2	37.2	47.0	28.9	21.6	23.8	29.5	38.1	41.4	36.5	**37**
	RM47	R	54.6	56.4	44.1	44.1	49.9	20.7	35.4	45.1	33.5	39.4	54.6	40.4	**43**
	RM48	R	44.9	52.7	43.1	43.1	52.6	42.6	41.6	41.6	41.6	48.3	54.8	48.0	**46**
	RM49	R	41.7	57.1	50.0	50.0	42.2	45.6	34.9	49.8	28.1	46.7	58.9	47.0	**46**
	RM50	R	56.1	62.1	42.7	42.7	77.2	60.4	61.0	*	46.1	52.6	66.3	56.3	**57**
	RM51	R	34.4	48.8	34.4	34.4	43.7	28.8	27.7	39.3	28.6	38.7	45.7	45.7	**38**
	RM52	R	53.9	55.4	41.3	41.3	64.2	62.1	49.3	56.9	*	54.4	70.2	56.4	**55**
	RM53	R	43.9	39.8	23.1	23.1	36.9	23.4	24.9	30.8	24.3	34.0	40.2	34.8	**32**
	RUT01	R	41.8	53.5	45.4	45.4	52.3	48.9	44.3	55.2	44.3	52.0	60.9	57.7	**50**
	RUT02	R	84.9	94.1	*152.1*	*	*154.6*	59.5	109.7	136.1	87.4	106.9	129.7	91.3	**100**
	RUT03	B	40.6	38.2	26.6	26.6	33.2	27.0	24.4	*	24.1	28.6	44.0	40.8	**32**
	RUT04	B	38.9	30.8	27.1	27.1	29.1	40.6	23.8	31.2	24.1	31.2	38.0	30.2	**31**
Westminster	WM37	B	37.3	*	64.8	66.4	*	48.0	*	51.3	60.3	55.4	45.7	55.8	**54**
	WM40	B	49.9	56.2	48.8	46.6	38.6	*	30.4	31.2	32.3	38.6	49.6	67.1	**44**
	WM41	B	21.3	38.7	42.2	*	30.6	23.9	2.8	24.7	23.0	30.2	1.7	47.0	**26**
	WM43	B	53.0	53.0	50.3	*153.2*	48.1	37.5	45.4	44.8	53.5	44.2	51.9	39.2	**47**
	WM47	B	40.8	47.6	41.0	52.2	38.7	34.5	23.9	35.7	31.2	41.5	*	54.6	**40**
	WM48	B	51.2	42.4	35.5	83.4	39.6	35.4	38.2	39.2	45.3	39.6	49.0	46.1	**45**
	WM49	B	50.6	52.7	17.2	*	43.2	41.9	43.7	*	36.5	*	41.2	54.0	**42**
	WM52	B	49.3	42.4	31.1	29.0	34.1	33.9	23.9	33.1	29.6	40.2	50.1	48.4	**37**
	WM53	B	40.2	29.2	39.1	30.3	41.9	34.4	39.1	38.2	*	*	*	*	***37***
	WM54	B	34.6	59.2	*	32.3	39.5	26.7	*	*	*	*	*	*	***38***
	WM56	B	30.4	45.6	25.1	95.6	30.5	18.8	25.0	25.2	19.7	31.5	39.8	*	**35**
	WM57	B	66.2	67.9	26.0	32.7	52.1	28.6	34.3	32.8	29.9	38.7	51.4	41.3	**42**
	WM58	B	37.4	46.8	47.7	50.7	45.4	31.8	43.3	47.8	40.0	41.3	44.8	50.0	**44**
	WM32	R	90.7	82.7	66.0	20.7	83.6	69.1	78.4	80.2	66.9	*	73.2	*	**71**
	WM36	R	60.9	59.6	52.7	48.6	*	*	*	*	*	*	*	*	***55***
	WM39	R	54.4	72.1	52.7	58.9	95.3	88.5	76.7	81.4	75.1	61.4	77.3	*	**72**
	WM46	R	68.7	59.6	65.4	21.6	59.5	54.2	64.2	66.0	77.5	51.9	53.9	45.5	**57**
	WM55	R	84.7	109.1	63.3	*30.9*	149.5	53.27	179.7	*226.9*	154.2	162.0	109.8	136.7	**128**

Appendix 2 Co-location Sites Triplicate Diffusion Tube Monthly Mean NO_2 Concentrations 2004

Co-Location Site	Diffusion Tube Code	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Conc. (µg/m3)
Kensington 1, North Kensington	KC47	42.0	43.1	37.4	25.7	36.8	52.4	29.4	33.4	32.1	37.8	41.2	37.5	34.9
Kensington 2, Cromwell Road	KC54	74.8	71.2	66.1	79.9	67.2	65.1	66.0	69.4	70.9	64.4	63.9	68.7	63.6
Brent 1, Kingsbury	BR51	35.7	34.1	33.7	30.0	31.4	24.0	24.9	26.6	21.0	*	30.8	35.6	29.8
Bloomsbury, AURN	CA29	52.2	62.0	58.2	56.3	50.4	43.2	39.3	40.7	41.3	41.5	50.8	50.1	50.5
Croydon, London Road	CY55A	40.8	59.5	56.2	35.7	34.8	49.8	56.0	56.1	56.3	56.4	59.5	59.5	51.5
Hounslow 4, Chiswick High Road	HSCHIS	71.7	59.7	67.4	60.3	69.4	64.4	62.5	69.7	59.4	70.2	*	67.5	65.0
Hounslow 1, Brentford	HCBREN	56.5	53.0	53.3	57.6	60.1	49.5	56.0	48.1	47.3	44.2	58.2	44.2	53.2
Hillingdon, AURN	HD31	41.6	38.2	46.0	48.0	36.6	37.3	38.2	51.4	39.9	44.1	35.5	44.6	40.3
Hillingdon 1, South Ruslip	HD46	45.6	48.9	56.0	52.3	42.0	42.9	43.3	*	35.2	46.7	49.4	53.0	45.0
Hillingdon 2, Hospital	HD50	*	42.2	35.9	40.5	36.2	35.4	39.7	*	28.7	41.5	47.4	47.6	39.5
Greenwich 5, Trafalgar Road	GW57	48.6	54.2	54.8	43.7	52.0	42.8	39.4	*	33.2	34.2	45.7	45.7	43.0
Greenwich 7, Blackheath	GW58	54.2	55.6	42.9	41.6	45.0	36.8	*	*	*	45.1	51.7	54.3	49.0
Richmond 2, Barnes Wetland Center	RM37	27.4	32.9	23.3	31.2	26.2	16.1	25.4	23.4	18.7	28.3	39.1	35.5	33.0

* No data recorded for this month

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Appendix 3 Co-location Sites Triplicate Automatic Analyser Monthly NO_2 Concentrations 2004

Co-Location Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Conc. (µg/m³)
Kensington 1, North Kensington	42.1	44.1	44.6	41.1	34.6	23.9	26.7	**46.7**	35.0	36.9	49.6	45.9	38.6
Kensington 2, Cromwell Road	83.3	76.7	85.4	89.1	72.5	70.4	71.0	71.1	79.5	76.4	85.4	94.2	79.6
Brent 1, Kingsbury	34.8	35.4	37.4	33.8	22.9	17.1	17.8	**17.1**	24.3	30.0	21.1	56.2	30.1
Bloomsbury, AURN	64.8	63.9	66.6	64.7	60.7	46.5	47.0	**40.0**	48.8	52.1	63.9	69.4	59.0
Croydon, London Road	56.1	71.9	72.5	76.4	70.8	48.9	47.7	53.8	56.9	60.6	74.7	73.9	63.7
Hounslow 4, Chiswick High Road	66.9	70.0	82.0	80.4	67.6	60.3	64.4	61.2	56.4	68.1	71.7	77.9	68.9
Hounslow 1, Brentford	52.5	56.0	57.6	54.8	32.1	19.7	37.8	**46.3**	**30.9**	32.8	56.4	63.8	46.4
Hillingdon, AURN	45.9	40.2	50.2	51.7	38.7	38.2	40.3	**39.4**	46.4	44.5	45.3	48.2	44.5
Hillingdon 1, South Ruslip	80.5	77.9	50.4	47.9	40.4	**32.2**	**48.3**	**53.7**	25.2	44.0	49.8	54.3	52.3
Hillingdon 2, Hospital	52.4	63.2	45.8	47.2	34.5	30.1	27.5	31.1	35.1	30.7	49.8	45.9	41.1
Greenwich 5, Trafalgar Road	54.1	53.3	53.1	56.5	54.5	38.1	37.1	34.6	35.9	33.2	49.2	45.5	45.4
Greenwich 7, Blackheath	55.3	54.1	**59.8**	56.5	80.7	**43.7**	**39.0**	46.3	41.4	43.4	58.1	55.3	51.2
Richmond 2, Barnes Wetland Center	65.2	59.5	34.7	46.0	37.9	24.2	27.6	24.1	34.7	37.4	41.7	42.7	39.6

Figures in bold where not included in calculation of annual mean due to less than 75% data capture