REVIEW AND ASSESSMENT OF AIR QUALITY IN THE ROYAL BOROUGH OF KENSINGTON AND CHELSEA

STAGE FOUR

Prepared by
The Directorate of Environmental Health's
Environmental Quality Unit as part of the Council's
Obligations under the National Air Quality Strategy.

August 2003

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Annexes (supplied on request)

EXECUTIVE SUMMARY

- ***Purpose of the stage four Review and Assessment of air quality in the National Air Quality Strategy process***
- ***Significance of monitoring trends and revised modelling predictions***
- ***Apportioning pollutants to sources of emissions***
- ***Contribution to air quality management planning***

National monitoring results show that air quality has been improving over the last seven years. However in London, especially central London, levels of two pollutants, **fine particles (PM_{10}) and nitrogen dioxide (NO_2), remain above Government standards. Significant reductions to NO_2 will almost certainly not meet the 2005 targets.**

The National Air Quality Strategy (NAQS) introduced in 1997, as well as setting standards and objectives, gave local authorities responsibility for periodically reviewing local air quality. The Royal Borough's 'Review and Assessment of Air Quality in the Royal Borough of Kensington and Chelsea - stages two and three' published in December 2000, concluded that the Council should declare an Air Quality Management Area for the whole Borough (Appendix A5). This largely relied on computer generated predictions showing that PM_{10} and NO_2 were unlikely to meet the objectives set according to health based standards.

This fourth Stage report has re-visited the third stage work. Its purpose has been to check the results of our previous reports in the light of the latest air monitoring results. The Review also takes into account the revised information gathered on road traffic emissions, **which essentially acknowledges that the exhaust emissions of newer vehicles are not as clean as previously claimed**. This did not surprise us as we had felt for some time that urban driving conditions would not allow exhaust treatment, i.e. catalytic converters, to perform at optimum levels. The new emission factors incorporated in the February 2002 edition of the London Atmospheric Emissions Inventory have been used to re-model the earlier predictions and incorporate a more modest and realistic assumption for the reduction in the oxides of nitrogen (NO_x) emissions and PM_{10} emission levels, due to improved engine and fuel technology.

After publishing our stage three report, we discovered a miscalculation in the data, which had led to an over-prediction of pollution concentrations throughout the Borough. Correcting the miscalculation and re-modelling confirmed that the areas likely to exceed the objectives should have been appreciably smaller, but were still significant. Since then the predictions have been readjusted - by including the data in the February 2002 London Atmospheric Emissions Inventory.

The results of the latest re-modelling reveal a markedly worse picture of NO_2 pollution in 2005 than in the third stage review (see maps 1 and 2 at the end of this section). **The latest map not only shows the whole Borough exceeding the annual average objective, without any exceptions, (compared with the previous map showing the majority of the Borough exceeding) but also a uniform pattern of higher concentrations superimposed over the major road network.** For the first time, the map of hourly average NO_2 concentrations predicts that parts of Knightsbridge towards Hyde Park Corner and the eastern end of Kensington High

Street are likely to exceed the objective. A degree of caution, however, should always be applied to the mapped information, since modelling predictions cannot be absolutely precise.

The re-modelled results are closer in relation to the record of our monitoring results, which show a trend **for roadside sites of annual average nitrogen dioxide concentrations currently at a level above 80 micrograms per cubic metre (µg/m^3) and decreasing slightly to 80µg/m^3 or just below in 2005, as compared with the national objective of 40µg/m^3**.

In contrast the re-modelled predictions for PM_{10} show a less severe picture. For the Borough the more critical 24-hour average objective (50µg/m^3 not to be exceeded more than 35 times) has been predicted to only exceed at a number of isolated locations along the A4, Kensington High Street, Notting Hill Gate and in a few other places (see map 4 at the end of this section). Following 2004, the longer-term outlook for PM_{10} requires London's local authorities to contend with more stringent objectives (24 hr average not to be exceeded more than 10 times) to be achieved by 2010.

It is important that we pay close attention to other sources of pollution aside from road traffic. A recent study of source apportionment in the Borough confirms that nitrogen oxide emissions from burning gas for domestic and commercial heating are perhaps as important as those from vehicles. We also believe that emissions from diesel locomotives on the railways that run through the Borough may be more significant than previously estimated.

The stage four results not only provide an updated "state of local air quality report", but also inform the Council's Air Quality Action Plan. This is the follow-up to the Air Quality Management Area declaration, and identifies a number of specific actions to improve air quality, in conjunction with the Mayor of London's Air Quality Strategy (published in September 2002). The most significant conclusions with regard to managing air quality are: -

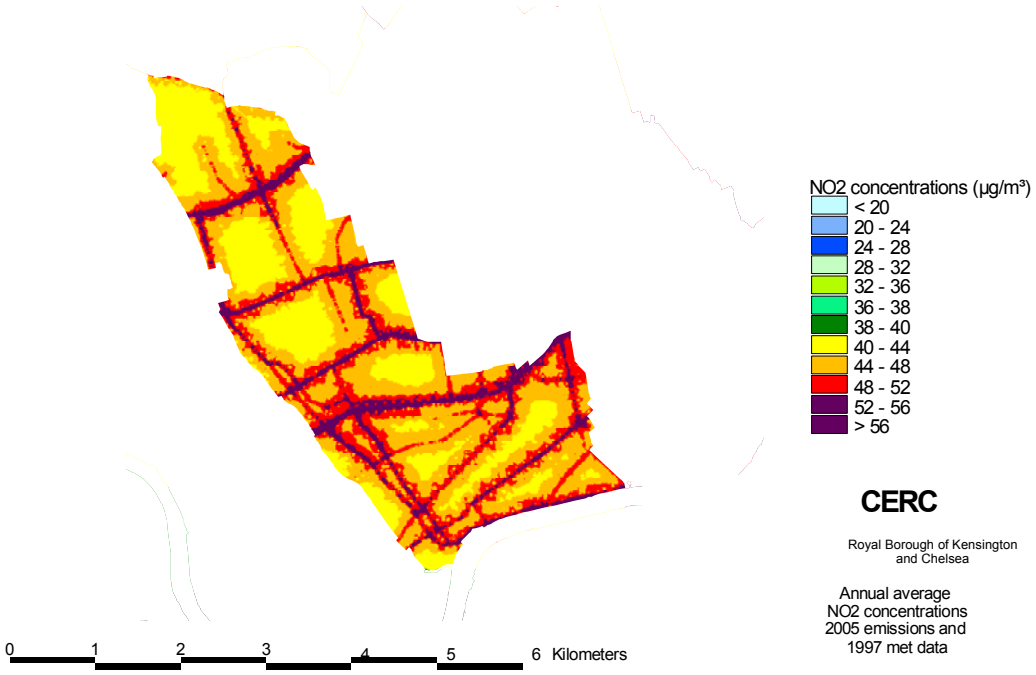
- **Re-modelling the air quality predictions, using more credible emissions factors strongly suggests that NO_2 conditions predicted for 2005 are substantially worse than predicted in 2000. This provides further justification for the previous declaration of an AQMA.**

- **Even adopting a note of caution, the latest modelling results are more consistent with air quality monitoring results, which show a trend indicating that the national target for NO_2 will not be met by a wide margin at busy roadside locations, and not even at background locations.**

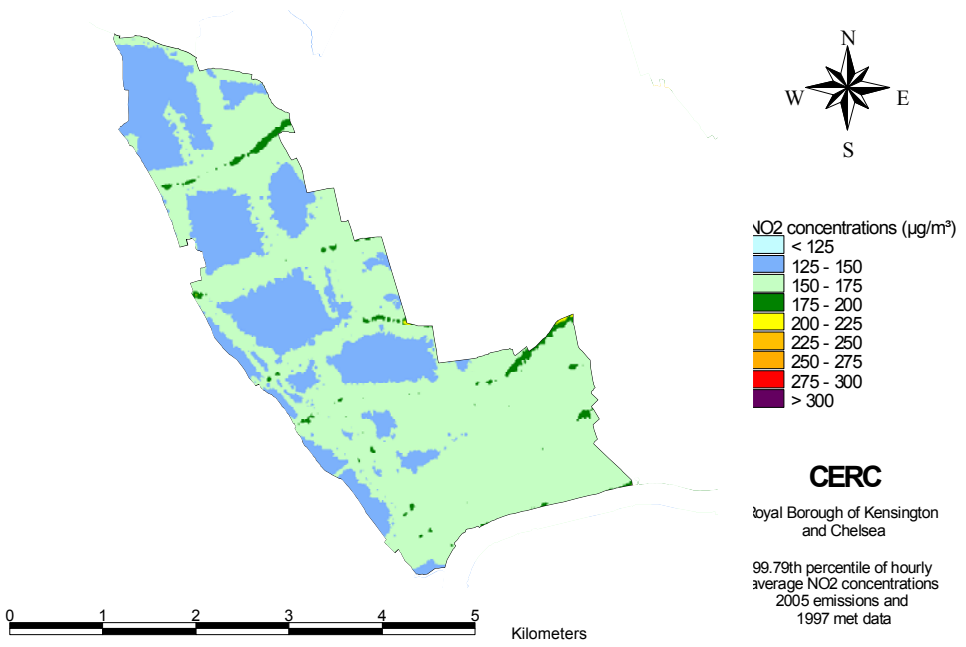
- **The worsened outlook for NO_2 in 2005 implies that the task of devising and implementing air quality management measures across central London will be more demanding.**

- **In contrast modelling and monitoring suggest that the national targets for PM_{10} should be met with few exceptions.**
- **Preliminary source apportionment work suggests that more attention should be given to non-road emission sources.**

Map 1 Annual average NO_2 concentrations using 2005 emissions and 1997 meteorological data



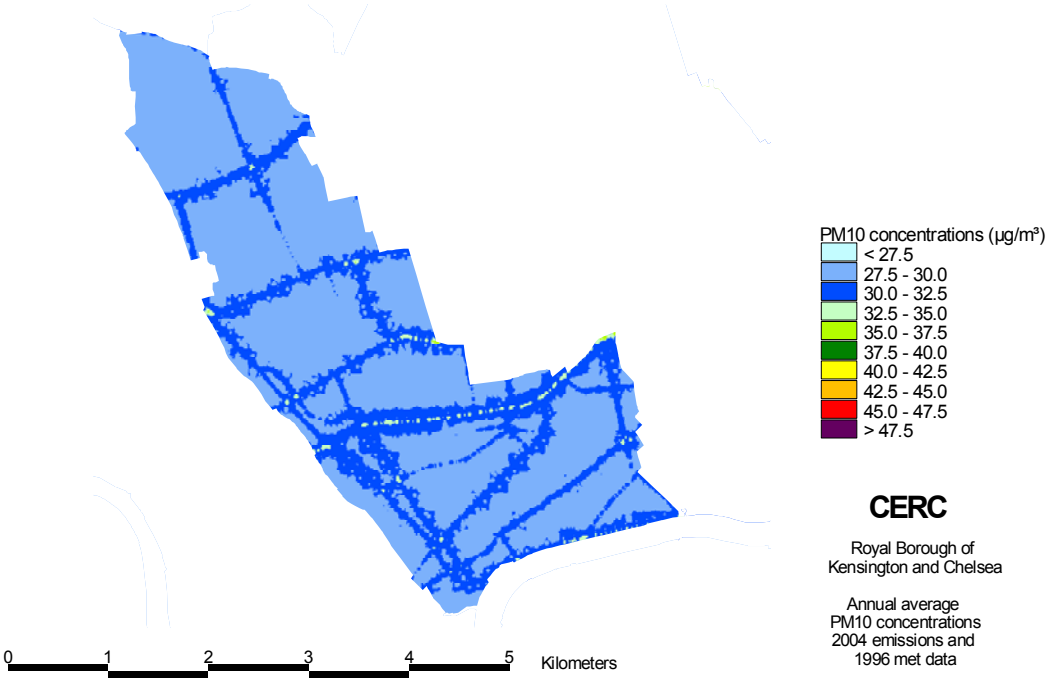
Map 2 99.79th percentile of hourly average NO_2 concentrations using 2005 emissions and 1997 meterological data



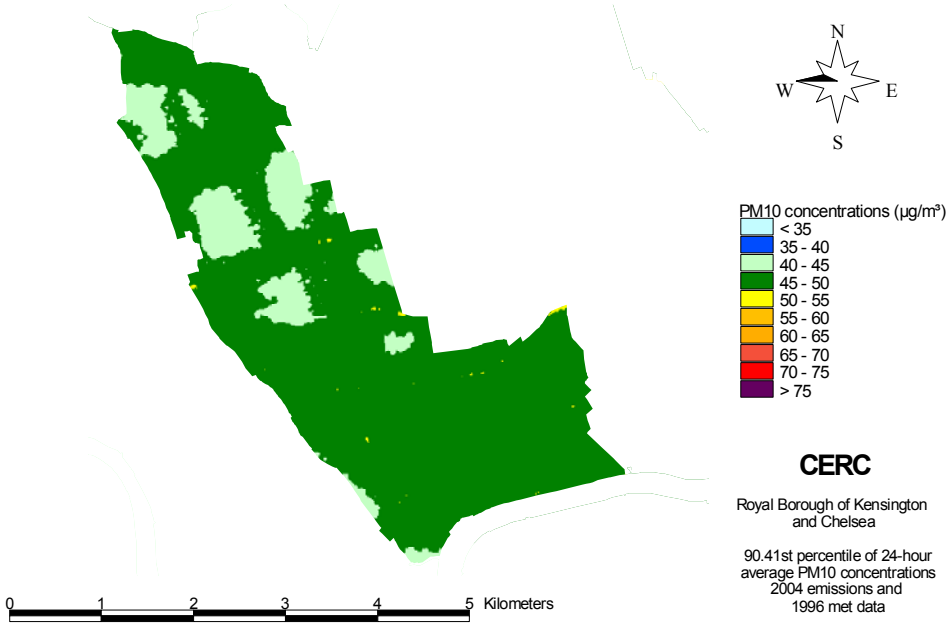
The map indicates that the whole Borough is likely to exceed the 2005 annual average objective of 40µg/m^3. It can also be seen that there is a uniform pattern of higher concentrations superimposed over the major road network with concentrations expected to exceed 52 µg/m^3 along the busiest roads.

The hourly average nitrogen dioxide concentrations are generally below the 2005 objective of 200µg/m^3 not to be exceeded more than 18 times. However, there are likely to be two areas where the objective may be exceeded. This is shown by the yellow areas in Knightsbridge towards Hyde Park Corner and the eastern end of Kensington High Street.

Map 3 Annual average PM_{10} concentrations using 2004 emissions and 1996 meterological data



Map 4 90.41st percentile of daily average PM_{10} concentration using 2004 emissions and 1996 meteorological data



The annual average PM_{10} concentrations are predicted to be below the 2004 objective of 40µg/m^3 across the whole Borough. Concentrations away from the roads tend to be between 27.5 and 30 µg/m^3. Along busy roads they rise to 32.5µg/m^3 and on major roads 37.5µg/m^3.

The 24-hour average objective (50µg/m^3, not be exceeded more than 35 times per year) is only likely to be exceeded in isolated places – towards the eastern end of Kensington High Street, Notting Hill Gate, Knightsbridge and in one or two other places.

INTRODUCTION

- ***Current pollution levels***
- ***The air quality reviewing process and the Air Quality Management Area designation***
- ***Purpose of the fourth stage review and date of the next review***
- ***Breakdown of chapter content***

The state of the air we breathe in central London continues to be a cause for public concern. Locally monitored levels of nitrogen dioxide, one of the two main problem pollutants, are significantly above the objective levels (Table 1) set by the Government to minimise the effects of the pollutants on health, particularly respiratory and coronary conditions. Two objectives have been set for nitrogen dioxide and particulate matter, a short term (hourly or 24 hourly mean, respectively) and a longer term (annual mean). The shorter term objective is designed to protect people from acute effects while the longer term standard relates to the cumulative effects of the pollutant.

Table 1 Government objective levels for nitrogen dioxide and particles

Pollutant	**Objective**	**Date to be achieved by**
Nitrogen dioxide	One hour mean of 200μg/m^3 not to be exceeded more than 18 times	31 December 2005
	An annual mean of 40μg/m^3	31 December 2005
Particles (PM_{10})	24 hour mean of 50μg/m^3 not to be exceeded more than 35 times	31 December 2004
	An annual mean of 40 μg/m^3	31 December 2004

Since the introduction of the National Air Quality Strategy in 1997, local authorities have been required to systematically assess and then review air quality on a regular basis. This report is the fourth produced by the Royal Borough as part of our work on the Government's Strategy, and follows the Council's declaration of an Air Quality Management Area (AQMA) in December 2000. The declaration was a formal acknowledgement of the unacceptable concentrations of air pollutants in the Royal Borough, and committed the Council to preparing an Air Quality Action Plan (subsequently referred to as the Action Plan) within 18 months of the declaration date. The draft plan was circulated in July 2002 and the final version was published in June 2003.

As supporting information for the Action Plan, this report re-visits the results of the previous review and assessment, incorporating new information on road traffic emissions and the latest air monitoring results, to ensure as far as possible that the Action Plan measures are based on reliable predictions of air quality in 2004/5. It describes work that has been done since the publication of the third report in 2000, and therefore although it re-evaluates key parts of the technical work of the Third stage, it does not repeat the entire process. Equally, the report does not attempt to reproduce information that will be contained in the Action Plan.

All local authorities, which have declared AQMAs, are required by the National Air Quality Strategy to continue to review air quality at two yearly intervals. The next round of review and assessment consists of two parts an updating and screening assessment followed by a detailed assessment where identified as necessary. The updating and screening assessment is due to be completed by Royal Borough by the end of 2003.

The report itself has been prepared in the light of guidance issued by DEFRA and is divided into 5 main chapters, which are: -

- BACKGROUND;
- SOURCE APPORTIONMENT;
- AIR MONITORING TRENDS;
- NEW COMPUTER MODEL RUNS;
- SUMMARY AND CONCLUSIONS.

Much of the technical detail has been reserved to the appendices, which include data sets, supporting tables and graphs, and methodological issues. An outline of each chapter follows:-

BACKGROUND
This chapter briefly sets out the history of Borough's work on the National Air Quality Strategy. It explains what an Action Plan is and how this report is important in validating the work that underpins the action plan. It also looks at the role of the newly formed Greater London Authority and the Mayor of London in tackling London's air quality problems.

SOURCE APPORTIONMENT
The findings of the latest source apportionment study are highlighted, and some implications are briefly discussed.

AIR MONITORING TRENDS
This and the following chapter focus on continuing monitoring work on the two specific pollutants that emerged as our problem pollutants at stage three – nitrogen dioxide and fine particles. These form the core of our air monitoring programme around the Borough, which has been expanded with three new monitoring sites. Monitoring trends show that pollutant levels are being reduced, although not significantly enough to meet the Government's objectives.

NEW COMPUTER MODEL RUNS
Since the publication of the stage three report we have had to revise the modelling findings for NO_2 and PM_{10} for several reasons. A miscalculation was discovered early on during our continuing review of the data. Since then there have been significant changes in the factors used to estimate the emissions from different types of vehicle under varying conditions. Consequently there has been a series of model runs to re-predict pollution conditions in 2004/5, the years for which the Government's air quality objectives are set. An assessment of the modelled data has been carried out to determine the necessary reductions in pollutant concentrations required to meet the Government's air quality objectives. This issue is discussed in the section on "Reduction on Pollutant Concentrations" (page number 19). A further brief section looks at the modelling results in relation to public exposure.

CONCLUSIONS
The overall conclusions to be drawn from the air monitoring trends and the latest modelling runs are set out in relation to sources of emissions, reductions in pollutant concentrations, and the implications for air quality management planning.

BACKGROUND

- ***A brief review of our previous air quality reports***
- ***Expansion of the Borough's air quality monitoring network***
- ***Difficulties and challenges of air quality monitoring***
- ***The role of the Mayor of London***

For central London boroughs, reviewing and assessing air quality has been a long process, which has now been concluded for the time being with the fourth stage. At Stage One the Council looked at each of seven national key pollutants (local authorities are not obliged to assess levels of ozone, the eighth key pollutant, although the Council does monitor it at its North Kensington site). The individual assessments had to be compared with Government objectives set for 2004/5. Of the seven pollutants, only lead and 1-3 butadiene gave no indication of being a problem in 2005. Levels of fine particles, nitrogen dioxide, sulphur dioxide, carbon monoxide, and benzene appeared to be potentially problematic to a greater, or lesser extent. Screening at Stage Two and air dispersion modelling at stage three, reduced the potential problem pollutants to fine particles and nitrogen dioxide. The predictive modelling showed not only the two pollutants exceeding the national objectives, but also identified "hotspots" on roads carrying the heaviest traffic.

Since 1998 the Council has closely coordinated its reviewing of local air quality with seven other central London boroughs: Corporation of London, Westminster City Council, and the London Boroughs of Camden, Islington, Hackney, Southwark and Lambeth. This is not only more economic when commissioning air quality modelling work, but also ensures consistency in methodology and the presentation of results. This report is the latest in our *'Review and Assessment of Air Quality'* series and is based on work carried out by Cambridge Environmental Research Consultants (CERC) commissioned as before by the eight central London boroughs.

In the report published in December 2000, results of sophisticated modelling carried out by CERC were used to predict whether two pollutants – nitrogen dioxide and fine particulates – would potentially exceed the Government's National Air Quality objectives set for 2005 and 2004 respectively, as specified under the National Air Quality Strategy. Our results indicated that the pollutants' would not meet these targets and consequently in December 2000, an Air Quality Management Area was declared throughout the whole of the Royal Borough.

Since December 2000 further research into the Borough's air quality has been undertaken. We now operate two additional continuous monitoring stations in the south of the Borough – both monitor levels of nitrogen oxides and nitrogen dioxide. These stations can be found outside Harrods in Knightsbridge, and Chelsea Old Town Hall. A further fine particles (PM_{10}) monitoring site has been installed on Earls Court Road, however, measurement data has only been available since April 2002.

Current monitoring of key pollutants in the Royal Borough shows that the previous Government assumption that its objectives would be largely achieved by 2005 was over optimistic. There remains concern that the Government's assumption that there was a 'technofix' solution, did not adequately take into account the fact that catalytic converters do not perform to their optimum level in an urban driving cycle. The trends taken from local monitoring results indicate that NO_2 will not meet the objectives at the majority of locations, whereas PM_{10} may be on target for 2005, but not for the new objectives for 2010.

We will continue to monitor the situation over the next 18 months and will report again with our findings.

In addition, some of the modelling work initially carried out has been re-modelled. Whilst examining and manipulating the data in our last report, a miscalculation was discovered in the modelling done by CERC, the consultants who carried out the modelling work on behalf of the Royal Borough. This meant that, when corrected at that time, the maps showing areas of the Royal Borough likely to exceed the objectives had significantly diminished. This is further discussed in the modelling chapter.

On its own this would have prompted the Council to revisit its decision on whether to declare the whole Borough as an AQMA. However the new edition of the London Emissions Inventory and further revisions of the emissions factors issued by DEFRA necessitated substantial remodelling and resulted in the 2005 predictions for nitrogen dioxide concentrations being higher than the original predictions. In view of these findings we are confident that the Council's decision was justified despite being based on inaccurate information during that stage.

In preparing this report, due regard has been paid to guidance published by DEFRA. The Department suggests that "stage four" reports may be seen as a 'technical annex' to the local authority's action plan, which between them should address the feasibility and cost effectiveness of different abatement options, the extent to which air quality improvement is required, and the exposure of individuals in relevant locations.

Public exposure was specifically considered in the stage three report. The latest mapped predictions suggest greater exposure, in that the average NO_2 pollution "footprint" along all the Borough's main roads extends to some distance on each side of the road, emphasising the exposure of the population living beside the roads. The predictions also indicate that there are no inhabited parts of the Borough, which are likely to escape from the higher than objective average NO_2 levels.

Otherwise in this report, model validation, quality control, further monitoring, liaison with other agencies, and previous consultation responses are discussed. Source apportionment, the required emission reductions and national policy developments are covered in later sections.

Our stage three report was published for public consultation in July 2000. We received a number of positive responses which agreed with the methodology we had used, and our conclusion to declare an AQMA covering the whole of the Royal Borough. Some minor amendments were suggested which we included however the most significant comment came from the then DETR. The Department had noted that a formal acknowledgement of the effect of proposed planned developments in the consultation draft had not been made. Corrections were made to the final version of the report.

Individual local authorities are not the only public bodies to have responsibilities for the management of local air quality in London. Under the Greater London Authority Act 1999, The Mayor of London, is required to prepare a State of the Environment report, and more specifically an Air Quality Strategy. The Mayor published his Air Quality Strategy in September 2002; it includes proposals and policies for implementing the National Air Quality Strategy to meet the air quality objectives and the EU air quality limit values. The aim of the strategy is: '… *to improve air quality in London to the point where it poses no*

risk to health or quality of life.' And, like our own review and assessment reports, the strategy also contains information about current air quality and future predictions, though for the whole of Greater London.

To achieve the objectives and limit values, the Mayor has previously stated that he aims to:

- "Reduce the impact of activities, including transport on air quality, consistent with promoting economic growth.
- Promote good quality, practical, pleasant and clean methods for transport of people and goods.
- Promote good environmental quality throughout London.
- Reduce emissions of air pollution."

The Mayor's Transport Strategy, published in July 2001, should have an important influence on air quality improvement. Through 'Transport for London', the Mayor is responsible for a significant proportion of main roads, buses and taxis. His Transport Strategy proposes a radical set of policies to reduce traffic and cut congestion in central London most important of which is the Road User Charging Scheme.

Since February 2003, motorists have been charged £5.00 to enter the congestion zone. At the time of writing this report, it is claimed that there has been a reduction of traffic of between 16 – 40% in the centre of London. It is too early to assess what impact this may be having on air quality, and it may be prudent to wait until twelve months of data has been compiled before making any such assessment. The present boundary of the charging zone does not include the Borough and the Council will be interested to find out what effects the operation of the Zone is having on local air quality – positive or negative - particularly in areas of the Borough immediately beyond the zone boundary.

The Action Plan takes into consideration the measures and the actions proposed in The Mayor's Air Quality Strategy. The Action Plan contains a number of measures aimed at reducing levels of fine particles and nitrogen dioxide. It is likely that the most comprehensive of these, if found to be feasible, will be a Low Emission Zone – a demarcated area over a large part of London from which heavy goods vehicles and buses not meeting a given emission standard would be excluded.

SOURCE APPORTIONMENT
AND THE LONDON ATMOSPHERIC EMISSIONS INVENTORY

- ***Use of the London Atmospheric Emissions Inventory***
- ***The latest information on the sources of the two key pollutants***

One of the more important elements of the stage four assessment is considering the differing degree to which the various sources of pollution contribute to the Borough's air quality problem. A better understanding of the different contributions helps in devising and adjusting action plans, so that they address the specific pollution problems being experienced locally. For example, if as much nitrogen dioxide is emitted by domestic heating plant as is emitted by vehicles on the road, then our action plans should contain measures to achieve reductions in both sources.

Using the latest London Atmospheric Emissions Inventory (LAEI) the consultants carried out a study to investigate the proportions of nitrogen dioxide and particles emitted from transport sources and static sources, predicted for 2004/5. For the purposes of the exercise, three different receptor locations in the Borough were chosen based on three of the automatic monitoring locations: Cromwell Road, Earls Court and North Kensington, representing both roadside and background situations.

Four scenarios were investigated; the preliminary draft report setting these out and their results is available upon request as technical Annex 2. Key points emerging from the preliminary results of the exercise are highlighted below.

- The percentage NO_x and PM_{10} being emitted within the Borough, compared with the whole of London is very low at only 1%.

- The proportion being emitted within central London is only 10%.

- The rest of London accounts for the vast majority of the pollutants - 89%.

- Both within the Borough, and across London as a whole, the contribution from traffic emissions compared to all other sources is 48% for NO_2 and 69% for PM_{10}.

- In the Borough 'sources other than road vehicles' were found to be 52% for NOx.

The report also looked at the contribution that NO_x emissions make to actual concentrations at a number of specific locations (monitoring sites were used as representative locations). At Cromwell Road, road sources contribute about 75% to the final concentration of nitrogen dioxide, whereas at North Kensington and West London the contributions are 43% and 50% respectively.

The contribution made by vehicles to PM_{10} **concentrations** is smaller (18% at Cromwell Road), compared to the contribution vehicles make to **emissions** from sources within the Borough (69%). This is because when modelling concentrations background sources (such as coarse and secondary sources) of PM_{10} have to be taken into account, whereas the emissions inventory can only account for direct emissions from manmade activities and processes (boilers, engines etc.) because of the high background levels of PM_{10} within the

Borough. Also when modelling a specific year for background and meteorological data must be selected and 1996 was particularly high for secondary sources.

The distribution between road vehicles is shown in the table below:

	NOx		PM10	
	Tonnes/Annum	%	Tonnes/Annum	%
Cars	74.4	33	6.5	35
Taxis	20.2	9	3.5	19
Light good vehicles	20.3	9	3.5	19
Heavy goods vehicles	65.0	29	3.6	20
Buses	45.2	20	1.2	7
Total	**225.1**	**100**	**18.3**	**100**

Table 1 approximate contribution of various vehicles sources to NO_x and PM_{10} within the Borough. *Source: determined from the London Atmospheric Emissions Inventory (Feb 2002)
In these tables NOx has been quoted as 'true NO_x'. The London Atmospheric Emissions Inventory assumes that all NO_x emitted is NO_2 (i.e. NOx as NO_2). This will lead to a different estimate in the emissions of NO_x.

- The table above suggests heavy goods vehicles and buses together contribute almost as much NO_x as the remaining categories combined, whereas they only contribute slightly more than a quarter of the particles.

- In general the largest single contributor of NO_x in the Borough are the major roads at 41%.

- Domestic and commercial gas burning accounts for 40%. The findings of the latest London Atmospheric Emissions Inventory suggest that more attention should be given to non-road sources such as gas consumption in future air quality action plans. In the meantime, further research needs to be carried out into gas boiler technology.

- Railways apparently produce 9% of NO_x along the northern and western edges of the Borough. More research is being done to quantify diesel locomotive emissions and to ascertain what improvements in fuel quality are planned.

These findings emphasise the need for coordination between Boroughs and for effective strategic action by the Mayor of London, on the basis that the actions of any individual Borough to reduce emissions within its boundaries will be insignificant without joint action to reduce "background" emissions.

The contribution of burning gas to NO_x levels has emerged as being as important as the contribution of road vehicles. There may be a need in future to concentrate more resources on efforts to promote energy efficiency and conservation in domestic and commercial heating systems.

These findings also suggest that some sources can be overlooked. The pollution contribution of railways (Paddington mainline and West London Line) had previously been underestimated. This significant proportion of emissions may be a consequence of diesel-powered trains serving Paddington Station and heavy (diesel-hauled) freight traffic on the West London Line, the principle cross-London route.

Lots Road Power Station, situated in the south of the Borough, was operating until July 2002, providing power to the London Underground network for the previous 100 years. It is estimated that the power station produced 369.17 tonnes of NO_x between January and December 2001, and therefore its closure has led to a sizeable reduction in NO_x emissions in the Borough. The reduction, however, was already taken into account in the modelling predictions.

AIR MONITORING TRENDS
ARE WE MEETING THE OBJECTIVES?

Nitrogen dioxide (NO_2)

- ***Currently concentrations measured at all automated monitoring sites exceed the annual mean objective for nitrogen dioxide***
- ***According to monitoring trends, only the North Kensington (background) monitoring site is likely to meet the annual mean objective level***
- ***Concentrations at the new monitoring site at Knightsbridge are also exceeding the one hour mean objective***

Whilst there has been an overall reduction in nitrogen dioxide levels since the 1980s, an examination of the monitoring trend for the past seven years (Figure 1 below) shows little change, with only the North Kensington site possibly meeting the annual mean objective level by 2005. The Marylebone Road site, whilst not in the Borough, is included to represent a longer-term kerbside monitoring location.

Figure 1

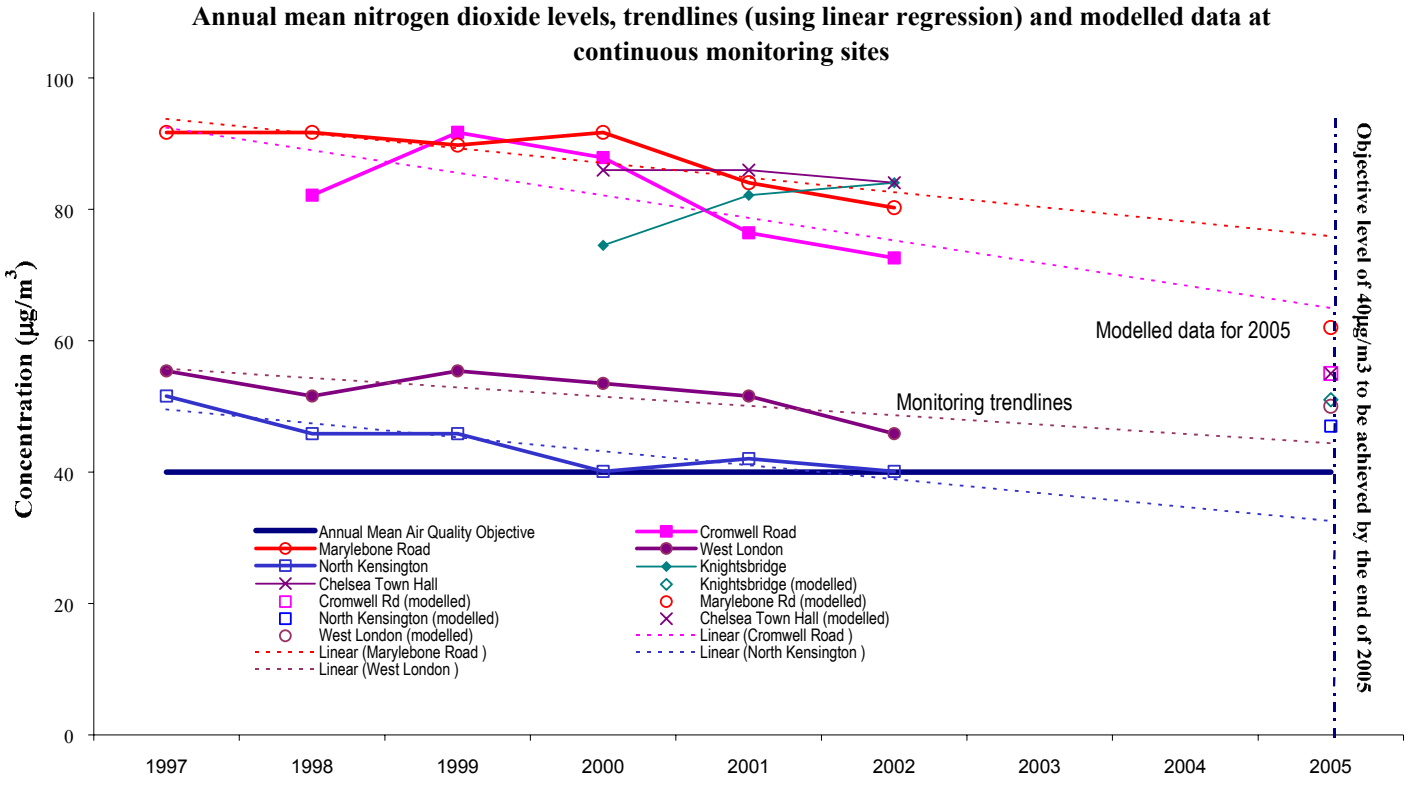
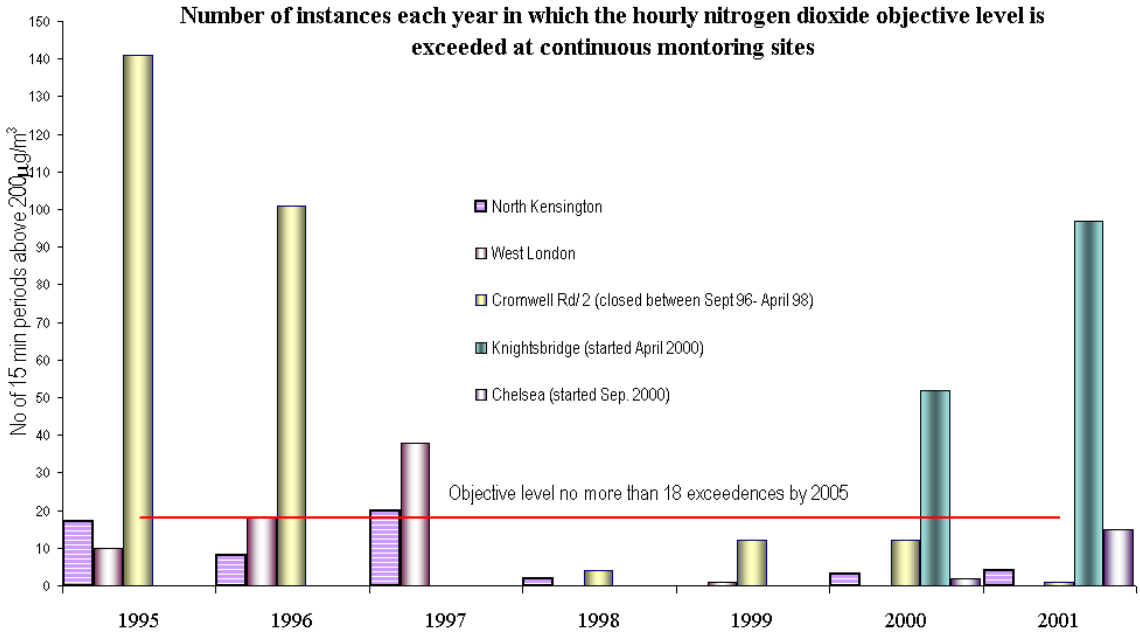


Figure 1 also shows **modelled** levels for 2005; these results show that all the monitoring sites in 2005 are predicted to remain above the objective level. Appendix 1 contains more information about monitoring, including data from the diffusion tube network. There is also a discussion on why reductions in NO_x emissions are not being followed by the same reduction in nitrogen dioxide concentrations.

Figure 2 shows the number of hours above the hourly standard (200µg/m^3) for nitrogen dioxide levels. The objective for the hourly mean is that there should be no more than 18 exceedences of this standard within a single year. This objective has been exceeded at the new monitoring site at Knightsbridge.

Figure 2

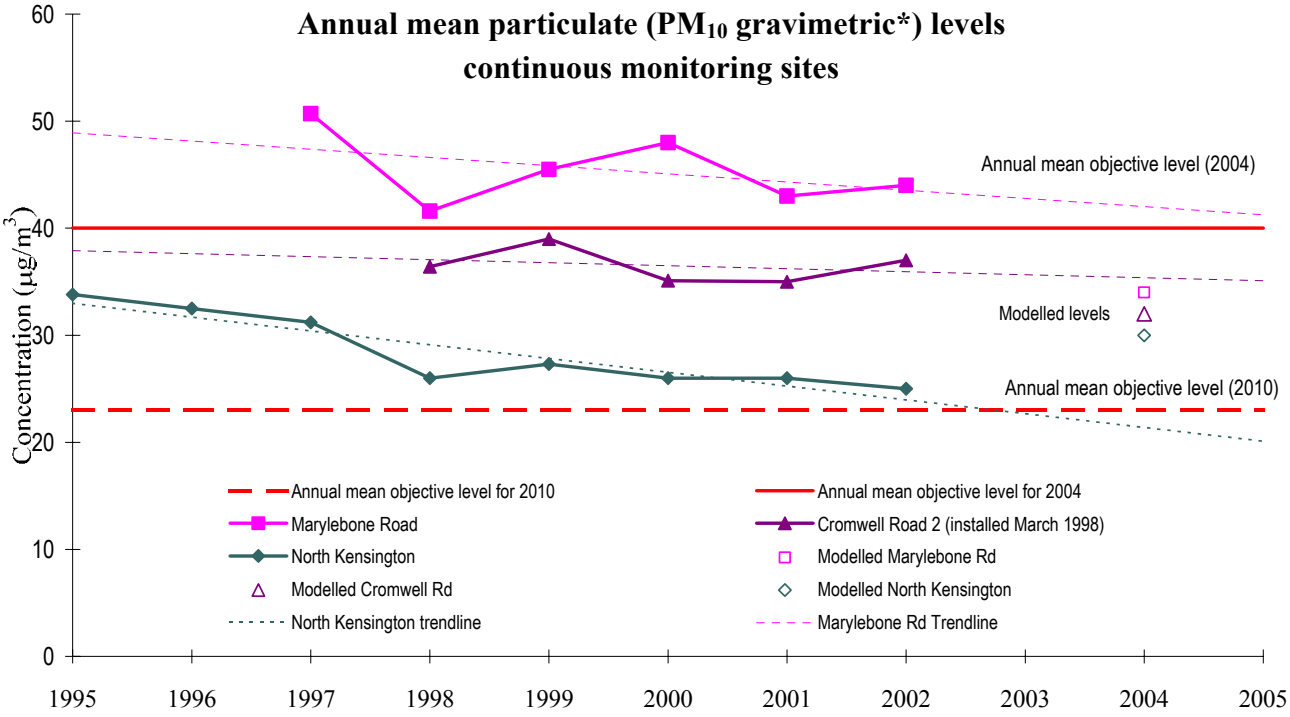


Particulate matter (PM_{10})

- ***Background levels are generally within the annual average standard***
- ***The number of days when the 24 hr standard is exceeded is below the objective level***
- ***New annual average standard for 2010 likely to be exceeded***
- ***New daily standard for 2010 also at risk of being exceeded***

The available data indicates that background sites are below the annual mean objective. The Cromwell Road site (a roadside location) is also lower than the objective (Figure 3), but only by a small margin. The Marylebone Road site (which is not in the Borough but representative of a location closer to the kerb) does exceed the objective level and is unlikely to meet the target by 2004.

Figure 3

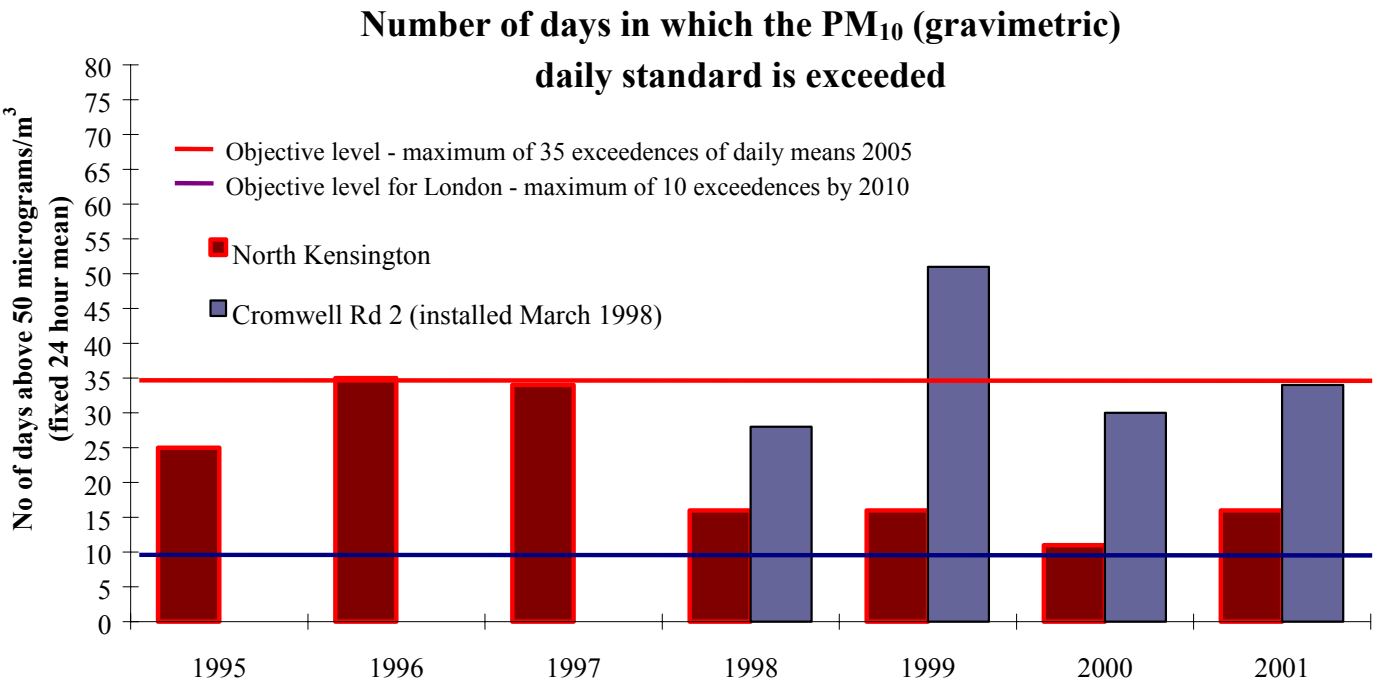


* Measurements made using TEOMs (an automatic method) must be converted to indicate levels in 'gravimetric' units i.e. results obtained by weighing particles on a filter. A further explanation of the two methods is given in Appendix 2.

Modelled levels for locations in the Borough are shown on the chart for 2004. These levels are also within the objective level for 2004, however whilst these have not been included in regulations, indications are that the new objectives for PM_{10} for 2010 are likely to be exceeded. For this reason it is important not to dismiss the PM_{10} issue.

A similar pattern for daily exceedences can also be observed for each site with the greatest number occurring at the Marylebone Road location. Only data for the Borough is shown in Figure 4, however at the Cromwell Road monitoring site the number of exceedences are only just below the objective.

Figure 4



QUALITY AUDIT AND CONTROL OF AIR MONITORING DATA

Given the reliance that is placed on the monitoring data obtained from our continuous monitoring sites, all sites are subject to quality assurance procedures. All data is manual checked on a daily basis. Monitoring equipment is regularly calibrated and serviced. In addition all sites undergo independent checks. The North Kensington site is audited as part of the London Affiliate Network intercalibration exercise because it is part of the government's Automatic Urban Rural Network (AURN); the remaining sites are calibrated as part of the London Air Quality Network (LAQN) Non-Affiliate Network intercalibration exercise. This work is undertaken, by the National Physical Laboratory (NPL), on behalf of the participating local authorities.

NEW COMPUTER MODEL RUNS

Extrapolating pollution monitoring results is a very approximate method of predicting future pollution concentrations. Because it depends on past results, it is best used when the past series of results extends some time back, preferably more than ten years. The forecast is required for a point in the immediate future. More statistical reliance can be placed on a longer time series, and the impact of future changes to the governing factors is usually minimised. Air quality modelling is designed to take account of future changes and is being progressively refined to perform more accurately. In practice, it is gratifying to see that modelling predictions are converging with monitoring trends, as theory would suggest.

This fourth stage review requires us to re-visit the modelling that we undertook for the stage three report and to update it where necessary. CERC (the Council's air quality modelling consultants) have carried out three modelling exercises since 2000, most recently using revised emission factors, to predict what the picture will be in the Royal Borough in 2004 and 2005, for particulates and nitrogen dioxide.

Within a few months of declaring the AQMA, we discovered that some of the data used in the stage three report was flawed. A miscalculation in traffic count data had produced maps showing overall emissions to be some 20% higher than they actually were. These maps had been instrumental in the decision to declare an AQMA across the whole of the Royal Borough. The revised work showed that although the levels for both nitrogen dioxide and particulate matter were lower than those modelled in May 2000, there were still significant areas likely to exceed the annual average standard for nitrogen dioxide, along most of the major roads in the Borough. The AQMA declaration was still valid, but not as strongly supported by the data. A fuller account is given in Appendix A3.

Once the miscalculation had been corrected, we then turned our attention to the credibility of the surprisingly optimistic Government emission reduction assumption. A 76% reduction was used in the modelling exercise, as this was the reduction in NO_x emissions found when comparing the modelled traffic predictions carried out by Transport for London between the years 1991 and 2005. This percentage reduction represents the rate at which the "technofix" (improvements to fuels and vehicle engines) would take effect.

Aside from low sulphur fuels much of the improvement was dependent on the introduction of catalytic converters. Although there was no data to examine, we suspected that London's driving conditions did not allow catalytic converters to perform at their optimum. Our concern led us to try a more modest emission reduction of 56%, which was the standard reduction assumed by the Government at the time. This resulted in predictions of increased levels of pollution across a much larger area of the Borough and for the first time, some areas exceeded the standard for the hourly mean for nitrogen dioxide along the Cromwell Road. More detail on this is shown in Appendix A4.

In the meantime, research into the government's emission factors was completed and the GLA made the final revisions to the London Atmospheric Emissions Inventory in February 2002. This incorporated new emission factors researched by TRL for DEFRA taking more account of actual driver behaviour in urban traffic conditions. Our reservations about the actual impact of 'technofix' were vindicated when CERC took into account recent Government guidance, remodelled the nitrogen dioxide levels predicted for 2005, and the produced maps showing that the NO_2 standard would be exceeded across the whole Borough.

The latest maps confirm that there may be some limited points on the eastern side of the Borough where the short-term standard - hourly average concentrations, exceed the objective level of 200ug/m^3 in 2005. More strikingly the entire Borough is predicted to exceed the long term standard – annual average 40µg/m^3 in 2005, with all the major roads such as Ladbroke Grove, Old Brompton Road and Fulham Road exceeding by 25% and the busiest roads including Kings Road, Knightsbidge – Cromwell Road, Kensington High Street, Kensington Church Street, Notting Hill Gate – Holland Park Avenue, Westway and the Earls Court one-way system exceeding by 35%. There is also a "halo" effect on areas around the entire road network, which exceed by 15%.

In contrast the outlook in 2004 (the objective year) for fine particle pollution is not so grim in the medium term. The standard for PM_{10} is only likely to be exceeded by a few percentage points at the busiest junctions including Knightsbridge/Sloane Street, Sloane Square, Earls Court Station, High Street Kensington/Kensington Church Street, Notting Hill Gate and Holland Park roundabout. The new fine particle standards for London in 2010 will be significantly stricter – annual average reduced from 50µg/m^3 to 25µg/m^3 and the existing 24 hour mean not to be exceeded more than 14 times a year compared with 35 times a year at present.

The "hotspots" of nitrogen dioxide, along the busiest roads and particularly at their junctions, are likely to prove very difficult to eradicate using local air quality management planning.

Whilst these latest predictions are cause for concern, they must be treated with a degree of caution. As mentioned earlier, air quality modelling does not achieve pinpoint accuracy and there may still be errors concealed in the data, or assumptions based on estimates and approximations that need further refining. However even allowing for 10% tolerance, a substantial part of the Borough near the road network is likely to continue to experience poor air quality beyond 2005.

REDUCTION IN POLLUTANT CONCENTRATIONS

The modelling results indicate that to achieve the annual mean objective the necessary reduction will need to be considerable. At background locations where concentrations are predicted to range from 40-49 μg/m^3, levels would need to decline by up to 10μg/m^3, whereas at intermediate locations (50-59 μg/m^3), the necessary reduction would have to be up to 20μg/m^3. The greatest reductions (up to 30μg/m^3) are required at roadside locations where concentrations are currently predicted to range from 55-69 μg/m^3.

Table 2 Predicted annual mean nitrogen dioxide concentrations, and approximate level of reduction necessary.

Location	Approximate distance to kerb (m)	Predicted concentration for 2005 (μg/m^3)	Estimated level of reduction to achieve objective (μg/m^3)
Background	>50	40-49	1-10
Intermediate	5-50	50-59	11-20
Roadside	<5	55-69	21-30

It is harder to determine the level of reduction required to achieve the hourly mean objective for nitrogen dioxide, since the standard is exceeded in only a few locations. The number of exceedences is also dependent on the meteorological conditions in any given year.

Our modelling indicates that annual mean levels for particles will be within the 2004 objective level by this deadline, but still above the 2010 objective. This will be considered in subsequent assessments. The 24 hour mean objective is only exceeded in isolated locations across the Borough. A rough estimation of the level of reduction necessary to achieve this objective by 2004 indicates that levels of particles would have to decrease by up to 10%.

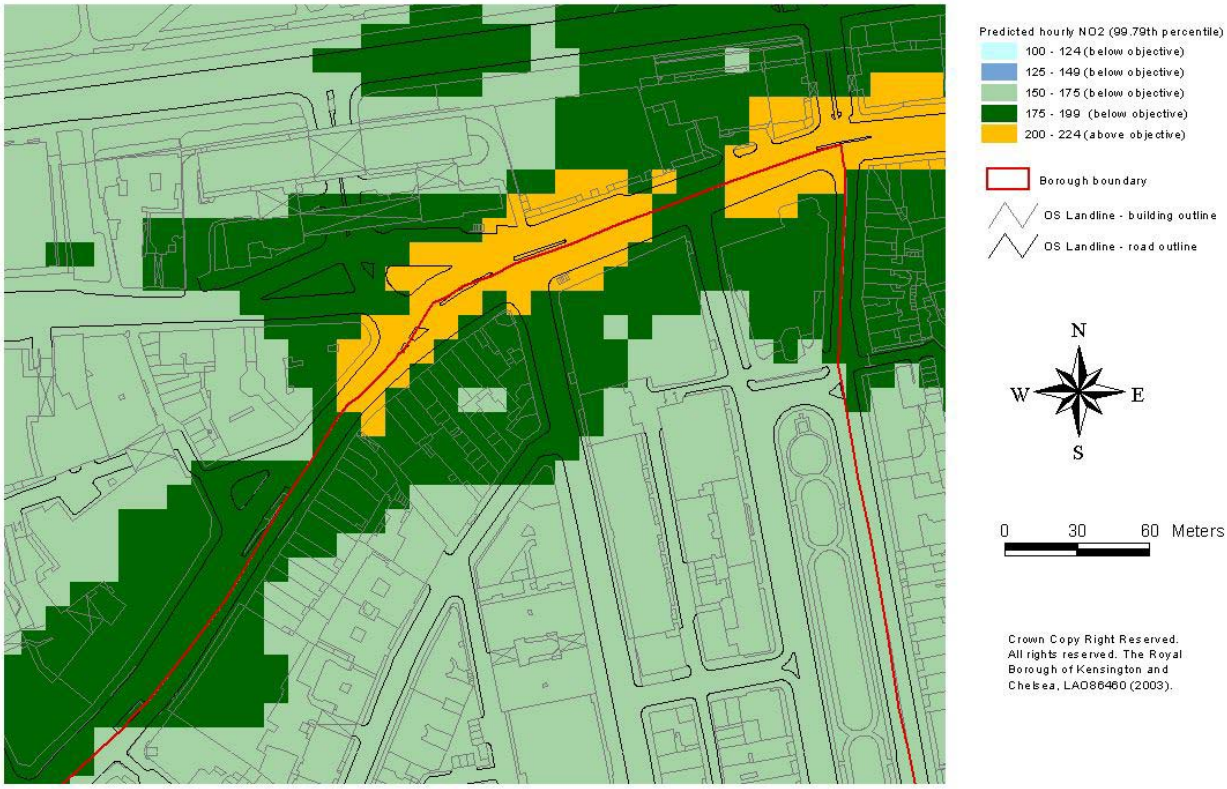
Please see our Action Plan for details on the initiatives planned to help improve air quality within the Borough.

PUBLIC EXPOSURE

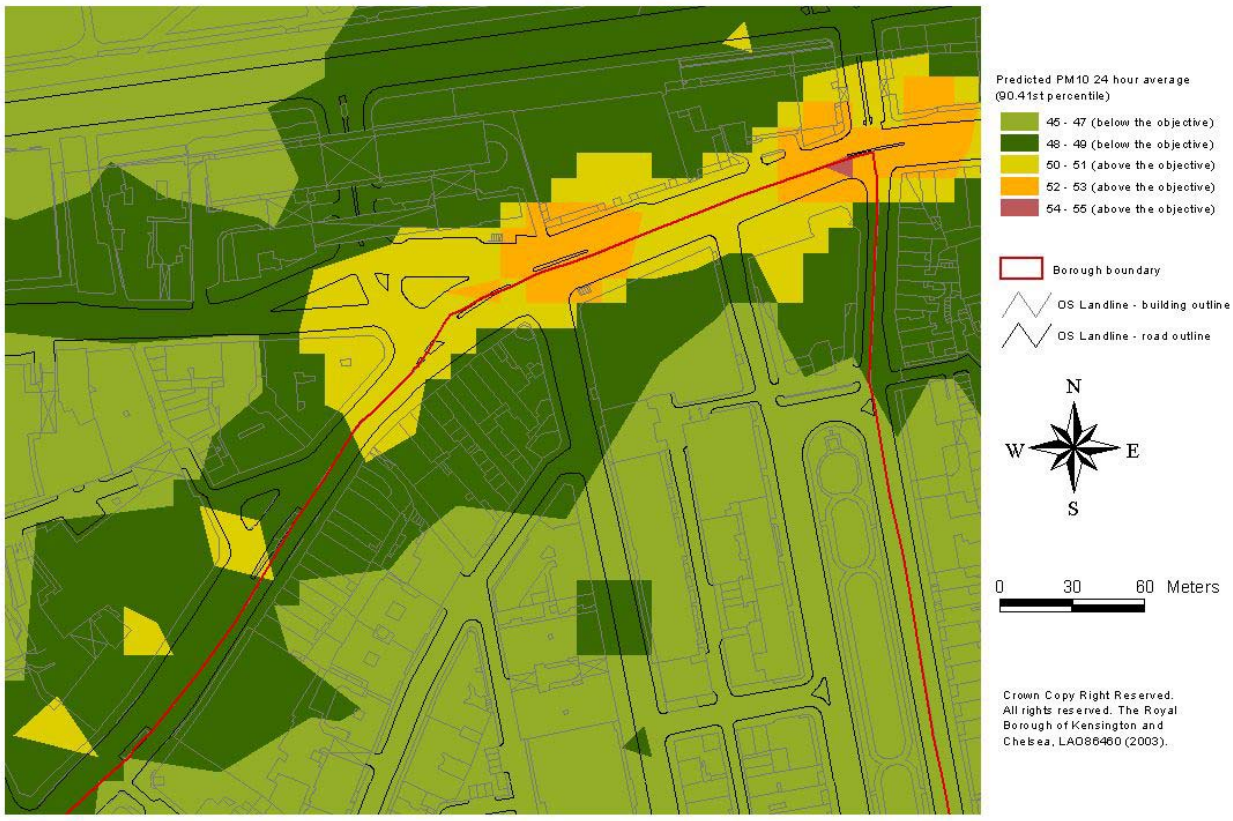
The modelling results show that the entire Borough is likely to be affected by the exceedence of the annual mean nitrogen dioxide objective, whereas only isolated areas are affected by the hourly mean exceedence for nitrogen dioxide and the 24 hour mean exceedence for particles.

Work carried out for stage three illustrated the high population density throughout the Borough as well as along major roads where exceedences of the hourly (NO_2) and 24-hour objective (PM_{10}) are predicted. These routes such as Kensington High Street, Brompton Road, and Knightsbridge (maps 5 and 6) are surrounded by residential and commercial properties, which are frequented by members of the public who are therefore likely to be affected over the relevant exposure period.

Map 5: Predicted levels of nitrogen dioxide in the Knightsbridge area in 2005



Map 6: Predicted levels of particles in the Knightsbridge area in 2004



SUMMARY AND CONCLUSIONS

Modernisation of the vehicle fleet, and more efficient energy use, have not been sufficient to reduce pollution to the Government's air quality objective levels. This report makes significant progress in assessing pollution conditions in 2-3 years time, when the national objectives are supposed to be met, compared with the position reached at the time of the stage three report.

We have re-modelled the air quality predictions for NO_2 using more realistic emission factors. These strongly suggest that NO_2 conditions predicted for 2005 are substantially worse than predicted in 2000. This provides us with further justification for our declaration of an AQMA in 2000, and also shows that meeting the national objectives for NO_2 will be more demanding. The latest modelling results are more consistent with actual air quality monitoring trends that show the national target for NO_2 will not be met by a wide margin at busy roadside locations. The modelling suggests a margin of 35% for these locations, and even areas adjoining the roads are likely to exceed by more than 10%. Residents are being exposed to these conditions every year.

In order for our monitoring of air quality in the Borough to provide a comprehensive data record, against which to validate our modelling, we have expanded the monitoring network with three new continuous monitoring sites. Whilst our monitoring work frequently measures levels of NO_2 in excess of the objectives, levels of PM_{10} are currently below objectives. The Government has introduced new national objectives for PM_{10} and it is unlikely that these stricter objectives will be met locally.

Air quality modelling compliments monitoring, and for stage four we carried out a series of three air quality modelling exercises. The first exercise corrected the consequences of a miscalculation at stage three. The second looked into the questionably optimistic assumption for emission reductions linked to technological improvements in fuels and engine design. Our decision to test the third stage results, using a more modest assumption to obtain less favourable predictions, was eventually vindicated by the third exercise using the Government's substantially revised emission factors. These have used empirical research to quantify the way in which vehicle engines, particularly more recent models, are performing in practice.

The work that we commissioned for this report looked not just at the levels of pollution in the Royal Borough, but also at its sources. The new London Atmospheric Emissions Inventory offers new information on the apportioning of emissions between different road and non-road sources. Amongst other things the findings suggest that more attention should be given to non-road sources in future air quality action plans.

The Borough published its Action Plan in June 2003. This contains a list of 25 actions designed to improve air quality in Kensington and Chelsea. It includes actions that the Council is already taking, often for reasons in addition to reducing pollution – and several new initiatives that are hoped will lead to improvements in our local air quality.

The action plan measure receiving the most attention is the possibility of a Low Emission Zone for London, which is currently the subject of a joint feasibility study supported by the London Boroughs, the GLA and DEFRA. The final report from the study has just been published. This initiative appears to have some potential to make a measurable improvement to air quality, although on its own it will not bring about the attainment of the

national objectives. The source apportionment work being reported on by all central, and many other London Boroughs, has informed the feasibility study, and is likely to influence the final choice of vehicle types to fall within the restrictions.

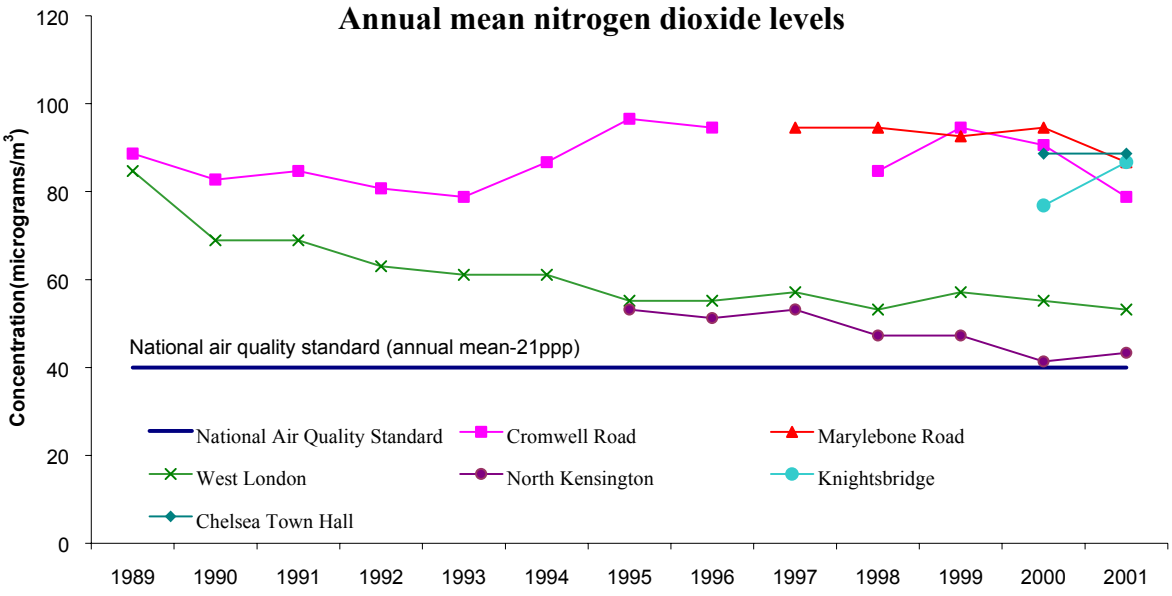
The Mayor of London's Congestion Charging Scheme in its current form has brought about some traffic reduction in the centre of London, but its impact on regional air quality is likely to be neutral. An assessment of the Zone's impact on local air quality is awaited.

The computer modelling work, which lies at the heart of this fourth stage Air Quality Assessment and Review, is a very useful tool, but it is not a "precision instrument" in the sense that the predictions generated are subject to a percentage error, which should be in the region of +/- 5%, but may reach +/- 10%.

Appendix A1 - Nitrogen dioxide monitoring data

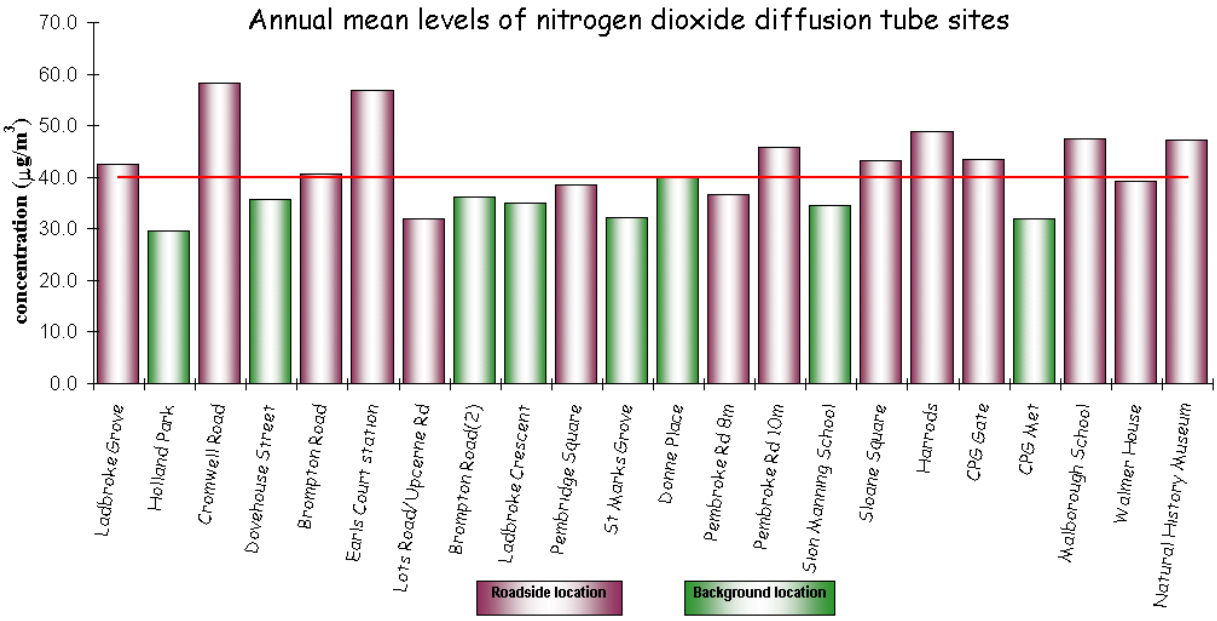
Annual mean levels of nitrogen dioxide at background sites have declined over the long term since the 1980s. Roadside locations show little overall change or a slight increase over the same time period. Despite some reduction in levels, all automated monitored sites are currently at, or exceed the annual mean objective level, including two new sites that were established during 2000 (annual means for these two sites are based on available data).

Figure 5



Diffusion tube monitoring provides further evidence of locations exceeding the standard (Figure 6). Though not as accurate as automated monitoring, this diffusion tube survey indicates that 12 out of 22 locations, predominately roadside, were also above or at the annual mean objective level in 2000.

Figure 6



The one-hour mean objective level of 200μg/m^3 (which must not be exceeded more than 18 times) by the end of 2005 has in recent years largely been achieved in the Borough except at the Knightsbridge site.

Table 2 Concentrations of nitrogen dioxide automatically measured in and near the Borough

Year	Site	Annual mean μg/m^3 (ppb)	Max hour μg/m^3 (ppb)	No of hours >200 μg/m^3	% Data Capture
1995	North Kensington*	52 (27)	283 (148)	17	75
	West London	54 (28)	251 (131)	10	98
	Cromwell Rd	90 (47)	325 (170)	141	92
1996	North Kensington	50 (26)	237 (124)	8	92
	West London	54 (28)	392 (205)	18	91
	Cromwell Rd*	82 (43)	300 (157)	101	68
1997	North Kensington	52 (27)	346 (181)	20	98
	West London	56 (29)	415 (217)	38	97
	Marylebone Rd*	92 (48)	300 (1570	69	39
1998	North Kensington	46 (24)	226 (118)	2	99
	West London	52 (27)	193 (101)	0	98
	Cromwell Rd 2*	82 (43)	222 (116)	4	60
	Marylebone Rd	92 (48)	176 (92)	71	98
1999	North Kensington	46 (24)	178 (93)	0	97
	West London	55 (29)	205 (107)	1	98
	Cromwell Rd 2	92 (48)	253 (132)	12	98
	Marylebone Rd	90 (47)	325 (170)	51	85
2000	North Kensington	40 (21)	425 (222)	3	96
	West London	53 (28)	304 (159)	0	98
	Cromwell Rd 2	88 (46)	746 (390)	12	94
	Harrods*	74 (39)	2818 (1473)	**52**	72
	Chelsea Town Hall*	86 (45)	270 (141)	2	25
	Marylebone Rd	92 (48)	570 (298)	100	96
2001	North Kensington	42 (22)	220 (115)	4	96
	West London	52 (27)	187 (98)	0	95
	Cromwell Rd 2	76 (40)	204 (107)	1	97
	Harrods	83 (43)	325 (170)	**97**	97
	Chelsea Town Hall	86 (45)	228 (120)	16	95
	Marylebone Rd	82 (43)	273 (173)	74	94

* Indicates sites which have operated for part of a year only, data from these sites must be treated with caution. Other sites in central London are included for an improved overview

NO_x emissions v NO_2

While there has been a decline both in estimated emissions and measured annual mean levels of total NO_x, a similar trend for nitrogen dioxide is far less clear-cut. This is because nitrogen dioxide is not emitted directly from combustion processes but formed as a result of reactions in the air involving other gases like ozone. Emissions from combustion processes are in the form of various nitrogen oxides (NO_x) but predominately nitric oxide. Because of the complex nature of its formation, a decline in NO_x emissions does not necessarily mean a proportional reduction in nitrogen dioxide. A more variable pattern is emerging at the monitoring sites. Using a linear regression method, slopes for the trends have been calculated and plotted on graphs. The results are given for three monitoring locations: 'West London', 'North Kensington', and 'Cromwell Road' and are in ppb not μg/m^3.

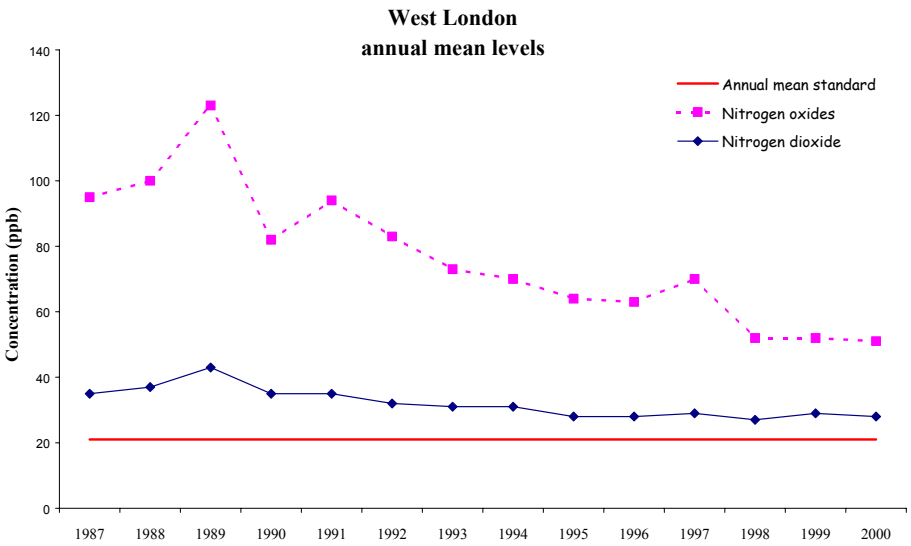


Figure 7

This chart shows that while NOx levels have declined by approximately 4.5 ppb per year over the timescale shown nitrogen dioxide has declined by less than 1 ppb per year.

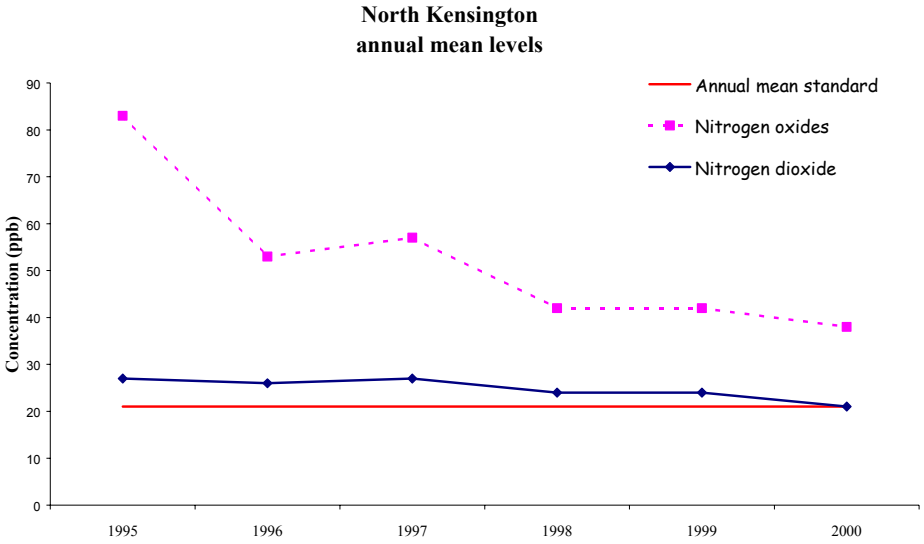


Figure 8

At North Kensington NOx levels have declined by 7.8 ppb per year nitrogen dioxide has declined by just over 1 ppb since 1995 when monitoring first started at this location.

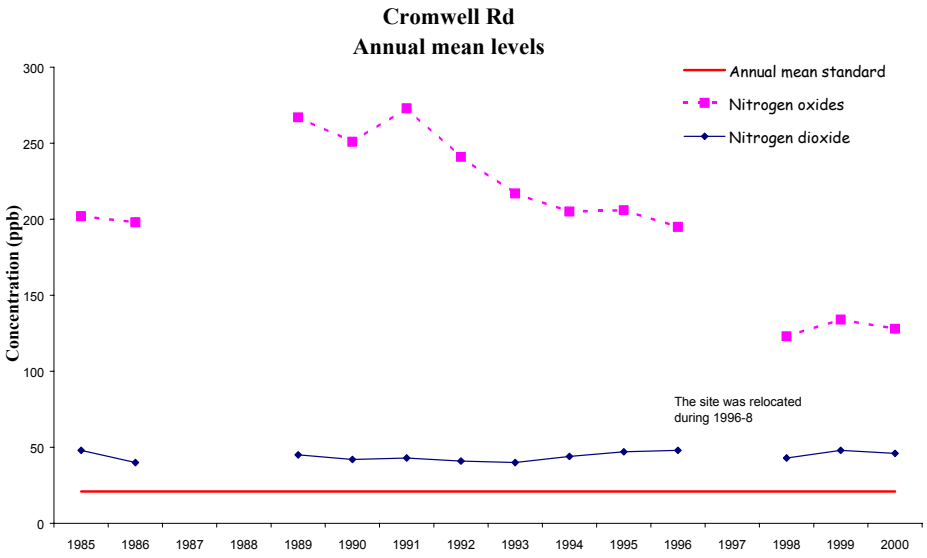


Figure 9

Cromwell Road NOx levels have declined by approximately 7ppb per year while nitrogen dioxide has increased by 0.2 ppb per year since 1985. It is important to note that this trend has been somewhat interrupted by data loss and the relocation of the site during 1996-98.

Appendix A2 - PM_{10} monitoring data

Monitoring difficulties

Particulate matter (PM_{10}) has only recently been monitored continuously and at fewer locations than nitrogen dioxide within the Borough, therefore clear trends are harder to establish for PM_{10} than nitrogen dioxide. For this reason, additional central London sites are examined. The government advise data collected by TEOM should be factored to take into account the difference between the automated (TEOM) and gravimetric method of monitoring. This introduces a further element of uncertainty, because the factor is uniformly applied. Consequently where monitored data is close to objective levels it may be advisable to be cautious in drawing conclusions. Increasingly more gravimetric monitoring is being undertaken, but it is not without its own problems. The method is more costly to operate because it is more labour intensive and for practical purposes the sampling frequency is limited to a 24-hour average. Because it is not a fully automated method, the results are only available normally some weeks after sampling.

New Monitoring

Gravimetric monitoring of PM_{10} by DEFRA commenced during 2000 at North Kensington but little data is available for 2000. A further site has now been installed by the council at a kerbside location on Earl's Court Road. It may be some time before long-term ratified data is available though initial results will be available shortly from this site.

Table 3 Concentrations of particulate matter PM_{10} (TEOM) measured in the Borough and other nearby locations ($\mu g/m^3$)

Year	Site	Annual mean $\mu g/m^3$ (TEOM)	Annual mean $40\mu g/m^3$ (GRAV)	No of days above $50\mu g/m^3$ (GRAV) fixed 24 hr mean	% Data Capture
1995	North Kensington*	26	34	25	75
	Bloomsbury	28	36	58	93
1996	North Kensington	25	33	35	98
	Bloomsbury	30	39	65	92
1997	North Kensington	24	31	34	98
	Bloomsbury	27	35	43	96
	Marylebone Rd*	39	51	50	45
1998	North Kensington	20	26	16	98
	Bloomsbury	23	30	21	94
	Cromwell Rd2*	28	36	28	60
	Marylebone Rd	32	42	85	98
1999	North Kensington	21	27	16	99
	Bloomsbury	22	29	21	96
	Cromwell Rd2	30	39	51	95
	Marylebone Rd	35	46	114	95
2000	North Kensington	20	26	11	96
	Bloomsbury	21	28	11	97
	Cromwell Rd2	27	35	30	97
	Marylebone Rd	37	48	159	99
2001	North Kensington	20	26	15	96
	Bloomsbury	22	29	18	98
	Cromwell Rd2	27	35	34	99
	Marylebone Rd	34	43	106	89

* Indicates sites that operated for part of a year, data from these sites must be treated with caution. Other sites in central London are included for an improved overview.

Appendix A3 – Unforeseen modelling problems

Whilst revisiting the stage three work a miscalculation was detected in the modelling work carried out by the consultants. The miscalculation related to pollution emitted from traffic and consequently affected both the nitrogen dioxide and the particulate matter results. It happened when the consultants increased the accuracy of the data for pollution being emitted from vehicles during the final stages of the stage three work, when using traffic counts instead of modelled traffic flows (see previous report entitled '*Review and Assessment of Air Quality in the Royal Borough of Kensington and Chelsea - Stage Two and Three'*, page 11, item 6.06). This miscalculation resulted in the overall emissions being about 20% higher than what they should have been.

The work, therefore, had to be repeated and the revised pollution maps are illustrated below.

The remodelled work showed that for both nitrogen dioxide and particulate matter the results were lower then the results modelled in May 2000. For example, the annual average nitrogen dioxide concentrations on the busiest roads were 3-6ppb lower then the 2000 results. Having corrected the mathematical error, the revised modelling results still showed significant areas of exceedence for annual average nitrogen dioxide along most of the major roads in the Borough. For particulate matter some of the major roads had areas of exceedences of the 90.14^{th} percentile of $50\mu g/m^3$ and nearly the whole Borough was greater then $49\mu g/m^3$. Therefore there were still grounds for declaring the whole Borough an air quality management area.

Figure 1. Annual average NO_2 concentrations for 2005 (1997 met data)

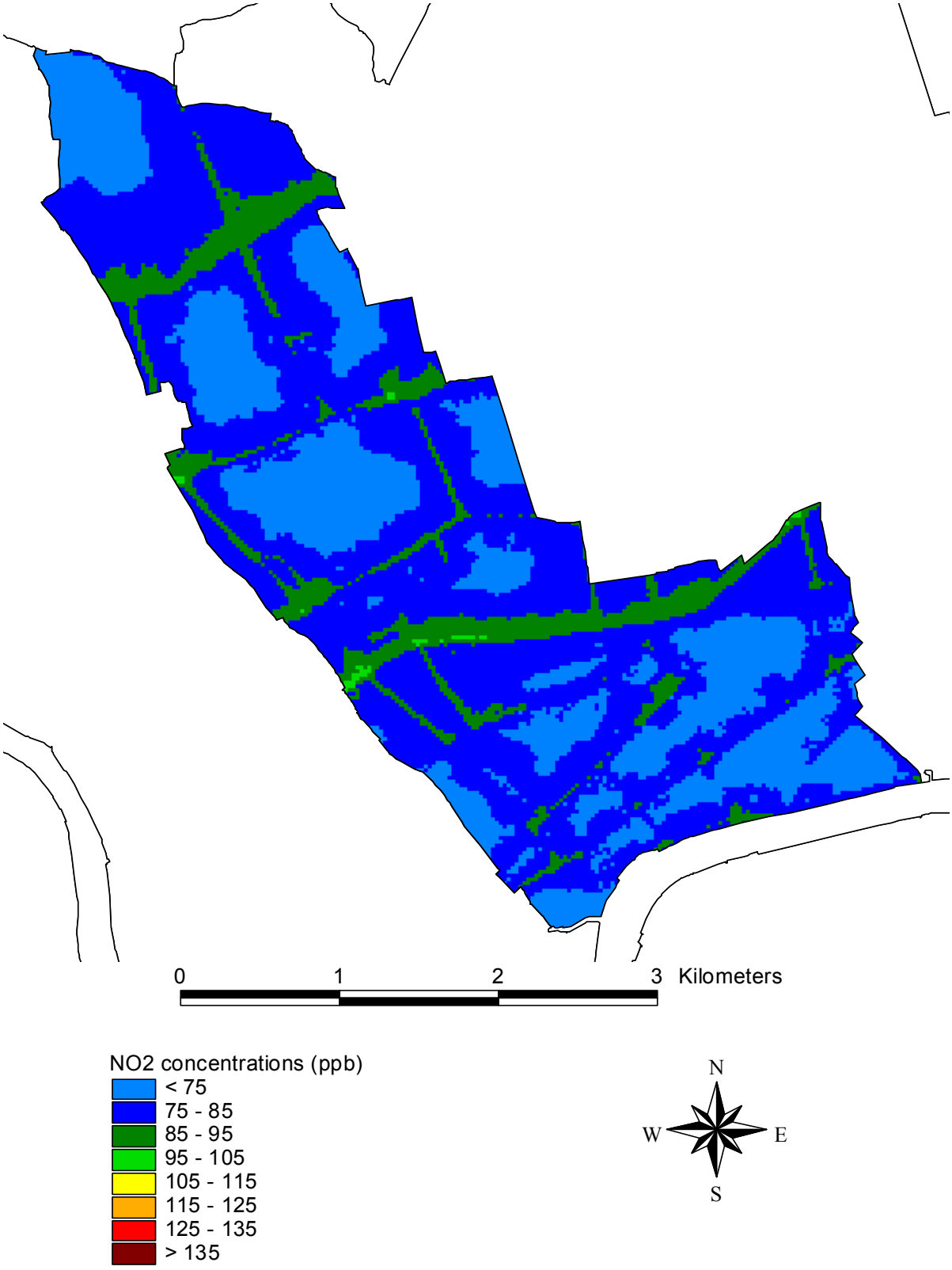


Figure 2. 99.8th percentiles of hourly average NO_2 concentrations for 2005 (1997 met data)

Figure 3. Annual average PM_{10} concentrations for 2004 (1996 met data)

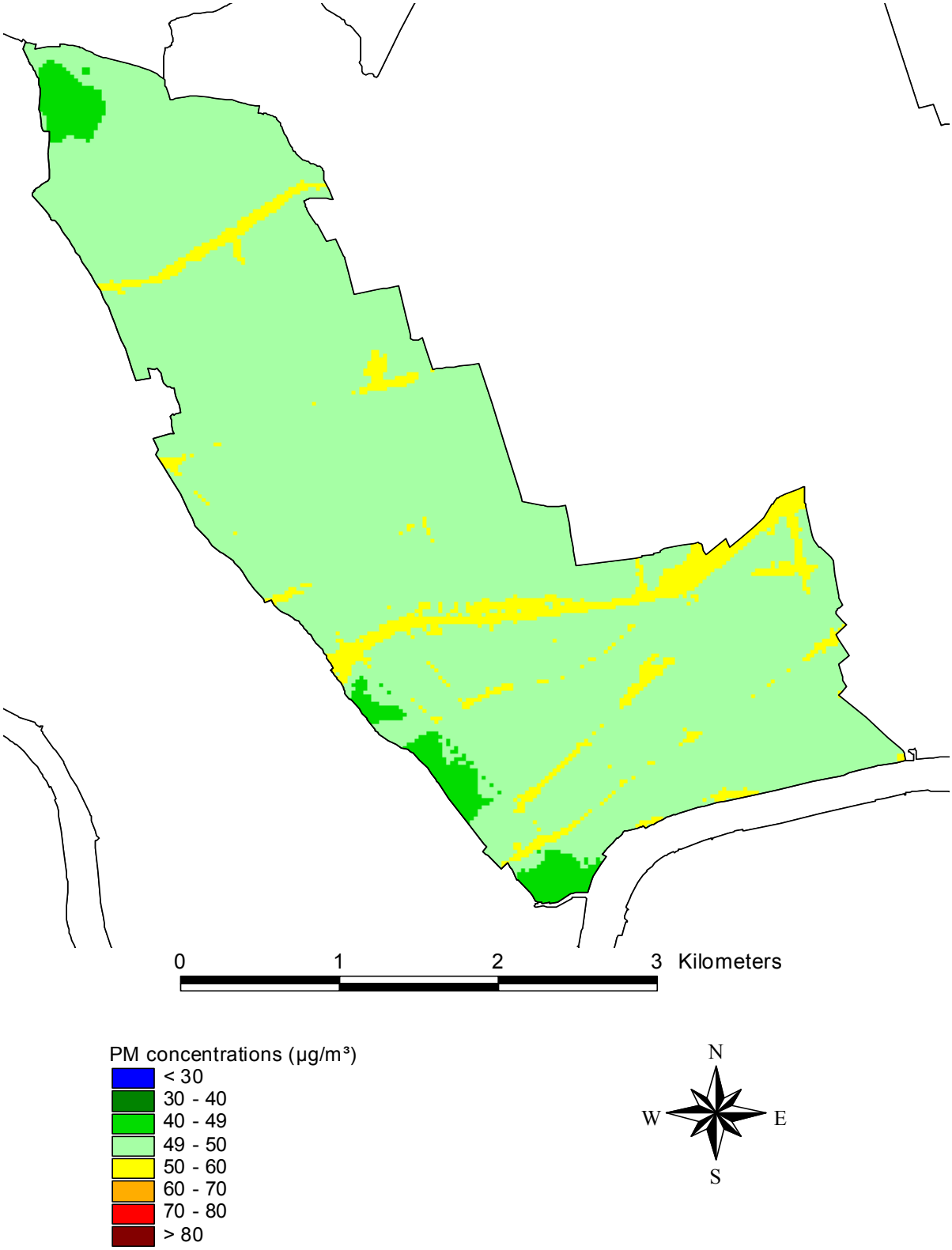


Figure 4. 90.14th percentiles of 24-hour average PM_{10} concentrations for 2004 (1996 met data)

Appendix A4 - The National Air Quality Strategy assumptions

In the modelling work carried out for stage three, the reduction in road emissions of nitrogen oxides (NOx) across London between 1996 and 2005 was 74%. However, in the National Air Quality strategy for England and Wales it states: '*Policies currently in place or to take effect before 2005 are expected to lead to further reductions of up to 56% of urban traffic emissions of nitrogen oxides (NOx) on 1996 levels'*[1]. Further modelling was therefore carried out to see what effect using the figure of 56% as stated by central government would have on the Borough's exceedences areas. This remodelling work was only carried out for the pollutant nitrogen dioxide, therefore all NO_x road emissions had to be increased by a factor of 1.69. This meant that inside Kensington and Chelsea, the traffic flow along all roads had to be increased by 69% and the emission rates recalculated giving an equivalent increase in NO_x emissions. Outside Kensington and Chelsea, the road component of the total gridded NO_x emission was also increased by 69%. The results of this work can be seen below.

In summary, the results have shown a much larger area around the Borough's busiest road where the annual mean objective was likely to be exceeded. For the first time, there were even some exceedence areas of the hourly mean for nitrogen dioxide along the Cromwell Road.

[1] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland 'Working together for Clean Air' – page 46 item 199 Current and future air quality.

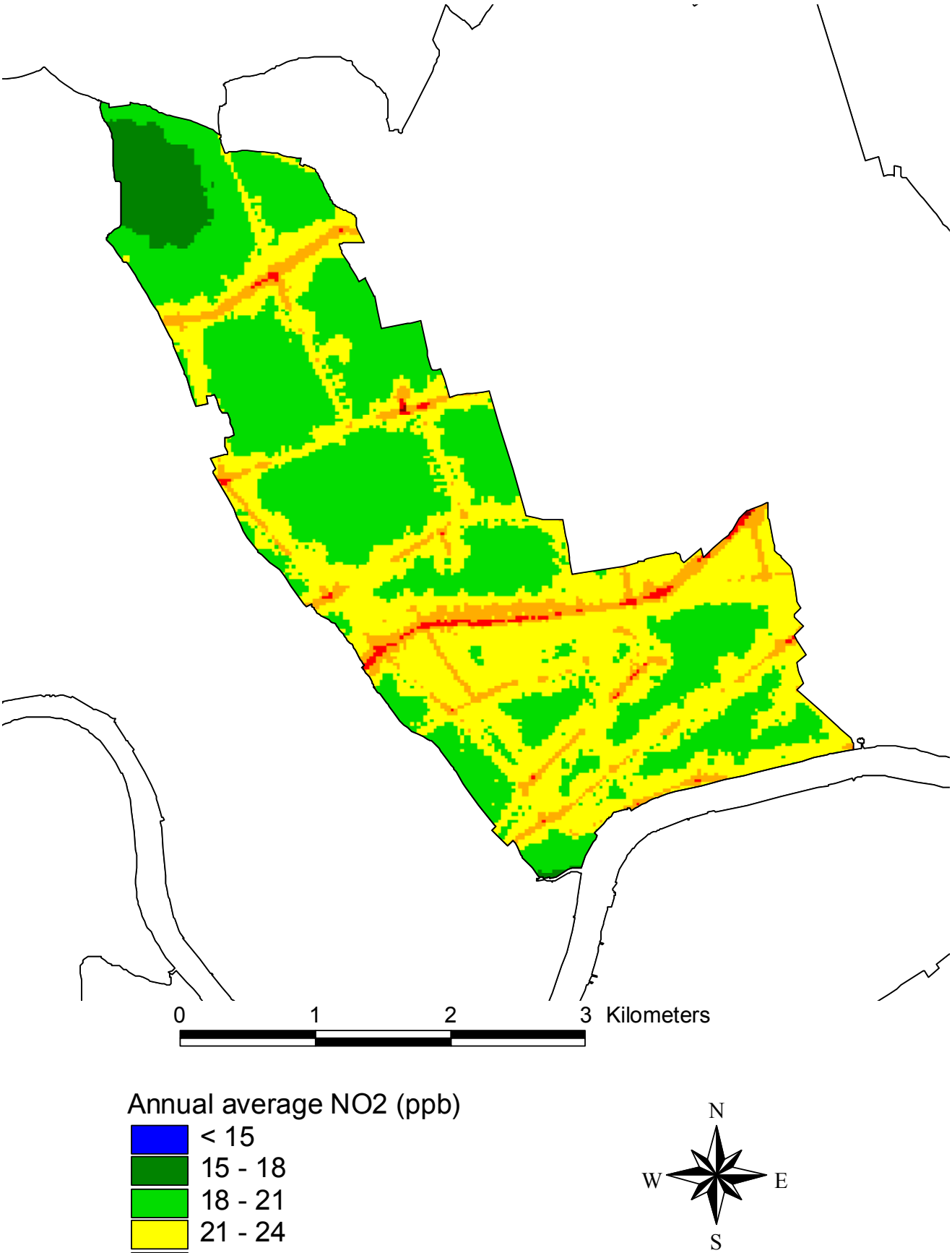


Figure 1. Annual average NO_2 concentrations with increased NO_x traffic emissions

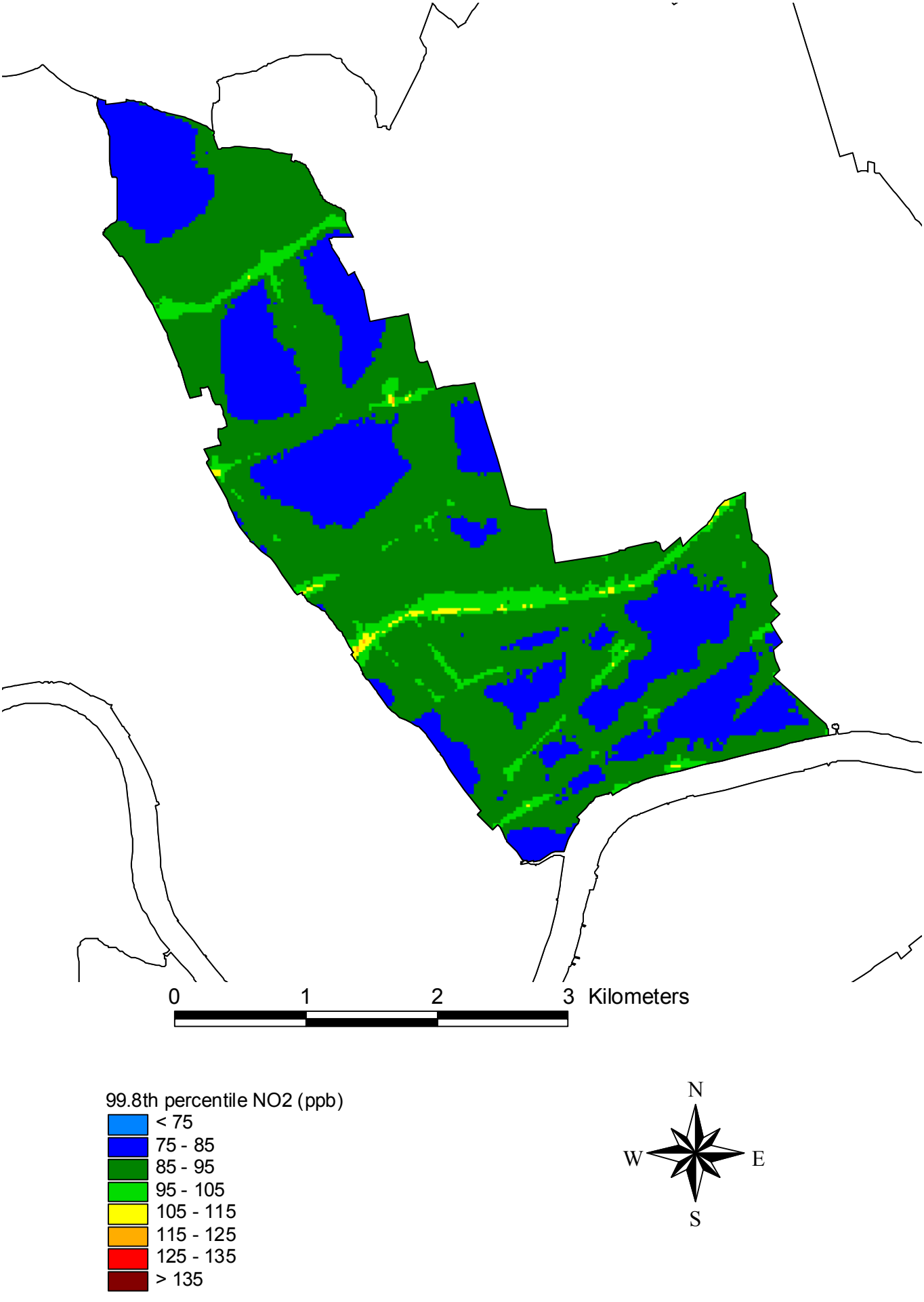


Figure 2. 99.8th percentile NO_2 concentrations with increased NO_x traffic emissions

Appendix A5 – The Air Quality Management Order

ROYAL BOROUGH OF KENSINGTON AND CHELSEA

ENVIRONMENT ACT 1995 SECTION 83

THE ROYAL BOROUGH OF KENSINGTON AND CHELSEA
AIR QUALITY MANAGEMENT AREA ORDER 2000

WHEREAS

(1) The Mayor and Burgess of the Royal Borough of Kensington and Chelsea of the Town Hall, Hornton Street, London W8 7NX (in this Order called "the Council") have carried out an air quality review in the Borough.

(2) As a result of the said review the Council has decided that the United Kingdom National air quality standards or objectives are not being achieved and are not likely to be achieved by 2004/2005.

NOW in exercise of the powers conferred upon them by the Environment Act 1995 Section 83 the Council makes the following order;-

1. This Order may be cited as the Royal Borough of Kensington and Chelsea Air Quality Management Area Order 2000 and comes into operation on 6th December 2000.

2. The whole of the area of the Royal Borough of Kensington and Chelsea shown hatched in blue on the plan attached hereto is designated as an air quality management area.

3. This Order may be varied or revoked by a subsequent order.

Dated 6th December 2000

THE COMMON SEAL of the MAYOR)
AND BURGESSES OF THE ROYAL)
BOROUGH of KENSINGTON AND)
CHELSEA was hereunto affixed)
in the presence of:-)

D. O'Brien.

ADMINISTRATION MANAGER

DATED DECEMBER 2000

ROYAL BOROUGH OF KENSINGTON AND CHELSEA

ENVIRONMENT ACT 1995 SECTION 83

THE ROYAL BOROUGH OF KENSINGTON AND CHELSEA AIR QUALITY MANAGEMENT AREA ORDER 2000

Richard Hemmings
Director of Legal Services
Royal Borough of Kensington and Chelsea
Town Hall
Hornton Street
London W8 7NX

Ref: LP
Tel: 020 7361 2180
Fax: 020 7361 3843

TECHNICAL ANNEXES
CERC REPORTS

This annex comprises of two lengthy technical reports, which cover the complex modelling work carried out for the Council and seven other central London local authorities, by Cambridge Environmental Research Consultants Ltd (CERC). Strictly speaking the findings are those of CERC, but the Council has based its conclusions on the findings.

The two reports are contained in two separate documents titled:

- **(Annex 1) – 'Modelling Air Quality in Central London Stage 4' 26th June 2002**
- **(Annex 2) – 'Source Apportionment for Central London' 21st August 2002**

To obtain copies of these documents please contact:

Mr Hugh Donohoe on tel: 020 7341-5683

GLOSSARY

Advanced air quality dispersion model - air quality dispersion models are used to predict pollutant dispersion and deposition patterns. This helps to identify areas where highest ambient concentrations are to be expected.
AQMA - Air Quality Management Area, an area to be designated by a local authority where it is likely that the air quality objectives in the NAQS will not be achieved by 2005.
Air Quality Action Plan – A plan of initiatives that will be taken to improve air quality.
Automatic monitoring sites - sites producing high-resolution measurements typically hourly or shorter period averages.
AURN - Automated Urban Rural Network - A DEFRA (then DETR) air quality monitoring network.
AURN affiliate - a monitoring site owned and operated by a local authority but included in the DEFRA network of sites.
Background site - a sampling site greater than 40 metres from the source/road.
Benzene - an aromatic hydrocarbon.
1,3-Butadiene - colourless gaseous hydrocarbon.
Carbon monoxide - gas formed by the incomplete combustion of carbon containing fuels.
DETR - Department of Environment, Transport and the Regions since replaced by DEFRA.
DEFRA – Department of Food & Rural Affairs.
Diffusion tube - a small air pollution monitor that passively absorbs a pollutant over a monthly time period, and is then collected and analysed.
Emissions inventory – a data set of pollution emitted from a variety of sources.
Fine particles – see Particles.
Gravimetric method – a method of sampling particulate matter by collecting it on a filter and weighing it.
8 hr running mean - an average taken over an 8-hour period, which progresses hour by hour.
Intermediate site - a sampling site within 20-40 metres of the source/road.
Kerbside site – a site sampling within 1 metre of a busy road.
Lead – one of the heavy metals that are a toxic and acts as a cumulative poison.
LAQN - London Air Quality Network, a network run by a consortium including local authorities, the Environmental Research Group - King's College (formerly South East Institute of Public Health) and the Association of London Government, to co-ordinate air pollution monitoring.
$\mu g/m^3$ - a microgram of pollutant in a cubic metre of air
NAQS - National Air Quality Strategy, issued by the DoE in 1997 to implement the air quality part of the Environment Act 1995.
Nitric oxide (NO) - a colourless toxic gas arising from the combination of atmospheric nitrogen with oxygen in high temperature combustion.
Nitrogen dioxide (NO_2) - a stable brown gas largely produced by the oxidation of NO which is more toxic than NO.
99^{th} percentile - the concentration at which 99% of the data are below
Particles – or fine particles, these are microscopic particles of varying composition, and for the purposes of this report the term 'particles' refers to a range of particle sizes from 10μ to 0.1μ.
Pollutant specific guidance – issued by DEFRA, provides advice on review and assessment for each pollutant identified in the air quality regulations 1997.

Objective –we have used the word objective throughout this report. This is the term used by the Government to describe standards which have a set timescale (i.e. a target date) for their achievement.
ppb - parts per billion.
ppm - parts per million.
PM_{10} - particulate matter less than 10 μ (micrometres) in diameter.
Roadside site - a sampling site between 1 metre of the kerbside of a busy road and the back of the pavement. Typically within 5 metres of the road.
Screening models - give a preliminary level of assessment and only require simple input data.
Source apportionment – the degree to which various sources of pollution contribute to air quality problems.
Sulphur dioxide (SO_2) - a colourless toxic and acid forming gas, it is the main product of the combustion of sulphur contained in fuels.
Technofix – the use of improved engine and fuel technology to reduce pollution.
TEOM - Tapered Element Oscillating Microbalance - a device for measuring fine particles.

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