Environmental Health Business Unit

OXFORD CITY COUNCIL

Local Air Quality Management: Central Oxford Air Quality Action Plan

Draft for Consultation

A Requirement under Part IV of the Environment Act 1995.

July 2005

Executive Summary

This document sets out Oxford City Council's draft Air Quality Action Plan (AQAP) for the Central Oxford Air Quality Management Area (AQMA). The AQMA was declared because assessments of air quality predicted that the annual mean objective for nitrogen dioxide of 40 $\mu g/m^3$ is not likely to be met by the target date of December 2005.

Nitrogen dioxide pollution arises primarily from emissions of a mixture of nitrogen dioxide and nitric oxide from combustion processes such as vehicle engines. When mixed with ambient air nitric oxide is converted to the pollutant nitrogen dioxide. Together, nitrogen dioxide and nitric oxide are referred to as oxides of nitrogen (NOx). The draft AQAP therefore puts forward a range of actions aimed at reducing NOx emissions in order to achieve the air quality objective for nitrogen dioxide.

An average reduction in NOx emissions of 68% is required in order to meet the air quality objective, although the amount varies from street to street (32% - 90%). In Queen Street, New Road, St Aldate's, George Street and the High Street buses contribute the largest proportion. Whereas in Beaumont Street, Longwall Street, Worcester Street and Hythe Bridge Street cars are the largest single contributor. Action plan measures have therefore been considered on a street-by-street basis where possible.

The main action proposed is that a Low Emission Zone (LEZ) should be introduced for certain streets in the AQMA. This would ensure that only vehicles meeting minimum emission standards would be allowed to enter designated parts of the city centre.

The main source of the pollution in the AQMA is from road traffic. Guidance from the Department for Environment, Food and Rural Affairs (DEFRA) states that, where road traffic emissions are the largest single contributor to pollution in the AQMA, the AQAP should be integrated with the Local Transport Plan (LTP). The next LTP, which sets out a five-year strategy (2006-2011) for the co-ordination and improvement of transport is currently being prepared by Oxfordshire County Council. Air quality is one of five priority objectives in the LTP against which investment in transport schemes will be assessed. Actions proposed in the LTP will therefore have a significant bearing on whether or not the air quality objective for nitrogen dioxide will be met.

Oxford City Council has a statutory duty to review and assess air quality and improvements in the AQMA will be assessed against the current baseline data. A local pollution concentration target will also be agreed with Oxfordshire County Council for inclusion in the LTP having regard to the air quality improvements required in the AQMA. It will be necessary to introduce actions over a number of years. Intermediate outcomes will therefore be set so that the effectiveness of the actions, in working towards the air quality targets can be assessed at regular intervals.

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1.1 Background

The Environment Act 1995 places a statutory duty on Local Authorities to carry out a programme of Local Air Quality Management (LAQM) including the periodic review and assessment of air quality in their area. The LAQM process to date and future programme is summarised in Appendices 1 and 2.

The review and assessment is made against air quality objectives prescribed in the Air Quality (England) Regulations 2000 as amended. The objectives are expressed as air quality standards with target dates for compliance, for example annual mean nitrogen dioxide of 40 microgrammes per cubic metre ($\mu g/m^3$) to be achieved by December 2005 (Appendix 3). The objectives for each pollutant have been set with regard to the impact of the pollutants on health, World Health Organisation Air Quality Guidelines, and European Union Directives. If the review and assessment concludes that an air quality objective is not likely to be met by the target date, then the Local Authority must declare an Air Quality Management Area (AQMA) for that area of its district. AQMA's are therefore pollutant specific. An Air Quality Action Plan (AQAP) must then be produced for each AQMA setting out actions and projects to improve air quality in that area.

In September 2001 Oxford City Council designated an AQMA, known as the Central Oxford Air Quality Management Area, covering part of the city centre. The designated area was extended in September 2003 (Figure 1).

The AQMA was declared because assessments of air quality predicted that the annual mean objective for nitrogen dioxide of 40 $\mu g/m^3$ is not likely to be met by the target date of December 2005.

The annual mean is the average concentration measured over a period of one calendar year. For an air quality objective not to be met members of the public must be regularly exposed over the averaging period of the objective. Nitrogen dioxide is thought to have both acute and chronic effects on airways and lung function, particularly in people with asthma.

Examples of where air quality objectives should or should not apply are summarised in Appendix 4.

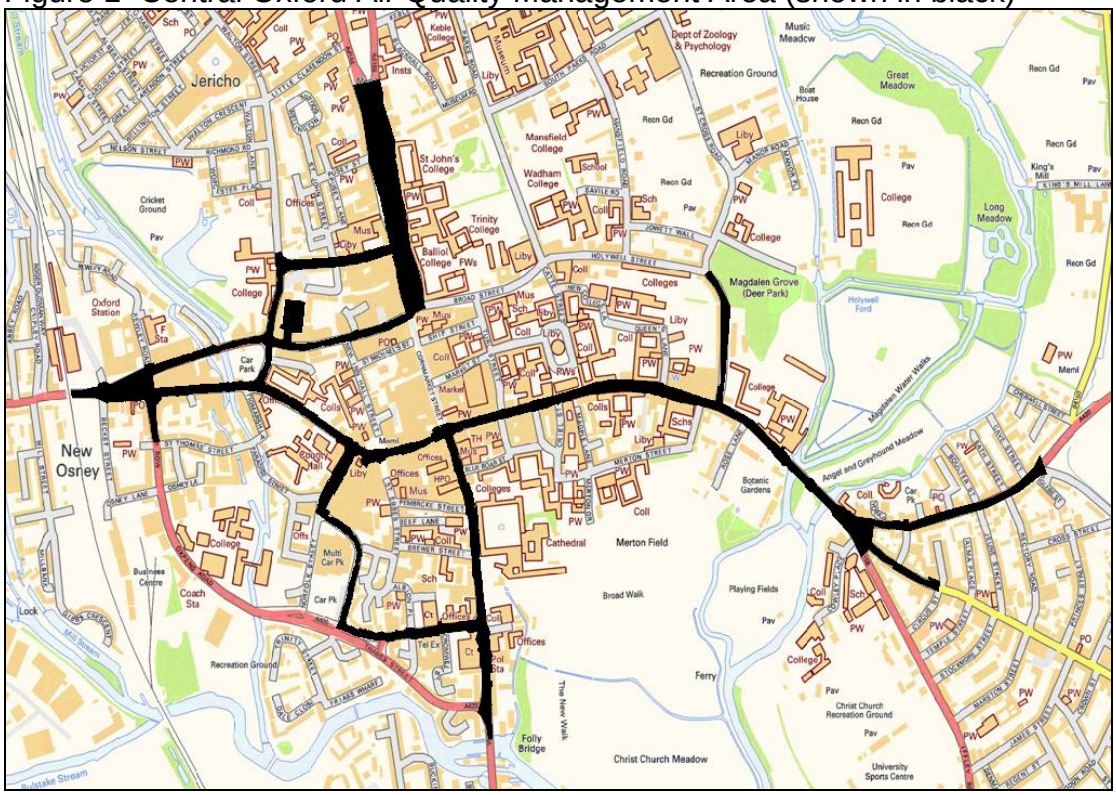
The AQMA was based on computer model predictions of likely air quality in the future taking account of matters such as traffic flows, new vehicle technology and weather data. Modelled predictions are validated against measured data from air quality monitoring sites. Air quality assessments will be repeated every three years and if air quality has improved or worsened, or if the air quality objectives change the AQMA may be revoked or modified.

1.2 Air Quality Action Plan

This document presents the consultation draft of the action plan for the AQMA. The action plan outlines a package of actions that are considered to be the most appropriate way of reducing nitrogen dioxide pollution in central Oxford. Many actions that will result in a reduction in nitrogen dioxide will also reduce other pollutants and the greenhouse gas carbon dioxide.

In central Oxford vehicles have been shown to account for up to 80% of nitrogen oxide (NOx) emissions[1]. Where road transport emissions are the largest single contributor to the pollution in the AQMA, it is recommended that the AQAP be integrated with the Local Transport Plan[2]. Oxfordshire County Council as the authority responsible for transport planning is required to develop the LTP. Under the Environment Act 1995 it has a duty to propose actions that work towards meeting the air quality objectives within the AQMA.

Figure 1 Central Oxford Air Quality Management Area (shown in black)



1.3 Local Transport Plan

The Local Transport Plan sets out a five-year strategy for the co-ordination and improvement of transport. The provisional LTP currently being drafted by Oxfordshire County Council will outline the transport policy for Oxford City from April 2006 until 2011. Five priority objectives; tackling congestion, delivering accessibility, safer roads, better air quality and improving the quality

[1] Air Quality Review and Assessment – Stage 1&2 for Oxford January 1999
[2] Local Air Quality Management Policy Guidance LAQM PG(03) DEFRA 2003

of the street environment are proposed in the LTP. Air quality as a priority objective is being introduced into the LTP process for the first time. The objectives are weighted, such that some are afforded greater priority than others see Table 1. These objectives, and the weightings afforded to them are likely to have a significant bearing on the priorities for investment in transport schemes over the next five years, and ultimately on whether or not air quality objectives are likely to be met.

Table 1 Proposed Weightings for Priority Objectives

Problem type	Maximum score
Congestion	1600
Road safety	1200
Accessibility	1100
Air Quality	1000
Street Environment	800

The weightings will be applied uniformly across Oxfordshire. Following a report to the Oxford City Council Environmental Scrutiny Committee in May 2005 Oxfordshire County Council were asked to apply a higher weighting to road safety and air pollution when assessing transport schemes in Oxford City.

Measures identified under one priority may impact on another. In some cases the knock on effect may be a net benefit, in others it may be in conflict and increase vehicle emissions in some areas. For example, reducing congestion should also result in a reduction in total emissions from road traffic. Whereas increasing accessibility, for example by creating a bus priority route and limiting through traffic in the city centre, has reduced emissions in some streets (Cornmarket Street), but increased emissions in others (St Aldate's and George Street).

Consultations on both the AQAP and the LTP have been scheduled to coincide see Table 2.

Table 2 AQAP and LTP Timetable

Date	Action Plan	Local Transport Plan
May 2005	Outline submitted to DEFRA and Oxfordshire County Council.	Provisional submitted to Oxford City Council and Oxfordshire District Councils for consultation.
June 2005	Finalise provisional document.	Provisional submitted to County Executive Board for approval.
July 2005	Provisional submitted to City Executive Board for approval. Amended as required by Executive Board. Submission to DEFRA	Provisional submitted to the Department for Transport (DfT).
Aug - Oct 2005	Public Consultation	Public Consultation
January 2006	Provisional amended to take account of public comments.	Provisional amended to take account of public comments.
February 2006	Final submitted to City Executive Board, and Council for approval and amended as required.	Action plan measures integrated into LTP.
March 2006	Final Action Plan submitted to DEFRA.	Final Local Transport Plan submitted to DfT.

1.4 Transport and Environment Policy Issues

The Government White Paper, "The Future of Transport" a network for 2030 acknowledges the need for a good transport system as essential for a successful economy and society. It also acknowledges that we must balance the increasing demand for travel against our goal of protecting the environment by delivering faster, greener and more reliable journeys, especially in urban areas.

Reducing the environmental impact of traffic is one of eight key challenges identified in the Government's 10 year Transport Plan[3], facing local transport authorities.

In the UK, transport is currently estimated to produce a quarter of the total UK emissions of CO_2. Cost-effective measures to reduce emissions from transport are therefore very important if the UK is to meet its climate change objectives.

Transport policies that aim to reduce congestion or CO_2 emissions, will also help to improve air quality. At the national and European level tighter emission standards for new vehicles and fuels have been the most effective measures to reduce total levels of vehicle emissions.

[3] DfT Transport 2010 : Meeting the Local Transport Challenge

A new car today produces 20 times less emissions than an equivalent vehicle in the mid-1980s. As a result NOx emissions from road transport have fallen by 50 per cent despite traffic growth.

There is an increased awareness within the Department for Environment Food and Rural Affairs (DEFRA) and the Department for Transport (DfT) of the close links that exist between actions that are broadly considered as transport management actions, and actions that are required to reduce polluting emissions, improve local air quality and limit the contributions to climate change.

Limiting the access of private vehicles to urban centres in historic cities is an increasing focus not only in the UK but Europe wide. Many cities are beginning to consider ways of a more sustainable approach to transport provision in urban environments. Some cities are considering using area management schemes such as Clear Zones[4] or Low emission zones.

The Clear Zone vision involves “a city where you can live without breathing-in polluted air; a city where you can travel with ease to work, to the shops, to a film, restaurant or bar; where your shopping is automatically delivered to your home, the train or bus station or your car; where zero-emission vehicles transport people from one location to another; and cyclists, pedestrians, elderly and disabled people can all move around freely and without fear “

In the European Union, the Trendsetter Project[5] within the Civitas Programme aims to improve mobility, quality of life, air quality, and reduce noise and traffic congestion.

Low emission zones enable priority access to designated urban areas by low emission vehicles. Low Emission Zones are, in effect, Clear Zones that are focusing on the use of clean vehicle technology to meet air quality objectives.

The options for cleaner vehicle fuels, clean low carbon transport and technologies are considered an important part of the urban transport solutions. The Energy Savings Trust Transport Energy Programme[6] has produced guides for Local Authorities to take forward appropriate actions to promote their use, including “The Route to Cleaner Buses”.

School travel plans, workplace travel plans and personalised journey planning have helped prompt people to consider, and take up, alternatives to the routine use of their own car, especially for journeys at peak hours. These measures are often referred to as “Smart Choices”, involve personal choice, and contribute to local road traffic reduction. It is considered that active promotion of these options can be a cost effective approach to changing travel behaviour and contribute towards limiting urban traffic growth.

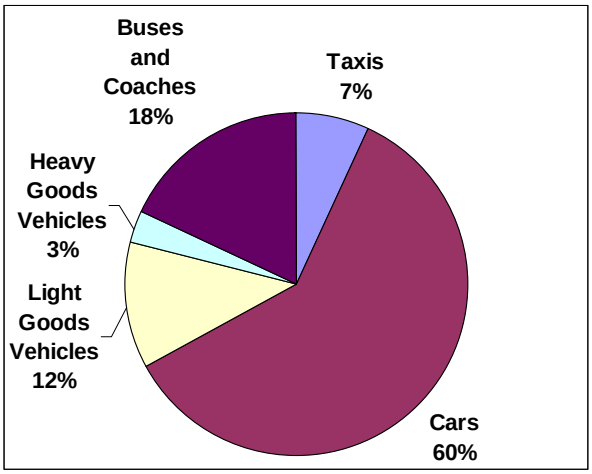
[4] Clear Zones Initiative. Details can be found at http://www.clearzones.org.uk
[5] EU Trendsetter programme can be accessed at http://www.trendsetter-europe.org
[6] Energy Savings Trust Transport Energy Programme http://www.transportenergy.co.uk

2 Air Quality and Transport

2.1 Where does the Pollution come from?

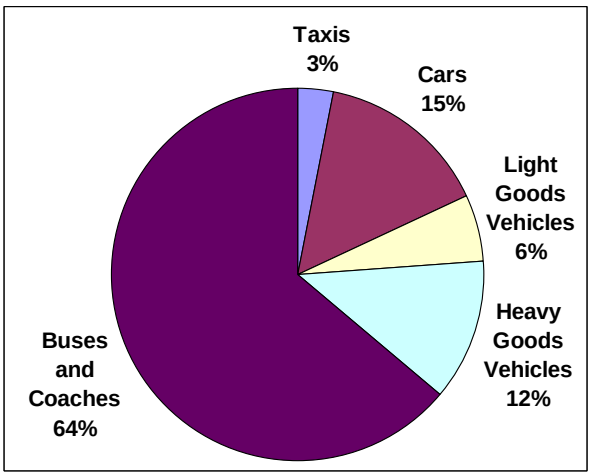
Nitrogen dioxide pollution arises primarily from the emissions of a mixture of nitrogen dioxide (NO_2) and nitric oxide (NO) from combustion processes such as vehicle engines. When mixed with air some of the nitric oxide is converted into the pollutant nitrogen dioxide. Nitrogen dioxide and nitric oxide are together referred to as nitrogen oxides (NOx). Reductions in NOx emissions need to be made in order to reduce nitrogen dioxide concentrations in the air. Improvements in nitrogen dioxide pollution concentrations should therefore be expressed in terms of equivalent NOx level emissions.

Within the AQMA approximately 60-65% of NOx emissions are from road traffic, although within particular streets the figure may be higher. At the monitoring site in St Aldate's, for example, emissions from traffic accounted for approximately 80% of the measured NOx levels[7].



In line with the national picture, the major traffic emissions in Oxford are from diesel powered heavy vehicles, including buses and coaches. This is despite the fact that over a 24hour period the majority of vehicle movements are due to cars. See Figure 2.

Figure 2 Traffic flow by vehicle type in the AQMA



A breakdown of NOx emissions by vehicle type shows the dominance of buses and coaches, and heavy vehicles. In the Oxford AQMA 76% of road traffic generated NOx is from the combined emissions from these sources, figure 3. This illustrates that a relatively small number of vehicles can contribute significantly to emissions of NOx.

Figure 3 NOx emissions by vehicle type in the AQMA

[7] Air Quality Review and Assessment – Stage 1&2 for Oxford January 1999

2.2 How much does pollution need to be reduced?

The objective level for nitrogen dioxide is 40μg/m^3. For the period 2000 to 2004 the average background concentration of nitrogen dioxide, that is the level in the atmosphere away from any pollution sources, measured 22μg/m^3. Therefore, to achieve the objective level the maximum nitrogen dioxide contribution from traffic sources must not be greater than 18μg/m^3. This is calculated by taking the background level from the objective level.

For the same period 2000 to 2004 the average roadside concentration of nitrogen dioxide measured within the AQMA was 45μg/m^3. This is 27μg/m^3 above the required level.

Based on the measured NO_2:NOx conversion relationship a 27μg/m^3 reduction in nitrogen dioxide equates to a 64μg/m^3 reduction in NOx, which represents a 68% reduction in NOx emissions.

This is an average figure for the whole AQMA. Where monitoring data is available for individual streets the total NOx reduction by street has been calculated. This was based on the predicted 2005 nitrogen dioxide level for that street. The figures in Table 3 give the percentage NOx reduction for individual streets for which monitoring data (diffusion tube data) was available. The contribution to the total NOx emissions by vehicle type within those streets is also given.

Table 3 NOx Reduction by Street and Contribution by Vehicle Type

Location	2005 Predicted NO_2 (μg/m^3)	% NOx Reduction Required	Percentage NOx Emissions by Vehicle Type				
			Car	Taxi	LV	Bus	HGV
Beaumont Street	51	49	43	4	16	18	19
High Street	81	83	1	4	1	71	23
Longwall Street	60	67	43	2	13	16	26
Queen Street	98	90	0	0	0	95	5
George Street	81	83	2	5	3	80	10
Frideswide Square	72	80	32	3	14	26	24
New Road	67	75	3	3	2	87	5
Park End Street	62	69	8	6	5	82	0
Speedwell Street	46	32	8	6	4	72	10
St Aldate's	58	63 (76)	4	4	3	81	8
St Giles	58	63	25	1	8	54	11
Worcester Street	55	58	44	4	17	24	11
St Clements Street	85	86	25	1	8	56	10
Hythe Bridge Street	48	40	43	4	17	25	11

Two figures are given for St Aldate's. The higher figure in brackets was calculated using continuous monitoring, and not diffusion tube data.

Continuous monitoring data are accurate measurements using pollutant specific monitors, subject to strict quality assurance control. The measurements are recorded at least hourly.

Diffusion Tube Data is less accurate than continuous monitoring. The diffusion tube contains a chemical that absorbs nitrogen dioxide over the sampling period, often a month.

These results highlight that measures to reduce NOx emissions in the AQMA have to be considered on a street-by-street basis. In Queen Street, New Road, St Aldate's, George Street and the High Street buses contribute the largest proportion. Whereas in Beaumont Street, Longwall Street, Worcester Street and Hythe Bridge Street cars are the largest single contributor.

2.3 What has been done already?

Some actions such as Park & Ride have been in place for over 30 years, and further developed through the Balanced Transport Strategy adopted in 1973. This policy had five key elements; control of city centre parking, residents parking schemes, bus priority measures, and facilities for pedestrians and cyclists.

2.3.1 Oxford Transport Strategy

The Oxford Transport Strategy (OTS) was implemented in 1999 and further developed the strong foundations of the Park & Ride network by increasing bus priority, accessibility and modal shift towards greater use of public transport. Key features of this included:

- Increased bus priority on radial routes into the city
- Introduction of a system for smoothing traffic signal control (SCOOT)
- Improvements to the cycling infrastructure
- Continual review of on-street parking controls and enforcement
- Traffic calming on residential roads close to the city centre
- Parking restrictions in residential roads
- High parking charges
- Expansion of the Park & Ride
- Exclusion of through traffic
- Pedestrianisation of Cornmarket Street

2.3.2 Bus Quality Partnership

The Bus Quality Partnership (BQP) introduced in 1998 is an agreement between Oxford City Council and Oxfordshire County Council, and the two main bus operators (Oxford Bus Company and Stagecoach). This agreement included a commitment from them to upgrade at least 85% of their buses on high frequency city bus routes to Euro 2 standard or better by summer 1999.

The agreement also included issues such as the operation of the bus priority route, location of bus stops and layover points for buses.

Unnecessary idling of engines causes needless pollution. The BQP therefore included a code of practice that bus engines will be switched off when the vehicle is likely to be stationery for any length of time. This practice covers the bus priority routes in the city centre, mainly Queen Street, St Aldate's, High Street, Castle Street, Magdalen Street, Butterwyke Place, Speedwell Street and New Road. The code is voluntary, has no statutory basis and therefore relies on the goodwill of the bus operators for its success.

Good information and awareness of public transport routes and timetables all help to encourage bus use as opposed to the car as a means of transport into Oxford.

2.3.3 Alternative Fuels

There are a number of alternative technologies on the market that have lower emissions than petrol or diesel. Oxford City Council believes it is important to lead by example and has implemented a clear policy to employ the cleanest technologies wherever possible. Up to 80% of the refuse trucks and road sweepers, and over half of all the vans in the fleet have either been replaced with low or zero emission vehicles, or had emissions abatement devices retro-fitted where the duty cycle allows. Oxford City Council is also actively investigating going over to 5% bio-diesel fuelled vehicles where possible. An independent report[8] of fleet emissions concluded that for the period 2000-2001 NOx emissions were reduced by 17%, along with more significant reductions in other pollutants. A further inventory of fleet emissions is to be completed by the end of March 2006.

2.3.4 Other Actions for road traffic reduction

These include initiatives such as Travelwise, Betterways to School, Corporate Travel Plans and Homezones. All these help to encourage or promote matters such as encouraging car sharing, providing pool cars, cycling incentives, cycle parking, showers and changing facilities, flexible working, homeworking, discounted bus and train tickets, and safer routes to school. These initiatives are generally referred to as 'smart choices' involve promoting changing travel behaviour in favour of reducing private car usage. Oxford City Council has already adopted a work place travel plan.

2.3.5 Impact on emissions and air quality

Looking at measured pollution data and modelling changes in traffic flows the impact in the AQMA of the OTS and accompanying measures outlined above have been assessed. As a result, since 1999 the AQMA has seen,

[8] An Emissions Inventory of Oxford City Council's Vehicle Fleet 2000-1. AEA Technology Jan 2002

- a 35% reduction in total vehicle movements
- an 8% reduction in NOx emissions
- a 14% increase in bus movements

There has however been a knock on effect with increased traffic flows and emissions in areas outside the AQMA, but the levels of pollution in the suburbs are not likely to be as high as in the City centre. This will be assessed in detail in future reviews and assessments of air quality.

3 Trends in Air Quality

Diffusion tube data from roadside locations within the AQMA has been used to examine the trends over the last ten years, see Figure 4. From 1995 to 2000 the data shows that nitrogen dioxide levels within the AQMA were falling by on average 4% per year. More recently however the trend shows levels to be increasing by on average 1.3% per year.

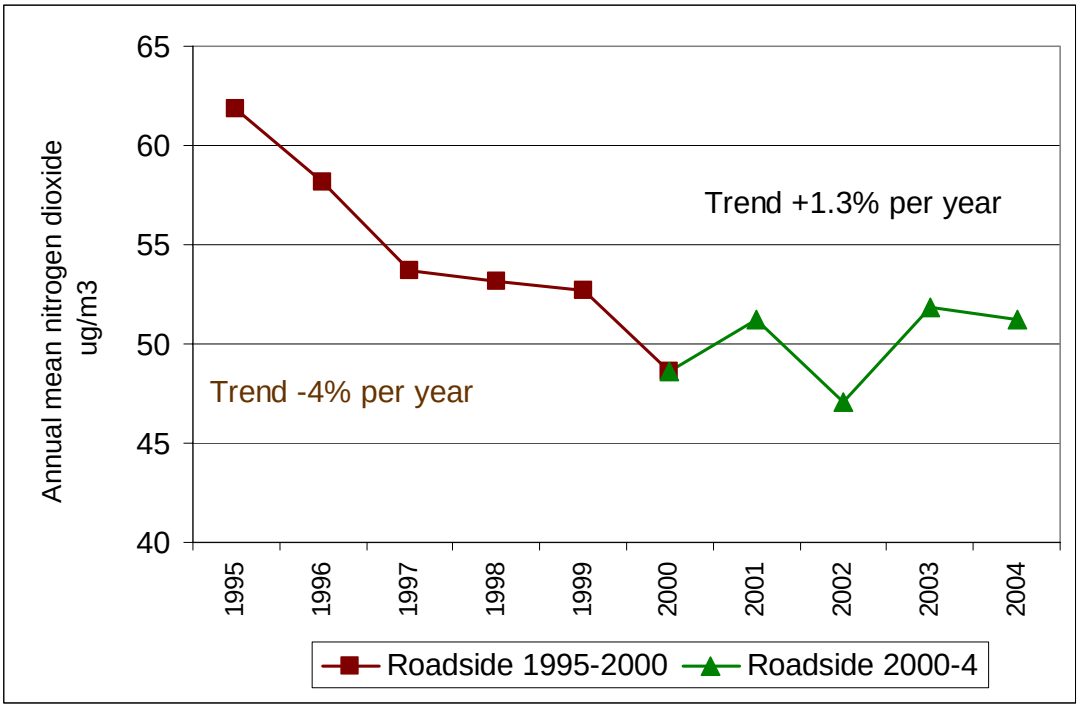


Figure 4 Average Diffusion Tube Data for the AQMA

Whilst this is the average trend across the whole AQMA the continuous monitoring data from the St Aldate's monitoring site shows a different picture, see Figure 5. The trend has on average, been a 5% per year increase in the annual mean nitrogen dioxide levels since 1998 for this one street. It is expected that this trend would be the same in other streets on the bus priority route (Queen Street, New Road, George Street and the High Street) where road traffic is dominated by buses. This increase has to be set against a small increase (approximately 1% per year) in the measured background levels of nitrogen dioxide.

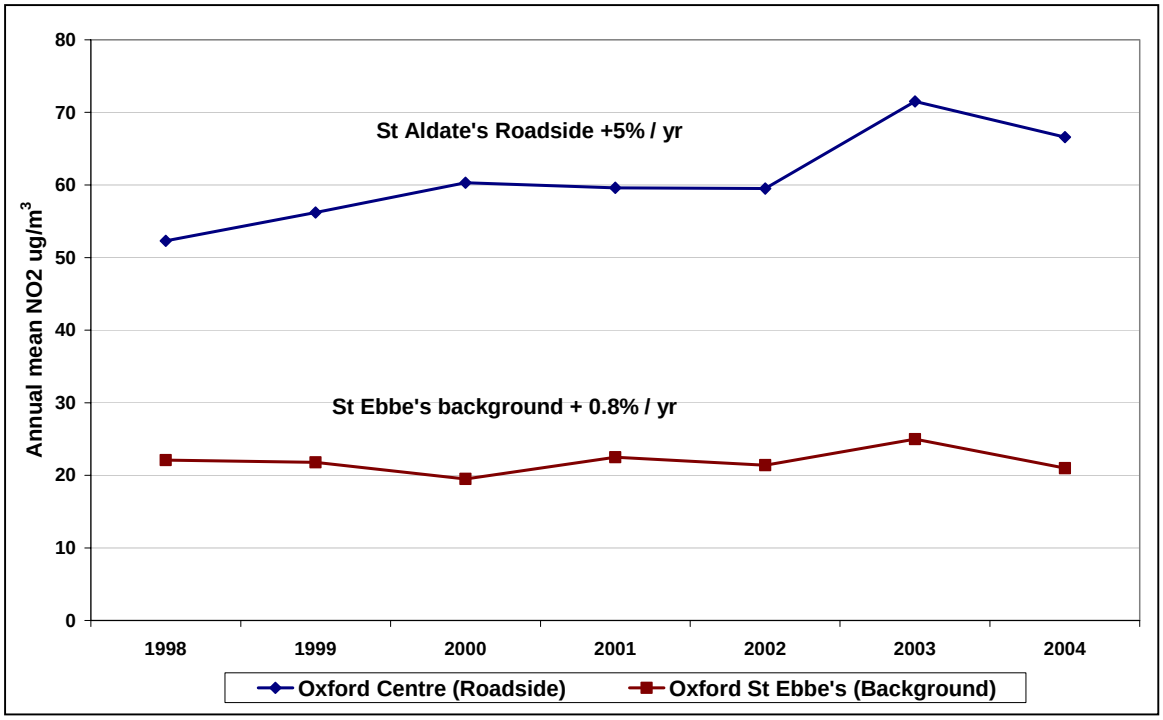


Figure 5 Trends in Continuous Monitoring data 1998-2004

These trends highlight that despite the measures taken to date, and the natural improvement in the vehicle fleet, the air quality objective for nitrogen dioxide will not be met without further intervention through the action plan.

Recently the speed limit in the city centre was reduced from 30mph to 20mph as an action to improve road safety. In some parts of the AQMA vehicle speeds will be even lower than this due to congestion. Whilst the speed limit has quite rightly been reduced for road safety reasons, buses and HGV's produce high levels of NOx at low speed and in stop-start traffic. For a vehicle fleet mix comprising 10% of heavy vehicles, a speed reduction from 30mph to 20mph is predicted to increase average NOx emissions by 27%[9].

[9] W S Atkins report 2001 Determination of the Potential Synergies and Conflicts Between Noise and Air Quality Action Plans

4 Central Oxford AQMA Summary

1. The air quality objective for nitrogen dioxide of 40 μg/m^3 is not likely to be met by the target date of December 2005.

2. Oxfordshire County Council is currently drafting the Local Transport Plan (LTP) for 2006 until 2011. The implementation of actions included in the LTP will have a significant bearing on whether or not air quality objectives will be met.

3. Buses generate the majority of emissions on the bus priority route within the AQMA. Cars, taxis and light goods vehicles are the main source of emissions on other roads in the AQMA.

4. To meet the air quality objective for nitrogen dioxide, emissions of NOx need to reduce by an average of 68% in the AQMA, although the amount required varies from street to street (32% to 90%).

5. Actions introduced under the Oxford Transport Strategy (OTS) reduced total traffic flows in the AQMA by as much as 35%.

6. The OTS (and other) actions introduced to date have reduced traffic generated NOx emissions by approximately 8% in the AQMA, although in some streets there has been an increase.

7. Despite the actions taken, trends in air quality measurements indicate that there has been no significant improvement in air quality in the AQMA over the last 5 years.

8. Speed reductions (from 30mph to 20mph) imposed in the city centre may have increased NOx emissions from heavy vehicles, including buses and coaches.

9. Without further intervention through the action plan the air quality objective for nitrogen dioxide will not be met.

10 Measures in the action plan need to focus on emissions from buses for streets on the bus priority route, and congestion due to the general traffic for other streets.

5 Options for reducing NOx emissions

5.1 Introduction

This section summarises the actions and projects that will need to be considered in order to deliver improved air quality within the AQMA. The majority of the actions are based on the recommendations of the Oxford City Council and Oxfordshire County Council Joint Scrutiny Review Group.

An average reduction in traffic generated NOx emissions of 68% is required within the AQMA. On a street-by-street basis the reduction varies from 32% to 90%, see Table 3.

It is not a requirement that the objective for nitrogen dioxide is achieved by the target date of December 2005. It is however a requirement that the AQAP identifies actions, with a timescale for implementation, which show that the City Council is doing all it reasonably can to work towards achieving the objective. Timescales for implementing the various actions will be confirmed following the consultation process and included in the final report.

The cost effectiveness of the options has still to be considered where appropriate and details on this will also be included in the final report following consultation. Local authorities are not expected to undertake a full cost benefit analysis, or a detailed analysis of the cost-effectiveness of every policy option.

5.2 Oxford Transport Strategy (OTS)

Some of the actions introduced through Oxford Transport Strategy (OTS) can be further be further enforced or developed to reduce congestion and restrict traffic growth.

5.2.1 Bus Gate Enforcement

The Oxford Transport Strategy restricted through traffic on the High Street between 07.30 hours and 18.30 hours. Since this measure was introduced there has been no formal enforcement of the restriction other than ad-hoc police checks. The Oxfordshire County Council Executive Board has approved funding and as soon as the measure has been passed by the Department for Transport (DfT) enforcement cameras will be put in place.

This is predicted to further reduce daytime traffic (mainly cars) through the High Street by 20% resulting in an estimated reduction in NOx emissions of between 2% and 5%.

5.2.2 Traffic light location and phasing

Queuing and congested traffic create local pollution hot spots. They can be reduced or relocated, by phasing of traffic flows to allow for the smooth

passage of traffic through a particular street or location. Although this is already in place, improved phasing of traffic lights in and around the AQMA may reduce NOx emissions by a further 1% or 2%.

5.2.3 Bus Quality Partnership

This is currently a voluntary agreement between Oxford City Council and Oxfordshire County Council and the two main bus operators (Oxford Bus Company and Stagecoach). The Government have committed to the introduction of statutory Quality Partnerships. It is considered that this will give local authorities greater influence over the provision of bus services and their marketing, and will enable them to encourage the provision of easy access buses.

The current agreement could be extended to all operators and used to set targets within two years for the minimum percentage of buses (for each operator) to conform to the highest emission reduction technology. The Royal Commission on Environmental Pollution have recommended that new buses with a high standard of comfort, low floors for easy boarding, must meet as a minimum Euro 3 standards for emissions. Upgrading of all bus services to Euro 3 standards is expected to result in a 20% reduction in NOx emissions.

The deregulation of bus services has been recognised as having a negative effect on air quality[10]. The introduction of more cross-operator ticketing would however reduce over-capacity, and ultimately the number of buses on some routes in the AQMA. It is difficult to assess the reduction in NOx emissions but it could be as much as 5% as buses are the main source of NOx emissions in the AQMA.

Increasing the availability of through tickets and off-board ticketing would speed up bus boarding times and therefore reduce congestion. It is difficult to assess the reduction in NOx emissions but it could be about 1%.

The Continued improvement of interchange facilities, connecting services, public information, electronic timetabling at bus stops, route planning and fare information could help increase bus use.

5.2.4 Freight Quality Partnership

Further restrictions on permitted hours for making deliveries along with better enforcement would reduce congestion. This could be significant in streets on the bus priority route such as Queens Street, St Aldate's and the High Street, but also in Beaumont Street where traffic congestion is the main cause of high emissions.

Transhipment centres at the edge of the city where freight is transferred to smaller vehicles could reduce the number of HGV vehicles in the AQMA, particularly at peak times. Experience from across Europe suggests that it can

[10] Royal Commission on Environmental Pollution 20th Report

be difficult to make ‘smart city’ logistics schemes effective. However where large numbers of retail units, large scale construction sites, or industrial premises are grouped together then the schemes may offer advantages. The reduction in NOx emissions as a result of a transhipment centre in Oxford is difficult to assess, but could be about 2%.

Minimum emission standards could be set for HGV’s entering the AQMA. It is difficult to assess the reduction in NOx emissions but it could be about 5%. (see figures listed under LEZ).

5.2.5 Taxi Quality Partnership

Through the taxi quality partnership the use of Botley Road bus lane could be used as the incentive for operators to reduce emissions from their vehicles. However the taxi fleet in Oxford is relatively small and contributes only 3% to the NOx emissions in the AQMA., so the reduction in NOx emissions would probably less than 1%.

5.2.6 Review of Parking

It only takes one illegally parked vehicle particularly at peak times to increase congestion problems. Better enforcement of parking restrictions in the AQMA would minimise this.

Increasing city centre parking charges could be used to encourage further bus usage, especially the use of the Park and Ride and reduce the number of vehicles coming in to the city centre. This could potentially reduce congestion in the AQMA particularly on streets such as Beaumont Street, Longwall Street, Worcester Street and Hythe Bridge Street where cars are the largest single contributor to NOx emissions.

It is difficult to assess the reduction in NOx emissions of these actions but it could be about 2%.

5.2.7 Work Place Travel Plans

Work place travel plans help companies reduce the traffic impacts of their businesses by reducing work-related car trips. Work place parking charges (with discounts for low emission vehicles) would also help encourage more use of public transport.

More effective travel plans would reduce the number of vehicle movements into and around Oxford generally and should be encouraged wherever possible. The impact on NOx emissions in the AQMA however, would probably only be about 1%.

5.2.8 More School Travel Plans

A high proportion of school children are driven to school by car. School traffic adds significantly to rush hour traffic, congestion and pollution. School travel

plans would look at matters such as safety improvements and traffic calming on the main routes to schools to encourage more children to walk or cycle to school.

More school travel plans would reduce the number of vehicle movements and localised congestion, particularly during peak periods, although the impact on NOx emissions in the AQMA would probably be minimal (<0.5%) because most schools are located outside the AQMA.

5.2.9 Car Clubs / Car Pools

Some cities have begun to introduce membership based City Car Clubs, which enable the use of a car from a centrally maintained car pool. These vehicles are likely to be newer less polluting vehicles, or even alternatively fuelled vehicles. It is difficult to assess the reduction in NOx emissions within the AQMA but it could be about 1%.

5.2.10 High Volume Occupancy of Vehicles

High volume occupancy can be promoted by giving priority use of dedicated traffic lanes to vehicles of certain occupancy and by incentives such as reduced parking charges. The scope for the former would be very limited in Oxford and certainly within the AQMA. Reduced parking charges for high occupancy could have some impact although the reduction in NOx emissions would probably be no more than 1%.

5.2.11 Encouraging Cycling and Walking

Healthy exercise by walking and cycling represents a zero pollution alternative to a motor vehicle journey. Many people do not cycle in cities due to safety concerns. The continued promotion of safer cycling, including safer crossings and cycle lanes are therefore needed. Also the continued improvement of secure cycle facilities and changing facilities in the workplace can promote cycling. Local employers can consider incentives for employees travelling to work without the use of a private vehicle. Streetscape design can influence the safety of pedestrians where shared use takes place between pedestrians and vehicle users. A crucial factor in the attractiveness of alternative modes of transport is the priority they receive at junctions[10].

It is difficult to assess the reduction in NOx emissions that promoting cycling and walking would have in the AQMA but it could be about 1%.

5.2.12 Engine Switch Off when Stationary

The Road Traffic (Vehicle Emissions Etc) Regulations 2002 permit local authorities to request drivers to switch off vehicle engines being run unnecessarily when parked and to issue fixed penalties of £20 to those drivers that refuse. Oxford City Council would need to apply to the Secretary of State to become a designated authority to issue fixed penalties.

There is already a voluntary agreement with the bus companies to switch off vehicle engines when stationary. This however would make it a statutory requirement and extend the provision to all vehicles in the AQMA. There would be a revenue cost for enforcement but the estimated reduction in NOx emissions could be about 1%.

5.3 Roadside Testing of emissions

Under the Road Traffic (Vehicle Emissions)(Etc.) Regulations 2002 local authorities that have designated an AQMA can apply to the Secretary of State for powers to conduct roadside testing of vehicle emissions and issue fixed penalties of £60 to drivers whose vehicles fail.

There would be a revenue cost for enforcement and the estimated reduction in NOx emissions on the bus priority route would be small. There could be a benefit in some streets (Beaumont Street, Longwall Street, Worcester Street and Hythe Bridge Street) where cars are the largest single contributor but again the reduction would be small probably no more than 0.5%.

Although emission testing would only have a small impact on NOx emissions in the AQMA, it would be seen as a statement of Oxford City Council's intent to tackle the problem across the city generally. A better option might however be to exclude older more polluting vehicles from the AQMA, see LEZ and scrappage schemes.

5.4 Scrappage Schemes

The average age of vehicles is increasing. Older vehicles pollute more than newer ones particularly those manufactured before 1993 (pre Euro 1 standard). However, encouraging drivers to replace older vehicles by financial incentives would need to be provided at a national and not local level. Schemes to exclude older, more polluting vehicles from the AQMA may lead to some small reductions in NOx emissions. Most of the busses are already Euro 2 standard, see comments under LEZ, and so the reduction on streets on the bus priority route would be very small. On streets where cars are the largest single contributor (Beaumont Street, Longwall Street, Worcester Street and Hythe Bridge Street) the reduction might be slightly higher.

It is difficult to assess the reduction in NOx emissions in the AQMA from a vehicle scrappage scheme but it could be about 1%. The benefits however would extend beyond the AQMA.

5.5 Retro-fitting of Tail Pipe Technology

Grants exist through the Energy Savings Trust, Transport Energy Clean-Up programme towards the costs of retrofitting particulate filters and devices to reduce NOx emissions. There has been a significant introduction of particulate filters by one bus company, that should be extended to all bus companies. Options exist under this scheme to retrofit Exhaust Gas Re-Circulation (EGR), or Selective Catalytic Reduction (SCR) Technology. EGR

systems typically reduce emissions per vehicle by 40%. It typically costs in the region of £6,000 to fit an EGR system to a bus.

A local trial of a bus fitted with SCR technology (Equivalent to Euro IV), delivered a reduction in bus generated NOx levels in excess of 70%. SCR technology is still under development and is likely to be available in the near future. The overall reduction in NOx emissions is estimated at 35% if applied to all buses and coaches, with some further reductions (an additional 5% reduction) possible if applied to other vehicles.

5.6 Greater use of Cleaner Fuels

Oxford City Council believes local authorities should lead by example and already has a clear policy to employ the cleanest technologies for all its vehicles. Oxfordshire County Council, as the authority responsible for transport planning should adopt a similar policy for the vehicles it uses, for example school buses contracted from other companies. Although good practice and would demonstrate their intent to reduce emissions, the reduction in NOx emissions in the AQMA would probably be no more than 0.1%, because their fleet usage within the AQMA is small.

A number of European Cities have joined together in programmes such as CIVITAS. The goal of the CIVITAS Initiative is to achieve a significant change towards the use of cleaner transport such as hybrid vehicles, electric vehicles, and natural or biogas vehicles.

The increased use of liquefied petroleum gas (LPG) and natural gas (NG) vehicles alongside the development of local refuelling infrastructure including charging points for battery electric vehicles (BEVs) should be encouraged. This development would be necessary as a means to encourage the uptake of higher levels of clean-fuelled transport. Oxford City Council is actively investigating going over to 5% biodiesel for some of its fleet vehicles.

Low emission or non-polluting fuels could theoretically reduce traffic emissions to near zero. However, this is unlikely and the reduction in NOx emissions in the AQMA could be up to 50% in the long term. There would also be a benefit outside the AQMA wherever the vehicles are driven.

5.7 Low Emission Zone (LEZ)

The aim of a LEZ is to restrict access to an area based upon the environmental standard of a vehicle and is potentially the most effective method of cleaning up the vehicle fleet. LEZ’s are normally considered by establishing a required Euro engine standard for vehicles to enter the restricted area. There would be no charge for vehicles to enter a LEZ, the primary aim is to ‘clean up’ vehicles not reduce traffic levels.

On the bus priority route in the AQMA the majority of NOx emissions are due to buses and coaches. A scheme could be phased in with standards initially

introduced for buses and coaches, then HGV's, and then cars at later dates if necessary.

The benefits of an LEZ would extend beyond the actual zone because vehicles that are cleaned up or replaced would produce lower emissions wherever they are driven.

In Oxford there are two main companies, the Oxford Bus Company and Stagecoach that provide bus services. Up to 90% of their vehicle fleet is already at least Euro 2 standard. This figure is much less amongst the smaller companies; none of the tour-buses for example meet any Euro standards. Based on estimates and figures from the Oxford Bus Company and Stagecoach of the bus fleet composition in the city centre, the impact of the progressive introduction of higher Euro engine standards to the local bus company fleets, and also HGV vehicles is shown in Table 4.

Table 4 Impact of an introduction of lower NOx emitting buses and HGV's

Measure	% Reduction in NOx Emissions
(1) All buses and coaches to Euro 2 standard.	3
(2) As (1) above plus all HGV's to Euro 2 standard	3
(3) As (2) above but all buses and coaches to Euro 3 standard	20
(4) As (3) above plus all HGV's to Euro 3 standard	22
(5) As (3) above but all buses and coaches to Euro 4 standard	35
(6) As (5) above plus all HGV's to Euro 4 standard	40
(7) As (6) above and adoption of enhanced Euro 4 2008 standards on buses	50
(8) As (7) above with adoption of enhanced Euro 4 2008 on HGV's	58

A LEZ phased in for buses and HGV's could result in a 58% reduction in NOx emissions in streets on the bus priority route (High Street, Queen Street, George Street, New Road, and St Clements Street) where the greatest reductions are required.

In other streets it is difficult to assess the reduction in NOx emissions, but it could be as much as 10% and up to 14% if the LEZ also included cars.

5.8 Campaign to Raise Awareness of Air Pollution

The decisions people make about the way they travel have an impact on air quality in the city and even small changes could help reduce pollution. If people are well informed about the air pollution problem and the solutions they will be more likely to do their bit to help improve air quality. Building public support to improve air quality must be an integral part of the AQAP. It is considered that when personal travel choices are taken in isolation they may appear ineffective. However, it is starting to be recognised that the widespread adoption of ‘smart choices’ for alternative travel can offer genuine long-term benefits in their contribution to pollution reduction.

6 Summary of Action Plan Options

Table 5 Summary of Action Plan Options

Paragraph Number	Option for Reducing NOx Emissions	Reduction in NOx Emissions %
5.2.1	Bus Gate Enforcement	2-5
5.2.2	Traffic light location and phasing	1-2
5.2.3	Bus Quality Partnership: - All buses to Euro 3 - Cross-operator Ticketing	 Up to 20 5
5.2.4	Freight Quality Partnership - All HGV's to Euro 3 - Transhipment Centres	 5 2
5.2.5	Taxi Quality Partnership - All Taxis to Euro 3	 Less than 1
5.2.6	Review of Parking	2
5.2.7	Work Place Travel Plans	1
5.2.8	School Travel Plans	Less than 0.5
5.2.9	Car Clubs	1
5.2.10	High Volume Occupancy	1
5.2.11	Cycling and Walking	1
5.2.12	Statutory Engine Switch-Off	1
5.3	Roadside Testing	Less than 0.5
5.4	Scrappage schemes	1
5.5	Retro-fitting	Up to 40
5.6	Cleaner Fuels	Up to 50
5.7a	LEZ (Buses, Coaches & HGV's)	Up to 58
5.7b	LEZ (5.7(a) plus all other vehicles)	Up to 70

7 Assessing improvements in Air Quality

7.1 Oxford City Council

Oxford City Council has a statutory duty to review and assess air quality in its area and this ongoing process is summarised in Appendix 2.

Improvements in air quality in the AQMA will be assessed against the following baseline data:

- A 68% reduction in oxides of nitrogen emissions across the whole AQMA
- A 32% to 90% reduction in oxides of nitrogen emissions in individual streets as specified in Table 3
- The trends in measured nitrogen dioxide levels at the St Aldate's monitoring site when compared to the background nitrogen dioxide levels measured at the St Ebbe's monitoring site (figure 5)
- The average trend in nitrogen dioxide levels (from diffusion tube data) across the AQMA (figure 4).

7.2 Oxfordshire County Council

Oxfordshire County Council is required to set a local pollutant concentration target for 2010/11 in the LTP against which air quality improvements can be assessed. Air quality has been allocated indicator LTP8. For Oxford City this target level must be set with regard to the air quality improvements required in the AQMA.

Intermediate outcomes must also be established in the LTP against which progress on achieving the target can be assessed. DfT guidance states that it is for local authorities to decide which of these intermediate outcomes to monitor. For the Central Oxford AQMA it is recommended that the following intermediate outcomes be adopted in LTP:

- Total road transport emissions within the AQMA
- Vehicle mileage within the AQMA
- Traffic flows within the AQMA
- Vehicle passenger movements in the AQMA

Appendix 1 Completed stages in LAQM

Review Process	Objectives likely to be met	Objectives not likely to be met	Comments
Stages 1&2 January 1999.	Carbon Monoxide, Benzene, 1,3 Butadiene, Lead.	Nitrogen Dioxide, Particulate Matter, Sulphur Dioxide.	Main emission source is road traffic for nitrogen dioxide and particulate matter. Possibility of short-term exceedences of 15 min SO_2 objective due to Didcot Power Station. Further review of SO_2 emissions from small boilers Stage 3 required for NO_2.
Stage 3 January 2001.	Carbon Monoxide, Benzene, 1,3 Butadiene, Lead, Sulphur Dioxide, PM_{10} Particulate Matter.	Nitrogen Dioxide.	Recommended declaration of AQMA for the city centre based upon exceedence of annual NO_2 objective, mainly due to road traffic emissions. PM_{10} Particulate Matter and SO_2 examined at this stage. Not considered necessary to proceed further.
Stage 4 July 2003.	Carbon Monoxide, Benzene, 1,3 Butadiene, Lead, Sulphur Dioxide, PM_{10} Particulate Matter.	Nitrogen Dioxide.	Confirmation of existing AQMA, with some geographical additions. Highlights the impact of streets with high proportion of buses and HGV's, and the significance of bus stops and congested traffic in the central area.
Updating and Screening Assessment Report November 2003.	Carbon Monoxide, Benzene, 1,3 Butadiene, Lead, Sulphur Dioxide.	Nitrogen Dioxide, PM_{10} Particulate Matter.	Concluded that a detailed assessment was required for nitrogen dioxide outside the AQMA, and for PM_{10} particulate matter inside the AQMA.
Detailed Assessment Report June 2004.	Carbon Monoxide, Benzene, 1,3 Butadiene, Lead, Sulphur Dioxide.	Nitrogen Dioxide, PM_{10} Particulate Matter.	Recommended declaration of AQMA for Green Road roundabout based upon exceedence of annual NO_2 objective, mainly due to road traffic emissions. Further review of PM_{10} Particulate Matter for 2010.

Appendix 2 Future stages in LAQM

Activity	Completion Date	Responsible Authority
Progress Report	End of June 2005	All Local Authorities (Oxford City Council)
Updating and Screening Assessment Report	End of April 2006	All Local Authorities (Oxford City Council)
Detailed Assessment Report	End of April 2007	Those Local Authorities (Oxford City Council) that identified a need for one in their April 2006 USA report
Progress Report	End of April 2007	Those Local Authorities (Oxford City Council) that identified that there was no need for a DA report in their April 2006 USA report
Progress Report	End of April 2008	All Local Authorities (Oxford City Council)
Updating and Screening Assessment Report	End of April 2009	All Local Authorities (Oxford City Council)
Detailed Assessment Report	End of April 2010	Those Local Authorities (Oxford City Council) that identified a need for one in their April 2009 USA report
Progress Report	End of April 2010	Those Local Authorities (Oxford City Council) that identified that there was no need for a DA report in their April 2009 USA report

Appendix 3 Air Quality Objectives

Air Quality Objectives (taken from the Air Quality Regulations 2000 and (Amendment) Regulations 2002)

Pollutant	Standard Measured as Concentration	Specific objective to be achieved
Carbon monoxide	116 mg/m^3 (10ppm) running 8-hour mean	By 31/12/03
Nitrogen dioxide.	200μg/m^3 (104.6ppb) 1 hour mean. 40μg/m^3 (21ppb) annual mean.	not to be exceeded more than 18 times a year by 31/12/05. By 31/12/05.
Particles PM_{10}.	50μg/m^3 24-hour mean. 40μg/m^3 annual mean. (20μg/m^3 annual mean).	Mean not to be exceeded more than 35 times a year by 31/12/04 (mean not to be exceeded more than 7 times a year by 31/12/10). By 31/12/04. (By 31/12/10).
Sulphur dioxide.	266μg/m^3 (100ppb) 15 minute mean. 125μg/m^3 (47ppb) 24-hr mean. 350μg/m^3 (132ppb) hourly mean.	Not to be exceeded more than 35 times a year by 31/12/05. Not to be exceeded more than 24 times a year by 31/12/04. not to be exceeded more than 3 times a year by 31/12/04.

Appendix 4 Where the Air Quality Objectives apply

Where Air Quality Objectives apply		
Averaging Period	Objectives should apply at:	Objectives should generally not apply at:
Annual Mean	All locations where members of the public might be regularly exposed. Includes building facades of residential properties, schools, hospitals, libraries, etc	Building facades of offices or other places of work where public do not have regular access. Gardens of residential properties. Kerbside sites, or any other location where public exposure is expected to be short term.
24-hr / 8hr mean	As above, plus gardens of residential properties	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
1 hr mean	As above, plus kerbside sites (inc busy shopping streets). Parts of car parks, bus stations and rail stations not fully enclosed, where public may spend 1hr or longer. Any outdoor locations where the public spend an hour or more.	Kerbside sites where the public would not be expected to have regular access.
15-min mean	All locations where public may spend 15 mins or longer	

Appendix 5 Glossary

AQMA	Air Quality Management Area
AQAP	Air Quality Action Plan
BQP	Bus Quality Partnership
CIVITAS	European initiative looking at urban transport including cleaner fuels
Clear Zones	DfT initiative for promoting pollution free urban centres
DEFRA	Department for Environment Food and Rural Affairs
DfT	Department for Transport
Euro Standards	European Auto Oil programme exhaust emission limits for new vehicles.
HGV	Heavy Goods Vehicle
LAQM	Local Air Quality Management
LEZ	Low Emission Zone
LGV	Light Goods Vehicle
LPG	Liquefied Petroleum Gas
LTP	Local Transport Plan
NO	Nitrogen monoxide**,** also termed nitric oxide.
NO_2	Nitrogen dioxide.
NOx	Nitrogen Oxides (a collective term for NO and NO_2)
OTS	Oxford Transport Strategy
$\mu g/m^3$	Micrograms per metre cubed