AIR QUALITY IN BARNET
A GUIDE FOR PUBLIC HEALTH PROFESSIONALS

MAYOR OF LONDON

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HOW TO USE THIS DOCUMENT

Air quality is an important Public Health issue in London, it contributes to shortening the life expectancy of all Londoners, disproportionately impacting on the most vulnerable. The Greater London Authority (GLA) estimated that in 2008 there were 4,267 deaths attributable to long-term exposure to small particles. The new Public Health Outcome Framework includes an indicator for air quality which local authorities will be expected to show progress on.

Borough specific versions of this document will be sent to the Public Health team in each of the London boroughs with the latest data to show the specific issues facing that borough within the context of London. Public Health teams moving into local authorities across London will find there is an Air Quality officer and in most instances an Air Quality Action Plan already in place working to address this important issue.

This document is for public health professionals in the London Borough of Barnet who may not have previously worked on air quality and aims to provide all the information needed to quickly get to grips with the issue of air quality in London and the borough.

Call to action

By engaging in this important area Public Health professionals are encouraged to bring a fresh perspective and new ideas for linking measures to tackle air quality with other determinants of health locally.

We hope you will find this report useful for:

- extracting data that you can use in your Joint Strategic Needs Assessment on air quality and Health and Wellbeing Strategy
- getting quickly up to speed with the key issues around air quality in London
- starting conversations with your colleagues in the local authority around how to tackle the health impacts of air quality
- understanding the Public Health Outcome measure for air quality, how to measure it and how to deliver against it
- participating in the process of developing your local Air Quality Action Plan and/or strategy
- finding additional sources of information for further reading on the subject.

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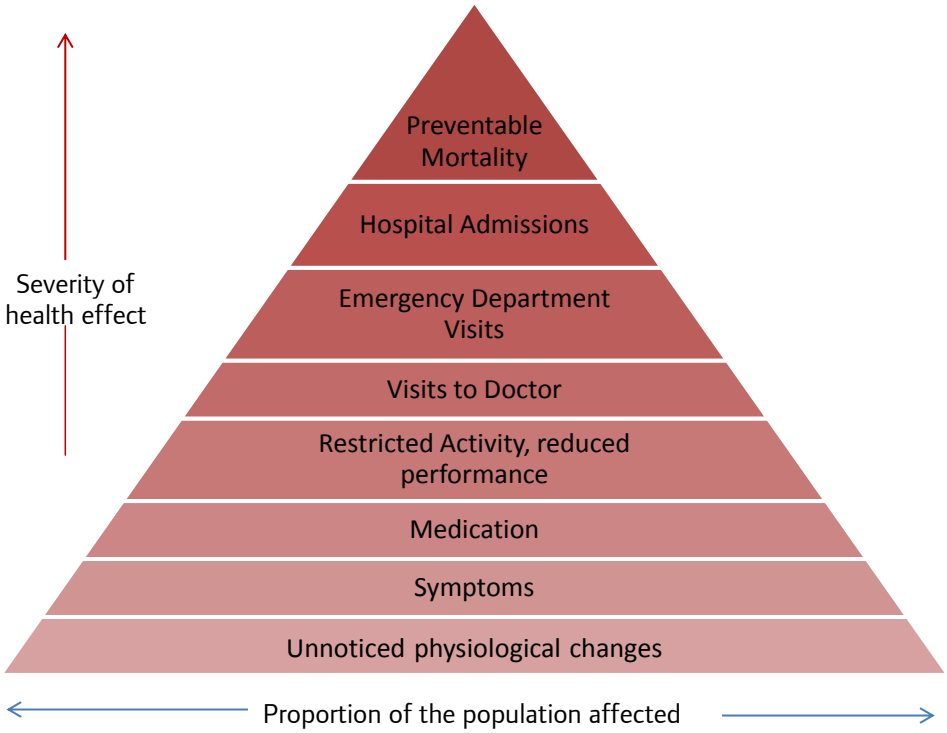
1 INTRODUCTION

The aim of this document is to provide an overview of the health impacts of air pollution in the London Borough of Barnet. In doing so it will examine the key pollutants of concern in London and the health risks associated with these. It will also examine the concentrations of these pollutants in LB Barnet and the number of deaths in the borough which can be attributed to exposure to air pollution. The chapter will also look at the legal framework which can protect health, along with actions that can, and are, being taken at national, regional, local and individual level to improve air quality and protect individuals.

The long term impacts upon health of air pollution can be represented by a pyramid structure, as shown in Image 1 below. For the majority of the population the effects of air pollution are not usually immediately obvious, although some individuals may notice symptoms such as irritation to eyes and throats when pollution levels are elevated.

However, smaller numbers of the population are more vulnerable to the effects of air pollution, as exposure to pollution can exacerbate existing health conditions including cardiovascular and respiratory disease. This can lead to restricted activity, hospital admissions and even premature mortality.

Image 1: Impact of Air Pollution on Health



WHO, 2005

2 AIR POLLUTION

2.1 External air pollution

The UK Air Quality Standards Regulations 2000, updated in 2010, sets standards for a variety of pollutants that are considered harmful to human health and the environment. These are based on EU limit values and are for a range of air pollutants, listed below:

- Sulphur dioxide
- Nitrogen dioxide
- Oxides of nitrogen
- Particulate matter (PM10 and PM2.5)
- Lead
- Benzene
- Carbon monoxide
- Benzo(a)pyrene
- Ozone

The majority of these pollutants are now at concentrations within London that do not affect human health. Defra is responsible for reporting on air quality in the UK to the EU Commission on an annual basis.[1] A graph showing the trends of air pollutant concentrations in London over 15 years between 1996 – 2011 is included in Appendix 1.

Despite the reductions in the majority of the pollutants mentioned above, levels of PM_{10} and NO_2 continue to exceed the national air quality standards and objectives in some areas of London. More information on the Air Quality Standards Regulation can be found in section 7 and the limit values are included in Appendix 2.

[1] http://uk-air.defra.gov.uk/library/annualreport/air_pollution_uk_2010_issue_2.pdf

Particulate Matter PM_{10} and $PM_{2.5}$

Particulate matter (PM_{10} and $PM_{2.5}$) is a complex mixture of non-gaseous particles of varied physical and chemical composition. It is categorised by the size of the particle (for example PM_{10} are particles with a diameter of less than 10 microns (µm)). Most PM emissions in London are caused by road traffic, in Central London this is as much as 80(%), with exhaust emission and wear, tyre and brake wear and dust from road surfaces being the main sources. Construction sites, with high volumes of dust and emissions from machinery are also major sources of local PM pollution, along with accidental fires and burning of waste. However, a large proportion of PM originates outside of London (between 40 – 55%) and includes particulates from natural sources, such as sea salt, forest fires and Saharan dust, as well as from sources outside London caused by human activity. Similarly London also exports PM to other parts if the UK and Europe. Small particles tend to be long-lived in the atmosphere and can be transported great distances ($PM_{2.5}$ can reach London from sources such as the Sahara up to 8,000 km away).

Nitrogen Dioxide: NO_2

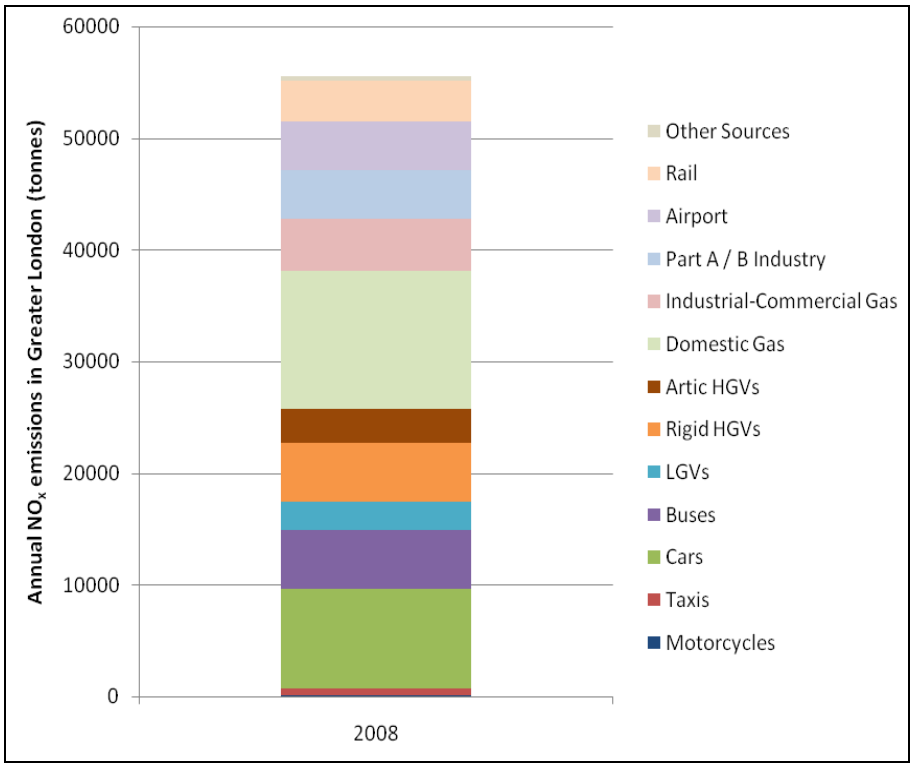
All combustion processes produce oxides of nitrogen (NO_x). In London, road transport and heating systems are the main sources of these emissions. NO_x is primarily made up of two pollutants - nitric oxide (NO) and nitrogen dioxide (NO_2). NO_2 is of most concern due to its impact on health. However NO_x easily converts to NO_2 in the air - so to reduce concentrations of NO_2 it is essential to control emissions of NO_x.

Ozone

Ground level ozone is another pollutant for which concentrations are at times high enough to impact upon human health and which causes summer smogs during hot, sunny periods. However, formation of ozone can take place over several hours or days and may have arisen from emissions many hundreds, or even thousands of kilometres away. For this reason ozone is not considered to be a 'local' pollutant. The long term objective for ozone is 120 micrograms per meter cubed (µg/m3) (over an eight hour mean.)

The direct sources (as opposed to external sources produced outside of London) of NO_x in Greater London in 2008 are presented in image 2 below. This shows that road transport contributed 46% and gas boilers 22% of the total NOx emissions.

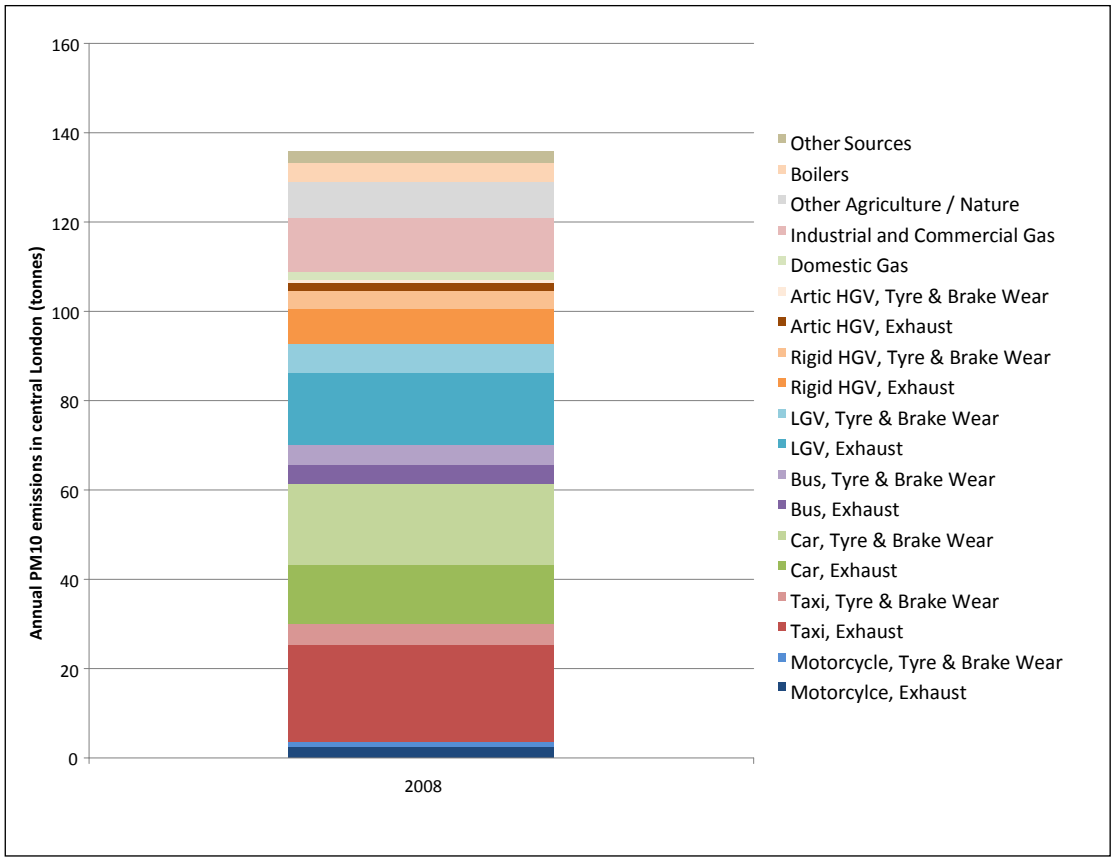
Image 2: NO_x emissions from all direct sources in Greater London in 2008 (from Mayor's Air Quality Strategy MAQS)[2]



The areas identified as being at most risk of exceeding the PM_{10} EU limit value are within central London. (Which for the purpose of the MAQS includes the Low Emission Zone central charging zone and the western extension zone). The direct sources of PM_{10} in central London in 2008 are presented in Image 3 below. This shows that road transport is the dominant source of PM_{10} emissions, contributing 79%.

[2] www.london.gov.uk/publication/mayors-air-quality-strategy

Image 3: PM_{10} emissions from all direct sources in central London in 2008, MAQS



2.2 Internal air pollution

The World Health Organisation (WHO) estimates that nearly two million people each year die prematurely from illness attributable to indoor air pollution, due largely to solid fuel use (2004 data)[3]. This is a particular problem in countries where solid fuel is the main fuel used for cooking and heating homes and where ventilation is poor.

In the UK, indoor air quality is affected by domestic gas combustion from cooking and heating. Other sources of indoor air pollution include cleaning agents, tobacco smoke, mould, condensation and asbestos. Tobacco smoke is the most harmful source of indoor air pollution, the WHO estimates that both women and men exposed to heavy indoor smoke are 2-3 times more likely to develop chronic obstructive respiratory disease (COPD).

In urban areas, where filters are not in place, outdoor air pollution also impacts upon indoor air quality (IAQ). IAQ can be improved through source control, filtration and ventilation.

[3] http://www.who.int/indoorair/en/

Guidance produced by the City of London, as part of its CityAir programme[4], recommends the use of the European standard EN 13779 for indoor air quality. CityAir provides guidance and advice for businesses operating in the City of London area (and elsewhere) to reduce the impacts of indoor air pollution. The CityAir guide for building engineers and facilities managers states:

Air conditioning and filtration

- Ensure that your air filters are regularly maintained and comply with EN 13779*
- Install low energy two stage particle and gas filters for maximum effect and cost savings

* It is a legal requirement to inspect all air conditioning systems with a rated output over 12kW at intervals not greater than 5 years

History of air quality in London

London has suffered with poor air quality for many centuries. In the 19th and 20th centuries thick fogs, known as pea-soupers were prevalent, caused by the burning of coal in homes and factories. These fogs caused large numbers of deaths from respiratory and cardiovascular problems, none more so than the great smog of 1952, which was a severe pollution event lasting for five days. It was estimated that the smog killed in excess of 4,000 people and affected the health of a further 100,000 (more recent research suggests that the number of fatalities was closer to 12,000). This event led to changes in practices and regulations including the development of the Clean Air Act in 1956.

[4] http://www.cityoflondon.gov.uk/business/environmental-health/environmental-protection/air-quality/cityair/Documents/Air%20Quality%20-%20Building%20Engineer%20Toolkit.pdf

3 AIR QUALITY IN LB BARNET

The London Borough of Barnet is situated in the North London. It is made up of twenty-one wards and has a population of 356,400 people.

In April 2001, the whole borough was designated an Air Quality Management Area (AQMA).

More information about air pollution limit values is included in Appendix 2.

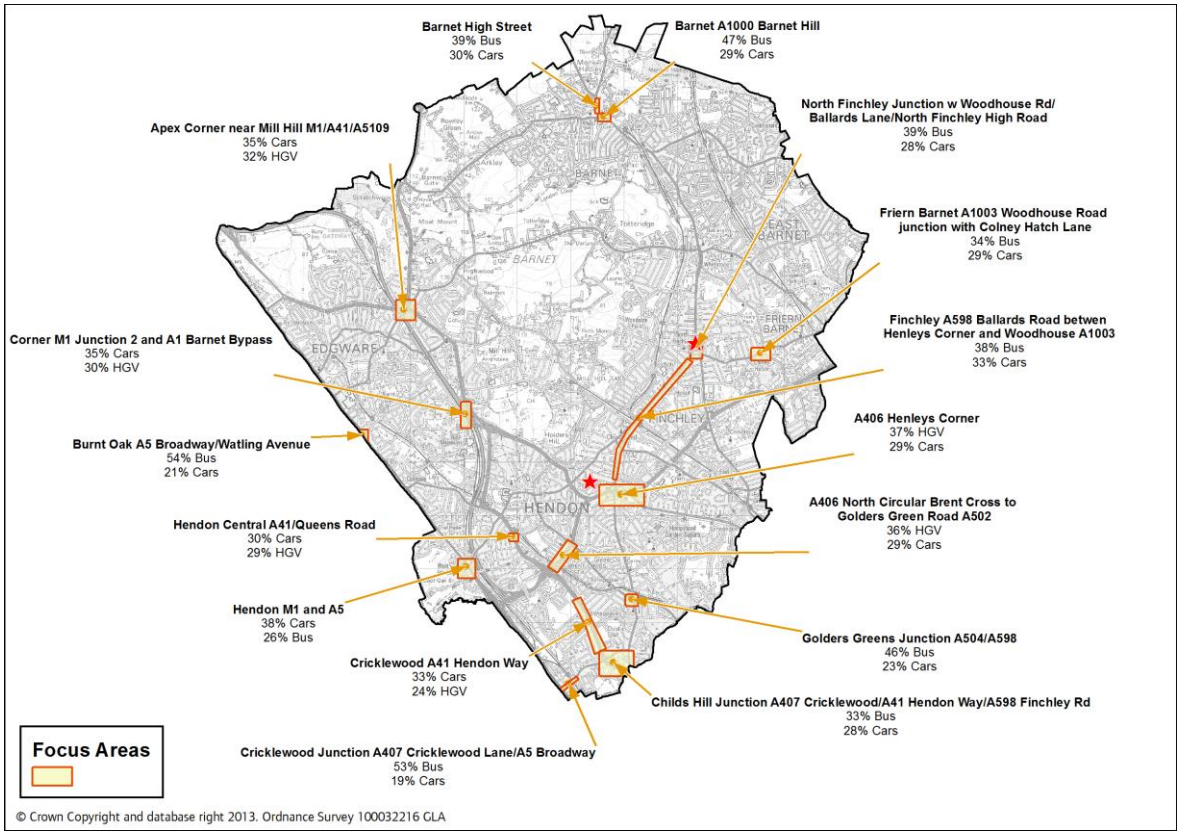
Air quality focus areas

In 2011 the Greater London Authority (GLA) identified eight Air Quality Focus Areas within LB Barnet, outlined in Image 4 below (represented by yellow area with description in yellow box). These areas are not necessarily situated at the same locations as the monitoring equipment (represented by a red arrow), the location of which was chosen for a number of reasons including ease of access.

Air quality focus areas have been selected by the GLA as areas where there is the most potential for improvements in air quality within the Capital. These areas have been selected through an analysis of the following factors:

- Baseline air quality for NO_2 and PM_{10} by 20m grid resolution
- Locations where air pollution limit values have been exceeded
- Level of human exposure
- Local geography and topography
- Local sources of air pollution
- Traffic patterns
- Future predicted air quality trends

Image 4 – LB Barnet Focus Areas and Air Quality Monitors, London Atmospheric Emissions Inventory



Emissions Inventory (LAEI)

Table 2 presents a breakdown of the NOx emissions produced by five key transport sources within the Focus Areas. This shows that a range of transport types impact on the levels of vehicle emissions in these areas.

Separate analysis has shown that non transport contributions e.g. domestic gas boilers in these areas are also significant. More information can be found in the London Atmospheric Emissions Inventory. [5]

Table 2 – NOx emissions from transport sources in LB Barnet

ID	Area Description	% of road transport NOx emissions from each mode				
		Taxi	Car	Bus	LGV	HGV
1	Apex Corner near Mill Hill M1/A41/A5109	2	35	16	16	32
2	Fiveways Corner M1 Junction 2 and A1 Barnet Bypass	2	35	16	18	30
3	Hendon Central A41/Queens Road	1	30	28	12	29
4	A406 North Circular Brent Cross to Golders Green Road A502	4	29	16	13	36

[5] http://data.london.gov.uk/laei-2008

5	A406 Henleys Corner	4	29	14	15	37
6	Finchley A598 Ballards Road betwen Henleys Corner and Woodhouse A1003	1	33	38	11	16
7	North Finchley Junction w Woodhouse Rd/Ballards Lane/North Finchley High Road	1	28	39	11	21
8	Barnet A1000 Barnet Hill	1	29	47	10	12
9	Barnet High Street	1	30	39	12	18
10	Cricklewood Junction A407 Cricklewood Lane/A5 Broadway	3	19	53	10	15
11	Childs Hill Junction A407 Cricklewood/A41 Hendon Way/A598 Finchley Rd	4	28	33	12	23
12	Golders Greens Junction A504/A598	3	23	46	9	19
15	Friern Barnet A1003 Woodhouse Road junction with Colney Hatch Lane	1	29	34	10	25
115	Cricklewood A41 Hendon Way	5	33	23	14	24
117	Hendon M1 and A5	2	38	26	13	20

Figures 5 and 6, below, spatially represent the annual mean concentrations of NO_2 and PM_{10} in LB Barnet 2011. These images show highest concentrations on some of the main arterial roads in the borough.

Image 5 Annual mean concentrations of PM_{10} in LB Barnet 2011

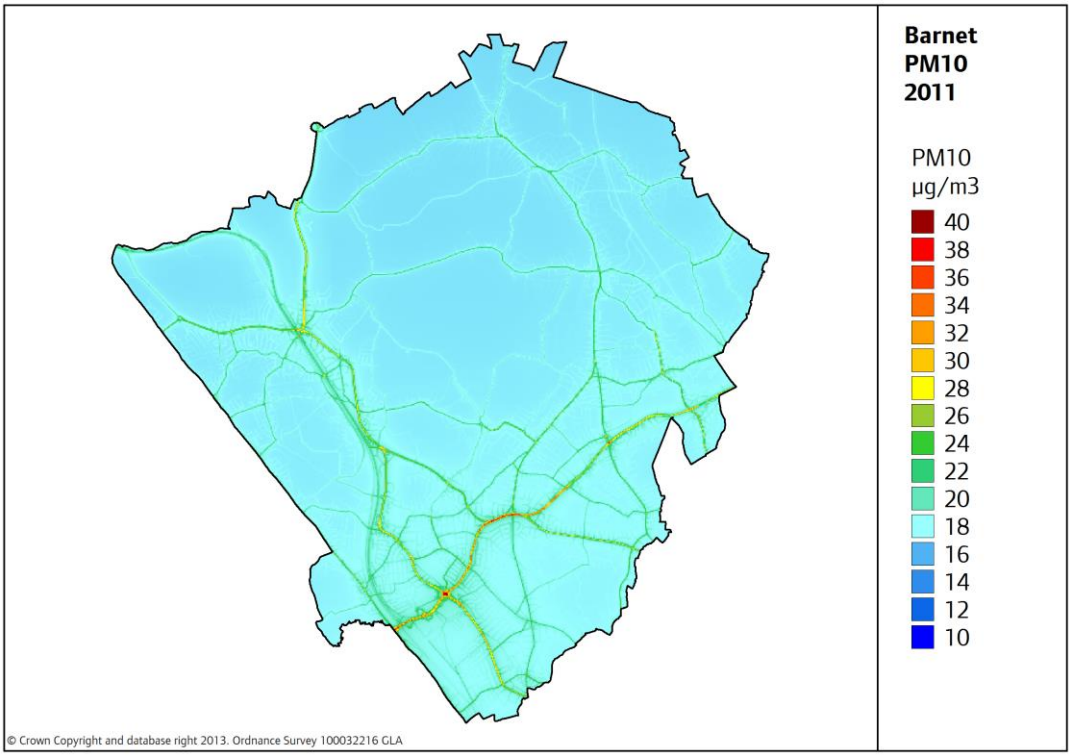
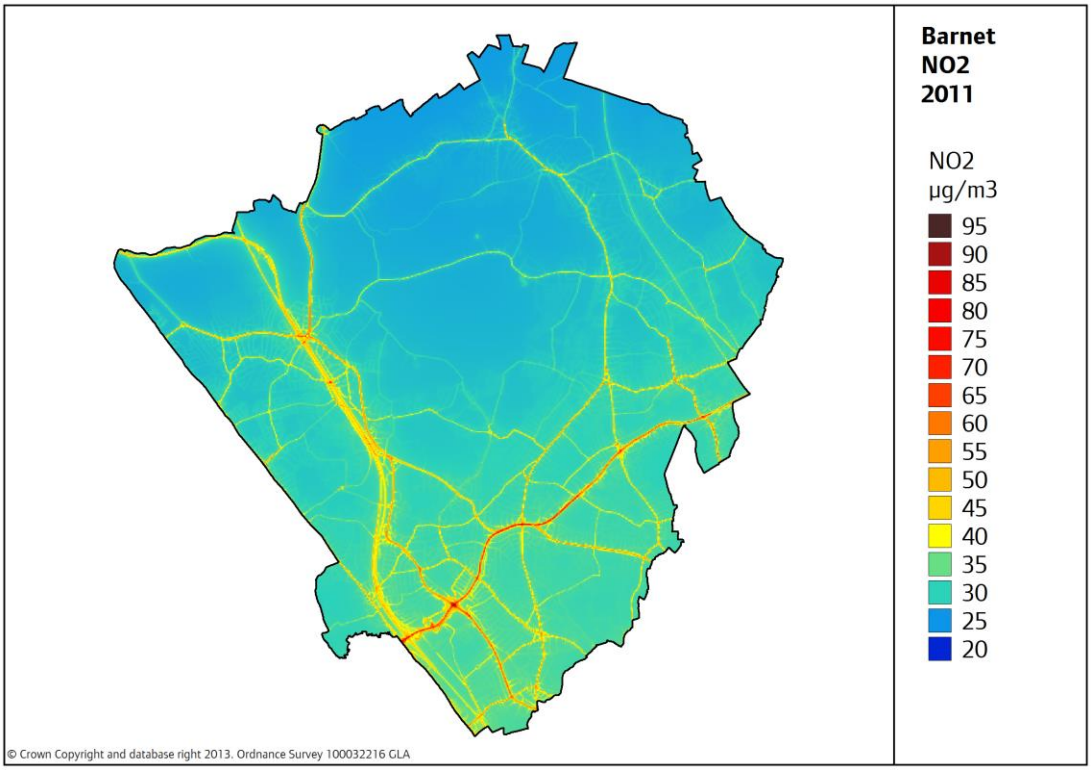


Image 6 Annual mean concentrations of NO_2 in LB Barnet 2011



4 AIR QUALITY IMPACTS ON HEALTH

In recent years, a number of studies have established the link between poor air quality and health in urban areas. In particular, it is clear that long-term exposure can contribute to the development of chronic diseases and can increase the risk of respiratory illness. In June 2012 the International Agency for Research on Cancer (IARC) confirmed that fumes from diesel engines are carcinogenic [6].Their research determines, for the first time, that exposure can cause lung cancer and possibly tumours to the bladder.

4.1 Premature deaths

There are several ways by which the impact of air pollution upon health could be measured.

COMEAP has released a guidance statement[7] on how local estimates of the mortality burden of long term exposure to particulate air pollution at the local level can be reached. They recommend that three matrices are used;

- Attributable fraction, the proportion of the local mortality burden (in terms of deaths) attributable to exposure
- Attributable deaths, a calculation of the number of actual deaths attributable to exposure
- Years of life lost, focusing upon the number of attributable deaths and the age at which these occur to determine the loss of life associated with exposure.

The 2007 Air Quality Strategy (AQS) estimated that based on air quality data from 2005, manmade $PM_{2.5}$ alone reduced the average life expectancy of people living in the UK by 7-8 months. An updated assessment[8], based on 2008 data, reveals that improvements in pollutant levels since 2005 mean that the average reduction in life expectancy of UK residents as a result of long term exposure to $PM_{2.5}$ is now 6 months.

It is also estimated that in 2008 29,000 premature deaths in the UK were attributed to long term exposure to $PM_{2.5}$. This compares with 2,222 people killed in road traffic collisions in 2009[9], 15,479 deaths partially or wholly attributable to alcohol in England in 2010[10] and 81,700 deaths wholly or partially attributable to smoking in 2010[11].

[6] http://press.iarc.fr/pr213_E.pdf
[7] http://www.comeap.org.uk/documents/statements/156-mortality-burden-of-particulate-air-pollution.html
[8] http://www.defra.gov.uk/publications/files/pb13378-air-pollution.pdf
[9] www.dft.gov.uk/
[10] www.nwph.net/
[11] www.nhs.uk/ServiceDirectories/Pages/Trust.aspx?id=T1430

In Greater London it is estimated that in 2008 there were 4,267 deaths attributable to long-term exposure to small particles. This figure is based upon an amalgamation of the average loss of life of those affected, of 11.5 years.

Nitrogen dioxide (NO_2): At high concentrations NO_2 causes inflammation of the airways and long-term exposure can affect lung function and respiratory symptoms. It can also increase asthma symptoms. The health impacts of NO_2 are less well understood than those of PM_{10} as less research has been undertaken in this area.

Particulate matter (PM) PM aggravates respiratory and cardiovascular conditions. The smaller the particle, the deeper it will deposit within the respiratory tract. The health impacts of $PM_{2.5}$ are especially significant. The Mayor commissioned a study in 2010, which suggested that around 4,300 deaths per year in London are partly caused by long-term exposure to $PM_{2.5}$ (which is widely acknowledged as being the pollutant which has the greatest effect on human health)[11]. Above and beyond this figure the Committee on the Medical Effects of Air Pollutants (COMEAP) speculate that air pollution acts as a contributory factor in early deaths from cardiovascular disease. Its impacts are most severely felt by vulnerable people such as children, older people and those with existing heart and lung conditions.

4.2 Vulnerable groups

Studies show that the greatest burden of air pollution usually falls on the most vulnerable in the population, in particular the young and elderly. The link between health inequalities and pollution is complex. [12]

Individuals particularly at risk also include those with existing respiratory problems and chronic illnesses such as asthma and chronic obstructive pulmonary disease (COPD). There are approximately 690,000 asthma sufferers in London and 230,000 individuals suffering from COPD[13].

The Health Effects Institute (HEI) panel concluded that the evidence is sufficient to support a causal relationship between exposure to traffic-related air pollution and exacerbation of asthma. It also found suggestive evidence of a causal relationship with onset of childhood asthma, non asthma respiratory symptoms, impaired lung function, total and cardiovascular mortality, and cardiovascular morbidity, although the data are not sufficient to fully support causality. [14]

There is a growing body of evidence, presented by the British Medical Association, 2012, showing that prenatal exposure to air pollution is associated with a number of adverse outcomes in pregnancy.

[12] http://uk-air.defra.gov.uk/reports/cat09/0701110944_AQinequalitiesFNL_AEAT_0506.pdf
[13] www.london.gov.uk/publication/mayors-air-quality-strategy
[14]http://www.comeap.org.uk/images/stories/Documents/Statements/asthma/does%20outdoor%20air%20pollution%20cause%20asthma%20-%20comeap%20statement.pdf

These include low birth weight, intrauterine growth retardation, and an increased risk of chronic diseases in later life. Emerging evidence also suggests that long-term exposure to particulate matter, at levels such as those seen in major cities, can alter emotional responses and impair cognition.

Individuals who reside or work near busy roads are at particularly high risk of exposure to the health harms of air pollution. The same is true of those that spend longer in traffic. Car occupants are typically exposed to higher levels of air pollution than cyclists or pedestrians. This is, in part, because cyclists and pedestrians can use quieter streets with lower traffic volumes, which are less heavily polluted. A 2011 study conducted by Sustrans,[15] found that the air quality on London greenways (safe, quiet routes through parks, green spaces and lightly trafficked streets) was significantly better than on adjacent busy roads. Congestion is also strongly associated with air pollution, with pollutant levels generally higher inside vehicles than in ambient air.

4.3 Air pollution and deprivation

A close link has been shown between areas of high deprivation and pollution. Research has demonstrated that those living in more deprived areas are exposed to higher concentrations of air pollution, often because homes and residences of these groups are situated next to roads with higher concentrations of emissions. Deprived communities suffer greater burdens from air-pollution-related death and sickness. As highlighted in the 2010 Marmot Review[16], individuals in deprived areas experience more adverse health effects at the same level of exposure compared to those from less-deprived areas. This is, in part, because of a higher prevalence of underlying cardio-respiratory and other diseases, as well as greater exposure to air pollution as a result of homes being situated nearer to busy congested roads and with fewer green spaces.

Index of multiple deprivations

The Index of Multiple Deprivation (2007) [17] is a measure of multiple deprivation which goes down to the lower layer super output area (LSOA). The index is made up of seven domain indices including:

- Income deprivation
- Employment deprivation
- Health deprivation and disability
- Education, skills and training deprivation
- Barriers to housing and services
- Crime
- The living environment

[15] www.sustrans.org.uk
[16] http://www.instituteofhealthequity.org/projects/fair-society-healthy-lives-the-marmot-review
[17] http://www.communities.gov.uk/communities/research/indicesdeprivation/deprivation10/

Air quality is a key indicator considered within the Living Environment domain. Using data from the National Atmospheric Emissions Inventory (NAEI) analysts have produced an air quality score for each LSOA based on concentrations of four pollutants: Nitrogen dioxide, particulate matter, benzene and sulphur dioxide.

4.4 Air pollution and the Public Health Outcomes Framework

The move of Public Health teams into Local Authorities facilitates the integration of considerations of the wider determinants of health into the planning and delivery of local authority services. The Public Health Outcomes Framework is a set of indicators compiled by the Department of Health to measure how effectively the activities of each local authority are addressing the determinants of health. Within four domains there are a total of 68 indicators. One of these indicators is Air Pollution and this is measured by modelled $PM_{2.5}$ levels in 2010. A table showing the breakdown of the fraction (%) of mortality attributable to long term exposure to $PM_{2.5}$ in each of the London boroughs is included in chapter 5 below.

Tackling air quality in London would contribute to increasing healthy life expectancy and reducing early death from cardio-respiratory diseases. In addition there are a number of other indicators which could be improved through the co-benefits of certain measures to improve air quality. For example policies and activities which reduce the speed and volume of motor traffic and increase walking and cycling would also contribute towards the following indicators:

- Health inequalities
- Killed and seriously injured on roads
- Injuries in under 18's
- Falls and falls injuries among over 65's
- Hip fractures in over 65s
- Use of green space for exercise
- Older people's perceptions of safety
- Childhood obesity
- Adult obesity
- Diabetes
- Preventable deaths
- Premature deaths from cardiovascular disease
- Premature death from all cancers
- Self-reported wellbeing
- Sickness absence rates
- Social connectedness

- Quality of life for older people
- Sustainable development plans for public sector organisations
- Population affected by noise

Out of a total of 68 Public Health Outcome Framework measures of the health of the local population certain transport related measures could contribute to a **third** of them. No other area of intervention could impact on so many key aspects of population health. Transport measures are therefore an excellent opportunity to deliver public health benefits across the life course through tackling one of the major wider determinants of health.

5 HEALTH IMPACTS IN LB BARNET

The Public Health Outcomes Framework, mentioned in chapter 4 above, includes a benchmark tool, which enables the comparison of the fraction (%) of mortality attributable to long term exposure to $PM_{2.5}$ in each local authority in the UK. This can be compared to the UK average which is 5.6% of mortality attributable to long term exposure to $PM_{2.5}$.

The statistics for each of the London boroughs are included in Table 3 below. LB Barnet is 21% higher than the UK average and is ranked best in London.

Table 3 – Fraction (%) of mortality attributable to long term exposure to PM2.5

Local Authority	Fraction (%) of mortality attributable to long term exposure to PM2.5
Bromley	6.3
Havering	6.3
Harrow	6.4
Sutton	6.4
Croydon	6.5
Hillingdon	6.5
Bexley	6.6
Enfield	6.6
Kingston upon Thames	6.7
Barnet	6.8
Richmond upon Thames	6.8
Merton	6.9
Redbridge	7
Barking & Dagenham	7.1
Haringey	7.1
Hounslow	7.1
Brent	7.2
Ealing	7.2
Greenwich	7.2
Lewisham	7.2
Waltham Forest	7.3
Wandsworth	7.3
Newham	7.6
Camden	7.7
Lambeth	7.7
Hackney	7.8
Hammersmith and Fulham	7.9
Islington	7.9
Southwark	7.9
Tower Hamlets	8.1
Kensington and Chelsea	8.3
Westminster	8.3
City of London	9

This research is comparable to research which was carried out by the Institute of Medicine (IOM)[18] which also estimates the mortality impacts of $PM_{2.5}$ in London. The overall findings from this research show that 4,267 deaths in London could be attributed to long term exposure to $PM_{2.5}$ in 2008 . This is the statistic which is included in the Mayor's Air Quality Strategy. 'Attributable deaths' do not represent a subset of all deaths that are solely caused by $PM_{2.5}$, everyone living in London breathes the air and their health is impacted, when the risk to all the individuals is combined it is equivalent to this 'attributable' number of deaths.

The IOM research determined that in 2008, 201 deaths were attributable to $PM_{2.5}$ in LB Barnet. Table 4, below, provides a breakdown of the number of deaths attributable in each of the wards in the borough based on population size.

Table 4 – Number of deaths attributed to exposure to $PM_{2.5}$ pollution in 2008 in wards in the London Borough of Barnet

Ward	Total Population	Annual deaths attributable to exposure to PM2.5
Brunswick Park	15,577	10
Burnt Oak	15,672	10
Childs Hill	18,103	11
Colindale	15,804	10
Coppetts	15,036	9
East Barnet	15,805	10
East Finchley	15,019	9
Edgware	15,253	9
Finchley Church End	14,652	9
Garden Suburb	15,064	9
Golders Green	16,787	10
Hale	16,088	10
Hendon	15,973	10
High Barnet	14,762	9
Mill Hill	17,036	10
Oakleigh	15,224	9
Totteridge	14,880	9
Underhill	15,996	10
West Finchley	14,960	9
West Hendon	14,977	9
Woodhouse	16,084	10
Total		201

Institute of Medicine (IOM), 2010

The data from the IOM research and the Public Health Outcomes Framework differ to some extent due to the methodologies used.

[18] www.iom.edu/

The Department of Health methodology used for the Public Health Outcomes Framework weights background concentrations (for a 1km x 1km grid) of $PM_{2.5}$ by local authority population size. The methodology makes the assumption that every 10µg/m^3 of population-weighted annual average background concentration of PM2.5 carries an annual relative death risk of 1.06. This means that for every 10µg/m^3 of $PM_{2.5}$ in the atmosphere, there will be 6% more deaths each year than there would be without that 10µg/m^3 of $PM_{2.5}$ present.

The IOM research follows a similar methodology however it used a London specific model which gives a finer resolution compared to the national model used for the PHOF. This, combined with other changes in other assumptions, accounts for the variation between the two datasets.

6 CO-BENEFITS OF IMPROVING AIR QUALITY IN LONDON

There are a wide range of potential benefits of measures to improve air quality, not only for the improvement of health and the reduction of health inequalities, but also for the economy, environment, climate change adaptation and mitigation. A selection are listed below.

Biodiversity

Long term exposure to pollutants can restrict the growth of plants and trees so improving air quality reduces costs to local authorities in replacing urban greenery as well as benefitting the environment.

Economic benefits

Improving air quality reduces the costs to local authorities of building maintenance and cleaning. As outlined in section 6.3 the cost to the economy of the health impacts of poor air quality are significant.

Climate Change

Ozone, which is caused by pollutants such as NO_x and volatile organic compounds (VOCs) reacting in sunlight are powerful greenhouse gases which contribute to global warming directly. Also black carbon (which is part of the particulate emissions from diesel engines) contributes to climate change.

6.1 Maximising the health benefits from improving air quality

Certain measures to improve air quality have significant co-benefits for health. These are listed below.

Motor traffic is responsible for air pollution and so measures that encourage people to use sustainable transport, such as walking and cycling would have the following benefits[19]

- Create an environment that is more pleasant to walk and cycle, hence increasing physical activity levels
- Reduce risks of injury and death from road traffic collisions
- Reduce community severance, increase community cohesion and social interactions
- Reduce noise pollution which also enables people to open windows to buildings reducing the costs of air conditioning
- Contribute to reducing the urban heat island effect

Greater number of trees and vegetation:

[19] http://publications.nice.org.uk/physical-activity-and-the-environment

- Reduce risks from localised flooding,
- Contribute to urban cooling and help to contribute to reducing the urban heat island effect
- Provide shade to enable people to keep cool and out of direct sunlight in sunny weather
- Improve mental health and wellbeing
- Improve resilience to climate change

Improving the energy efficiency of homes would reduce emissions from heating systems, which would have the additional benefits of:

- Reducing fuel bills, thus reducing fuel poverty (which is the situation where households are required to spend more than 10% of their income to heat their homes to an appropriate temperature)
- Reduces likelihood of damp and mould occurring, which aggravate respiratory disease
- Reduce the number of falls in the home (falls are more likely to occur in cold homes due to poor blood circulation)

6.2 Cost of the Impact of Air Pollution

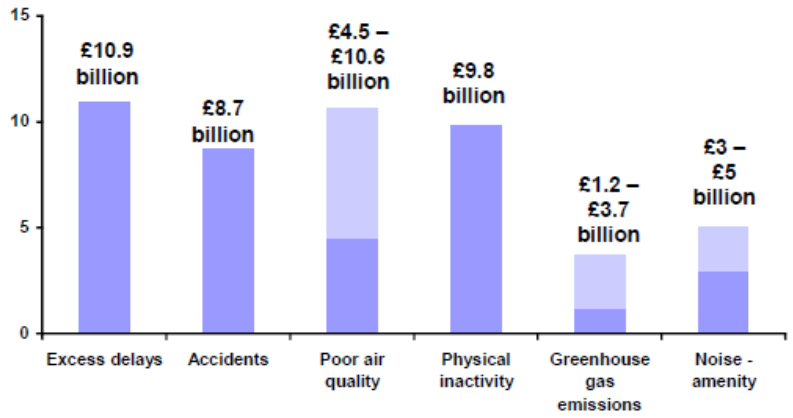
It is difficult to estimate the cost of the impact of air pollution on society. Defra estimate that the annual health costs of air pollution to UK citizens is £15 billion, within the range of £8 - £17 billion (based on 2008 data). This is comparable to the growing annual health costs of obesity at £10 billion (although the basis of the cost calculation differs).[20]

The Cabinet Office has reviewed the costs of various outcomes associated with transport in urban areas. This provides an indication of the scale of the challenges faced by urban areas. The estimated costs are presented in Image 7 below. This estimates the cost of poor air quality to between £4.5 billion and £10.6 billion pounds per year, which is comparable with the cost of excess delays, accidents, poor air and physical inactivity in urban areas.

These results suggest that transport policy has the opportunity to contribute to a wide range of objectives.

[20] http://www.defra.gov.uk/publications/files/pb13378-air-pollution.pdf.

Image 7: Comparison of the wider cost of transport in English urban areas (£ billion per annum, 2009 prices and values)



Cabinet Office, 2009

7 POLICY AND LEGAL FRAMEWORK FOR IMPROVING AIR QUALITY

Most air quality legislation in Europe and the UK is derived from health-based evidence provided by the World Health Organisation (WHO). The WHO has published various guidelines for both global air quality and European air quality based on the latest research from around the world. These guidelines are neither standards nor legally binding criteria; they are designed to offer guidance in reducing the health impacts of air pollution based on expert evaluation of current scientific evidence. Nevertheless, many administrations use these guidelines as the basis for their own air quality standards and in some instances the UK legislation is more stringent than the WHO Air Quality guidelines.

7.1 EU Directive

The European Union has issued an air quality Directive (2008/50/EC – the "Air Quality Directive")[21] that sets standards for a variety of pollutants that are considered harmful to human health and the environment. These standards, which are based on WHO guidelines, include limit values, which are legally binding and must not be exceeded. These limit values comprise a concentration value for the pollutant, an averaging period over which it is measured, the date by which the limit values are to be achieved and in some cases an allowable number of exceedences of the value per year. The Directive also includes target values, which are set out in the same manner as limit values, but which are to be attained where possible by taking all measures that do not entail disproportionate costs.

7.2 UK Air Quality Policy

The Air Quality Standards Regulations 2010

The EU Directive, including the emission concentration limit values, has been transposed into English law by the Air Quality Standards Regulations 2010[22]. These Regulations include criteria for determining how achievement of the limit values should be assessed, including consideration of locations and length of exposure in relation to the averaging period of the limit values.

In addition, the 2010 Regulations state that sampling points must be sited to provide data on areas where the highest concentrations occur to which the population is likely to be exposed for periods of time which are significant in relation to the averaging period of any limit value (ie 15 minutes, one hour, 24 hours etc).

The limit values for the Air Quality Standards Regulation can be found in Appendix 2. The limit values for nitrogen dioxide were not met in many parts of Greater London in 2011 and continue to pose a significant challenge. This is also reflected in other cities in the UK.

[21] http://ec.europa.eu/environment/air/quality/legislation/existing_leg.htm
[22] www.legislation.gov.uk/uksi/2010/1001/contents/made

Due to a variety of measures to reduce PM emissions from vehicles, the limit values for PM_{10} were met across Greater London in 2011, however it is important to remember that concentrations of PM even below EU and UK limits can have an adverse effect on health and it is therefore necessary to consider further reductions.

National Air Quality Strategy, 2007

The Government's National Air Quality Strategy[23] provides the Government's policy framework for air quality management and assessment in the UK. It identifies air quality standards and objectives for key air pollutants which are designed to protect health and the environment. It also sets out how different sectors (industry, transport and local government) can contribute to achieving the air quality objectives, though it includes little direct guidance on policy, nor does it constitute an action plan.

7.3 Regional Strategies

The London Plan [24]

Improving air quality is a key priority for the Mayor and is one of the six objectives for London in the London Plan. The objective states that 'London will become a world leader in improving the environment locally and globally, taking the lead in tackling climate change, reducing pollution, developing a low carbon economy, consuming fewer resources and using them efficiently.'

In addition London Plan Policy 7.14 specifically relates to improving air quality, with a focus upon strategy, planning decisions and Local Development Framework (LDF) preparation.

Mayor's Air Quality Strategy (MAQS)

The Mayor of London launched his Air Quality Strategy 'Clearing the Air' in 2010. This sits alongside the Mayor's Climate Change Mitigation and Energy Strategy 'Delivering London's Energy Future'[25], which was published in 2011. These two strategies help to tackle air pollution in London.

The key aspects of the Mayor's Air Quality Strategy (MAQS) include:

- sustainable transport measures
- measures to reduce pollution from construction and demolition sites
- using the planning process to improve air quality
- energy efficient buildings
- raising public awareness

[23] http://www.defra.gov.uk/environment/quality/air/air-quality/approach/
[24] www.london.gov.uk/priorities/planning/londonplan
[25] http://www.london.gov.uk/priorities/environment/climate-change/climate-change-mitigation-strategy

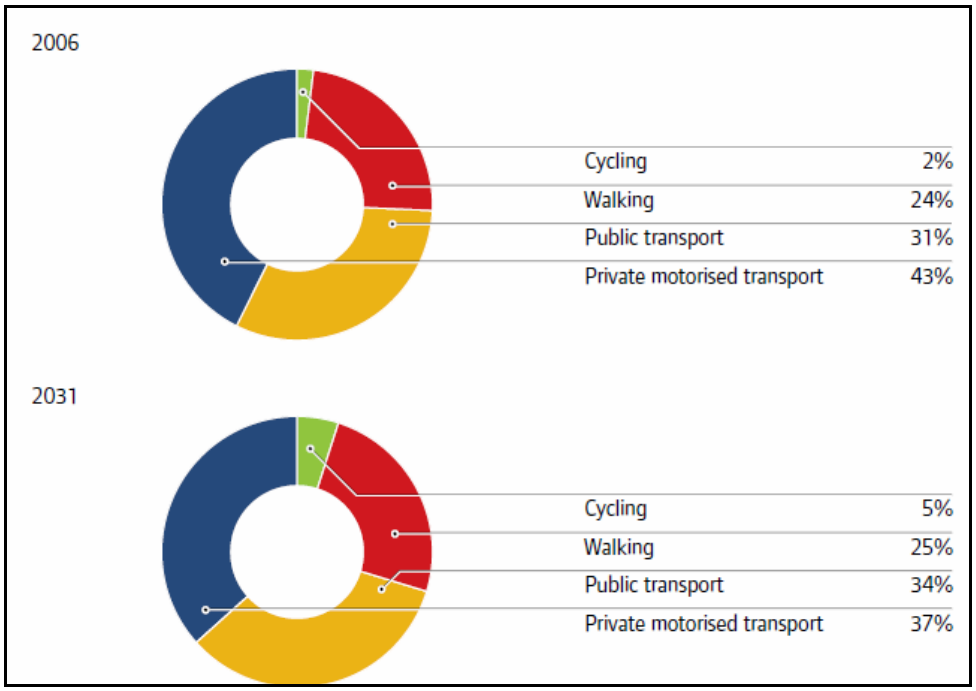
The Mayor's Transport Strategy [26]

The Mayor's Transport Strategy (MTS) is a statutory document, developed alongside the London Plan and Economic Development Strategy[27] (EDS) as part of a strategic policy framework to support and shape the economic and social development of London over the next 20 years. It sets out the Mayor's transport vision and describes how Transport for London (TfL) and its partners, including the London boroughs, will deliver that vision.

The aim of this strategy is to reduce transport's contribution to climate change and improve its resilience whilst supporting economic development and population growth.

The modal share goals to 2031 (from a 2006 baseline) outlined within the strategy are set out below in Image 8:

Image 8: Modal Share Transport Goals to 2031



[26] www.london.gov.uk/publication/mayors-transport-strategy
[27] www.london.gov.uk/who-runs-london/mayor/...economy/eds

Local Implementation Plans (LiPs) [28]

Local Implementation Plans (LIPs) are documents required under the Greater London Authority Act 1999. They set out how each borough will deliver the Mayor's Transport Strategy in their area.

LIPs provide a way of ensuring transport improvements are well-integrated across London.

Each LIP will address priorities such as improving accessibility, safety and security, reducing traffic congestion and improving bus services.

7.4 Local Authority Responsibilities

Local Air Quality Management

Under the Environment Act 1995 [29] local authorities have a statutory responsibility to partake in Local Air Quality Management (LAQM). This includes the review and assessment of air quality within the borough on a regular basis. Currently a three year cycle of review is in place with local authorities required to produce an annual progress report. If a Local Authority identifies any locations within its boundaries where the Air Quality Objectives are not likely to be achieved, it must declare the area as an Air Quality Management Area (AQMA). The Local Authority is subsequently required to put together a plan to improve air quality in that area.

Local Authorities which have wholly or partly designated their Boroughs as Air Quality Management Areas are required under LAQM to produce an Air Quality Action Plan[30]. AQAPs provide the mechanism by which local authorities, in collaboration with other agencies, will state their intentions for working towards the air quality objectives through the use of the powers they have available.

Particulate Matter $PM_{2.5}$

Particulate matter with a diameter of 2.5 microns have not been incorporated into the LAQM regulations and so Local Authorities do not have a statutory obligation to review and assess air quality against them. The responsibility for monitoring $PM_{2.5}$ lies with the Defra. The Government has set national air quality objectives for $PM_{2.5}$, which are included Appendix 2.

Although $PM_{2.5}$ is only monitored at a few locations across Greater London it is included within the London Atmospheric Emissions Inventory (LAEI) and it is possible to model concentrations of this pollutant. Local Authorities wishing to assess the impact of measures upon $PM_{2.5}$ can use concentrations of PM_{10} as a proxy indicator.

[28] http://www.tfl.gov.uk/corporate/about-tfl/1472.aspx
[29] www.environment-agency.gov.uk/netregs/legislation/.../107183.aspx

[30] http://uk-air.defra.gov.uk/reports/cat09/1107211126_Mapping_Action_Plan_Guidance_Final__Report_April_2011.pdf

8 TAKING ACTION

8.1 Actions taken by the Mayor

Over the last few years, a number of measures have been taken to improve London's air quality and reduce carbon emission including new hybrid and zero-emission buses on London's streets, adapting buses to make them cleaner, introducing a citywide Low Emission Zone (LEZ), (see box below), initiatives to encourage cycling and walking, smoothing the flow of motor vehicles to reduce pollution, and promoting zero-emitting electric vehicles.

These measures alone are not enough to minimise the risk to human health and quality of life and to achieve air quality limit values. As such the Mayor has taken further actions including:.

- An age limit for black cabs and private hire vehicles that will retire 2,600 of the most polluting vehicles in 2012;
- Investment in cycling;
- Cleaner hybrid and hydrogen buses;
- A £5m Clean Air Fund from DfT which has targeted pollution reduction measures, such as dust suppressants, green walls and other green infrastructure and a 'no engine idling' campaign, across central London where particulate matter concentrations are highest;
- Tighter standards for the London Low Emission Zone;
- Making construction and demolition sites cleaner to improve local air pollution;
- Using the planning system to reduce emissions from new developments;
- Improving energy efficiency in 55,000 homes and 400 public buildings;
- Raising awareness amongst Londoners to the impacts of air quality and what they can do to help deliver Cleaner Air for London.

London Low Emission Zone (LEZ)

The London Low Emission Zone (LEZ) is a traffic pollution charging scheme which aims to ensure that the most polluting heavy diesel vehicles driving in the Capital become cleaner. The vehicles currently affected include heavy goods vehicles, light goods vehicles, buses, coaches, large vans and mini buses.

The LEZ covers most of Greater London. To drive within it without paying a daily charge these vehicles must meet certain emissions standards that limit the amount of particulate matter coming from their exhausts. The emissions produced by a vehicle are estimated based upon the vehicle type, its age and whether any retrofit emissions abatement technology has been installed.

The LEZ is administered by Transport for London (TfL). It started operating in February 2008 with phased introduction of an increasingly stricter regime. Phase IV was introduced on the 3rd of January 2012.

The LEZ has been very effective in reducing emissions and compliance with the current (January 2012) standards is already high at 92 per cent for lorries, buses and coaches, and 98 per cent for vans and minibuses. It is estimated that Phases 1 and 2 of the LEZ reduced emissions of PM10 by 28 tonnes in 2008. The new standards introduced in January 2012 are expected to broadly double the reduction in emissions achieved in 2008.

More information can be found at http://www.tfl.gov.uk/roadusers/lez

8.2 Borough level actions

Exemplar Air Quality Borough

The GLA is in the process of launching the Air Quality Exemplar Borough programme. The aim of this programme is to encourage local authorities to share best practice and promote shared working across different internal teams (e.g public health, planning and transport etc) and across local authorities

In order to become an Exemplar Borough local authorities will be required to make certain commitments to improve local air quality. The commitments will focus on the following areas:

- Political leadership
- Leading by example
- Taking action
- Incorporate air quality into the planning system
- Informing the public
- Integrating air quality into public health

In the future it is hoped additional resources will be made available to exemplar boroughs through the LIP programme, as well as other sources, to enable the delivery of air quality projects and activities.

Case study - Air text

In 2005 the London Borough of Croydon worked with the European Space Agency and Cambridge Environment Research Consultants to develop an air quality forecasting service called airTEXT. This service provided information on the level of pollution in the borough using "low", "moderate" and "high" bandings. Whenever moderate or high levels of pollution are expected subscribers to the airTEXT service would receive a text message, call or voicemail. This would enable the recipient to determine what action they may need to take in order to prepare themselves for the expected level of pollution, e.g. taking a different route/mode of transport to work, keeping their medication with them or not exercising outside on certain days.

After a successful trial the airTEXT service was rolled out across London with funding from the Mayor of London and Defra. In 2012 a new app was developed which provides information on four health-relevant alerts: UV, pollen, air quality and temperature.

Currently around 10,000 people use the airTEXT service through text, Twitter or the website.

8.3 Individual action

Reducing individual contribution to air pollution

Everyone can do their bit to reduce the pollution on themselves and others. Some examples are included in Appendix 3.

Reducing exposure to air pollution

The health benefits of being physically active far outweigh the risks from poor air quality in London. Only 40% of men and 28% of women in England are meeting the minimum recommendations for physical activity of 150 minutes of moderate intensity activity (e.g. brisk walking) per week. Physical inactivity contributes to a wide range of health problems including over 20 chronic conditions including coronary heart disease, stroke, type 2 diabetes, cancer, obesity, mental health problems and musculoskeletal conditions and reduces life expectancy.

However, Londoners can reduce the risks when air pollution levels are elevated by:

- Signing up to receive pollution alerts from the airTEXT[31] service or via the LondonAir smartphone apps
- Planning bike rides and walks to avoid busy main roads – use quieter side roads and off-road routes if available [32]
- Plan your physical outdoor activities around the hourly air pollution readings which can be found at London Air [33]. Table 7, below, provides health advice for both at risk individuals (adults and children with lung problems, and adults with heart problems) as well as the general population.

[31] www.airtext.info/
[32] www.walkit.com, www.tfl.gov.uk
[33] www.London.air.org.uk

Table 5. Air Quality Index [34]

Air Pollution Banding	Value	Accompanying health messages for at-risk groups and the general population	
		At-risk individuals*	**General population**
Low	1-3	**Enjoy** your usual outdoor activities.	**Enjoy** your usual outdoor activities.
Moderate	4-6	Adults and children with lung problems, and adults with heart problems, **who experience symptoms**, should **consider reducing** strenuous physical activity, particularly outdoors.	**Enjoy** your usual outdoor activities.
High	7-9	Adults and children with lung problems, and adults with heart problems, should **reduce** strenuous physical exertion, particularly outdoors, and particularly if they experience symptoms. People with asthma may find they need to use their reliever inhaler more often. Older people should also **reduce** physical exertion.	Anyone experiencing discomfort such as sore eyes, cough or sore throat should **consider reducing** activity, particularly outdoors.
Very High	10	Adults and children with lung problems, adults with heart problems, and older people, should **avoid** strenuous physical activity. People with asthma may find they need to use their reliever inhaler more often.	**Reduce** physical exertion, particularly outdoors, especially if you experience symptoms such as cough or sore throat.

* Adults and children with lung problems, and adults with heart problems

[34] uk-air.defra.gov.uk/air-pollution/daqi

9 NEXT STEPS

We hope that the information provided in this report has been a useful introduction into air quality and health issues in your borough and given you some ideas for actions you might like to take.

It is hoped that the document will stimulate discussions within the council on how to improve air quality and tackle the health impacts of air pollution in the borough.

Here are some suggestions for next steps you could take:

- Include borough specific data from this report in your Joint Strategic Needs Assessment
- Find your borough Air Quality officer and talk to them about what is being done locally to tackle air quality
- Read your borough Air Quality Action Plan and identify opportunities for maximising the health benefits and joining up work e.g promoting physical activity through increasing walking and cycling, then add these to your Health and Wellbeing Strategy
- Use the glossary as an easy reference guide to get to grips with the terminology
- Let us know what you think of this report, what further information would be useful to you and what innovative work on air quality and health you are doing in your borough.

More information on how the Mayor is delivering Cleaner Air in London can be found on the london.gov.uk website http://www.london.gov.uk/airquality

10 REFERENCES

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4 http://www.who.int/indoorair/en/

5 http://www.cityoflondon.gov.uk/business/environmental-health/environmental-protection/air-quality/cityair/Documents/Air%20Quality%20-%20Building%20Engineer%20Toolkit.pdf

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9 http://www.defra.gov.uk/publications/files/pb13378-air-pollution.pdf

10 www.dft.gov.uk/

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16 www.sustrans.org.uk

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32 www.airtext.info/

33 www.walkit.com, www.tfl.gov.uk

34 www.London.air.org.uk

35 uk-air.defra.gov.uk/air-pollution/daqi

36 http://www.energysavingtrust.org.uk/Transport/Consumer/Fuel-efficient-driving

37 www.green500.co.uk

38 www.travelfootprint.org

11 GLOSSARY

A

- **Air Pollution Bandings** - The Air Pollution Information Service uses four bands to describe levels of pollution. The bands are Low, Moderate, High and Very High. Healthy people do not normally notice any effects from air pollution, except occasionally when air pollution is "Very High".

- **Air Pollution Index** - The Air Pollution Index is a numerical index for air pollution ranging from 1 to 10 related to the Low, Moderate, High and Very High Air Pollution Bandings.

- **Air Quality Management Area (AQMA)** - If a Local Authority identifies any locations within its boundaries where the Air Quality Objectives are not likely to be achieved, it must declare the area as an Air Quality Management Area (AQMA). The Local Authority is subsequently required to put together a plan to improve air quality in that area.

- **Air Quality Objectives** - The Air Quality Objectives are policy targets generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedences, within a specified timescale. The Objectives are set out in the UK Government's Air Quality Strategy.

- **Air Quality Standards** - Air Quality Standards are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The Standards are based on assessment of the effects of each pollutant on human health, including the effects on sensitive sub-groups.

- **Air Quality Strategy** - The Air Quality Strategy for England, Scotland, Wales and Northern Ireland describes the plans drawn up by the Government and the Devolved Administrations to improve and protect ambient air quality in the UK in the medium-term. The Strategy sets Objectives for the main air pollutants to protect health. Performance against these Objectives is monitored where people regularly spend time and might be exposed to air pollution.

- **Ambient Air** - The air (or concentration of a pollutant) that occurs at a particular time and place outside of built structures. Often used interchangeably with "outdoor air".

- **Annual Mean** – The annual mean is the average concentration of a pollutant measured over one year.

- **Asthma** - the common chronic inflammatory disease of the airways characterized by variable and recurring symptoms, reversible airflow obstruction, and bronchospasm.[1] Symptoms include wheezing, coughing, chest tightness, and shortness of breath.

- **Automatic Monitoring** - Monitoring is usually termed "automatic" or "continuous" if it produces real-time measurements of pollutant concentrations. Automatic fixed point monitoring methods exist for a number of pollutants, providing high resolution data averaged over very short time periods. BAM, TEOM and FDMS instruments are all automatic monitors.

B

- **Benzene (C6H6)** - Benzene is an organic compound. The main sources of benzene in the atmosphere in Europe are the distribution and combustion of petrol. Benzene is a known human carcinogen.

- **Black carbon** - is an agent which affects climate change and which is formed through the incomplete combustion of fossil fuels, biofuel, and biomass, and is emitted in both anthropogenic and naturally occurring soot. Black carbon stays in the atmosphere for several days to weeks.

C

- **Carbon Monoxide (CO**) - Carbon monoxide is a colourless, odourless gas resulting from the incomplete combustion of hydrocarbon fuels. CO interferes with the blood's ability to carry oxygen to the body's tissues and results in adverse health effects.

- **Cardiovascular disease** - is a class of diseases that involve the heart or blood vessels (arteries, capillaries and veins). Cardiovascular disease refers to any disease that affects the cardiovascular system, principally cardiac disease, vascular diseases of the brain and kidney, and peripheral arterial disease.

- **Chronic obstructive pulmonary disease (COPD)** - is the occurrence of chronic bronchitis or emphysema, a pair of commonly co-existing diseases of the lungs in which the airways become narrowed. This leads to a limitation of the flow of air to and from the lungs, causing shortness of breath (dyspnea).

- **COMEAP** - Committee on the Medical Effects of Air Pollutants, COMEAP is an Advisory Committee of independent experts that provides advice to Government Departments and Agencies on all matters concerning the potential toxicity and effects upon health of air pollutants.

D

- **Data Capture** - is the term given to the percentage of measurements for a given period that were validly measured.

- **Days with Exceedences** - the number of days with exceedences is the number of days on which at least one period has a concentration greater than, or equal to, the relevant air quality

standard (the averaging period will be that defined by that Standard). Since the National Air Quality Standards cover different time periods (15 min average, 24 hour running mean etc.), this gives a useful way of comparing data for different pollutants.

- **Diffusion Tube Samplers** - tube samplers which collect nitrogen dioxide and other pollutants by molecular diffusion along an inert tube to an efficient chemical absorbent. After exposure for a period of time, the absorbent material is chemically analysed and the concentration calculated.

- **Dispersion model** - A dispersion model is a means of calculating air pollution concentrations using information about the pollutant emissions and the nature of the atmosphere. Air Quality Objectives are set in terms of concentration values, not emission rates. In order to assess whether an emission is likely to result in an exceedence of a prescribed objective it is necessary to know the ground level concentrations which may arise at distances from the source. This is the purpose of a dispersion model.

E

- **Emission Factor** - An emission factor gives the relationship between the amount of a pollutant produced and the amount of raw material processed or burnt.

- **Emission Inventories** - Emissions inventories estimate the amount and the pollutants that are emitted to the air each year from all sources. The National Atmospheric Emissions Inventory covers the UK and the London Atmospheric Emission Inventory covers London.

- **EU Directives** - The European Union has been legislating to control emissions of air pollutants and to establish air quality objectives since the early 1970s. In June 2008, a new Directive came into force: the Council Directive on ambient air quality and cleaner air for Europe (2008/50/EC), known as the "Air Quality Directive".

- **Exceedence** - An exceedence defines a period of time during which the concentration of a pollutant is greater than, or equal to, the appropriate air quality criteria.

H

- **Hydrocarbons** - Hydrocarbons are compounds containing various combinations of hydrogen and carbon atoms. They are emitted into the air by natural sources (e.g. trees) and as a result of fossil and vegetative fuel combustion, fuel volatilization, and solvent use. Hydrocarbons are a major contributor to smog.

I

- **Index of multiple deprivations (IMD)** - The Index of Multiple Deprivation is a UK government statistical study of deprived areas in UK local authorities which covers aspects of

deprivation including income, employment, health and disability, education, housing and services and crime and the living environment.

L

- **Local Air Quality Action Plan** - When a Local Authority has set up an Air Quality Management Area, AQMA, it must produce an action plan setting out the measures it intends to take in pursuit of the Air Quality Objectives in the designated area.

- **Local Air Quality Management (LAQM)** - The Local Air Quality Management (LAQM) process requires Local Authorities to periodically review and assess the current and future quality of air in their areas. A Local Authority must designate an Air Quality Management Area (AQMA) if any of the Air Quality Objectives set out in the regulations are not likely to be met over a relevant time period.

- **London Implementation Plan (LiP)** - Local Implementation Plans (LIPs) are documents required under the Greater London Authority Act 1999. They set out how each borough will deliver the Mayor's Transport Strategy in their area.

N

- **Nitrogen dioxide (NO_2)** - Nitrogen dioxide has a variety of environmental and health impacts. It is a respiratory irritant which may exacerbate asthma and possibly increase susceptibility to infections. In the presence of sunlight, it reacts with hydrocarbons to produce photochemical pollutants such as ozone.

M

- **Maximum hourly average** - The maximum hourly average is the highest hourly reading of air pollution obtained during the time period under study.

- **Microgrammes per cubic metre** ($\mu g/m^3$) - A measure of concentration in terms of mass per unit volume. A concentration of 1 $\mu g/m^3$ means that one cubic metre of air contains one microgram (10-6 grams) of pollutant.

O

- **Oxides of Nitrogen (NO_x)** - Combustion processes emit a mixture of nitrogen oxides (NO_x), primarily nitric oxide (NO) which is quickly oxidised in the atmosphere to nitrogen dioxide (NO_2).

- **Ozone (O_3)** - Ozone (O_3) is not emitted directly into the atmosphere, but is a secondary pollutant generated following the reaction between nitrogen dioxide (NO_2), hydrocarbons and

sunlight. Ambient concentrations are usually highest in rural areas, particularly in hot, still and sunny weather conditions which give rise to summer "smogs".

P

- **Particulate matter (PM)** - Airborne PM includes a wide range of particle sizes and different chemical constituents. It consists of both primary components, which are emitted directly into the atmosphere, and secondary components, which are formed within the atmosphere as a result of chemical reactions. Of greatest concern to public health are the particles small enough to be inhaled into the deepest parts of the lung. Air Quality Objectives are in place for the protection of human health for PM_{10} and $PM_{2.5}$ – particles of less than 10 and 2.5 micrometres in diameter, respectively.

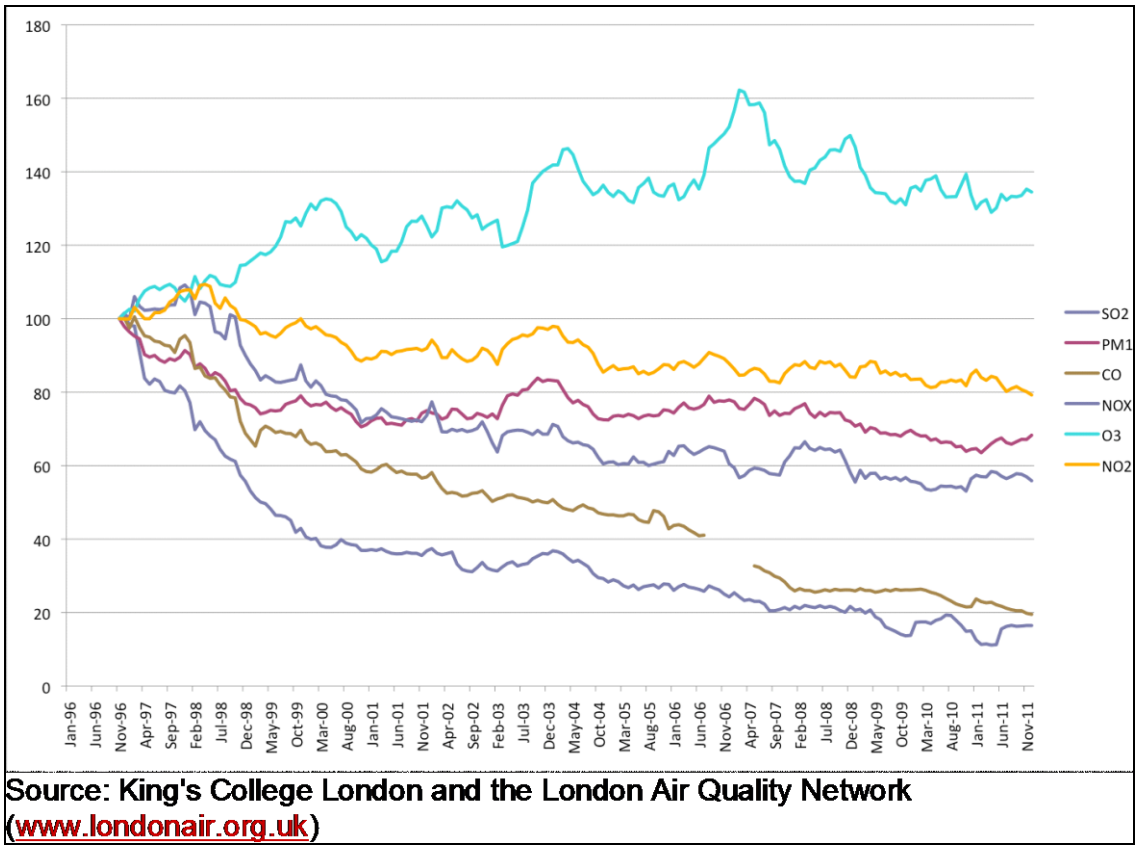
S

- **Sulphur Dioxide (SO_2)** - Sulphur dioxide is a corrosive, acidic gas which combines with water vapour in the atmosphere to produce acid rain. SO_2 in ambient air is also associated with asthma and chronic bronchitis.

12 APPENDICES

Appendix 1

Annual mean concentrations of ground level pollutants in London 1996 - 2011



Source: King's College London and the London Air Quality Network (www.londonair.org.uk)

Appendix 2

National air quality objectives and European Directive limit and target values for the protection of human health							
Pollutant	**Applies**	**Objective**	**Concentration measured as[10]**	**Date to be achieved by and maintained thereafter**	**European obligations**	**Date to be achieved by and maintained thereafter**	**New or existing**
Particles (PM_{10})	UK	50µg.m^{-3} not to be exceeded more than 35 times a year	24 hour mean	31 December 2004	50µg.m^{-3} not to be exceeded more than 35 times a year	1 January 2005	Retain existing
	UK	40µg.m^{-3}	annual mean	31 December 2004	40µg.m^{-3}	1 January 2005	
	Indicative 2010 objectives for PM_{10} (from the 2000 Strategy and 2003 Addendum) have been replaced by an exposure reduction approach for $PM_{2.5}$ (except in Scotland – see below)						
	Scotland	50µg.m^{-3} not to be exceeded more than 7 times a year	24 hour mean	31 December 2010			Retain existing
	Scotland	18µg.m^{-3}	annual mean	31 December 2010			
Particles ($PM_{2.5}$) Exposure Reduction	UK (except Scotland)	25µg.m^{-3}	annual mean	2020	Target value 25µg.m^{-3} [12]	2010	New (European obligations still under negotiation)
	Scotland	12µg.m^{-3}		2020	Limit value 25µg.m^{-3}	2015	
	UK urban areas	Target of 15% reduction in concentrations at urban background[11]		Between 2010 and 2020	Target of 20% reduction in concentrations at urban background	Between 2010 and 2020	
Nitrogen dioxide	UK	200µg.m^{-3} not to be exceeded more than 18 times a year	1 hour mean	31 December 2005	200µg.m^{-3} not to be exceeded more than 18 times a year	1 January 2010	Retain existing
	UK	40µg.m^{-3}	annual mean	31 December 2005	40µg.m^{-3}	1 January 2010	
Ozone	UK	100µg.m^{-3} not to be exceeded more than 10 times a year	8 hour mean	31 December 2005	Target of 120µg.m^{-3} not to be exceeded more than 25 times a year averaged over 3 years	31 December 2010	Retain existing

National air quality objectives and European Directive limit and target values for the protection of human health							
Pollutant	**Applies**	**Objective**	**Concentration measured as**	**Date to be achieved by and maintained thereafter**	**European obligations**	**Date to be achieved by and maintained thereafter**	**New or existing**
Sulphur dioxide	UK	266µg.m^{-3} not to be exceeded more than 35 times a year	15 minute mean	31 December 2005			Retain existing
	UK	350µg.m^{-3} not to be exceeded more than 24 times a year	1 hour mean	31 December 2004	350µg.m^{-3} not to be exceeded more than 24 times a year	1 January 2005	
	UK	125µg.m^{-3} not to be exceeded more than 3 times a year	24 hour mean	31 December 2004	125µg.m^{-3} not to be exceeded more than 3 times a year	1 January 2005	
Polycyclic aromatic hydrocarbons	UK	0.25ng.m^{-3} B[a]P	as annual average	31 December 2010	Target of 1ng.m^{-3}	31 December 2012	Retain existing
Benzene	UK	16.25µg.m^{-3}	running annual mean	31 December 2003			Retain existing
	England and Wales	5µg.m^{-3}	annual average	31 December 2010	5µg.m^{-3}	1 January 2010	
	Scotland, Northern Ireland	3.25µg.m^{-3}	running annual mean	31 December 2010			
1,3- butadiene	UK	2.25µg.m^{-3}	running annual mean	31 December 2003			Retain existing
Carbon monoxide	UK	10mg.m^{-3}	maximum daily running 8 hour mean/in Scotland as running 8 hour mean	31 December 2003	10mg.m^{-3}	1 January 2005	Retain existing
Lead	UK	0.5µg.m^{-3}	annual mean	31 December 2004	0.5µg.m^{-3}	1 January 2005	Retain existing
		0.25µg.m^{-3}	annual mean	31 December 2008			

National air quality objectives and European Directive limit and target values for the protection of human health							
Pollutant	**Applies**	**Objective**	**Concentration measured as**	**Date to be achieved by and maintained thereafter**	**European obligations**	**Date to be achieved by and maintained thereafter**	**New or existing**
National air quality objectives and European Directive limit and target values for the protection of vegetation and ecosystems							
Nitrogen oxides	UK	30µg.m^{-3}	annual mean	31 December 2000	30µg.m^{-3}	19 July 2001	Retain existing in accordance with 1st Daughter Directive
Sulphur dioxide	UK	20µg.m^{-3}	annual mean	31 December 2000	20µg.m^{-3}	19 July 2001	Retain existing in accordance with 1st Daughter Directive
	UK	20µg.m^{-3}	winter average	31 December 2000	20µg.m^{-3}	19 July 2001	
Ozone: protection of vegetation & ecosystems	UK	Target value of 18,000µg m^{-3} based on AOT40 to be calculated from 1 hour values from May to July, and to be achieved, so far as possible, by 2010	Average over 5 years	1 January 2010	Target value of 18,000µg m^{-3} based on AOT40 to be calculated from 1 hour values from May to July, and to be achieved, so far as possible, by 2010	1 January 2010	New EU target

http://uk-air.defra.gov.uk/documents/National_air_quality_objectives.pdf

Appendix 3

Actions for Londoners to mitigate against, and adapt to, air pollution

Travel

- If possible walk or cycle or take public transport rather than travelling by car
- If you need to drive:
  - ensure that your car is not wasting fuel by regularly checking oil levels and tyres are not flat
  - use eco driving techniques as advised by the Energy Saving Trust [35]
  - avoid idling your engine when stationary
  - consider joining a car club
- If you are buying a car:
  - avoid older diesel cars, as they tend to be more polluting than petrol models
  - buy the most efficient and cleanest vehicle that you can. Look for the car's Euro standard – this is the air pollution standard that the vehicle was constructed to meet, ranging from Euro 1 (worst) to Euro 5 (best)
  - consider purchasing an electric car and benefit from road tax and congestion charge exemption, cheaper fuel costs and government subsidies

At work

- Develop travel plans to encourage employees to use public transport, walk or cycle
- If employees have to drive as part of their jobs, organise eco-driving training for them
- Install workplace energy efficiency measures [36]
- Freight operators are encouraged to sign up to TfL's Freight Operator Recognition Scheme which encourages safe and sustainable driving and maintenance practices
- Buy, or hire, the cleanest vehicles available [37]

At home

- Turn down the central heating when possible
- Install home energy efficiency measures
- Avoid installing polluting wood-burning stoves
- Avoid burning garden or domestic waste, especially in urban areas

[35] http://www.energysavingtrust.org.uk/Transport/Consumer/Fuel-efficient-driving
[36] www.green500.co.uk
[37] www.travelfootprint.org

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