Public Consultation

This report has been circulated to all local authorities in Kent, members of Dartford Borough Council, public libraries and other interested parties. Any comments or questions should be directed to the following address no later than Monday 3 August 1998;

Duncan Philips
Scientific Officer
Environmental Strategic Development
Directorate of Environment and Leisure
Dartford Borough Council
Civic Centre
Dartford
Kent DA1 1DR

Tel: 01322-343250
Fax: 01322-343963

e-mail : Duncan@genesis2.demon.co.uk

All comments received will be given due consideration and taken into account during the preparation of the Stage 2 Review and Assessment.

Contents

The Borough of Dartford

Dartford Borough lies 15 miles from Central London in North West Kent between the North Downs and the River Thames. One of the smaller of the Kent districts, it covers an area of about 7000 hectares and has a population approaching 84,000. The Borough is strategically located on two of the principal lines of communication within the South East - the M25 London orbital motorway and the A2, linking London to the Channel ports - and lies close to the M20.

The northern part of the Borough between the A2 and the Thames includes the towns of Dartford and Swanscombe and is substantially built-up. It also includes the major development sites within the Borough, and lies within the Kent Thames-side area of the Thames Gateway. This area has been identified by Government as one of two areas within Thames Gateway with the potential for significant growth. The southern part of the Borough is generally rural in character and comprises a mix of open countryside, covered by Green Belt designation, and a number of villages and dormitory settlements.

Dartford is an important employment centre with major employers such as Glaxo Wellcome, Dartford and Gravesham and Thameslink Health Trusts, the Borough Council and J&E Hall located within the town centre. However, the Borough's proximity to London and it's good rail and coach connections mean that many residents commute to work elsewhere.

Several major developments are planned or under construction within the Borough e.g. Ebbsfleet, the Channel Tunnel Rail Link and the new Bluewater Regional Shopping Centre. Also there are an estimated 22,000 new homes and other leisure and commercial projects planned. It is anticipated that road traffic on major and local roads will increase significantly.

Review and Assessment of Air Quality in the Borough of Dartford

Stage 1

1.0 Executive Summary

Section 88(2) of the Environment Act 1995 places a statutory obligation upon local authorities to periodically review and assess air quality within the boundary of their jurisdiction. The enactment of the Air Quality Regulations 1997 signified the start of the review process and that this should be completed no later than 22 December 1999. Guidance issued by the Department of the Environment, Transport and the Regions (DETR) advises that the review process should be carried out in a staged approach. The aim of the process is to give consideration to the likelihood of the standards specified in the Air Quality Regulations 1997 being achieved by the objective target date of 31 December 2005.

In considering the individual pollutants, each authority is to be aware that national policies are expected to deliver an improvement in air quality by 2005 and that local control measures should be minimal. However, it is accepted that some pollutants, such as fine particulates, represent a combined regional and local problem and that measures to control them may be more challenging than some other pollutants such as lead.

This report presents the Stage 1 Review and Assessment of Air Quality in the Borough of Dartford. It does not contain a detailed record of air quality monitoring and/or modelling in the Borough, as this work will form the basis for the Stage 2 Review and Assessment. The report has been written following an assessment of information from a variety of sources. Where possible, actual monitoring data has been used and this has been combined with information taken from the National Atmospheric Emissions Inventory (NAEI) and the Kent Air Quality Partnership (KAQP) and also from monitoring sites in neighbouring areas. The report also contains a summary of atmospheric chemistry so that the subject can be placed in some perspective.

1.1 Benzene

It is believed that the current levels of benzene in the Borough do not exceed the Air Quality Standard. Data from the NAEI suggests that background levels of benzene are in the order of less than 1 ppb and monitoring using diffusion tubes indicates roadside levels are less than 5 ppb. UK Government estimations are that future emissions of benzene will decrease by 50% by 2005 based on 1995 levels and therefore it is considered that the risk of exceeding the 5 ppb running annual mean standard is unlikely.

1.2 1,3-Butadiene

It is believed that the current levels of 1,3-butadiene in the Borough do not exceed the Air Quality Standard. There is no local monitoring of this pollutant, but data from sites in Bloomsbury and Eltham suggest that there is no observable trend either seasonally or over time and that levels are consistently less than 1 ppb. It is therefore considered that the risk of exceeding the 1 ppb running annual mean is unlikely.

1.3 Carbon Monoxide

It is believed that current levels of carbon monoxide in the Borough do not exceed the Air Quality Standard. There is no local monitoring of this pollutant but data from a site in Bexley indicates that since 1995 the 8-hour running mean has been consistently within the 2-4 ppm range. Data from the NAEI suggests that background levels are less than 1 ppm. However, there are several roads that already have average daily traffic flows greater than 50,000 and with the projected growth in traffic that is expected to occur due to the development in the Borough it is felt that there is sufficient evidence to warrant proceeding to a Stage 2 review and assessment for this pollutant.

1.4 Lead

It is believed that current levels of lead in the Borough do not exceed the Air Quality Standard. There is no local monitoring of this pollutant but there is a roadside site on Cromwell Road in London. Since the introduction of unleaded petrol the levels of background lead have reduced from approximately 1.5 $\mu g/m^3$ to approximately 0.2 $\mu g/m^3$. Despite the location of Britannia Metals just over the boundary in Gravesham, it is considered that the risk of exceeding the 0.5 $\mu g/m^3$ annual mean is unlikely.

1.5 Nitrogen Dioxide

It is believed that current levels of nitrogen dioxide in the Borough exceed the Air Quality Standard in some locations and during periods of the year, particularly when specific atmospheric conditions exist. The Air Quality Standard is expressed in two formats; 150 ppb as an hourly mean and 21 ppb as an annual average. Data from the NAEI and monitoring using diffusion tubes indicates that the annual average is currently exceeded in the town centre area and that there are likely to be other areas in the Borough where it is also exceeded. Continuous monitoring at other sites in Kent that are comparable indicate that there are exceedences of the 150 ppb hourly standard during certain atmospheric conditions. This evidence, combined with the expectation for significant increases in road traffic, is sufficient to warrant proceeding to a Stage 2 review and assessment for this pollutant.

1.6 Fine Particulates (PM_{10})

It is believed that current levels of PM_{10} in the Borough may exceed the Air Quality Standard in some locations and during periods of the year, particularly when specific atmospheric conditions exist. The Air Quality Standard is expressed as 50 $\mu g/m^3$ measured as a 24-hour running mean. The objective is to achieve the 99th percentile of this by the end of 2005. This means that in any one year there are a maximum of four 24 hour periods when the standard can be exceeded. Most recently, since specific attention was given to the observations of nearby monitoring stations, episodes of poor air quality have occurred on several occasions and the standard has been exceeded. There are a wide variety of potential sources of PM_{10} and this evidence, combined with recent monitoring data, is sufficient to warrant proceeding to a Stage 2 review and assessment for this pollutant.

1.7 Sulphur Dioxide

It is believed that current levels of sulphur dioxide in the Borough may exceed the Air Quality Standard in some locations and during periods of the year, particularly when specific atmospheric conditions exist. The Air Quality Standard is expressed as 100 ppb measured as a 15 minute mean. The objective is to achieve the 99.9th percentile of this standard by the end of 2005. This means that in any one year there are a maximum of 35 periods of 15 minutes when the standard can be exceeded. There have been recent incidences of poor air quality and there are a number of sources of sulphur dioxide in or near to the Borough. This evidence is sufficient to warrant proceeding to a Stage 2 review and assessment for this pollutant.

1.8 Conclusion

Having looked at the individual pollutants it is considered that there is sufficient evidence to warrant proceeding to a Stage 2 Review and Assessment for the following;

- carbon monoxide
- nitrogen dioxide
- particulates
- sulphur dioxide

2.0 Introduction

2.1 National Air Quality Strategy - a brief summary and introduction

The National Air Quality Strategy (NAQS) is an important and significant UK central Government measure which intends to focus attention on air quality issues with the objective of producing an improvement in air quality through local and national measures. A substantial amount of research and consultation went into the formation of several publications which collectively offer guidance to those involved in areas that might influence air quality control.

The NAQS was published in March 1997 and the Air Quality Regulations 1997 was published in December 1997. A consultation paper '*Review and Assessment: Pollutant-Specific Guidance*' was published in March 1998 and is likely to become another in the series of guidance documents listed below. The following publications have also been made available;

LAQM. G1(97) Framework for Review and Assessment of Air Quality
LAQM. G2(97) Developing Local Air Quality Actions Plans and Strategies: the principal considerations
LAQM. G3(97) Air Quality and Traffic Management
LAQM. G4(97) Air Quality and Land Use Planning
LAQM. TG1(98) Monitoring for Air Quality Reviews and Assessments
LAQM. TG2(98) Preparation and use of Atmospheric Emissions Inventories
LAQM. TG3(98) Selection and Use of Dispersion Models

The NAQS and the Air Quality Regulations 1997 form a powerful addition to the existing control mechanisms for air quality. An important element is that, for the first time, air quality can now be considered as a material planning consideration alongside other traditional planning requirements. How this materialises in practice is yet to be seen as any such refusal could be the subject of an appeal.

The concept of the NAQS should be placed into the overall context of policies at national and international level to control air quality. The Government has deemed that there should a local level of responsibility and control for air quality issues and in the brief period since the introduction of the Air Quality Regulations 1997 it is clear that the level of expertise and budget allocation to fulfil the statutory obligations varies widely across the country. Without doubt, local air quality management will now have a high profile when considering local development issues.

Of the pollutants identified in the NAQS, the Government only expects those authorities who anticipate that the objectives will not be achieved to have to devise an Action Plan. The intention is that local authorities target their resources towards the pollutants of greatest concern and to get to this point a three stage review and assessment process has been devised. This report presents the results of the Stage 1 Review and Assessment and will be followed by a Stage 2 Review and Assessment which focuses only on those pollutants identified in Stage 1 as being potentially of concern. In some cases, a Stage 3 Review and Assessment will be required and if this suggests that it is highly likely that the objectives will not be achieved then an Air Quality Management Area has to be established and an Action Plan must be devised to tackle the air pollution problems. This process will require public consultation.

It should be noted that the NAQS has been devised from a human exposure perspective. Objectives that have short averaging times (such as sulphur dioxide and nitrogen dioxide) should focus on locations where people are exposed for short period of times whereas longer averaging times (such as annual averages) would consider more typical background levels.

2.2 Atmospheric Chemistry - a brief summary and introduction

The pollutants identified and selected for inclusion in the Air Quality Regulations 1997 are just a few of the many gaseous pollutants that potentially exist. The number of variations of hydrocarbons is vast although many of them exist at very small levels and have been discounted for the purposes of the NAQS. Historically, air pollution is linked with economic development and in the UK the period that signified the start of concerns was the industrial revolution. The rapid drive for an advancement of technology, power generation and social regeneration created a largely uncontrolled situation where pollutants were emitted into the atmosphere quite freely. Air quality suffered, the health of the local population suffered and the consequence was that the science of atmospheric chemistry had begun.

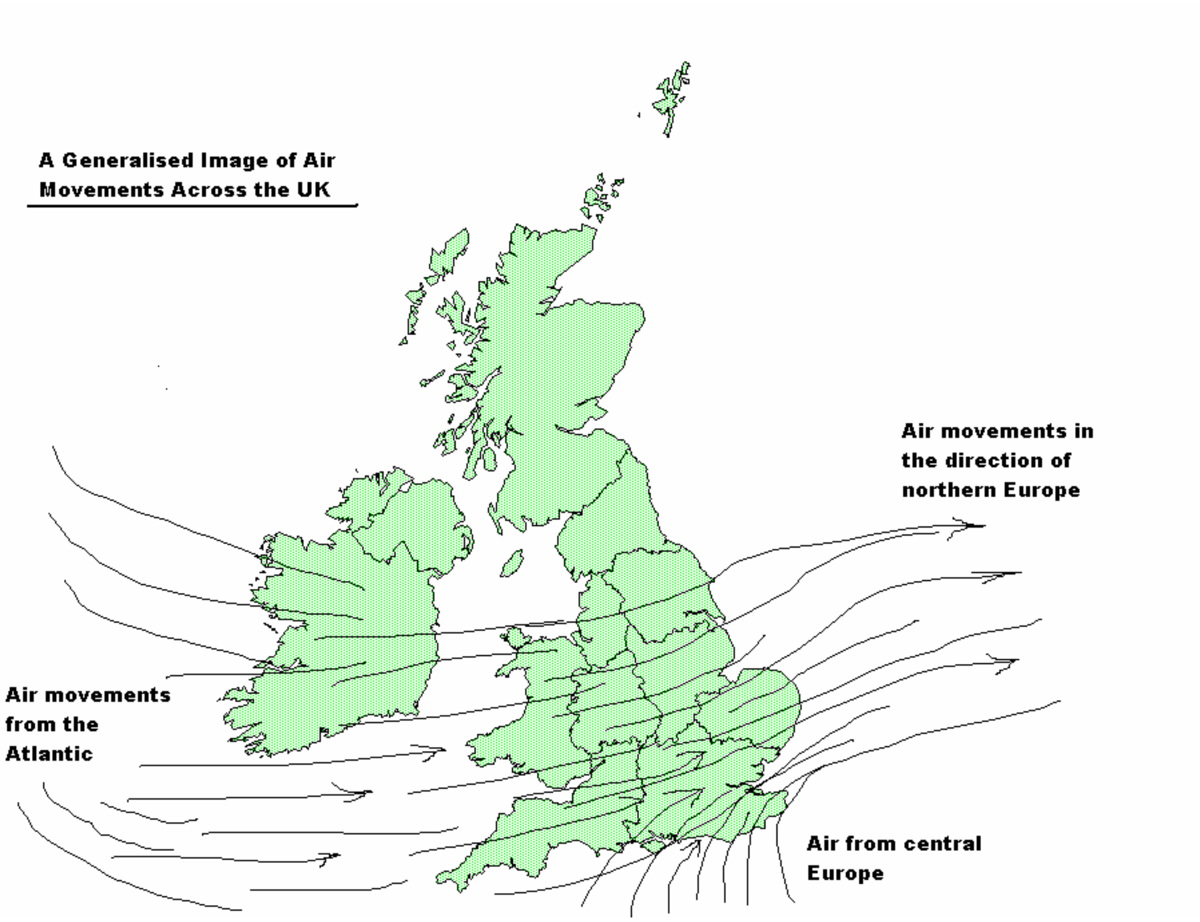
Over the last 120 years or so, legislation has been introduced that has gradually tightened up and restricted the emissions of specific pollutants into the atmosphere. Initially smoke and sulphur dioxide emissions from fossil fuelled (mainly poor quality coal) sources were targeted. The now infamous smogs were caused by emissions of smoke, sulphur and the acidic combination and reaction with fog. The result was a dense cocktail of pollution that would be present in the air for long periods of time waiting for dispersion by the wind. The widespread use of coal for domestic heating exacerbated the problem in densely populated areas and low chimney heights for industrial processes also contributed to the cause. This is still seen today in some developing countries.

As legislation began to take effect and the introduction of cleaner gas fired domestic heating became more common, the problem of smoke and sulphur emissions changed from being a local concern to being a transboundary and global concern. The death of forests, rivers and lakes was attributed to what has become known as ‘acid rain’ and this led to further tightening of sulphur emissions. The sulphur dioxide emissions react in the atmosphere with water vapour and form a weak sulphuric acid solution. During rainfall, the effect of this landing on vegetation and water courses has been seen to be devastating. As a result of international co-operation these problems are now largely under control and the installation of flue-gas desulphurisation (FGD) in fossil fuelled power stations is becoming more common place. Emissions of some other pollutants, most notably methane and carbon dioxide, have been identified as being a contributing cause in the damage to the ozone layer. This is subject to continuing research.

Atmospheric chemistry is a developing science and the detailed understanding of how different pollutants react with each other in the atmosphere is subject to continued research and investigation. It is known that some pollutants have a short residence time and disperse quickly, whilst others will take longer to disperse and are more likely to cause problems some distance away from their source. The problem of transboundary air pollution is a distinct problem for those areas that are ‘down-wind’ of a major polluting source and controlling incidences of poor air quality is often out of their control. The theory behind tall chimney design is that the flue gases leave the chimney with an optimum temperature, velocity and buoyancy so that they are easily diluted and dispersed in the air streams above. Unfortunately, there are several factors that can impede this action, such as;

- poor chimney design
- poor quality control of the flue gas characteristics
- adverse weather conditions

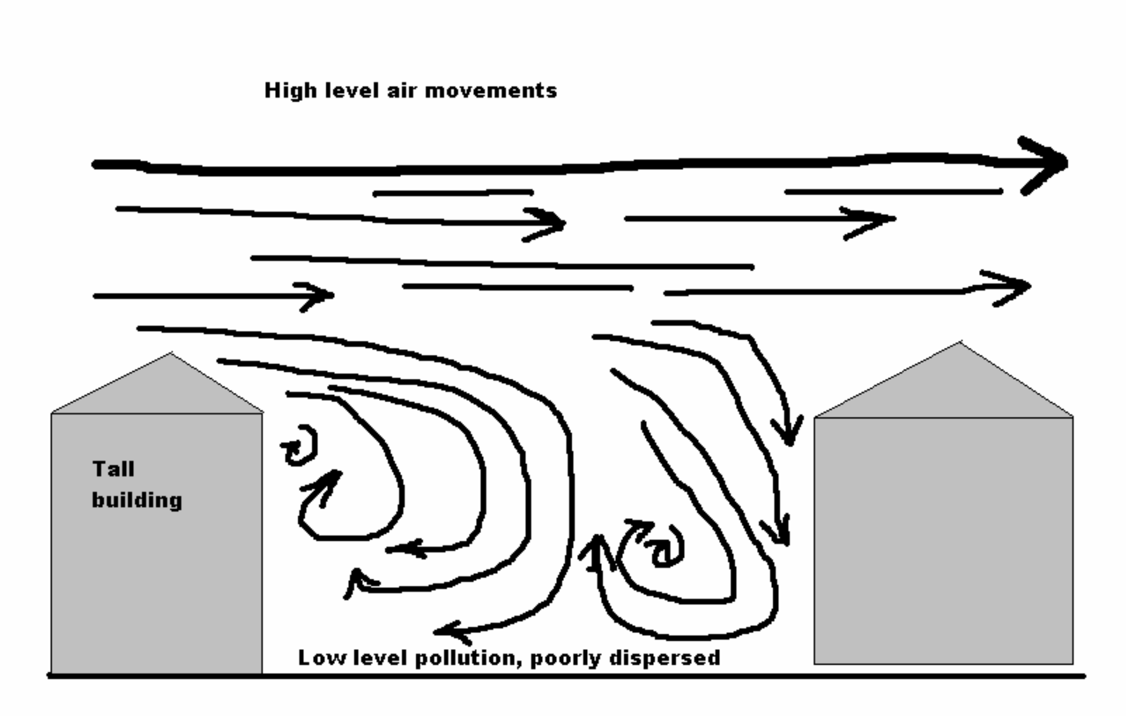
Indeed, in considering the dispersion of all atmospheric pollutants, whether from static sources such as industrial processes and power plants or from line sources such as busy roads, it is the weather that is the single most important factor. Incidences of poor air quality are usually characterised by specific weather conditions rather than by a sudden increase in emissions of the pollutant which has been monitored.



The diagram above illustrates how air movements have the ability to carry pollutants great distances. The southern part of England can be subjected to particulate and ozone pollution episodes that originate in central Europe. Similarly, the industrial parts of the UK have tended to become net exporters of pollutants to northern Europe and this has been particularly well illustrated by sulphur dioxide emissions which contributed to 'acid rain' deposits over Germany and Scandinavia.

The NAQS has identified pollutants that mostly originate from road transport. Sulphur dioxide is primarily a pollutant emitted from industrial sources, but is included in the strategy owing to the acute health effects from short term exposure to high levels. Road transport is currently the main focus of attention for air quality monitoring and for strategies to reduce air pollution episodes. Ground level ozone is a secondary pollutant formed by a photo-chemical reaction and, by definition, if emissions of oxides of nitrogen can be controlled then the likelihood of high levels of ozone pollution will be reduced.

Each of the pollutants reacts differently in the atmosphere and the immediate dispersion of emissions from road traffic is very much dictated by the surrounding area. Factors such as wind speed and direction, solar heat gain, humidity, temperature, pressure, topography and proximity to buildings, trees and other vegetation all contribute to the overall mixing and dilution of the pollutants. The variability of each of these factors compounds the difficulty in understanding the chemistry of the air that we breathe.



As time passes, the amount of data from continuous monitoring of individual pollutants grows and trends in concentrations can be observed. It has been identified that summer and winter air pollution episodes are caused by different climatic conditions. This is illustrated on the following page. In hot weather, oxides of nitrogen react with oxygen to form ozone. This process occurs naturally and areas that suffer high levels of ozone can be many miles down wind of the source of the pollutants. Hot weather is typically associated with low wind speed and high atmospheric pressure and this can also cause levels of PM_{10} and nitrogen dioxide to rise. Conversely, in winter, low temperatures combined with still weather conditions and low cloud cover act as a mechanism to prevent the dispersion of pollutants. Nitrogen dioxide and PM_{10} levels can rise and exceedences of this type were seen on several occasions during the winter of 1997/1998. From time to time during the year, depending on the topography and weather conditions a process called an ‘inversion’ can occur and this can lead to poor air quality in a very localised area. An inversion occurs when cold air near to ground level is trapped by a layer of warm air above and dilution between the two is prevented or restricted because of low wind speed. This can typically occur in areas that are in valleys or natural ‘bowls’, two famous examples of this are Los Angeles and Mexico City. Pollutants, especially nitrogen dioxide, become trapped in the stagnant air mass and air quality suffers as a result.

It is clear that meteorology and the chemistry of pollutant mixing in the air are fundamental requirements in understanding the concept of air pollution issues and they need to be combined with a local appreciation of influencing factors. There are a number of computer models now available commercially and the best of these will try to combine detailed meteorological data with emission inventories. However, at best they should be used as an indicative tool and not viewed as being a definitive scientific answer.

This is illustrated in the diagram overleaf:

3.0 Stage 1 Review

Information in this section of the report has been derived from many sources and has been appropriately quoted. However, small extracts from the following DETR '*Expert Panel on Air Quality Standards'* documents have been used but have not been individually quoted in order to avoid repetition:

1st Report	Benzene	February 1994
3rd Report	1,3-Butadiene	December 1994
4th Report	Carbon Monoxide	December 1994
5th Report	Sulphur Dioxide	September 1995
6th Report	Particles	November 1995
7th Report	Nitrogen Dioxide	December 1996
8th Report	Lead	May 1998

3.1 Benzene

The NAQS standard is 5 ppb, measured as a running annual mean, and the objective is to achieve this standard by the end of 2005.

3.1.1 Sources

Benzene is a chemical consisting of atoms of carbon and hydrogen (C_6H_6) which is a liquid at normal ambient temperatures but readily evaporates and small amounts can be measured in the atmosphere. The main atmospheric source of benzene is from the combustion of petrol in motor vehicles and from the fugitive escape of fumes during the distribution of petroleum. Other sources, albeit at smaller levels when compared to petroleum emissions, are from cigarette smoke and to a lesser extent some foods and even water samples have been found to have a very slight benzene concentration. Benzene is naturally broken down by chemical reactions in the atmosphere, but these reactions take several days. Hence, the public are potentially exposed to benzene in the air that we breathe, especially in urban areas.

3.1.2 Health Effects

Benzene is readily absorbed into the body when breathed into the lungs, about half of it being retained. As it is more soluble in fat than in water, it is distributed in the body to fatty tissues including the brain and the bone marrow where blood cells are made. In the absence of further exposure, the benzene is eliminated by chemical breakdown in the body or by metabolite excretion in the urine, approximately 80% being eliminated within about two days. The effect of long term exposure to benzene is leukaemia and in particular several types of this disease known collectively as non-lymphocytic leukaemia. Experiments have shown that the genetic material of cells can be damaged causing malignant diseases. The risks of leukaemia in industrial workers, exposed to much higher concentrations, has been related to their calculated lifetime exposure - the more benzene they have been exposed to, the greater the risk.

3.1.3 Data Sources and Predictions

Exposure to benzene has been identified as being primarily from road vehicle emissions. Another potential source is from the distribution and storage of petroleum and, depending upon their individual circumstances, some petrol stations may be required to obtain authorisation under Part 1 of the Environmental Protection Act 1990. This will place obligations for vapour recovery during the distribution of the fuel from the tanker into the holding tanks. At the present time there is no requirement to provide for vapour recovery at the consumer end of the pump. The following chart shows the petrol filling stations in the Borough and at the time of writing these are being assessed for their need to comply with the vapour recovery issue.

Name	**Address**
Beadles	Spital Street, Dartford
Betsham Service Station	Park Corner Road, Betsham
Burnham Road Service Station	Burnham Road, Dartford
Cascade Garage	1-3 Station Road, Longfield
Cascade Motor Services	Watling Street, Dartford
Church Road Garage	Church Road, Swanscombe
Darenth Service Station	107-115 Dartford Road, Dartford
Dartford Service Station	Princes Road, Dartford
Elms Service Station	Princes Road, Dartford
Greenhithe Service Station	London Road, Greenhithe
Hawley Service Station	Hawley Road, Dartford
Joydens Wood Service Station	Summerhouse Drive, Dartford
KT Dartford Ltd	171-173 The Brent, Dartford
Lane End Garage	Green Street Green Road, Dartford
Milton Road Service Station	Milton Road, Swanscombe
Refil Garage	Princes Road, Dartford
Springhead Service Station	A2 Coastbound
St. Vincents Road Garage	St. Vincents Road, Dartford
Station Road	Station Road, Longfield
Winston Service Station	Princes Road, Dartford

Some of these petrol stations are in residential areas but it is not yet known whether benzene levels are higher in their vicinity. There is the possibility that the existing benzene diffusion tubes (see below) could be relocated in April 1999 to clarify this matter.

Monitoring for benzene, using diffusion tubes, commenced in the Borough in December 1997 and was expanded to four sites in April 1998. The results obtained, in ppb, are as follows;

	Lunn Poly	Princes Rd	Ightham Cot	Axton Chase
Jan	3.75	3.79		
Feb	3.98	5.08		
Mar	4.6	0.4*		
Apr	1.6	1.7	0*	0*

* A problem existed with these tubes and the results are unreliable

The Lunn Poly and Princes Road sites are both roadside. Lunn Poly is located on Lowfield Street in the town centre, in an area of high pedestrian exposure and slow moving congested traffic for most of the day. The Princes Road site is located at the busy junction of Lowfield Street and Princes Road and is indicative of other busy junctions in the Borough. The Ightham Cottages and Axton Chase sites are both intermediate. The Ightham Cottages site is located near to a busy road which is expected to receive a significant increase in traffic volume within the next year and there is a terrace of houses adjacent. The Axton Chase site is located in a rural area, adjacent to a busy road and at the entrance to a secondary school. Both of these tubes are believed to be representative of other intermediate sites in the Borough.

Data taken from the National Atmospheric Emissions Inventory (NAEI) on the internet (http://www.aeat.co.uk/cgi-bin/pix2osbz.pl) suggests that estimated background benzene concentrations in the Borough range from 0.37 ppb to 0.89 ppb.

Continuous monitoring data since 1992 using an OPSIS monitor on Marylebone Road in London, by Westminster City Council, showed that annual average levels are approximately 2.5 ppb. Additional continuous monitoring at the 'supersite' on Marylebone road started in November 1997 but it is too early to form any long-term conclusions from the data at this stage. However, early data suggests that levels are in the 5 ppb range. Whilst not totally conclusive, the data suggests that benzene levels are higher close to busy roads and lower in rural areas and research continues into studying levels close to petrol filling stations.

3.1.4 Assessment

The NAQS indicates that total benzene emissions are expected to decline by almost 40% by the year 2000, over 50% by 2005 and about 60% by 2010 based on 1995 figures. On the basis of this prediction and having reviewed the evidence obtained above, it is considered that **there is no need to progress to a Stage 2 review and assessment for benzene.**

3.2 1,3-Butadiene

The NAQS standard is 1 ppb, measured as a running annual mean, and the objective is to achieve this standard by the end of 2005.

3.2.1 Sources

1,3-butadiene is a chemical consisting of atoms of carbon and hydrogen (C_4H_6) which is a gas at normal ambient temperature and trace amounts can be detected in the atmosphere. With the exception of accidental releases, the 1,3-butadiene that can be detected in the air is derived mainly from combustion of petrol and diesel fuel, but some also comes from house fires and the burning of other fossil fuels. 1,3-butadiene is also present in cigarette smoke. It does not exist as a constituent of petrol, but is formed by the combustion process itself. It is understood that 1,3-butadiene is removed efficiently by catalytic converters on cars and that this is likely to signify a trend of reducing emissions as the proportion of cars with 'cats' increases.

3.2.2 Health Effects

There is limited evidence to demonstrate the effect of 1,3-butadiene on humans and many conclusions have been derived from laboratory experiments on animals. The data is consistent in showing that 1,3-butadiene is a potent carcinogen and that it acts on the genetic material of cells as a genotoxic carcinogen. Some information has also been derived from humans exposed to the pollutant during their occupation. The combined data illustrates that an absolutely safe level of exposure cannot be established but that the general public are likely to only be exposed to very small levels.

3.2.3 Data Sources and Predictions

Nationally, there is very little continuous monitoring for 1,3-butadiene and technology to detect the pollutant at very small levels is still developing. There is no monitoring for this pollutant within the Borough or within the whole of Kent. The following table shows data that has been published in the NAQS and this has been used for the purposes of this review;

Table 1 - 1,3-butadiene Monitoring Data

Site	Year	Annual mean	Maximum Running	% Data Capture

			Annual Mean	
Belfast	1994 1995	0.18 0.17	0.20 0.18	95.3 94.0
Birmingham	1994 1995	0.22 0.24	0.34 0.25	91.4 97.1
Bristol	1994 1995	0.22 0.24	0.53 0.24	41.8 82.6
Cardiff	1994 1995	0.27 0.23	0.41 0.27	94.1 83.8
Edinburgh	1994 1995	0.11 0.13	0.40 0.13	79.0 84.8
Harwell (rural)	1994 1995	- 0.18	- -	- 16.0
Leeds	1994 1995	- 0.21	- 0.21	- 94.3
London Eltham	1994 1995	0.24 0.24	0.25 0.26	71.9 87.2
London Bloomsbury	1994 1995	0.38 0.36	0.45 0.38	90.3 90.0
Middlesborough	1994 1995	0.26 0.27	0.28 0.31	63.3 91.5

(Source: National Air Quality Strategy 1997, page 97) (Units = ppb)
(To be considered as being representative, data capture should be >75%)

Additional monitoring for 1,3-butadiene has been established at the 'supersite' on Marylebone Road in London in November 1997. It is too early to form any conclusions from the data from this site, but early indications suggest that the potential running annual average may be in the order of 0.4 ppb.

3.2.4 Assessment

The NAQS estimates that petrol-engined vehicle 1,3-butadiene emissions are expected to decline by about 55% by the year 2000 based on their 1992 values and by 73% by the year 2010. Whilst the Borough does not have any monitoring for this pollutant it is considered that traffic levels are largely similar to other towns and cities and that levels of the pollutant are likely to be similar to monitored data elsewhere. Therefore, in the light of the evidence obtained above, it is considered that **there is no need to progress to a Stage 2 review and assessment for 1,3-butadiene.**

3.3 Carbon Monoxide

The NAQS standard is 10 ppm, measured as a running 8-hour mean, and the objective is to achieve this standard by the end of 2005.

3.3.1 Sources

Carbon monoxide is produced by the incomplete combustion of carbon based substances. Complete combustion, in the presence of sufficient oxygen leads to carbon dioxide, whereas incomplete combustion, possibly due to slight oxygen deficiency, leads to carbon monoxide. Human exposure can be from a variety of sources, internally and externally. Internal sources might be from domestic heating appliances and is often related to poor installation or maintenance and combined with inadequate ventilation. Smokers are also exposed to high levels and it has been shown that the amount of carbon monoxide in the blood of a regular smoker is considerably greater than that which can be obtained from breathing air in even a heavily polluted street. The NAQS, however, is concerned with exposure for non-smokers in the external environment and the main source is from vehicle exhausts.

When a vehicle engine is cold or badly tuned, or when the engine is idling or moving slowly, it will depart from its optimal operating condition and produces more carbon monoxide. Thus, it is seen that levels of the gas in ambient air are highest close to busy roads, especially when traffic flow is reduced as in peak rush hours.

3.3.2 Health Effects

Carbon monoxide is both colourless and odourless and life-threatening concentrations can be breathed without giving any warning to the victim. The first sign of severe poisoning is loss of consciousness and further inhalation of high concentrations readily leads to death. These effects are due to the interference of carbon monoxide with the processes whereby oxygen is taken up by the blood and utilised in the cells in the body. It does this by both interfering with the transport of oxygen by red cells in the blood (by the formation of carboxyhaemoglobin, which substantially reduces the ability of red cells to carry oxygen) and also by blocking essential biochemical reactions in cells. In those people who recover from accidental or deliberate poisoning by carbon monoxide, brain damage to a greater or lesser extent due to lack of oxygen is a common consequence.

The formation of carboxyhaemoglobin in the blood of people exposed to carbon monoxide and the amount present depends on both the level and duration of exposure, as well as on the rate and depth of breathing. Thus, someone exercising and breathing more rapidly and deeply, will have higher levels than someone resting but exposed to the same concentration. Some people are at more risk than others, notably; those with pre-existing heart or lung conditions and pregnant women.

3.3.3 Data Sources and Predictions

There is no monitoring for this pollutant in the Borough. Elsewhere in Kent, it is monitored at two background sites at Luton (near Rochester) and Sevenoaks. Data taken from the NAEI on the internet (http://www.aeat.co.uk/cgi-bin/pix2osco.pl) identifies that estimated background carbon monoxide concentrations across the Borough are in the 0.2 - 0.4 ppb range. This data compares favourably to the data in the following table that has been extracted from information in the NAQS;

Table 2 - Carbon Monoxide Monitoring Data

Site	Year	Annual Average	Maximum 1-hour	Maximum 8-hour Running Average
Bexley	1994	0.5	8.4	4.5
	1995	0.4	6.2	4.7
Leicester	1994	0.6	8.8	5.9
	1995	0.5	10.1	7.9
London - Cromwell Road (kerbside)	1990	2.9	18.4	15.5
	1991	3.3	18.7	13.9
	1992	2.8	11.0	8.7
	1993	2.2	12.6	9.1
	1994	1.9	10.7	10.1
	1995	1.8	9.7	6.7
Stevenage	1990	0.7	6.4	3.5
	1991	0.7	7.4	4.9
	1992	0.6	5.0	3.0
	1993	0.5	6.8	3.0

(Source: National Air Quality Strategy 1997, pages 102 & 103) (Units = ppm)

DETR guidance indicates that consideration for this pollutant should identify roads that have high volumes of traffic and a combination of high volumes with very slow speed. Using data from the Kent County Council Highways transport model, the following roads have been identified as having a current or projected average daily traffic flows greater than 50,000

- M25
- A2
- Thames Road / University Way
- Watling Street
- Princes Road

However, the model did not identify any roads with current or projected annual average daily traffic flows greater than 25,000 and where traffic travels at mean speeds < 10 km/hr for prolonged periods.

Data obtained from the NAEI 1 km grid, and included pictorially in the appendix to this report, shows that there are several grid squares across the Borough where current or projected annual emissions of carbon monoxide is greater than 200 tonnes. These areas are predominately the town centre and the more densely populated locations.

3.3.4 Assessment

The NAQS suggests that national emissions of carbon monoxide will reduce by 32% in 2000, 48% in 2005 and by 54% in 2010 when compared with 1995 levels. Data from comparable towns and predictions quoted in the NAQS would suggest that the Borough should not be at risk of exceeding the standard. However, due to the expected growth in road traffic from anticipated development, the absence of local monitoring data and the levels obtained at sites elsewhere where high traffic numbers are seen it is considered that **there is sufficient concern to warrant progressing to a Stage 2 Review and Assessment for carbon monoxide.**

3.4 Lead

The NAQS standard is 0.5 µg/m^3, measured as an annual mean, and the objective is to achieve this standard by the end of 2005.

3.4.1 Sources

Lead is the most widely used non-ferrous metal and has a large number of industrial applications. The single largest use is in the manufacture of batteries. However, as the compound tetraethyl lead, it has been used as a petrol additive to enhance octane rating. With the recognition of the adverse effects of lead on human health and the increasing use of catalytic converters, which are poisoned by lead, this use is rapidly declining. Most of the airborne emissions of lead in the UK arise from petrol engined motor vehicles. Since 1993, all new petrol engined cars have been fitted with a catalytic converter and must run on unleaded petrol and from the end of 1999 leaded fuel is expected to be withdrawn from sale. Humans can be exposed to lead in other ways, most commonly from food or water intake.

3.4.2 Health Effects

The effects of lead poisoning vary depending upon the degree of exposure. Low levels can lead to concentration loss and intelligence deficiencies, especially in children. Severe cases can lead to anaemia and even damage to the brain, liver and kidneys.

3.4.3 Data Sources and Predictions

Lead is not currently monitored in the Borough or elsewhere in Kent. Since the introduction of unleaded fuel, data from the Cromwell Road kerbside site in London has indicated that levels have dropped from around 1.4 µg/m^3 to the order of 0.2 - 0.3 µg/m^3. Data from a site on Marylebone Road in London also appears to have stabilised at the 0.2 µg/m^3 level. These roads are both very busy and suggest that lead from road traffic sources is largely under control.

Just over the north east Borough boundary with Gravesham there is a lead and silver metals processing factory. It is possible that there are localised higher levels of airborne lead which originate from this source (an authorised process under Part 1 of the Environmental Protection Act 1990). However, this is unlikely to represent a risk of exceeding the standard.

3.4.4 Assessment

In the light of the evidence obtained above and having consideration for the growth in unleaded petrol consumption, it is considered that **there is no need to progress to a Stage 2 review and assessment for lead.**

3.5 Nitrogen Dioxide

The NAQS standard is expressed in two ways. Firstly as 150 ppb, measured as a 1 hour mean, and the objective is to achieve this standard by the end of 2005. Additionally, it is expressed as 21 ppb, measured as an annual mean, and the objective is to achieve this standard by the end of 2005.

3.5.1 Sources

Nitrogen dioxide is a gas produced by the reaction of nitrogen and oxygen generally in a two stage reaction which initially results in the formation of nitric oxide. Nitric oxide, once emitted into the atmosphere, combines further with oxygen atoms, usually derived from ozone, to form nitrogen dioxide. This means that there tends to be an inverse relationship between ozone and nitrogen dioxide. This process can be clearly seen during air pollution episodes. Nitric oxide emitted from motor vehicles in cities reacts with, and thus removes, ozone and generates nitrogen dioxide. The nitrogen dioxide is then carried downwind and acts as a source, under the influence of sunlight, to produce ozone in rural areas.

The two main sources of emissions of oxides of nitrogen are from the fossil fuelled power stations and road transport. According to 1995 data these together represent about 70% of the total emissions.

3.5.2 Health Effects

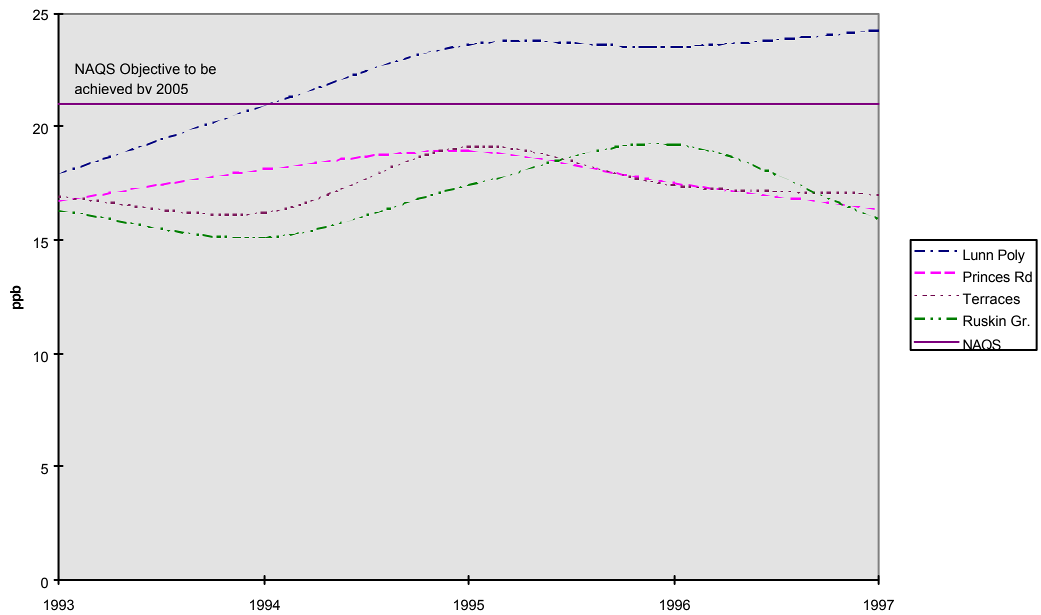
Exposure to nitrogen dioxide can bring about reversible effects on lung function and airway responsiveness. In very high concentrations, such as during industrial accidents and the pollution episode in London in December 1991 when the maximum hourly average concentration was recorded at 423 ppb, nitrogen dioxide can cause very severe and sometimes fatal lung damage. Lower level effects are more uncertain but it is believed that the gas have may both short and long term effects on the respiratory system due to inflammation of the airways. Research is still continuing to identify whether asthmatics are at a greater risk and this aspect is largely unclear at the current time.

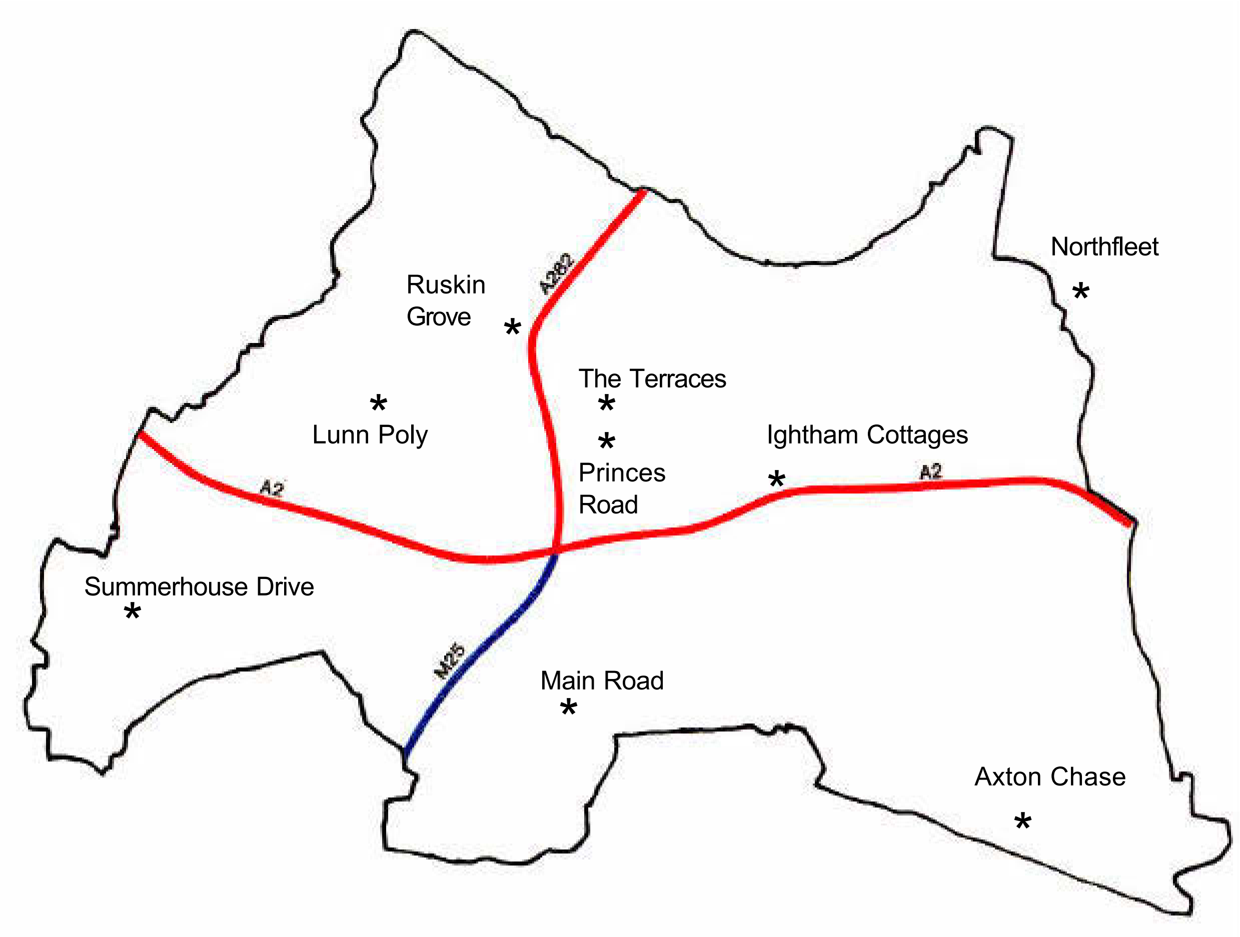
3.5.3 Data Sources and Predictions

Nationally and locally, nitrogen dioxide has been widely monitored and of all the pollutants selected in the NAQS it is the one for which the largest body of data is available. Locally, the Borough currently has eight passive diffusion tubes and their locations are illustrated overleaf;

Results for four tubes that are included in the UK National Survey for the period 1993 to 1997 are shown below;

<u>Chart 1 - Diffusion Tube Data, 1993 - 1997</u>





Notes:

- Ruskin Grove was discontinued in Dec. 1997
- Lunn Poly has two tubes, one on a 2/3 week cycle (from April 1998) and another on a 4/5 week cycle
- Northfleet is outside of the Borough boundary but data is held for comparison purposes

There is currently some debate about the accuracy of the diffusion tubes and research continues to determine their optimum use. The dual tubes at Lunn Poly are part of this research strategy. One line of thought shown by recent combined continuous monitoring and diffusion tube monitoring, funded by DETR, is that the tubes on a four week cycle may be under-estimating by about 35% although the most recent DETR reports suggest, confusingly, that they may be over-estimating by about 10%. The debate about this will be on-going for some time. Taking a 'worst-case' scenario it would appear that each of the four tubes included in the National Survey exceed the 21 ppb standard. At the very least, the tube on Lowfield Street, outside Lunn Poly, currently exceeds the standard and has done since 1994.

There is no data available within the Borough to quantify the hourly average levels of nitrogen dioxide. A continuous chemiluminescent monitor is to be installed in a roadside cabinet near to Ightham Cottages, Bean, during late June 1998 and this will provide valuable data. Elsewhere within Kent, there are several monitors in comparable locations to sites in the Borough and from time to time some of these have shown that pollution episodes occur. These pollution episodes follow the classic summertime smog scenario and are often associate with ozone and particulate episodes.

DETR guidance suggests that attention is directed at roads where annual average daily traffic flows are greater than 25,000. Data from Kent County Council highways transport model indicate that almost all the main roads in the Borough currently have or are projected to have flows in excess of this figure. Additional to road sources, there are two processes authorised as Part A under Part 1 of the Environmental Protection Act 1990 that are potentially a source of local nitrogen dioxide emission; Littlebrook D power station and the waste incinerator at Glaxo Wellcome.

Data taken from the NAEI on the internet (http://www.aeat.co.uk/cgi-bin/pix2os2.pl) suggests that estimated background nitrogen dioxide concentrations are in the 21 - 26 ppb region for the higher density town areas to the north of the A2 and in the 17 -19 ppb for the rural areas to the south of the A2. These figures largely correspond with monitored data previously shown. Included in the appendix to this report is a graphical representation of the estimated emissions of nitrogen dioxide on a 1 km grid basis. It can be seen that although the graph is an estimate and not totally accurate, the peak sources are shown to follow the major road network.

Emissions of nitrogen dioxide are likely to increase across the Borough as a result of increased traffic growth following completion of anticipated large developments in the area. The M25 currently has daily traffic flows in the order of 135,000 and this peaks to about 175,000. The A2 is less but similarly high. Following completion of the Bluewater development (expected April 1999) the local road network serving that area will see a significant increase in traffic. Large growths in new housing on the Darenth Park hospital site and at Greenhithe will also contribute to traffic growths. The concern, therefore, is that whilst technological improvements to car engines and fuel may allow for a reduction in emissions, this will be over taken by the sheer quantity of additional traffic on the roads.

3.5.4 Assessment

In the light of the evidence obtained above, it is considered that **there is sufficient concern to warrant progressing to a Stage 2 Review and Assessment for nitrogen dioxide.**

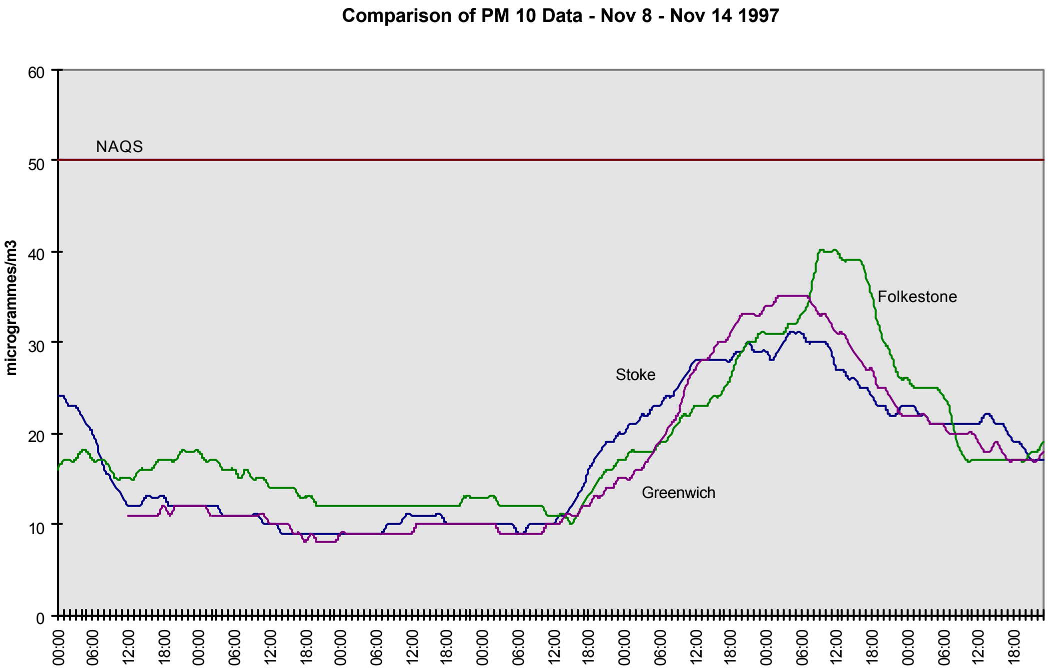
3.6 Fine Particulates - PM_{10}

The NAQS standard, which has been set for particulate matter less than 10 µm in diameter, is 50 µg/m^3, measured as a running 24 hour mean, and the objective is to achieve the 99th percentile of this standard by the end of 2005. This means that in any one calendar year the standard should not be exceeded for greater than four 24 hour periods.

3.6.1 Sources

Unlike individual gaseous pollutants, particulate matter in the atmosphere is composed of a wide range of materials and originates from a wide range of sources. Particle composition is divided into primary and secondary categories. Primary particles might be carbon particles from combustion, mineral particles derived from stone abrasion and salt from the sea and are released directly into the air. Secondary particles could be any of these plus chemical reaction of atmospheric ages and water vapour and are formed in the atmosphere into less volatile compounds which condense into particles. Therefore, identifying the nature of particles is very complicated. These particles, from whatever source, are all measured as PM_{10} if they fall within the appropriate size range.

The largest source of particulate matter is from; fossil fuelled power stations, industrial and quarrying activities and diesel engined road vehicles. Particulates have been identified as presenting both a regional and local problem. Episodes of poor air quality related to particulate matter in one town can often be seen to also occur in other towns in the same locality. The following graph shows a ‘snap-shot’ of one weeks worth of hourly data from three sites in November 1997. This data was chosen at random to illustrate the phenomenon. The distance from Greenwich to Folkestone is about 70 miles and Stoke is approximately mid-way between the two. Excepting the slight time delay, the trace of the three data sets (all using TEOM monitors) is very compatible. If the data was analysed at very short time scales it is probable that there would be local variances from traffic sources, but the averaging time used more clearly illustrates the overall atmospheric levels.



Accurately identifying the source of the particles that cause this to happen is not easy. Other issues, such meteorology, are also clearly an important factor.

3.6.2 Health Effects

The size of particle chosen for the standard, 10µm, has been identified as the size most likely to be deposited in the lung. Some research, particularly that originating in the US, suggests that finer particle sizes, possibly PM_5, $PM_{2.5}$ or even PM_1, should be chosen. For the purposes of the NAQS, however, only PM_{10} has been considered. In the 1950's and 1960's, the effects of the high levels of airborne particles, in combination with sulphur dioxide, in the notorious smogs were clear. In the last few years, research has demonstrated associations between respiratory and cardio-vascular effects and mortality at much lower levels than in the earlier smog studies. Research is continuing into the long-term effects of exposure to high levels of PM_{10} and as yet this is an area of uncertainty. It would appear that medical evidence suggests that there is indeed a link between exposure to higher levels of PM_{10} over a 24 period, or longer, and ill-health.

3.6.3 Data Sources and Predictions

There is currently no monitoring for PM_{10} in the Borough. However, there is monitoring at other sites within Kent and there are a good number of sites nationally. The following chart shows a selection of comparable sites to the Borough with the data presented in a manner that is consistent with the NAQS standard and it can be seen that there is a significant improvement required if the standard is to be achieved.

Table 3 - Number of Days Exceeding 50 µg/m^3 as a 24 Hour Running Mean

Site	1992	1993	1994	1995
Bexley	-	-	18	33
Bristol	-	50	30	27
Edinburgh	6	4	3	18
London Bloomsbury	43	57	39	46
Southampton	-	-	16	13

(Source: National Air Quality Strategy 1997, pages 155)

Nationally, it is estimated in the NAQS that current levels of PM_{10} in the UK are such that the standard is exceeded on typically 10% of days in a year. The highest daily means are observed in Belfast where domestic solid fuel heating is widespread.

Data from the NAEI on the internet (http://www.aeat.co.uk/cgi-bin/pix2ospm.pl) indicates that estimated PM_{10} background concentrations for the Borough range from 24-26 μg/m^3. The National Environmental Technology Centre (NETCEN) suggests that 10μg/m^3 should be added to these figures to allow for secondary particles. A pollutant-specific study of the Part A and Part B authorised processes in the Borough suggests that most could represent a potential primary source of this pollutant.

Making predictions of future PM_{10} levels is complicated owing the wide range of sources as mentioned above. Joint research carried out by Westminster City Council and King's College, London, has estimated that emissions from traffic in Oxford Street, London, are at least 50% of the total PM_{10} count. Analysis of filters at other roadside sites has shown that they include salt spray which has travelled from the coast. It is apparent, therefore, that the composition of the PM_{10} count may vary both from day to day and location to location. Taking this into consideration, an improvement in overall PM_{10} levels requires a multi-disciplinary approach and simply tackling diesel vehicle emissions is unlikely to be wholly sufficient.

3.6.4 Assessment

Despite there currently being no localised monitoring equipment for PM_{10} it is considered that **there is sufficient concern to warrant progressing to a Stage 2 Review and Assessment for PM_{10}.**

3.7 Sulphur Dioxide

The NAQS standard is 100 ppb, measured as a 15 minute mean, and the objective is to achieve the 99.9th percentile of this standard by the end of 2005. This means that in any one year there are a maximum of 35 periods of 15 minutes when the standard can be exceeded.

3.7.1 Sources

Sulphur dioxide is a gas at normal ambient temperature and pressure. It dissolves in water to give an acidic solution which is readily oxidised to sulphuric acid. The predominant source of sulphur dioxide is from the combustion of sulphur-containing fuels, primarily coal and heavy oils. As a result of effective enforcement of air quality controls on sulphur emissions and restrictions on the burning of coal for domestic heating, national emissions of sulphur dioxide have decreased by 63% since 1970 and by 52% since 1980. The major source of emissions from coal fired power station which is in excess of 60% of the total quantity. Other heavy industry equates for about 20%. Despite the significant reduction in emissions, continued pressure is imposed of the power generation industry and the increasing used of flue-gas desulphurisation (FGD) is reducing emissions still further.

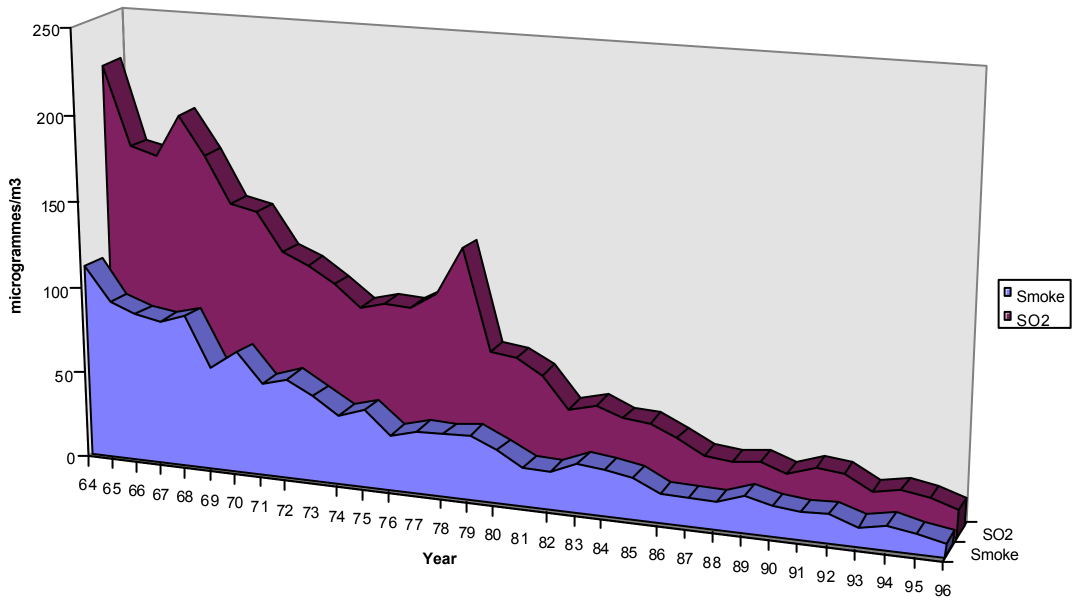
Locally, the Borough has Littlebrook D Power Station, which is currently oil fired, but outside of the Borough there are other power stations in the Thames Gateway area and at a distance where plume grounding can occur. Plume grounding is an effect where the plume reaches ground level before adequate dispersion of the pollutants has taken place. This occurs when unstable weather conditions produces eddies and the plume is brought rapidly down. Early in 1998 a new sulphur dioxide monitoring station was established in Sevenoaks and it has already shown that a significant problem exists with high sulphur dioxide levels being recorded when the wind blows from the north east Kent direction. It is possible, but not yet confirmed, that these incidences are related to the power stations along the Thames estuary.

3.7.2 Health Effects

Exposure to very high concentrations (in excess of 1000 ppb) is known to cause painful irritation of the eyes, nose, mouth and throat, and the acute chemical injury to the linings of the airways may cause serious difficulty in breathing and possibly even death. At lower concentrations, levels more likely to be experienced in ambient outdoor air during pollution incidences, the gas causes an irritant effect by stimulating nerves in the lining of the nose, throat and the lungs airways. This causes a reflex cough, irritation, and the feeling of chest tightness, and may lead to narrowing of the airways. Asthmatics and people who suffer from chronic lung disease are most likely to be affected.

3.7.3 Data Sources and Predictions

At the current time, long term monitoring for sulphur dioxide has been carried out using the volumetric 'bubbler' and the following graph shows the improvement in background levels since 1964.



Additional longer term data is being collected through two diffusion tubes which have been set up at Ightham Cottages and Axton Chase school. This monitoring only started in April 1998 and it is too early to present any results. Data obtained from the NAEI on the internet (http://www.aeat.co.uk/cgi-bin/pix2osso2.pl) suggest that estimated background sulphur dioxide concentrations are in the order of 5 - 6 ppb.

Whilst this information is of general use, it is not suitable for comparison to the standard which requires 15 minute averaging. Equipment to do this is not currently located in the Borough, but there are suitable analysers located elsewhere in Kent and at other locations nationally. The following chart is extracted from the NAQS and shows the results from some comparable sites to the Borough of the maximum 15 minute average values and the number of times in a calendar year that the 100 ppb standard was exceeded.

Table 4 - Number of Exceedences of the 100 ppb 15 Minute Averages

	Maximum 15 minute averages	**No. of 15 minute averages > 100 ppb**		
Site	(Units = ppb)	**1993**	**1994**	**1995**
Bexley	481	-	61	164
Bristol	197	14	3	1
Edinburgh	218	50	30	19
London Bloomsbury	306	121	38	63
Southampton	134	-	2	0

(Source: National Air Quality Strategy 1997, page 166)

Included in the appendix of this report is a graphical illustration of sulphur dioxide emissions and the data has been taken from the NAEI 1 km grid. This data is not wholly accurate or complete but is indicative of the situation and using local knowledge and common sense it follows an expected pattern.

3.7.4 Assessment

The UK Government, under the Second Sulphur Protocol, is committed to reduce emissions of sulphur dioxide from large combustion plant by 50% by 2000, 70% by 2005 and 80% by 2010 when compared to a 1980 base. The enforcement of these obligations falls to the Environment Agency under their jurisdiction as regulators of Part A processes under the Environmental Protection Act 1990. Whilst it is accepted that sulphur dioxide levels are likely to continue falling, it is also apparent that the potential for future exceedences to occur as a result of plume grounding exists from sources outside out the Borough. Therefore, despite there currently being no localised monitoring equipment which matches the standard, it is considered that **there is sufficient concern to warrant progressing to a Stage 2 Review and Assessment for sulphur dioxide.**

4.0 Conclusions

This report has considered the source, health effects, available data and the need for further consideration of seven pollutants that have been identified in the NAQS; benzene, 1,3-butadiene, carbon monoxide, lead, nitrogen dioxide, PM_{10} and sulphur dioxide. On the basis of the evidence available it is considered that it is **unlikely** that the standards specified in the Air Quality Regulations 1997 will be exceeded at the end of 2005 for the following pollutants;

- benzene
- 1,3-butadiene
- lead

Therefore, the following pollutants are believed to offer **sufficient doubt** to require some more detailed investigation for a Stage 2 Review and Assessment;

- carbon monoxide
- nitrogen dioxide
- PM_{10}
- sulphur dioxide

5.0 Recommendations

Dartford Borough Council should proceed immediately with the Stage 2 Review and Assessment of Air Quality within the borough for the following pollutants:

- **carbon monoxide**
- **nitrogen dioxide**
- **PM_{10}**
- **sulphur dioxide**

The Stage 2 review should utilise detailed monitoring, modelling and comparative data and give consideration to the necessity for proceeding to a Stage 3 review for any of the pollutants which, upon it's completion, might still be considered likely to exceed the standards by the end of 2005.

6.0 Appendices

The following pages of this report contain the following information which is intended to supplement the reader and to provide a comprehensive, but not exhaustive, source of information that is available at this stage.

- public register of Part A and Part B authorised processes under Part 1 of the Environmental Protection Act 1990
- register of small combustion plant > 1 MW thermal input
- GIS based map showing the locations of the Part A and Part B processes
- GIS based map showing carbon monoxide levels based upon the 1 km grid of the NAEI
- GIS based map showing nitrogen dioxide levels based upon the 1 km grid of the NAEI
- GIS based map showing sulphur dioxide levels based upon the 1 km grid of the NAEI
- priority pollutant chart

6.1 Supplementary Information

During the preparation of this report, some additional sources of information was collated but has not been included here. This information complies with para 3.04 of the Framework for Review and assessment of Air Quality [(LAQM. G1(97)] and can be inspected, if required, at Dartford Borough Council offices. It includes the following;

- copies of letters to, and responses from, all local Part A and Part B authorised operators and other local businesses
- copies of letters to all neighbouring local authorities within a 10 mile radius of the Borough
- responses from neighbouring local authorities with copies of their part B public register, where appropriate
- basic data used for the emissions inventory maps
- basic data used for the traffic flow assessment
- other miscellaneous information