Stage I Air Quality Review and Assessment for Arun District

as required by
Environment Act 1995 Part IV

Prepared by:

Environmental Health
Arun District Council
in conjunction with
Sussex Air Quality Steering Group

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Contents

Contents

1. Introduction

Arun District Council is commencing a review of local air quality in order to fulfil its obligations under the Environment Act 1995 Part IV [1]. The Act requires Arun District Council to review the sources of pollution in its own and neighbouring areas, and to assess likely future concentrations of a number of pollutants.

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This work began in April 1998 and is required to be completed by the end of 1999.

There are two main objectives of a review and assessment of air quality:

- to identify those areas at a local level where national policies and measures appear unlikely to deliver the air quality objectives by the year 2005

- to ensure that air quality considerations are integrated into a local authority's decision making process

1.1 National Targets

In its National Air Quality Strategy (1997) [2], the Government set a series of targets for concentrations of harmful pollutants in air, these are listed in Table 1:

Table 1: National Air Quality Standards and Objectives

Pollutant	Standard Concentration	Measured as	Specific Objective to be achieved by 2005
Benzene	5 ppb	Running annual mean	5 ppb
1-3 Butadiene	1 ppb	Running annual mean	1 ppb
Carbon Monoxide	10 ppm	Running 8hr mean	10 ppm
Lead	0.5 $\mu g/m^3$	Annual mean	0.5 $\mu g/m^3$
Nitrogen Dioxide	150 ppb	1 hour mean	150 ppb
Nitrogen Dioxide	21 ppb	Annual mean	21 ppb
Ozone	50 ppb	Running 8 hour mean	50 ppb as the 97th percentile

SO2	100 ppb	15 minute mean	100 ppb as the 99.9th percentile

Note:

A running annual mean is a mean which is calculated on an hourly basis, yielding 1 running annual mean per hour. The running annual mean for a particular substance at a particular location for a particular hour is the mean of the hourly levels for that substance at that location for that hour and the preceding 8759 hours. (similar process for running 8 and 24 hour means). The nth percentile (i.e. 90th or 99th percentile) is calculated for a calendar year (yielding one result per calendar year) as follows:

Let (1) N equals the number of measurements for that calendar year

(2) k equals (n x N)/100

rounded to the nearest whole number (or rounded up to the nearest whole number where the fractional part of the number is 0.5); and

(3) the N measurements be listed in ascending order:

X_1; X_2; X_3;…..X_k;….X_{N-1};X_N

Then; the nth percentile for that calendar year is the value of the measurement listed in the kth position; that is X_k.

The Air Quality Regulations (1997) [3] made a statutory duty on local authorities to ensure that, by the year 2005, air pollutant concentrations, both in Arun and nationally, comply with the specific objectives.

Ozone was not included in the list of pollutants for local authority control, and is not therefore covered in the Air Quality Regulations. Due to the nature of ozone pollution, action at the local authority level will not be effective in tackling high concentrations. Action is therefore being taken by the National Government at International level to combat high concentrations of ozone.

The review and assessment has regard to the air quality objectives as laid down in the Regulations rather than the air quality standards. The recommended air quality **standards** from the Strategy are set purely with regard to scientific and medical evidence of the effects of that particular pollutant on health. As such, they represent minimum or no significant risk levels. The air quality **objectives** however, represent the Government's present judgement of achievable air quality by the year 2005 on the evidence of costs and benefits and technical feasibility.

1.2 Review and Assessment Process

In order to determine compliance with these objectives, a process of air quality review and assessment has been recommended. To ensure that there is some consistency between local authorities, the Government has issued Guidance on how local authorities should carry out their reviews and assessments. The guidance notes issued are as follows:

General Guidance

- Framework for Review and Assessment of Air Quality [4]
- Developing Local Air Quality Strategies and Action Plans: The Principal Considerations [5]
- Air Quality and Traffic Management [6]
- Air Quality and Land Use Planning [7]

Technical Guidance

- Monitoring for Air Quality Reviews and Assessments [8]
- Preparation and Use of Atmospheric Emission Inventories [9]
- Selection and Use of Dispersion Models [10]
- Review and Assessment: Pollutant Specific Guidance [11]

This document has been prepared with regard to these guidance notes, most notably "Review and Assessment: Pollutant Specific Guidance".

This Guidance note breaks the process down into three stages:

- **Stage I** – gather information about current and likely future sources of air pollution. This includes levels of traffic on the road, industrial processes (large and small) and an examination of current air pollution monitoring data for the area. The sources of pollution are then examined to determine whether the general public are likely to be exposed to any pollution over the time scales of the air quality objectives, and to determine if either the operation (road or industry) will close before 2005, or whether new operations are planned. If significant sources of any of the pollutants named in Table 1 above are identified then the authority must progress to Stage II.

- **Stage II** – This Stage involves the application of screening techniques to determine both current and future levels of air pollution. A further examination of any current monitoring data should be carried out. If air quality in 2005 is predicted to be above any of the objectives above then a Stage III assessment will be required.

- **Stage III** – In Stage III more complex techniques (dispersion modelling, real-time monitoring and emission inventories) are required, in order to determine the nature and size of any areas where the objectives are exceeded.

If at the end of Stage III air pollutant concentrations are predicted to be above any of the specific objectives (see Table 1) then an Air Quality Management Area must be declared, and wider consultation is then required. Following from this, an Air Quality Action Plan should then be prepared, detailing how the local authority proposes to introduce measures to reduce the concentrations of air pollutants in line with the Government objectives.

This report covers Stage I of this review and assessment process, and gives details of all those sources of pollution which are of concern in Arun District. Further work will be carried out and separate reports produced on the second and third stage reviews should such reviews be required.

2. The Pollutants of Concern

Benzene

National Air Quality Strategy Objective: 5 parts per billion (ppb) rolling annual average

Concerns: Benzene is a known human carcinogen (cancer causing substance), and also contributes to the formation of ozone (summer smog).

Sources: The major source of benzene is motor vehicle emissions, which nationally account for 64% of emissions (the majority arising from petrol vehicles), with the other major source being certain industrial processes accounting for 15% of emissions. [11]

Monitoring: Benzene is monitored by a few authorities at a number of sites in Sussex, both at the roadside and in background locations, using passive diffusion tube monitors. Arun District Council have in the past conducting monitoring at three sites within the district which is explained further in Section 6.

Concentrations: National benzene monitoring data, obtained from the Department of the Environment, Transport and Region's (DETR's) national automatic hydrocarbon network, shows that recorded concentrations are all below the 5 ppb annual objective, even at the roadside in central London. [12] Monitoring data from London measured using benzene diffusion tubes shows that concentrations in excess of the 5 ppb objective were recorded close to certain roadside locations, and values of 5 ppb were recorded in the vicinity of petrol filling stations. [13]

Controls and Trends: Benzene monitoring data from London have shown declining concentrations over the past few years, and work by Imperial College London suggests that concentrations have been declining since the 1970's.

Since 1993 it has been effectively mandatory to fit three-way catalytic converters onto petrol fuelled vehicles under European Legislation. As more catalyst fitted vehicles come into the fleet on the road (due to the replacement of old vehicles) concentrations will continue to decline.

Controls are also being implemented at petrol filling stations to recover some of the evaporating vapour during refilling of storage tanks at the station. Further controls on individual vehicle refuelling are currently under discussion.

These reductions should mean that by the year 2005 there should be no or very few areas in the UK with concentrations in excess of the 5 ppb objective.

1,3-butadiene

National Air Quality Strategy Objective: 1 part per billion (ppb) rolling annual average

Concerns: 1,3-butadiene is a probable human carcinogen, and as with benzene, no absolutely safe level can be defined.

Sources: The major source of 1,3-butadiene, nationally, is motor vehicle emissions, which account for 67% of emissions (from petrol vehicles), with other major sources being industrial processes (13% of the national total). [11]

Monitoring: No local monitoring of 1,3-butadiene is currently being carried out.

Concentrations: National 1,3-butadiene monitoring data shows that recorded concentrations are all below the 1 ppb annual average objective, even at the roadside in central London. Monitoring of 1,3-butadiene has only been carried out by the DETR on a systematic basis since 1992 as part of the national automatic hydrocarbon network.

Controls and Trends: As with benzene, the fitting of catalytic converters to petrol vehicles reduces their emissions of 1,3-butadiene. Concentrations of 1,3-butadiene in the atmosphere are also heavily dependent on the chemical composition of petrol. Recently introduced controls on the loading of petrol at petrol stations will also have an effect on 1,3-butadiene concentrations, with planned future controls on the refuelling of individual vehicles adding to this reduction.

These controls mean that by 2005 there should be no or very few areas in excess of the 1ppb annual average objective.

Lead

National Air Quality Strategy Objective: 0.5 micrograms per cubic metre ($\mu g/m^3$) annual average

Concerns: Lead has been identified as causing acute and chronic damage to the nervous system, effects on the kidneys, joints and reproductive system. At extremely high concentrations lead is toxic.

Sources: The major source of lead is motor vehicle emissions, which nationally account for 65% of emissions, with other major sources being metal industries (18%) and power generation (5%).[11]

Monitoring: There is currently no local monitoring of lead. Historically, lead was more widely monitored, but concentrations declined dramatically in the late 1980's, early 1990's due to the introduction of unleaded petrol and the introduction of the catalytic converter.

Concentrations: National lead monitoring data shows that recorded concentrations are below the 0.5 $\mu g/m^3$ annual objective, except in the vicinity of very large lead smelters, such as those in Walsall which fall under Part A process control [11] (large industries such as power stations and chemical works are classified as Part A processes and fall under the jurisdiction of the Environment Agency). The EC requires that monitoring be carried out in the vicinity of such large sources of lead, to determine whether the EC Directive lead levels are being breached.

Controls and Trends: The fitting of catalytic converters to vehicles has meant that less four star leaded petrol has been sold. Catalytic converters are "poisoned" by the lead in petrol, and vehicles must therefore use unleaded fuel. There are also restrictions across the European community to limit the lead levels present in petrol.

Carbon Monoxide

National Air Quality Strategy Objective: 10 parts per million (ppm) running 8 hour mean

Concerns: Carbon monoxide affects the body by restricting the uptake of oxygen by forming carboxyhaemoglobin in the blood stream. At ambient levels, carbon monoxide may affect concentration, with higher levels leading to more serious nervous system effects.

Sources: The major source of carbon monoxide is motor vehicle emissions, which nationally account for 71% of emissions, although this figure will be higher in most urban areas. [11]

Monitoring: Some local assessment of carbon monoxide concentrations has been made when new road schemes are under assessment. Assessment has been conducted by some local authorities and West Sussex County Council.

Concentrations: National carbon monoxide monitoring data shows that recorded concentrations have exceeded the 10 ppm objective, especially in the vicinity of major roads in large urban areas. [11] The numbers of exceedences have declined greatly since the 1970's due to improvements in vehicle technology.

Controls and Trends: Improvements in vehicle technology and the fitting of catalytic converters has meant that concentrations of carbon monoxide have declined over recent years. These decreases are expected to continue, giving rise to very few carbon monoxide air quality management areas.

Sulphur Dioxide

National Air Quality Strategy Objective: 100 Parts per billion as a 15 minute average. 99.9th percentile compliance to be achieved by 2005

Concerns: Sulphur dioxide is an acute respiratory irritant, hence the short averaging time for the standard. Sulphur dioxide may also be converted through chemical reactions in the atmosphere to secondary sulphate particulate matter.

Sources: Nationally, the major source of sulphur dioxide is power stations, which account for 65% of emissions, with other major sources being industrial emissions (24%) and commercial and domestic heating (6%). [11]

Monitoring: Some monitoring of sulphur dioxide is undertaken in Sussex by Crawley, Eastbourne and Adur Local Authorities, as part of the national survey of smoke and sulphur dioxide. This method uses wet chemical techniques, and is only capable of giving daily average sulphur dioxide concentrations. A continuous automatic ultra violet monitoring system is in operation at Lullington Heath (DETR) site in East Sussex.

Concentrations: National sulphur dioxide monitoring data shows that recorded concentrations have exceeded the 100 ppb objective, especially in the vicinity of large point sources of sulphur dioxide, such as power stations. Exceedences have also been recorded in domestic coal burning areas of the north-east, and in the East Thames Gateway. [12]

Controls and Trends: Discussions at European level on measures to combat acid rain will influence future sulphur dioxide concentrations, as will the introduction of low sulphur diesel and its derivatives. Many large point sources are regulated by the Environment Agency, who review emission limits for industrial plant on a four yearly basis.

Nitrogen Dioxide

National Air Quality Strategy Objective: 2 Standards: Hourly mean of 150 ppb and an annual mean of 21 ppb

Concerns: Nitrogen dioxide is a respiratory irritant, and is also thought to be a sensitiser, which may worsen other conditions such as hay fever. There are a number of oxides of nitrogen present in the atmosphere, but it is nitrogen dioxide which gives rise to health concerns.

Sources: The major source of nitrogen dioxide is the motor vehicle, which nationally accounts for 47% of emissions, with other major sources being power generation (22%) and domestic sources (4%). In urban areas the contribution of traffic sources is likely to be higher. [11]

Monitoring: Nitrogen dioxide is the pollutant for which most local monitoring in Sussex has been conducted. This is because cheap and relatively simple monitoring equipment is available to monitor nitrogen dioxide. Most districts have at least four sites, which participate in a national survey of nitrogen dioxide which has been running for 5 years. More sophisticated monitoring equipment is also in use, giving hourly readings of nitrogen dioxide concentration.

Concentrations: Results from within Sussex show that at certain kerbside (within 1 metre of the road) locations the annual average (21 ppb) objective is being breached, as well as at a small number of intermediate sites (1-30 m of the road).[14] Data from the Department of the Environment, Transport and Region's (DETR's) run Lullington Heath site (near Eastbourne) and in Brighton and Hove suggest that the hourly maximum standard (150 ppb) is not currently exceeded in Sussex. [12]

Controls and Trends: The introduction of catalytic converters into the vehicle fleet will lead to further reductions in nitrogen dioxide concentrations, although the exact size of this reduction will depend on the effectiveness of these control measures in urban areas. During short journeys, catalysts do not reach their effective operating temperatures, giving high levels of emissions.

Particulate Matter (PM_{10} - particles less than 10mm in diameter)

National Air Quality Strategy Objective: 50 microgrammes per cubic metre ($\mu g/m^3$)

Concerns: Particulate matter is of major concern, as it has been linked with both increased morbidity and premature mortality, estimates have placed the figure as high as 10,000 excess premature deaths per year for the whole of the UK.

Sources: The major source of particulate matter is the motor vehicle, which nationally accounts for 24% of emissions, with other major sources being industrial emissions (38%) and power stations (16%) and domestic and other low power combustion (17%).[11] These are only the primary PM_{10} emissions, and additional contributions in the atmosphere arise from secondary particles (formed through chemical reactions involving nitrogen dioxide and sulphur dioxide in the atmosphere, and particles such as sea salt, road dust and wind blown soil.

Monitoring: Monitoring of PM_{10} has only been carried out nationally since 1992, and there is little local monitoring in Sussex.

Concentrations: PM_{10} is the major pollutant of concern as far as the National Air Quality Strategy is concerned, as monitoring data from the national networks show that the objective is currently exceeded at the vast majority of monitoring sites throughout the UK. These include both central urban sites and more remote monitoring in rural areas. [12]

Controls and Trends: Controls on PM_{10} are expected to deliver reductions, but these may not reduce concentrations sufficiently to meet the NAQS standard by 2005. Low sulphur diesel fuels and controls on industrial emissions will reduce PM_{10} concentrations, but the natural sources provide a background level, which is always present onto which the vehicle emissions are added. Analysis of concentrations and meteorological data have suggested that long-range transport, such as aircraft, may also provide a significant source of particles.

3. Information About Arun District

- Arun has an area of 85 square miles, stretching from Pagham in the west to Findon in the east, from Houghton in the north to the 14.5 miles of coastline in the south.

- Arun District is situated in the middle of the West Sussex coastal plain, stretching from the Hampshire boundary to Brighton. To the north, the South Downs rise from 200 feet to a maximum of about 700 feet beyond the district boundary, before falling steeply to the broad Sussex Weald.

- Running through the District is the River Arun, which reaches the sea at Littlehampton and divides the area into two roughly equal parts. Between the foot of the Downs and the sea lies a flat coastal plain, where most of the District's urban development has taken place.

- Arun has a population of over 140,000 and is the largest of the seven districts and boroughs within the County of West Sussex, which has a total population of over 740,000. During the summer months, Arun's population increases noticeably due to seasonal employment. The projected population of Arun by 2005 is approximately 148,000.

- Most of the small settlements (under 1,000) are in the north of the area, with the slightly larger settlements (1,000 - 5,000) extending across the coastal belt.

- There are over 62,000 households in Arun District, 81% of which are owner occupied; 9% are rented privately; 3% are rented from housing associations; 7 % are rented from the local authority.

- The three main towns within the District are Littlehampton, Bognor Regis and Arundel - which reflect some of the differences within the District.

- The urban areas of Littlehampton and greater Bognor Regis (which includes not just the town itself, but the surrounding urban parishes) are on either side of the River Arun, highlighting an east-west split in the District. On the other hand, the historic town of Arundel is situated at the foot of the South Downs, an area more commonly made up of small, rural towns and villages.

- Bognor Regis has its origins in the fashion for sea water bathing in the early 19th Century. As it has grown, it has encompassed a number of what were originally separate village settlements. Manufacturing is a more important source of employment here than in the rest of the District, with particular strengths in electrical and electronic engineering activities. The service sector is also important here.

- Littlehampton's origins are as a port, but the town also grew as a seaside resort. Although a settlement was registered here in the Domesday Book, the town really flourished in the 18th century, and by the 1800 had become a popular resort welcoming between two and three thousand day visitors. A range of employment opportunities exist in the Littlehampton area including river related activities. The service sector is important particularly for tourism. The horticultural industry, although in decline, still employs a significant number of people.

- Historic Arundel presents a unique skyline, dominating important views of the Arun Valley. The origins of the town date back to the Second or Third Century AD. With its historic castle, many fine buildings and surrounding countryside, the town is increasingly popular with visitors.

- The "Coastway" rail route runs east-west through the District with branch lines to both Bognor Regis and Littlehampton. There are direct services to Gatwick, London and Brighton. Angmering and East Preston are on the "Coastway" route itself.

- There are 780 listed buildings in Arun, 21 conservation areas, 4 nature reserves and 9 Sites of Special Scientific Interest, and almost half the district is included within the Sussex Downs Area of Outstanding Natural Beauty.

4. Road Traffic

Details of road traffic movements in Arun District are collected by West Sussex County Council.

The pollution specific guidance note requires details of those roads with more than 50,000 vehicles per day (a possible significant source of carbon monoxide), those with more than 25,000 vehicles per day (a possible significant source of PM_{10}), and those with more than 20,000 vehicles per day (a possible significant source of nitrogen dioxide). The worst case flows for both 1998 and 2005 are required for this Stage 1 Review and Assessment

Information supplied by West Sussex County Council

A series of plots showing the "County Model" for Arun were obtained from West Sussex County Council identifying those roads classified in the above categories. A Burrell multi-path assignment model was used to load traffic onto the 1997 road network. Data for the model was obtained from a matrix of traffic flows produced with the use of intensive roadside interview surveys and a traffic count data collected in 1990/91. The traffic matrix is relatively old but a 10% global traffic increase on Arun's roads is assumed. Most of flows on the network correlate quite well with traffic flows obtained in March 1998 where these are available.

Each district within West Sussex has its own "high growth" factor which can be used to convert 1998 traffic flows into 2005 traffic flows assuming there is no local development, nearby, likely to increase traffic flows before this date. It is best to use the high growth factor for the district in order to provide a worst case figure as, historically, the county tends to have real traffic flows which are close to the "high growth" trend.

The "high growth" factors for each district, used in estimating traffic flows, are:

1.141 Adur
1.171 Arun
1.149 Chichester
1.183 Crawley
1.143 Horsham
1.168 Worthing

indicating that Arun's traffic growth is one of the highest in the county.

To obtain 24 hour flows using the 12 hour "county model" i.e. 1990 data, the following procedures apply for the purposes of Stage 1:

a) Addition of each 12 hr directional flow (1990) together to obtain 12 hr unidirectional flow (1990)

b) Multiplication of the 12 hr unidirectional flow (1990) by 1.25 to obtain 24 hr unidirectional flow (1990)

c) Multiplication of the 24 hr unidirectional flow (1990) by 1.10 to obtain **24 hr unidirectional flow (1998)**

d) Multiplication of the 24 hr unidirectional flow (1998) by 1.171 to obtain **24 hr unidirectional flow (2005)**

Those road sections which fall into the categories are listed and shown on maps in Section 9.

Angmering By-Pass, A280, is a proposed road which is likely to be built by 2005. West Sussex County Council have two traffic models, A SATURN and TRIPS, which indicate that traffic flows by 2005 will be below 20,000 vehicles per day on this section of road should it be built.

There are no existing roads in Arun with current traffic flows over 50,000 vehicles per day. There are also no existing or planned roads with predicted traffic flows over 50,000 vehicles per day by 2005.

5. Industrial Sources

Industrial sources are currently controlled under the Environmental Protection Act 1990, and are classified into either Part A (large industries such as power stations and chemical works) or Part B processes (such as crematoria and vehicle respraying facilities) for guidance and control. Part A processes fall under the jurisdiction of the Environment Agency, whilst control of Part B processes is a duty carried out by local authorities.

The continuing operation of the Local Authority Air Pollution Control authorisation process (for Part B processes) is the subject of a report issued by the Department of the Environment. This report refers specifically to the role of local authorities in local air quality management. It is stated that local exceedences of air quality standards and objectives caused by a Part B process may be grounds for the imposition of stricter conditions in an authorisation than would normally be the case. However, it will have to be clear that the industry alone is responsible for the exceedence, and not a combination of factors.

Lists of Part B processes in Arun District together with their potentially significant emissions are given in Table 2. The table also shows planned authorised processes as legislation requires these processes to be authorised after 31st December 1998. These processes currently operate without the necessity for authorisation. Details also appear in Figure 3 which follows. There are no Part A processes in Arun District. As shown in Figure 4.

Those small industrial processes that fall outside of Part B Process control are also of concern. The pollutant specific review and assessment guidance requires details of boiler plant with a thermal rating of greater than 5MW where solid fuel or fuel oil is the power source.

There are no such combustion systems within Arun District.

Current information suggests that there are no planned industrial developments for the Arun District which will significantly impact on air quality.

6. Air Pollution Monitoring

DETR Guidance states that data obtained in 1996 be used for the Review and Assessment.

Arun District Council continue to monitor ozone at Burpham however, although data has been available from this site since 1996, ozone as a pollutant is not included in this Review and Assessment. The National Air Quality Strategy recognises that ozone is not easily controlled by local measures due to its transboundary nature and that strategies to reduce it will therefore need to be agreed at European level. While local authorities are able to make a significant impact on the reduction of ozone precursors at the local level, their action is unlikely to reduce ozone levels in the same locality. Local authorities and the Environment Agencies continue to play an important role in controlling the emissions of volatile organic compounds, which are ozone precursors, through Local Air Pollution Control (LAPC) and Integrated Pollution Control (IPC).

Air quality monitoring takes place at a number of locations in Arun District using passive diffusion tubes.

6.1 Nitrogen Dioxide

Nitrogen dioxide is the pollutant for which the most monitoring has been carried out in Arun District, through participation in the national nitrogen dioxide diffusion tube survey. This survey has provided results over a number of years. There is also additional local monitoring, conducting by the Council, of nitrogen dioxide using diffusion tubes in addition to the national survey.

The diffusion tube sampler consists of an acrylic tube, 7cm long with a 1cm internal diameter. Triethanolamine, an extremely effective absorbent of nitrogen dioxide is used to coat a stainless steel grid fixed at one end of the tube by an airtight cap. The tube is then fixed vertically with the capped end uppermost. Nitrogen dioxide diffuses up the tube and is trapped by the absorbent coating. After exposure, the tubes are then sent for analysis at a laboratory where sulphanilamide in orthophosphoric acid and naphyl ethylene diamine dihydrochloride are added. The resultant colour change is monitored using colour spectrometric techniques at 540nm. By measuring the total amount of nitrogen dioxide absorbed, and knowing the exposure time of the tube and the rate at which the gas diffuses up the tube, the mean concentration of nitrogen dioxide in the air over the exposed period can be determined. The tubes are generally exposed for 3-4 weeks. Thus they only provide an estimate of long-term concentrations, and cannot measure short-term (e.g. daily) peaks in concentration.

Analysis of nitrogen dioxide diffusion tube data from 1996 in Arun District shows exceedances of the Air Quality Standard throughout the Year at a number of sites, particularly Maltravers Street in Arundel and Bognor Regis High Street.

Levels at two sites in Littlehampton did exceed the Quality Standard on a few occasions during 1996 and were constantly at levels near the Standard for the remaining months.

All monitoring positions in of Arundel, Bognor Regis and Littlehampton were witness to levels which were generally above 15 ppb (70% of the Air Quality Standard).

Monitoring commenced at the Canada Grove, Bognor Regis site in 1997 and therefore no results are indicated in Figure 7.

Table 3 - Nitrogen dioxide diffusion tube monitoring sites

Monitoring is ongoing and sites are located at:

TUBE NUMBER	I.D. NUMBER	LOCATION	TYPE OF SITE
1	L1	TERMINUS ROAD LITTLEHAMPTON	KERBSIDE
2	L2	CONNAUGHT ROAD LITTLEHAMPTON	INTERMEDIATE
3	L3	THATCHWAY CLOSE LITTLEHAMPTON	URBAN BACKGROUND
4	L4	WESTLANDS LITTLEHAMPTON	URBAN BACKGROUND
5	A1	HIGH STREET ARUNDEL	KERBSIDE
6	A2	MALTRAVERS STREET ARUNDEL	KERBSIDE
7	A3	KING STREET ARUNDEL	URBAN BACKGROUND
8	A4	PRIORY ROAD ARUNDEL	URBAN BACKGROUND
9	B1	HIGH STREET BOGNOR REGIS	KERBSIDE
10	B2	REGIS COURT BOGNOR REGIS	INTERMEDIATE
11	B3	CHURCH LANE BOGNOR REGIS	URBAN BACKGROUND
12	B4	MORNINGTON CRES. BOGNOR REGIS	URBAN BACKGROUND
13	B5	CANADA GROVE BOGNOR REGIS	KERBSIDE

6.2 Benzene

Monitoring for benzene was conducted from March 1996 until March 1997 and, therefore, as the monitoring period was only conducted for 1 year in total, no running annual averages can be calculated.

The diffusion tube sampler consists of a metal tube, 8.5cm long with a 0.5cm internal diameter. The tubes are stored and transported with brass caps on both ends preventing vapours entering or leaving the tube prior to monitoring. One end of the metal tube is packed with Tenax, an extremely effective absorbent of benzene. The brass cap at the other end is removed and a diffusion cap pushed onto the tube. The tube is then fixed vertically with the diffusion cap lowermost at a height of approximately 3 metres. After exposure, the tubes are then sent for analysis were the total amount of benzene absorbed is determined. Knowing the exposure time of the tube and the rate at which the gas diffuses up the tube, the mean concentration of benzene in the air over the exposed period can be determined. The tubes were generally exposed for 2 weeks. Thus they only provide an estimate of long-term concentrations and cannot measure short-term (e.g. daily) peaks in concentration.

Analysis of benzene diffusion tube data from 1996 in Arun District indicate that levels are well below the Air Quality Standard, however, there is a marked increase in observed levels during the winter months and levels at Bognor Regis High Street are quite close to the standard limit. It is unlikely that the Air Quality objective will be exceeded.

During the winter months, cold, stable weather conditions can trap pollutants close to the ground near to sources, and inhibit their dispersion, causing elevated concentrations. The major pollutant source in the UK is traffic and therefore elevated concentrations of other traffic related pollutants are also observed.

If monitoring of benzene was continued and the running annual averages obtained, obviously the peak events (such as winter) would be averaged over the whole year. Existing data indicate annual running averages would be approximately 2 - 3 ppb, well below the running annual average air quality standard of 5 ppb.

Table 4 - Benzene diffusion tube monitoring sites

Monitoring sites were located at:

TUBE NUMBER	I.D. NUMBER	LOCATION	TYPE OF SITE
1	1	HIGH STREET BOGNOR REGIS	KERBSIDE
2	2	TERMINUS ROAD LITTLEHAMPTON	KERBSIDE
3	3	HIGH STREET ARUNDEL	KERBSIDE

7. Other Sources of Information

Within the pollution specific guidance note[11] there are particular requirements to review and assess a number of other sources of information against targets. These include limits on background concentrations of PM_{10} and emissions of PM_{10} and sulphur dioxide. The nature of this assessment is outlined below.

7.1 National Pollution Mapping Work

The DETR has commissioned a series of maps undertaken jointly by two consultancies, AEA Technology and National Environmental Technology Centre (NETCEN), showing how **background concentrations** of the various pollutants vary across the country. These are shown in Figures 11- 12 for all pollutants for which they have been prepared. The figures provide estimates, and are designed to give an indication of pollutant levels in areas where there is no monitoring. The maps provide an estimate of the annual mean of the pollutant on a 1km grid across the UK. The maps currently show 1996 data. (Further details of the mapping methodology are indicated in Stedman 1998 [15]).

Results from dispersion or other models can be used to estimate the impact of individual sources on local air quality. Ambient air quality near to sources, such as at the edge of a busy road or near to an industrial chimney, can be estimated by calculating the sum of this individual source impact plus the background concentration given by the maps.

These national maps are to be used more extensively in Stages II and III of review and assessment if required, but should be used in Stage I to screen PM_{10} concentrations.

- The DETR pollutant specific guidance requires that, in Stage I, an assessment is made of whether in urban areas, annual mean levels of secondary particulate matter currently exceed 8 $\mu g/m^3$.

At the present time there is no rural background monitoring of PM_{10} in Sussex. Figures 10 and 11 indicate concentrations of both total and secondary PM_{10} . These maps indicate that for all authorities in both East and West Sussex a second stage review and assessment will be required for PM_{10}, as annual mean levels of secondary particulate matter currently exceed this 8 $\mu g/m^3$ limit.

Information on current rural background concentrations of PM_{10} (from the national maps) indicate that the estimated Annual Mean Background Concentrations in Arun are between 20.1 and 25 $\mu g/m^3$, with half the district having levels in the range 20.1 to 22.5 $\mu g/m^3$, whilst the other half of the district having levels in the range 22.6 to 25 $\mu g/m^3$. Estimated Annual Mean Secondary PM_{10} concentrations indicate that levels in Arun are above 11 $\mu g/m^3$.

7.2 National Atmospheric Emissions Inventory

In addition to the above maps of *estimated concentration*, there are also national maps of **pollutant *emissions*** on a 1km by 1km grid square basis (also produced using data from AEA/NETCEN).

In Stage I of review and assessment this information is required to be used to screen levels of emissions of sulphur dioxide and PM_{10}:

- The DETR pollutant specific guidance requires that in Stage I an assessment is made of any 1km by 1km grid squares within a local authority area with PM_{10} emissions from low level dispersed sources of greater than 10 tonnes in any 1 km x 1km grid square, or emissions greater than 5 tonnes in several adjacent squares.

Figure 12 shows that there are two areas within Arun District, each of an area of $1km^2$, which have total PM_{10} emissions of between 5.00 and 9.99 $\mu g/m^3$. The majority of the district has total PM_{10} emissions in the range 0.00 to 4.99 $\mu g/m^3$.

- The DETR pollutant specific guidance also requires in Stage I that details are given of any 1km x 1km grid squares in the authority's area for which maximum low-level (i.e. domestic combustion and other short stack) emissions are greater than 25 kg per hour or 40 tonnes per year. Where domestic emissions are the main source of concern, this can be assumed to approximate to 300 houses burning coal in a 1km x 1km grid square.

Figure 13 shows that Domestic plus Small Industry SO_2 Emissions in Arun District are generally between 0.10 and 19.99 tonnes per year. There is one area of 1 km^2 which has SO_2 Emissions in the range 20.00 and 39.99 tonnes per year. Approximately one sixth of the district has emissions less than 0.10 tonnes per year.

Figure 14, showing Total SO_2 Emissions, indicates one area of $1km^2$ with a range of 20.00 to 39.99 tonnes per year, approximately 16 km^2 of the district with a range of 5.00 to 19.99 tonnes per year and the majority of the district below 5.00 tonnes per year.

7.3 Details of any significant sources in neighbouring areas which could impact significantly within the authority's area

Once Stage I reviews have been completed, full data sets will be exchanged between neighbouring local authorities. In the meantime, it is estimated that the following sources in neighbouring areas are of concern:

Table 5 - Part A Processes in neighbouring districts which could impact significantly

Firm	District	Process	PG Note	Carbon Monoxide	Benzene	1,3 Butadiene	Sulphur Dioxide	Nitrogen Dioxide	Lead	PM_{10}
Cairn Energy	Chichester	Gas Flaring	1.4		**X**	**X**	**X**	**X**	**X**	**X**
Smithkline Beecham	Worthing	Pharmac-e uticals	4.8							

X - significant emissions as defined by DETR Review + Assessment: Pollutant-Specific Guidance, Part IV of the Environment Act 1995. Local Air Quality Management August 1998.

Table 6 - Major Roads in neighbouring districts which could impact significantly

Road	District	Location	Current traffic flows (vehicles per day)
A27	Worthing	North of Worthing	>25,000
A27	Chichester	East of Chichester	>25,000
A24	Horsham	Between Horsham + Crawley	>25,000
A259	Worthing	East of Arun District	>25,000
A259	Chichester	West of Arun District	>25,000

8. Review and Assessment

8.1 Source Screening

For all existing *and* proposed activities identified, those which have the potential, singly or together to emit significant quantities of pollution and

- Are expected to be in operation by the end of 2005
- And for which there is a potential for exposure of individuals in relevant locations

SHOULD THEN BE IDENTIFIED.

Carbon Monoxide

There are no existing or proposed activities which have the potential, singly or together to emit significant quantities of carbon dioxide.

Benzene

The gas flaring Part A Process in adjoining Chichester District, operated by Cairn Energy Onshore Limited, has a potential to produce significant emissions of benzene.

1,3-Butadiene

The gas flaring Part A Process in adjoining Chichester District, operated by Cairn Energy Onshore Limited, has a potential to produce significant emissions of 1,3-butadiene.

Lead

The gas flaring Part A Process in adjoining Chichester District, operated by Cairn Energy Onshore Limited, has a potential to produce significant produces significant emissions of lead

Nitrogen Dioxide

There are a number of roads within the district that have flow levels exceeding 20,000 vehicles per day. The resulting emissions of nitrogen dioxide from such roads are classed as significant. The roads are listed in Table 8.

The gas flaring Part A Process in adjoining Chichester District, operated by Cairn Energy Onshore Limited, has a potential to produce significant emissions of nitrogen dioxide.

PM10

There are a number of roads within the district that have traffic flow levels exceeding 25,000 vehicles per day. The resulting emissions of PM_{10} from such roads are classed as significant. The roads are listed in Table 9.

There is one Part B process, Lafarge Redland Aggregates Limited, operating within the district that has the potential to produce significant quantities of PM_{10} .The gas flaring Part A Process in adjoining Chichester District, operated by Cairn Energy Onshore Limited, also has a potential to produce significant emissions of PM_{10}.

Sulphur Dioxide

The Part B roadstone coating process in the district, operated by Lafarge Redland Aggregates Limited, has a potential to produce significant emissions of sulphur dioxide.

The following Stage I Review and Assessment Checklist, Table 7, categorises the above sources which have the potential to produce significant emissions for each pollutant.

8.2 Exposure

A key concept in review and assessment is that of exposure, with the DETR stating that:

"For the purposes of determining the focus of review and assessment local authorities should have regard to locations where individuals are likely to be exposed over the averaging time of the objective."

It is therefore recommended that:

- For objectives with short averaging times (e.g. sulphur dioxide and the hourly nitrogen dioxide objective) reviews and assessments should be focused on any non-occupational, near ground level outdoor location where the objective is likely to be breached.

- For objectives with longer averaging times (from the carbon monoxide rolling 8 hour objective upwards), reviews and assessments should be focused on the following non-occupational, near ground level outdoor locations; background locations; roadside locations; and other areas of elevated pollutant concentrations where a person might reasonably be expected to be exposed (e.g. in the vicinity of housing, schools or hospitals etc.) over the relevant averaging time of the objective.

Cairn Energy, the Part A gas flaring process located in Chichester, has significant emissions as indicated in Section 7.3 but is in the middle of the adjoining district and at a considerable distance from Arun District. It is unlikely that persons within Arun will be affected by this process.
There are no significant emissions from Smithkline Beecham, the Part A pharmaceutical process located in Worthing District.
The nitrogen dioxide monitoring site located on Bognor Regis High Street was witness to levels very close to 30 ppb however levels since 1996 have declined and have stabilised around 26 ppb (5 ppb higher than the air quality standard of 21 ppb). Possible pedestrianisation of the High Street would reduce the nitrogen dioxide levels within the standard. Levels may rise elsewhere as a result but are expected to remain well below the standard. Monitoring will be continued and any impact will be assessed.

9. Sources of Concern for Stage II

If no sources are identified in Arun which could lead to exposure of the public over the averaging periods of the appropriate objective, then the risk of exceeding the air quality objective should be considered negligible, and the authority should proceed no further.

If the first stage review and assessment indicates that the risk of exceedence is not negligible then the authority should carry out a second and or third stage review and assessment, with a view to determining the risk of exceedence more precisely.

Those sources which are of concern, and will need to be considered in a Stage II review and assessment are listed below:

Part B and other Industrial Processes
Lafarge Redland Aggregates Limited operating a roadstone coating process.

Road Sections
A27; A259; A27; B2166; Aldwick Road, Barrack Lane and Hawthorn Road in Bognor Regis

This means that Stage II assessments will be undertaken for at least one source for the following pollutants:

Nitrogen Dioxide - NO_2

Table 8 : Roads with existing traffic flows over 20,000 vehicles per day and predicted traffic flows over 20,000 vehicles per day by 2005 (worst case prediction)

Road No.	Between	Existing	Predicted
A27	WORTHING-PATCHING	,	,
A27	PATCHING-B2225 JUNCTION	,	,
A27	B2225 JUNCTION-CROSSBUSH	,	,
A27	LYMINSTER ROAD/STATION ROAD/THE CAUSEWAY	,	,
A27	ARUNDEL BYPASS	,	,
A27	CHICHESTER ROAD/ARUNDEL ROAD-B2132 JUNCTION	,	,
A27	B2132 JUNCTION-FONTWELL	,	,
A27	FONTWELL-CHICHESTER	,	,
A259	A2032 JUNCTION-FERRING LANE	,	,
A259	FERRING LANE-B2140 JUNCTION	,	,
A259	ROUNDSTONE BYPASS ROAD	,	,
A259	B2140 JUNCTION-B2187 JUNCTION	,	,
A259	B2187 JUNCTION-WATERSMEAD	,	,
A259	WATERSMEAD TO TODDINGTON LANE	,	,
A259	TODDINGTON LANE-A284 JUNCTION(WICK)	,	,
A259	A284 JUNCTION(WICK)-B2187 JUNCTION		,
A259	B2187 JUNCTION-CHURCH ROAD JUNCTION(CLIMPING)	,	,
A259	CHURCH ROAD JUNCTION(CLIMPING)-B2233 JUNCTION	,	,
A259	GREVATTS LANE		,
A259	WORMS LANE		,
A259	FELPHAM WAY-SUMMERLEY LANE	,	,
A259	FELPHAM WAY	,	,
A259	UPPER BOGNOR ROAD	,	,
A259	HOTHAM WAY	,	,
A259	A29 JUNCTION-ORCHARD WAY	,	,
A259	ORCHARD WAY-NORTH BERSTED		,
A259	NORTH BERSTED-CHICHESTER	,	,
	ALDWICK ROAD SOUTH OF B2166	,	,
	BARRACK LANE	,	,
	HAWTHORN ROAD	,	,
B2166	SOUTH FROM UPPER BOGNOR ROAD	,	,

PM_{10}

Table 9 : Roads with existing traffic flows over 25,000 vehicles per day and predicted traffic flows over 25,000 vehicles per day by 2005 (worst case prediction)

Road No.	Section	Existing	Predicted
A27	WORTHING-PATCHING		,
A27	PATCHING-B225 JUNCTION	,	,
A27	B225 JUNCTION-CROSSBUSH	,	,
A27	LYMINSTER ROAD/STATION ROAD/THE CAUSEWAY	,	,
A27	ARUNDEL BY-PASS	,	,
A27	CHICHESTER ROAD/ARUNDEL ROAD-B2132 JUNCTION	,	,
A27	B2132-FONTWELL	,	,
A27	FONTWELL-CHICHESTER	,	,
A259	A232 JUNCTION-FERRING LANE	,	,
A259	FERRING LANE-B2140 JUNCTION	,	,
A259	ROUNDSTONE BYPASS ROAD	,	,
A259	B2140 JUNCTION-B2187 JUNCTION	,	,
A259	B2187 JUNCTION-WATERSMEAD	,	,
A259	WATERSMEAD-TODDINGTON LANE		,
A259	B2187 JUNCTION- CHURCH ROAD JUNCTION(CLIMPING)	,	,
A259	CHURCH ROAD JUNCTION(CLIMPING) -B2233		,
A259	FELPHAM WAY-SUMMERLEY LANE	,	,
A259	FELPHAM WAY		,
A259	UPPER BOGNOR ROAD	,	,
A259	HOTHAM WAY		,
A259	A29 JUNCTION-ORCHARD WAY	,	,
A259	NORTH BERSTED-CHICHESTER	,	,
	ALDWICK ROAD TOWARDS ALDWICK		,
	BARRACK LANE		,
	HAWTHORN ROAD		,

Lafarge Redland Aggregates Limited - Part B authorised process.
Urban areas for which the average regional background is greater than 8µg/m^3.

SO_2 Lafarge Redland Aggregates Limited - Part B authorised process.

The following Stage I Review and Assessment Checklist categorises the sources of concern for Stage II for each pollutant.

10. Consultation

10.1 Statutory Consultees

Under the Environment Act, all local authorities are required to consult on their air quality review and assessment with the Environment Agency and their Highways Authority. Through the Sussex Air Quality Steering Group both of these bodies have been involved since the early stages of the air quality management process, and will be made fully aware of all of Arun District Council's air quality review and assessment.

The Sussex Air Quality Steering Group is also working to ensure a free flow of information between neighbouring local authorities, including those which border Sussex but which are located in Kent, Surrey and Hampshire.

10.2 Public Consultation

The following bodies will be sent copies:

Arun Friends of the Earth, Arundel Chamber of Commerce, Bognor Regis and District Chamber of Trade, Rustington Chamber of Trade and Commerce, Lafarge Redland Aggregates Limited, Arun District Association of Local Councils, West Sussex County Council, Worthing BC, Horsham DC, Chichester DC.

Further information concerning air quality management is available from Arun District Council. There is also a video produced by the Department of the Environment, Transport and the Regions which is available from the Stationary Office, as well as technical guidance on air quality management for local authority officers.

We have issued a Press Release inviting the public to comment on Stage 1 Review and Assessment. Copies of the Stage I are available in local libraries and council offices for inspection. All comments on the Stage I Review and Assessment should be addressed to Pollution Section, Environmental Health, Arun District Council, Arun Civic Centre, Maltravers Road, Littlehampton, West Sussex, BN17 5LF and returned by ***28th February 1999***. Comments received concerning Stage I Review and Assessment will be considered in Stage II Review and Assessment.

11. The Way Forward

The First Stage Review and Assessment will now be submitted to the DETR and work will commence on the second stage of review and assessment, and a similar, separate report will be produced detailing the outcome of the second stage. Compilation and completion of the second stage review and assessment will determine if there is a need to progress to Stage III or otherwise.

Guidance indicates that there are a number of specialist cases where information gathered in Stage I and the tools available for Stage II would not be sufficient to give an accurate air quality assessment. In these cases, the authority should proceed directly to Stage III:

- Benzene – Where an authority needs to review and assess the impact of a planned rather than existing, industrial site the authority should undertake a third stage review and assessment

- 1,3-Butadiene – Where the first stage review indicates a risk of exceedence of an annual mean of 1 ppb at the end of 2005, the authority should carry out a third stage review and assessment of 1,3-butadiene

- Lead – Where there are significant fugitive emissions of lead or significant emissions from sites or parts of sites that do not come under the control of either Part A or Part B of the Environment Act 1990, the authority may complete a second stage review and assessment but should also carry out a third stage review and assessment

- PM_{10} – If low-level combustion sources other than road transport are significant (i.e. a 1km x 1km grid area for which the emission of PM_{10} is more than 10 tonnes) the authority may wish to undertake a second stage review and assessment but should also complete a third stage review and assessment

- PM_{10} – If an industrial source emits significant quantities of PM_{10} from sources other than regulated stacks, the authority should similarly complete a third stage review

- Sulphur Dioxide – If dispersed low-level sources (a 1km x 1km grid square exists in the authority's area for which annual low-level emissions are greater than 40 tonnes) the authority may carry out a second stage review and assessment but should also carry out a third stage review and assessment.

None of the above factors apply in Arun.

A local authority may also decide of its own accord to skip Stage II and proceed directly to Stage III.

Arun District Council has decided that a second stage review and assessment is the most appropriate course of action.

References

DETR documentation published by the Stationary Office:

1. *Environment Act* (1995)

2. *National Air Quality Strategy* (1997)

3. *The Air Quality Regulations 1997*, Environment Protection, SI No 3043 (1997)

4. LAQM.G1 *Framework for Review and Assessment of Air Quality*
5. LAQM.G2 *Developing Local Air Quality Strategies and Action Plans: The Principal Considerations*
6. LAQM.G3 *Air Quality and Traffic Management*
7. LAQM.G4 *Air Quality and Land Use Planning*
8. LAQM.TG1 *Monitoring for Air Quality Reviews and Assessments*
9. LAQM.TG2 *Preparation and Use of Atmospheric Emission Inventories*
10. LAQM.TG3 *Selection and Use of Dispersion Models*
11. LAQM.TG4 *Review and Assessment: Pollutant Specific Guidance*

12. *Air Pollution in the UK 1996* - Broughton GFJ, Bower JS, Clark II and Willis PG, AEA Technology, AEAT-2238 (1998)

13. *London Wide Benzene Monitoring Programme Annual Report 1995*, Stanger Science (1996)

14. *UK Nitrogen Dioxide Survey 1996* - Bush T, Mooney D and Stevenson K, AEA Technology, AEAT-2779 (1998)

15. *Revised High Resolution Maps of Background Air Pollutant Concentrations in the UK: 1996*, Stedman, AEA Technology, AEAT-3133 (1998)