WYCHAVON DISTRICT COUNCIL
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Review of Air Quality

1. Summary

Local Authorities are required by law[1] to carry out a review and assessment of the air quality in their areas. The Council must assess whether the limits contained within The Air Quality Regulations 2000 will be met by the dates specified in the regulations.

The primary objective is to identify areas within the district where the limits, or *"air quality objectives"* will not be met through national initiatives and actions alone, as part of the *National Air Quality Strategy.*

The National Air Quality Strategy sets *air quality standards* which represent minimum levels at which there is so significant risk of adverse health effects occurring. These standards were based on the advice of the *Expert Panel on Air Quality Standards (EPAQS).*

The National Air Quality Strategy also sets *air quality objectives.* These represent the Government's medium term policy intentions and are based on the standards, taking into account the feasibility, costs and benefits of moving towards those standards.

Air Quality standards and objectives have been set for the following key pollutants:

- Benzene
- 1,3 – Butadiene
- Carbon monoxide
- Lead
- Nitrogen dioxide
- Particles
- Sulphur dioxide

The review and assessment process involves a number of stages. Stage One requires each Local Authority to review information available on significant or proposed sources of the key pollutants and to consider whether the standards or objectives will be met by the due date.

If the Local Authority decides that from the information gathered in stage one, it appears that the standard or objectives will not be met, a Stage Two assessment is required. Additional data will be gathered, for example using *simple monitoring* and *dispersion modelling.* If this data indicates that the standards or objectives will not be met by the due date, a Stage Three assessment is required to be carried out which requires more complex data to be gathered. If there is a significant risk that the objectives and standards will not be met, the Local Authority is required to designate locations as *air quality management areas* and to produce an action plan in order to secure improvements to air quality.

Wychavon District Council carried out a first stage review for all key pollutants and a second stage review for nitrogen dioxide and particulate matter. The Council has assessed this information and has concluded that there will be no requirement to carry out a third stage review or to designate air quality management areas.

The Government introduced a duty on Local Authorities on 1st April 2000 to secure *Best Value* for the services which are provided. Best Value means that Councils must seek continuous improvement in the way they carry out their functions, including local air quality management. Whilst it would appear that the current standards and objectives will be met, scientific research is continuing to produce evidence in order to inform the development of revised limits. Wychavon District Council has also adopted a number of policies and strategies which clearly require

that protection of the environment is a key area for local action. As a result of this review and in consultation with local people, the Council will produce an air quality strategy in order to secure continuous improvement and safeguard the health of the local population.

2. Introduction

2.1 Air Quality Objectives

The Government published the *National Air Quality Strategy* in January 2000. The main objective is to ensure that no harm is caused to health or the environment due to poor air quality. This is to be achieved through the control of eight key pollutants. The air quality standards and objectives for each pollutant are given in the following table.

Air Quality Objectives

Pollutant	Standard (Concentration)	Measurement period	Objective (Date to be Achieved)
Benzene	16.25ug/m^3 or 5ppb	Running annual mean	31st December 2003
1,3 - Butadiene	2.25ug/m^3 or 1ppb	Running annual mean	31st December 2003
Carbon monoxide	11.6mg/m^3 or 10ppm	Running 8 hour mean	31st December 2003
Lead	0.5ug/m^3	Annual Mean	31st December 2004
	0.25ug/m^3	Annual Mean	31st December 2008
Nitrogen dioxide	200ug/m^3 or 105ppb not to be exceeded more than 18 times per year	1 hour mean	31st December 2005
	40ug/m^3 or 21ppb	Annual mean	31st December 2005
Particles (PM_{10})	50ug/m^3 not to be exceeded more than 35 times per year	24 hour mean	31st December 2004
	40ug/m^3	Annual mean	31st December 2004

Pollutant	Standard (Concentration)	Measurement Period	Objective (date to be achieved)
Sulphur dioxide	350ug/m^3 or 132ppb not to be exceeded more than 24 times per year	1 hour mean	31st December 2004
	125ug/m^3 or 47ppb not to be exceeded more than 3 times per year	24 hour mean	31st December 2004
	266ug/m^3 or 100ppb not to be exceeded more than 35 times per year	15 minute mean	31st December 2005
Tropospheric Ozone	100ug/m^3 or 50ppb not to be exceeded more than 10 times per year	8 hour running mean	31st December 2005

Ozone is not included in the local air quality review because it is a *transboundary pollutant*. Responsibility for achieving the ozone objective lies at national and international levels.
Distinction should be made between *tropospheric* or "ground level" *ozone and stratospheric ozone.* Tropospheric ozone is a secondary pollutant formed by the action of sunlight on *nitrogen oxides* mainly from vehicle emissions and *volatile organic compounds* found in solvents. These chemicals react in sunlight to produce ozone, which can cause irritation to the eyes, nose and throat. Ozone may also slow crop growth.

Stratospheric ozone can be found in the stratosphere, 15 to 50km above the ground. Here it forms a protective layer, which filters out harmful rays from the sun. Concern has been expressed that damage has and continues to be made to the "ozone layer", as it is known. Damage to the ozone layer is partly responsible for the phenomenon called *global warming* and may also contribute to the increased incidence of skin cancer.

3.1 Review Process

3.1.1 First Stage Review

In carrying out the review of pollutant levels at this stage, the following information has been gathered.

Industrial, Commercial and Agricultural Sources

- Details of emissions from existing and proposed *Part A processes* within the district
- Details of emissions from existing or proposed *Part B processes* within the district
- Details of other significant sources of the pollutant within the district.
- Details of significant sources of the pollutant in adjoining Local Authority areas
- Surveys or other investigations which have been undertaken

Traffic

- Details of planned developments in the district if traffic volume or flow will be affected where vehicle emissions are a source of the pollutant under consideration.
- Current and forecast *annual average daily traffic flow (AADFs)* for existing and proposed roads where vehicle emissions are a source of the pollutant under consideration.

Other Sources

- Details of significant sources of the pollutant in adjoining Local Authority areas if there could be an impact upon the Wychavon district
- Information relating to planned developments which could be a significant source of the pollutant under consideration.

Background Concentrations

- Estimated annual mean concentrations of the pollutant

The focus of the review is to consider the level of each pollutant at locations where people are most likely to be exposed to pollutants for a substantial part of the day.

This includes background locations, roadside locations close to the façade of a building and any other locations where potentially vulnerable groups could be exposed, such as schools or hospitals.

3.1.2 Second Stage Review

- Simple modelling techniques are used to enable more detailed predictions to be made, for example *ADMS-Urban* and the *Design Manual for Roads and Bridges* for traffic pollution. Modelling will be required for certain pollutants where predicted *AADFs* exceed a particular level, depending on the pollutant in question. These figures are contained within government guidance documents. More detailed pollutant monitoring at sites which may be exposed to higher levels of the pollutant, for example using simple *diffusion tubes.*

4. Overview of the Wychavon District

4.1 Location

Wychavon District Council is located in south west Worcestershire, between Birmingham to the north and Cheltenham to the south. The district covers a total area of 260 square miles, populated by 108,000 people living in the towns of Droitwich, Evesham, Pershore and Broadway and nearly 100 villages and hamlets. It is crossed from end to end by the M5 motorway.

4.2 Topography

The district lies on the river plain of the Avon between the Cotswold Hills to the south and the Birmingham plateau to the north. The district is relatively flat, having isolated hills, most notably Bredon Hill, 6km south of Pershore. Such a topography influences the extent and persistence of pollutants in the area.

4.3 Prevailing Meteorology

An important factor in the assessment of air quality is the effect of local weather conditions since these can affect the dispersion and distribution of pollutants emitted into the atmosphere. Observations of meteorological parameters are made at a number of weather stations, one of which is located in Pershore operated as part of a network by the UK Meteorological Office. Observations made at the Pershore weather station are deemed to be representative of the district for the purposes of this study.

4.4 Bordering Local Authority Areas

Wychavon district lies adjacent to Worcester City, Redditch Borough, Tewkesbury Borough and Wyre Forest, Bromsgrove, Stratford on Avon, Cotswold and Malvern Hills District Councils.

4.5 Principal Transport Routes

The principal transport routes are illustrated in appendix 1.

- The M5 motorway runs along the western side of the district
- The A422 runs east to west from Worcester to Stratford on Avon
- The A44 runs northeast to southwest from Evesham to Moreton in Marsh
- The A435 runs south from Evesham to Cheltenham

The main railway lines which traverse the district include the Cheltenham to Droitwich line which splits at Droitwich to Kidderminster and Birmingham. A second line runs northwest to southeast from Worcester to Evesham and beyond. A further line runs along the southeastern border from Cheltenham to Stratford on Avon.

4.6 Industry and Commerce

Wychavon is best known for its traditional rural industry, particularly horticulture, food manufacturing and distribution. However, light industry is growing, particularly engineering, manufacturing, warehousing and distribution, much of it centred in Droitwich, Evesham and Pershore. New industrial developments are planned for each of these towns.

4.7 Local Authority Air Pollution Control Authorised Sites

There are 63 premises which are authorised by the Council situated throughout the district, referred to as *Part B processes.* These are listed in appendix 2, together with the type of emission which is made. All 63 premises are required to meet emission limits specified by the Government. The Council routinely inspects these premises in order to ensure that environmental conditions are met.

One operation in the district is regulated by the Environment Agency due to the nature of pollutants emitted. This is also listed in appendix 2 as a *Part A process.*

5. Future Developments

5.1 Housing[2]

Worcestershire County Council in its draft *Structure Plan* for the period 1996 to 2011 indicates that Wychavon District Council will be required to allocate 7,550 housing

units for this period. A recent assessment of *residual housing requirement* found that approximately 1100 units are required. The majority of development will be directed towards the main urban areas. 700 of these units will be required to be provided in Droitwich. *Sustainability* is a key factor in determining where new development is to be located. Emphasis is to be placed on locating development close to the main transport corridors and to main employment centres.

5.2 Economic Development[3]

The Council seeks to attract inward investment, promote a sustainable approach to development and to develop land and business premises in order to develop and promote the local economy in order to meet local needs. In addition, the Council aims to develop the leisure and tourism sector, but will always consider the possible detrimental effects that tourism may have on the local environment.

No major new industrial sites are planned in the period up to 2003. However, there will be extensions to existing industrial sites at Evesham (Vale Park Industrial Centre) and Droitwich (Stonebridge Cross) as well as increased availability at Pershore (Keytech 7) and Hartlebury (Hartlebury Trading Estate)

5.3 Local Transport Plan[4]

Worcestershire County Council has produced a five-year transport plan in response to the Government white paper, “A New Deal for Transport: Better for Everyone”. Working in partnership, the County Council have created and supported initiatives, in order to meet the demands for an integrated and more environmentally conscious transportation system. Such initiatives include the development of an integrated public transport strategy in order to provide a viable alternative to the use of private vehicles, developing a safe, convenient and efficient cycle infrastructure, ensuring safe routes to school in order to reduce the need for children to travel by car, production of a freight strategy to assist in reducing congestion and pollution whilst supporting the local economy and reducing speed limits in rural villages.

5.4 Sustainable Development [5]

Sustainability underpins all the strategies described above and is an integral part of the day to day work of the Council. There are three main goals of sustainable development;

- Protecting and improving the environment
- Meeting social needs
- Promoting economic success

One of the targets of the Wychavon Sustainable Development Strategy is to ensure that the Council reduces its emissions of *carbon dioxide* by 2002 from energy use in the Civic Centre and Officer travelling. Whilst carbon dioxide has not been identified as one of the key pollutants to be included in the air quality review, it is a significant contributor to the *"greenhouse effect",* leading to the phenomenon known as *"global warming".*

In addition, each service provided by the Council will be responsible for setting and achieving at least one sustainability target in the forthcoming year. Initiatives such as reducing work related mileage, based on an overall corporate target and opting for less polluting vehicles are examples of such targets.

5.5 The Importance of Air Quality

Fortunately, the extreme cases of air pollution which were a feature of urban areas in the 1950s no longer exist and air quality throughout the UK is generally quite good. At the same time, evidence is growing that lower levels of pollutants may have an adverse effect on people's health, particularly those suffering from lung diseases or heart conditions. At the same time, some studies suggest that the incidence of lung diseases and heart disorders is rising. The causal link between a health problem being caused by air pollution (rather than other factors such as diet, fitness or inherited problems) has not been definitively proven. However, it is extremely likely that poor air quality makes these conditions worse, resulting in a poorer quality of life and in some cases, reducing the expected lifespan. In view of this, the Government has adopted the "precautionary principle" in the absence of definitive scientific evidence and has adopted standards in order to safeguard health and the environment, erring on the side of caution.

6. Benzene

6.1 Air Quality Objective

The air quality standard for benzene is a *running annual mean* of **16.25ug/m^3 or 5ppb, which** must be met by **31st December 2003**.

6.2 Sources

The main atmospheric sources of benzene are the combustion of petrol in motor vehicles and the storage and distribution of petrol. Currently, petrol contains approximately 2% benzene by volume. Petrol vehicles accounted for 64% of the total UK emission of 41,000 tonnes (1996 figures). Cigarette smoking is also a major subsidiary source.

6.3 Health Effects

At high levels, benzene is a recognised *carcinogen.* Long term exposure to high levels has been linked with certain types of *leukaemia*. It is absorbed into the body by inhalation, some of which is retained in the fatty tissues and some broken down by the body and excreted. The air quality standard has been set at a level at which the risks to health are exceedingly small.

6.4 Environmental Effects

Benzene is naturally broken down by chemical reactions in the atmosphere over several days.

6.5 Review of Benzene Levels

Information Considered	Assessment
Part A processes	No significant benzene emissions
Part B processes	No significant benzene emissions
Other processes	No major processes which handle, store or emit benzene.
Emissions from adjacent Council areas	No existing or planned Part A or B processes which may affect the air quality in Wychavon.

Future developments	None planned which will result in increased emissions of benzene.
Diffusion tube monitoring within Wychavon (refer to appendix 3)	All sites well below Air Quality Standard

6.6 Conclusions

The Air Quality Objective for benzene will be achieved by 31st December 2003.

Nationally, benzene levels are predicted to decrease due to

- The increase in the number of *three way catalytic converters* fitted to vehicles.
- European Union Directives require that the level of benzene in petrol be reduced from 2000. This will reduce emissions to atmosphere from vehicles and petrol stations.
- The Directives also require that the sulphur content of fuel be reduced in stages from 2000 to 2005. Sulphur compounds are known to cause deterioration in the performance of catalytic converters. Reduced sulphur in fuel will enable catalytic converters to remain effective for longer.

7. 1,3 – Butadiene

7.1 Air Quality Objective

The air quality standard for 1,3 - butadiene is a running annual mean of **2.25ug/m^3 or 1ppb, which** must be met by 31st December 2003.

7.2 Sources

1,3-butadiene is produced from the combustion of diesel and to a lesser extent, petrol. In 1995, 67% of national emissions arose from this source. It is also an

important industrial chemical, principally used in the manufacture of tyres, which accounted for 13% of emissions in 1995. 1,3- butadiene can also be found in tobacco smoke.

7.3 Health Effects

Little is known about the effects of 1,3-butadiene, although it is a recognised *carcinogen* if persons are exposed to moderately high levels over a long period of time. Short term exposure to high levels (i.e. greater than 10,000 ppb) may cause irritation of the airways and skin. The health risk becomes smaller as the cumulative exposure is reduced.

7.4 Environmental Effects

1, 3-butadiene will decompose in the environment over time.

7.5 Review of 1,3-Butadiene Levels

Information Considered	Assessment
Part A processes	No significant emissions
Part B processes	No significant emissions
Other processes	No significant emissions
Emissions from adjacent Council areas	Polymer Latex factory in Bromsgrove, adjacent to Wychavon's northern boundary is a Part A process which uses 1,3-butadiene. Less than 100kg per year is emitted, therefore this is not considered to be a significant

	emission.
Future Developments	None planned which will result in increased emissions
Background concentrations	Estimated to be 0.27ppb based on the *National Air Quality Archive.*

7.6 Conclusions

The Air Quality Objective for 1,3-butadiene will be achieved by 31st December 2003.

Nationally, levels of 1,3-butadiene are predicted to decrease due to

- The increase in the number of *three way catalytic converters* fitted to vehicles.
- European Union Directives require that the level of *aromatic compounds* in fuel will be reduced. This will mean that less 1,3-butadiene will be released as a result of fuel combustion.
- The Directives also require that the sulphur content of fuel be reduced in stages from 2000 to 2005. Sulphur compounds are known to cause deterioration in the performance of catalytic converters. Reduced sulphur in fuel will enable catalytic converters to remain effective for longer.

8. Carbon Monoxide

8.1 Air Quality Objective

The air quality standard for carbon monoxide is an 8-hour running mean of **11.6mg/m^3 or 10ppm** which must be met by **31st December 2003**.

8.2 Sources

Carbon monoxide is produced when materials are burnt incompletely. The main source of emission in the UK is road transport, particularly petrol fuelled vehicles, being 71% (3.3 million tonnes) of the total emission in 1996. The second most important source is cigarette smoking. Other internal sources include gas cookers

and paraffin heaters. Some natural sources have also been identified which contribute to background concentrations. The level of carbon monoxide in the atmosphere is significantly influenced by weather conditions; cold, still air will prevent dispersal and will result in greater concentrations building up near busy roads.

8.3 Health Effects

Carbon monoxide is a toxic gas that will reduce the oxygen carrying capacity of the blood, due to the formation of *carboxyhaemoglobin.* Those people who have existing *respiratory* diseases are the group who are most likely to be affected by the presence of carbon monoxide in the atmosphere.

8.4 Environmental Effects

Carbon monoxide will disperse in the atmosphere and will be broken down as a result of *photochemical reactions* within the environment over time.

8.5 Review of Carbon Monoxide Levels

Information Considered	Assessment
Part A processes	No significant emissions
Part B processes	No significant emissions
Other processes	No significant emissions
Emissions from adjacent Council areas	No existing or planned Part A or B processes which may affect the air quality in Wychavon.
Future developments	The planned increases in residential and industrial provision are unlikely to lead to excedances of the air quality standard.

Estimated average annual daily traffic flows (current and 2003 forecast) *	The estimated current and predicted flows are not considered to affect attainment of the air quality objective. Modelling of carbon monoxide levels will not be required.
Background concentrations	Estimated to be 0.16ppb throughout the majority of the district, with levels of 0.21ppb along the M5 corridor, based on the *National Air Quality Archive.*

* Refer to appendix 4

8.6 Conclusions

The Air Quality Objective for carbon monoxide is likely to be achieved by 31st December 2003.
Nationally, levels of carbon monoxide are predicted to reduce due to the more widespread use of *three way catalytic converters*.

9. Lead

9.1 Air Quality Objective

The air quality standard for lead is an annual mean of **0.5μg/m^3,** which must be met by **31st December 2004.** A standard of **0.25μg/m^3** must be achieved by **31st December 2008.**

9.2 Sources

Lead is the most widely used *non-ferrous* metal. It has a large number of applications and is commonly present in the atmosphere as fine particles. In 1996, lead in petrol accounted for 66% of the total usage. Lead as a fuel additive was prohibited in 1999, thereby significantly reducing the amount of lead in the

environment. Other sources of lead include coal combustion; production of non-ferrous metals and waste treatment as well as naturally occurring sources.

9.3 Health Effects

Exposure to lead can occur through inhalation of lead particles in the air as well as eating food or drinking water which has been contaminated by lead. Lead, once absorbed, spreads around the body and accumulates, particularly in bone, teeth, skin and muscle, eventually being destroyed by the kidneys. Exposure to lead may result in harmful effects to the nervous system, particularly in the developing brain of children as well as anaemia and raised blood pressure in adults.

9.4 Environmental Effects

Excessive amounts of lead can prevent plants from taking up carbon dioxide and may restrict the ability of the plant to utilise light in order to grow and release oxygen.

9.5 Review of Lead Levels

Information Considered	Assessment
Part A processes	No significant lead emissions
Part B processes	No significant lead emissions
Other processes	No major processes
Emissions from other Council areas	An incinerator is authorised to operate close to the WDC boundary, but is currently not in operation.
Future Developments	None planned which will result in increased emissions
Background levels	Estimated to be 0.012$\mu g/m^3$ in the majority of the district, increasing to 0.28$\mu g/m^3$ along the M5 corridor, based on the *Air Quality Archive.*

9.6 Conclusions

The air quality objective for lead will be achieved by 31st December 2004. The background levels referred to above are based on data collected in 1996. Since this time, the lead content of petrol has been gradually reduced, culminating in the total cessation from this year onwards.

10. Nitrogen Dioxide

10.1 Air Quality Objective

There are 2 air quality standards for nitrogen dioxide;

- a *1 hour mean* of **200μg/m^3** or **105ppb** which must not be exceeded more than 18 times per year and
- an *annual mean* of **40μg/m^3** or **21ppb**

which must be met by **31st December 2005.**

10.2 Sources

Nitrogen dioxide gas is formed as a result of high temperature combustion. The most significant source is generated by road traffic, accounting for approximately 1 million tonnes of nitrogen dioxide released in 1996. Emissions from vehicles are highest at

speeds below 15mph, above 60mph and where vehicles are continually accelerating and decelerating. Power generation is another important source, contributing around 0.5 tonnes per year. Other sources include industrial emissions, railways, aircraft and domestic heating.

10.3 Health Effects

Nitrogen dioxide may have both *acute* and *chronic* effects on health, particularly of those suffering from asthma and other respiratory diseases. Nitrogen dioxide may penetrate the airways and increase the risk of respiratory infections. Normal levels of nitrogen dioxide have very little effect on people with healthy lungs.

10.4 Environmental Effects

Nitrogen dioxide is a key contributor to the production of *acid rain.* This can have a significant impact on the environment, upsetting the natural balance of ecosystems by causing damage to soil, vegetation and freshwater aquatic life. *Acid rain* may also attack buildings, causing stone to crumble. Unfortunately, the use of *catalytic converters* to reduce emissions of nitrogen dioxide may produce *nitrous oxide* as a by-product. Nitrous oxide is one of the main *greenhouse gases* which contribute to *global warming.*

10.5 Review of Nitrogen Dioxide

Information Considered	Assessment
Part A processes	No significant emissions
Part B processes	No significant emissions
Emissions from adjacent Council areas (refer to appendix 5)	No significant emissions at the present time.
Future developments	The development of new housing and industry is unlikely to result in significant additional emissions. Improvements to the road network (e.g. Wyre Piddle bypass) will assist in reducing emissions in residential areas. A waste incineration plant may be constructed in Kidderminster. The impact upon air quality in Wychavon is uncertain at present.
Existing and 2005 forecast annual mean traffic flows which could	There are 10 major roads where emissions may be significant. This

generate significant emissions(i.e. roads with an *AADF* greater than 10,000 vehicles (refer to appendix 4)	may affect the air quality in Droitwich, Bredon, Strensham, Norton, Whittington, Wychbold, Upton warren, Ombersley and Hartlebury. Overall, traffic volumes are predicted to increase by 6.5% by 2005.
DMRB calculation (based on vehicle speed, flow and background concentration) (refer to appendix 6)	DMRB calculation indicates that there are 5 major roads where the air quality standard may be exceeded; M5 N of J9, M5 N of J6, M5 N of J7, M5 N of J8, A38T S of Wychbold
Diffusion tube survey (refer to appendix 7)	Levels of nitrogen dioxide have been shown to be falling in most areas. However, 1 area does not currently meet the standard; High St/Swan Lane Evesham.
Background levels	Estimated to be in range 7.3ppb to 17.2ppb in 2005, based on the *National Air Quality Archive.*

10.6 Conclusions from First Stage Review

The review indicated that it was possible that the air quality objective would not be met in certain locations within the district. A second stage review was therefore carried out.

10.7 Second Stage Review

This is a more detailed assessment of predicted levels of nitrogen dioxide where the first stage review concluded that the air quality objective may not be met.

- Additional Diffusion tube Monitoring

Following the conclusions of the first stage review which identified a number of locations where it was possible that the objective would not be met, 9 additional sites (refer to appendix 7) were chosen in order that nitrogen dioxide levels could be more closely monitored. The 10 month mean (January 2000 to October 2000) reveals that Westlands (Droitwich) and Wychbold currently experience levels above the 21ppb standard.

- M5 Motorway and A38

A detailed study[6], using the dispersion model *ADMS-Urban version 1.52* was carried out by Cambridge Environmental Research Consultants Ltd on behalf of a housing developer in relation to a proposal for the development of land for residential use at Hanbury Road, close to the M5 motorway at Droitwich. The study concluded that the air quality objectives would be met. The site in question is considered to reflect the worst possible circumstances, given that the section of the motorway considered carries the highest flow of traffic, (95,066 vehicles per day in 1998 and predicted to be 112,938 vehicles per day in 2005) 12% heavy duty vehicles travelling at estimated speeds of 100kph and light duty vehicles travelling at 130kph and location of dwellings within 50m of the central reservation of the motorway. The areas of Westlands and Wychbold are further from the motorway with the result that most nitrogen dioxide will have dispersed before it reaches these areas.

The study predicted that the highest annual average mean concentration would be 18.3ppb.

- Evesham Town Centre

The High Street/Swan Lane junction in the centre of Evesham has experienced higher levels of nitrogen dioxide following changes to the road network in 1997, which has increased the level of congestion at peak times within the town centre. Nevertheless, annual mean levels are reducing, such that the objective has almost been met this year.

A *DMRB* calculation has been carried out in order to predict levels of nitrogen dioxide in this area in 2005 (refer to appendix 6) The predicted level is 19.6ppb.

A further prediction has been made using guidance contained within *LAQM. TG4(00)*. The predicted level in this area is 20.5ppb.

10.8 Conclusions of Second Stage Review

The air quality objective of 21ppb annual mean will be met by 31st December 2005.

The air quality objective of 105ppb hourly mean not to be exceeded more than 18 times per year will be met by 31st December 2005, given that the highest recorded monthly levels have never exceeded 43.57ppb.

Nationally, nitrogen dioxide levels will reduce due to the more widespread use of *catalytic converters.*

11. Particulates

11.1 Air Quality Objective

There are two air quality standards for particulate matter (PM_{10})

- An *annual mean* of **40μg/m^3**
- A *24-hour mean* of **50μg/m^3** which must not be exceeded more than 35 days per year (*90th percentile*)

which must be met by **31st December 2004.**

11.2 Sources

PM_{10} is the fraction of particles in the atmosphere which are less than 10μ in diameter. There are three principal source categories;

- Primary particles released directly from combustion processes such as road traffic, predominantly from diesel fuelled vehicles, which are released directly into the air. These particles normally have a diameter of less than 2.5μ.
- Secondary particles which are formed as a result of chemical reactions in the atmosphere, such as *sulphates* and *nitrates.* These particles are normally less than 2.5μ in diameter and tend to remain suspended in the atmosphere, often drifting across national boundaries.
- Coarse particles such as soil, dust, pollen and fungal spores occur naturally in the atmosphere, particularly in rural areas. These particles usually have a diameter greater than 2.5μ.

In 1996, an estimated 213,000 tonnes of PM_{10} was emitted by the UK. 24% came from road transport (principally diesel-fuelled vehicles), 38% from industrial sources and around 33% from large and small scale power generation.

11.3 Health Effects

Particles may be inhaled and deposited within the airways leading to a variety of health effects. At low concentrations, particles may cause coughing and constriction of the airway. Particle size is important because coarse particles are usually prevented from travelling any further into the body, having been trapped in the nasal passages, whilst smaller particles, known as PM_{10} are able to travel further into the lungs and cause damage to the soft tissues.

Since *EPAQS* made its recommendation to the Government to assess levels of PM_{10}, further evidence has emerged suggesting that finer particles, $PM_{2.5}$ or smaller are more likely to cause adverse health effects, due to the ability to penetrate the lungs and exacerbate existing respiratory diseases, leading in some cases to premature death. Research continues into the combined effect of inhaling particles which have reacted with other pollutants. It is possible that in future, the standard will be changed to $PM_{2.5.}$

11.4 Environmental Effects

Particles may cause damage to buildings, through blackening of the surface and, if combined with other pollutants may cause corrosion or abrasion of buildings and other structures. Plant growth may also be reduced if the processes involved in cell health and generation are disrupted.

11.5 Review of Particles

Estimates of PM_{10} levels are known to be less accurate than assessments of other pollutants because typical monitors only measure levels over a short period and may not be typical of longer-term levels. In addition, it is very difficult to measure the required fraction of particles, rather than total particles. Estimates should therefore be taken to be indicators rather than more accurate predictions.

Information Considered	Assessment
Part A processes	No significant emissions
Part B processes	There are 3 processes which have the potential to emit significant quantities of particles. Emissions are controlled via the authorisation process and it is considered that there will not be an impact on overall particle levels
Background concentrations	The estimated 2004 background PM10 concentration ranges from 20 to 22μg/m3, based on *NETCEN* predictions. Highest values are predicted close to the M5.
Existing and predicted daily traffic flows exceeding 20,000 vehicles per day in 2005 and simplified *DMRB* calculation (refer to appendices 4 and 6)	10 roads are expected to have *AADFs* in excess of 20,000 vehicles. This may have an impact on particle levels in Droitwich, Bredon, Strensham, Norton, Whittington, Wychbold, Upton warren, Ombersley and Hartlebury. The *DMRB* calculation indicates that the objective may not be met in 5 locations; M5 N of J5, M5 N of J6, M5 N of J7, M5 N

	of J8, A38T S of Wychbold.
Other sources	Wychavon is largely rural; hence dust emissions may arise through agricultural and quarrying activities. These are unlikely to be significant.
Use of domestic solid fuel	Not significant – heating is mainly generated by gas.
Emissions from adjacent Council areas	No significant emissions
Automatic Urban & Rural Network monitoring data	Predicts that the objective will be achieved throughout the UK, except in London.
Future developments	No significant emissions predicted.

11.6 Conclusions from First Stage Review

The air quality objective for particles will be achieved throughout most of the district by 31st December 2004. However, the first stage review indicated that certain sites close to the M5 motorway and A38T may exceed the standard by 2004. A second stage review was therefore carried out.

11.7 Second Stage Review

A more detailed assessment of the predicted levels of particles was carried out in those locations which it was considered might not meet the air quality objective.

- M5 Motorway and A38T

A detailed study[6], using the dispersion model *ADMS-Urban version 1.52* was carried out by Cambridge Environmental Research Consultants Ltd on behalf of a housing developer in relation to a proposal for the development of land for residential use at Hanbury Road, close to the M5 motorway at Droitwich. The study concluded that the air quality objectives would be met. The site in question is considered to reflect the worst possible circumstances, given that the section of the motorway considered carries the highest flow of traffic, (95,066 vehicles per day in 1998 and predicted to be 112,938 vehicles per day in 2005) 12% heavy duty vehicles travelling at estimated speeds of 100kph and light duty vehicles travelling at 130kph and location of dwellings within 50m of the central reservation of the motorway.

The highest predicted annual average concentration was 17μg/m^3, resulting in an estimated 90th percentile of 24-hour averages concentration of 21μg/m^3.

- Town Centres

A *DMRB* calculation (refer to appendix 6) was carried out to predict the estimated annual mean concentration in High Street, Evesham. This area was not identified by the first stage review. However, it is accepted that levels of nitrogen dioxide arising from transport generally relate to levels of particles arising from vehicle use. Given that Evesham High Street experiences the highest levels of nitrogen dioxide in the district, it was considered that this site should be considered in more depth.

The estimated annual mean for 2004 using this calculation is 23.8μg/m3.
The estimated 90th percentile of 24 hour means is 42.5μg/m3.

11.8 Conclusions of Second Stage Review

Both air quality objectives will be met by 31st December 2004.

Nationally, particle levels are expected to fall due to

- The increase in the number of *three way catalytic converters* fitted to vehicles.
- European Union Directives require that the sulphur content of fuel be reduced in stages from 2000 to 2005. Sulphur compounds are known to cause deterioration in the performance of catalytic converters. Reduced sulphur in fuel will enable catalytic converters to remain effective for longer.
- More stringent emission limits for all new vehicles in 2001 and 2006
- More stringent emission limits for all heavy diesel fuelled vehicles
- Changed fuel quality specifications from 2000 and 2005.
- The combined effect of the implementation of Integrated Transport strategies and related transportation improvements.

12. Sulphur Dioxide

12.1 Air Quality Objective

There are 3 air quality standards for sulphur dioxide,

- A 1 hour mean of **350μg/m^3** or **132ppb** which must not be exceeded more than 24 times per year (99.7th percentile)
- A 24 hour mean of **125μg/m^3** or **47ppb** which must not be exceeded more than 3 times per year (99th percentile)

Which must be achieved by **31st December 2004.**

- A 15 minute mean of **266μg/m^3** or **100ppb** which must not be exceeded more than 35 times per year (99.9th percentile)

Which must be achieved by **31st December 2005**.

12.2 Sources

Sulphur dioxide is formed as a result of the combustion of sulphur containing fossil fuels, principally coal, oil and gas. Emissions in the UK are generated by a small number of very large power stations. Other sources include diesel-fuelled vehicles, heating and some industries.

Historically, power was generated mainly from coal and oil. The use of natural gas and *renewable* energy sources has resulted in a major reduction in the national level of sulphur dioxide in the atmosphere. The total UK emission in 1996 was 2 million tonnes, 65% of which came from power generation.

12.3 Health Effects

Medical evidence suggests that the effects of sulphur dioxide exposure appear almost immediately. At high concentrations (i.e. 5000ppb), sulphur dioxide is a strong irritant to the eyes and airways. At lower concentrations, it may restrict the airway and cause coughing, particularly in those suffering from asthma and other chronic lung diseases as well as smokers. Research suggests that exposure to sulphur dioxide may increase sensitivity to *allergens*, such as house dust mites and pollen. Normally healthy individuals do not normally experience adverse health effects at these levels.

12.4 Environmental Effects

Sulphur dioxide, in conjunction with nitrogen dioxide is a key contributor to the formation of *acid rain.* This can have a significant impact on the environment, upsetting the natural balance of ecosystems by causing damage to soil, vegetation and freshwater aquatic life. *Acid rain* may also attack buildings, causing stone to crumble.

12.5 Review of Sulphur Dioxide

Information Considered	Assessment
Part A processes	No significant emissions
Part B processes	3 processes emit small quantities of sulphur dioxide. These are not considered to be significant
Power generation from solid fuel or oil greater than 5MW	All power generation less than 5MW thermal rating.
Background concentrations	The estimated 15 minute mean (99.9^{th} percentile) concentration predicted for 2005 ranges from 50-68$\mu g/m^3$ in the north of the district and from 36 to 50 $\mu g/m^3$ in the south of the district.
Density of domestic premises burning solid fuel	New residential development is heated mainly by natural gas and older estates were converted to natural gas some time ago. There are no areas where the density of coal or solid smokeless fuel burning exceeds 300 properties per $1km^2$. Emissions are not significant.

Emissions from adjacent Council areas (refer to appendix 2)	There are 2 Part A combustion processes located close to the district boundary. Both will convert from oil firing to low sulphur fuels prior to 2004.

12.6 Conclusions

The air quality objectives for sulphur dioxide will be achieved by 31st December 2004.

Nationally, levels of sulphur dioxide are predicted to fall due to

- The Second Sulphur Protocol requires that large combustion plant emissions of sulphur dioxide must be reduced by 50% by 2000, 70% by 2005 and by 80% before 2010.
- National controls regulating the sulphur content of heavy fuel oil and gas oil, which are commonly used industrially.
- National policies and initiatives to reduce energy consumption

13. Conclusions

13.1 The assessment indicates that it is expected that all air quality standards will be met within Wychavon by the required date.

13.2 Notwithstanding this, the predicted levels of nitrogen dioxide and particles are close to the limit set in the standard.

13.3 Assessment of the health and environmental effects of pollutants is constantly changing as research continues and as more information is gathered in relation to non-occupational exposure to pollutants as well as the existence of *synergistic effects* of pollutants on health. It is likely that the Government will revise the standards at some point in the future in order to reflect this.

13.4 A review of the assessment is required to be carried out during 2003.

14. Further Actions

The Council will continue to monitor levels of nitrogen dioxide within the district in order to provide a more comprehensive view of progress towards meeting the air quality objectives. As more information becomes available nationally, this too will enable the Council to monitor progress.

The Council will produce, in consultation with residents, visitors and business interests a Local Air Quality Strategy in order to seek continuous improvement. This strategy will recognise that everyone has a part to play in protecting air quality and the Council itself is expected to adopt good practices as an example for others to follow. It is anticipated that the remit will be widened to cover indoor air quality as well as outdoor air in view of the increasing concern over health in this area. A consultation exercise will be undertaken, but if you have any comments to make either about this document or ideas or suggestions for a strategy at this stage, please send them to

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15. Glossary of Terms

µg micrograms (1,000,000th of a gram)

µg/m^3 *micrograms* per cubic metre
24 hour mean the average value of measurements taken over a 24-hour period

90th percentile The 90th figure in a set of figures which has been divided into 100 values of equal frequency.

99.7th percentile The 99.7th figure in a set of figures which has been divided into 100 values of equal frequency.

99.9th percentile The 99.9th figure in a set of figures which has been divided into 100 values of equal frequency.

AADFs (Annual Average Daily Flows of traffic) These figures are collected by the County Council by means of manual counts carried out by visual means and by automatic counting devices which are placed across the carriageway for a period of time.

Acid rain The term given to rain made more acidic by gas pollution. There are two kinds of acid rain; wet deposition, which is rain made more acidic, for example due to sulphur dioxide and oxides of nitrogen and dry deposition, which is the direct fallout of acidic pollutants from chimneys on sources close to the source of emission.

Acute The term applied to the reaction of the body to pollutants. An acute reaction occurs quickly and usually severely.

ADMS-Urban (Atmospheric Dispersion & Modelling System) A modelling tool used for reviewing and assessing air quality. It is used throughout the UK by industry and the Environment Agency.

Air Quality Management Area An area or region must be declared by a Council to be an AQMA if it is predicted that the air quality objectives for a particular area will

not be achieved. The Council must then produce an action plan, setting out the local steps to be taken to ensure that the objectives are met.

Air Quality Objectives The standards set by EPAQS are required to be met within a specific period of time, depending on the nature, effect and cost of the pollutant.

Allergens Substances which cause the body to adversely react to contact with it, e.g. pollen.

Annual mean The average value obtained by adding all the individual measurements for a specific pollutant over 12 months together and dividing by the total number of measurements.

Automatic Urban & Rural Network A series of sites in the UK where monitoring of pollutants is carried out by automatic means. The information is fed to a central database and forms the basis of information used primarily for public information, including production of the National Air Quality Archive.

Benzene A liquid derived from fossil fuel which evaporates readily in the atmosphere.

1,3-butadiene A gas at normal temperature and pressure which is used mainly in the production of synthetic rubber for tyres.

Best Value The requirement for all Councils to review all services to ensure that value for money is achieved and that services are delivered in the best way to serve the interests of all those receiving a service from the Council.

Carbon dioxide A colourless, odourless gas formed by natural processes (including human breathing) and by the combustion of fuels containing carbon (e.g. coal, gas and oil)

Carbon monoxide A colourless, odourless, flammable gas formed by incomplete combustion of fuels.

Carboxyhaemoglobin A substance carried in the blood of people exposed to carbon monoxide. Oxygen is carried around in the blood attached to a substance known as haemoglobin. If the body is exposed to carbon monoxide, the carbon monoxide attaches itself to the haemoglobin, which means that the blood has less capacity for carrying oxygen around the body.

Carcinogen A substance which is linked to the formation of cancers.

Chronic The term applied to the reaction of the body to pollutants. A chronic reaction occurs over a longer period of exposure.

Design Manual for Roads & Bridges (DMRB) A document produced by the Department of Transport, Environment and the Regions (DETR) providing guidance on predicting levels of pollutants which arise from vehicles.

Diffusion Tubes Small plastic tubes, with one open end which is exposed to the atmosphere. The closed end contains an absorbent material which collects nitrite from nitrogen dioxide in the atmosphere (similar types of tubes are also used to monitor benzene levels) The tubes are exposed to the atmosphere for a period of one month and analysed by an accredited laboratory. A mathematical equation is used to convert the collected data into a figure of X ppm of nitrogen dioxide in the air.

Dispersion Modelling A scientific paper based method of using various statistics to predict the way in which pollution spreads from its point of emission and becomes diluted in the atmosphere

Expert Panel on Air Quality Standards (EPAQS) A body of independent experts who review the scientific and medical information relating to the health effects of pollutants and recommend maximum standards for pollutants which must not be exceeded.

Global warming A rise in global temperature, thought to be caused by an increase in greenhouse gases in the atmosphere, which could result in unpredictable changes in regional and seasonal weather patterns, leading to serious effects on forestry, agriculture and sea levels.

Greenhouse effect As gases have built up in the atmosphere, more heat is absorbed, rather than being released from the earth, in the same way that heat is trapped within a greenhouse.

Greenhouse gases The gases that contribute to global warming by absorbing heat; including carbon dioxide, methane, nitrous oxide and ozone.

Hourly mean The average value of a number of figures collected over the period of one hour.

Hydrocarbons Compounds which contain carbon and have a particular molecular structure, formed naturally in the atmosphere as a result of geological reactions and formed artificially, principally as a result of burning. Tobacco smoke is an important source in indoor air, whilst vehicles contribute to atmospheric levels.

LAQM TG4(00) A document produced by the Department of Transport, Environment and the Regions (DETR) giving guidance on the review and assessment of specific pollutants.

Lead A metallic element which, in the form of dust is highly poisonous.

Leukaemia An acute or chronic disease involving the extreme over-production of white blood cells

Mean The average figure of a group of numbers.

National Air Quality Archive A national archive of information and data relating to air pollution levels gathered from various monitoring stations.

NETCEN National Environmental Technology Centre, an organisation operated by AEA Technology Ltd which researches developments and collates information in the field of air quality.

Nitrates A chemical salt containing nitrogen.

Nitrogen oxides The name given to a number of gases containing nitrogen and oxygen. This includes nitrogen oxide and nitrogen dioxide.

Nitrogen oxide A colourless toxic gas

Nitrogen dioxide An acidic irritant gas

Non-ferrous A metal which does not contain iron.

Ozone An irritant gas, related to oxygen, formed naturally in the higher layers of the atmosphere, where it helps to filter harmful ultraviolet rays. At lower levels in the atmosphere, it is formed as a result of reactions of pollutants in strong sunlight

Oxygen The gas contained in air which is essential for almost all forms of life.

Ppb Parts of a substance per billion parts of air.

Ppm Parts of a substance per million parts of air.

Particles/Particulate matter Fine solid dusts found in the air.

Part A processes Those industries where polluting emissions are regulated by the Environment Agency.

Part B processes Those industries where polluting emissions are regulated by Local Authorities by means of an Authorisation to operate the process in line with specific conditions which are designed to minimise emissions of various substances into the air.

Photochemical reactions Reactions between nitrogen oxides and hydrocarbons during sunlight which can produce a “haze” or “smog” which can damage health and vegetation.

Renewable energy Energy generated from naturally occurring resources which will never run out e.g. solar energy, wind and water power.

Residual Housing The number of houses required in a district which have not yet been allocated development land.

Respiratory The breathing of air into the lungs and transfer of oxygen into the blood via the lungs. Also the breathing out of carbon dioxide, via the lungs from the blood.

Running annual mean The average value obtained by adding all the individual measurements for a specific pollutant over the preceding 12 months (e.g. January 99 to December 99) together and dividing by the total number of measurements, then adding the next month to the preceding 11 months (e.g. February to December 99 plus January 00) and dividing by the total number of measurements. Therefore the standard must be met not just at the end of a year, but takes into consideration the effect of each month’s measurements.

Simple Monitoring This includes the use of diffusion tubes, simple pumps and filters and basic deposit systems.

Stratospheric The higher layers of the atmosphere.

Structure Plan The 15 year plan produced by the County Council, providing a broad framework of land use policies, to which the Council has regard when assessing planning applications and in formulating its own local policies.

Sulphates A chemical salt containing sulphur.

Sulphur dioxide A colourless irritant gas with a pungent “bad egg” aroma.

Sustainability Is the term used to mean ensuring a better quality of life for everyone today and in the future. It encompasses development that balances economic, social and environmental considerations.

Synergistic effects The effect of two or more substances acting together may be more hazardous to the body than if a person were exposed to each substance on its own.

Three way catalytic converters A device which can be fitted to vehicle exhaust systems to reduce emissions of carbon monoxide, hydrocarbons and nitrogen oxides by converting them into carbon dioxide, nitrogen and water.

Transboundary Pollutant Substances which are emitted in one area and travel across district, national or international boundaries.

Tropospheric The lower layers of the atmosphere

Volatile Organic Compounds A class of carbon containing (organic) compounds which easily evaporate and contribute to air pollution, mainly through the production of secondary pollutants, such as ozone

16. References

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