South Cambridgeshire District Council

Detailed Assessment of PM_{10} Along the A14 Corridor

South Cambridgeshire District Council

December 2007

Acknowledgements

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Executive Summary

The Environment Act 1995, requires all local authorities to take a risk-based approach to reviewing air quality in their area, assessing pollutant concentrations against health based objectives prescribed in regulations. Where it is found that the objective levels are unlikely to be met, local authorities must declare Air Quality Management Areas (AQMAs) and draw up Air Quality Action Plans (AQAPs) for improving air quality in those areas.

In 2006, South Cambridgeshire District Council identified a potential area of exceedence of the 24-hour mean PM_{10} objective in areas adjacent to the A14 at Bar Hill and Impington. This was based on actual 2006 monitoring data.

This exceedence was indicated by monitoring results from measurements undertaken in the vicinity of the A14 by standard continuous automatic techniques. As required, a detailed assessment of emissions in this area has been undertaken employing atmospheric dispersion modelling to predict the extent of any possible exceedence for PM_{10}

The detailed assessment has shown that traffic emissions from the A14 are likely to cause an exceedence of the daily PM_{10} objective at the relevant locations. However, it has also shown that it is likely that the current annual mean objective will be achieved. It will, therefore, be necessary to declare an Air Quality Management Area for PM_{10}.

The AQMA will cover approximately the same area as the AQMA declared in July 2007 for Nitrogen Dioxide.

Contents

Appendices

Figures

Tables

Graphs

1.0 Introduction

1.1 Why a Detailed Assessment?

The Air Quality Review and Assessment (AQR&A) Progress Report published in 2006 by the Cambridgeshire air quality group identified a potential area of exceedence of the annual PM_{10} objective in areas adjacent to the A14 in South Cambridgeshire. Pollutant concentrations are suspected to be elevated around the junctions owing to congestion and queuing traffic. This Detailed Assessment, commenced in 2007 has been carried out to ascertain the extent of any possible exceedence.

The approach taken to this study was to:

- Collect and interpret additional data to that already used in the screening assessment, including more detailed traffic flow data;
- Utilise the continuous monitoring data to assess the ambient concentrations resulting from road traffic emissions and to validate the output of modelling studies;
- Model the concentrations of PM_{10} around the selected sections of the A14 concentrating on the locations where people may be exposed over the averaging times of the air quality objectives;
- Present the concentrations as contour plots of concentrations and assess the uncertainty in the predicted concentrations.

1.2 Aims of the Detailed Assessment

This detailed assessment has been created to fulfil South Cambridgeshire District Councils obligations under Part IV of the Environment Act 1995. The assessment aims to:

- Ascertain whether or not the National Air Quality Objectives for Fine Particulate Matter (PM_{10}) are being met at present. This is in response to the findings of South Cambridgeshire District Councils' Progress Report published by the Cambridgeshire air quality group in 2006.

- Ascertain whether or not the National Air Quality Objectives for Fine Particulate Matter (PM_{10}) will be met in the future.

- Determine the extent of any exceedencess of the National Air Quality Objectives for Fine Particulate Matter (PM_{10}).

- Suggest the actions required following the findings of the assessment.

1.3 Scope of the Detailed Assessment

The detailed assessment will be carried out in line with the statutory duties laid out within Part IV of the Environment Act 1995. Specifically, the assessment will:

- Give a full review of updated traffic data
- Review latest data and information available for road and grid sources

- Model road and grid sources for PM_{10} to obtain predictions for 2006 concentrations
- Model road and grid sources for PM_{10} to obtain predictions for 2010 concentrations
- Compare modelled and measured data
- Compare modelled and measured data with the National Air Quality Strategy Objectives
- Give recommendations based on the findings of the assessment.

1.4 The National Air Quality Strategy (NAQS)

The Environment Act 1995 provides the legal framework for requiring Local Authorities in England and Wales to review the air quality in their area against national objectives including for some pollutants the number of times they must not be exceeded. Where a Local Authority predicts these objectives will be exceeded then they must declare an air quality management area in those locations.

The main elements of the NAQS can be summarised as follows:

- National Air Quality Standards and Objectives have are based upon the health effects of the pollutants of concern.
- The use of policies by which objectives can be achieved and which include the input of important factors such as industry, transportation bodies and local authorities.
- The predetermination of timescales with target dates for the achievement of objectives.

At the centre of the AQS is the use of national air quality standards to enable air quality to be measured and assessed. These also provide the means by which objectives and timescales for the achievement of objectives can be set. Most of the proposed standards have been based on the available information concerning the health effects resulting from different ambient concentrations of selected pollutants and are the consensus view of medical experts on the Expert Panel on Air Quality Standards (EPAQS). These standards and associated specific objectives to be achieved between 2004 and 2010 are attached as Appendix 1. This shows the standards in $\mu g/m^3$ with the number of exceedences that are permitted.

Specific objectives relate either to achieving the full standard or, where use has been made of a short averaging period, objectives are sometimes expressed in terms of percentile compliance. The use of percentiles means that a limited number of exceedences of the air quality standard over a particular timescale, usually a year, are permitted. This is to account for unusual meteorological conditions or particular events such as Bonfire Night, November 5th.

2.0 The A14

The A14 trunk road, which passes through the South Cambridgeshire District Council area is a strategic route of national importance and also forms part of the trans European Highway, linking the Midlands and North of England to the ports of Felixstowe and Harwich and the M11 and Stansted to the south. Additionally it is the most important route for local traffic linking Huntingdon and Cambridge with St Ives and other villages along the A14 corridor. The route of the A14 through the District is shown in Figure 1, below.

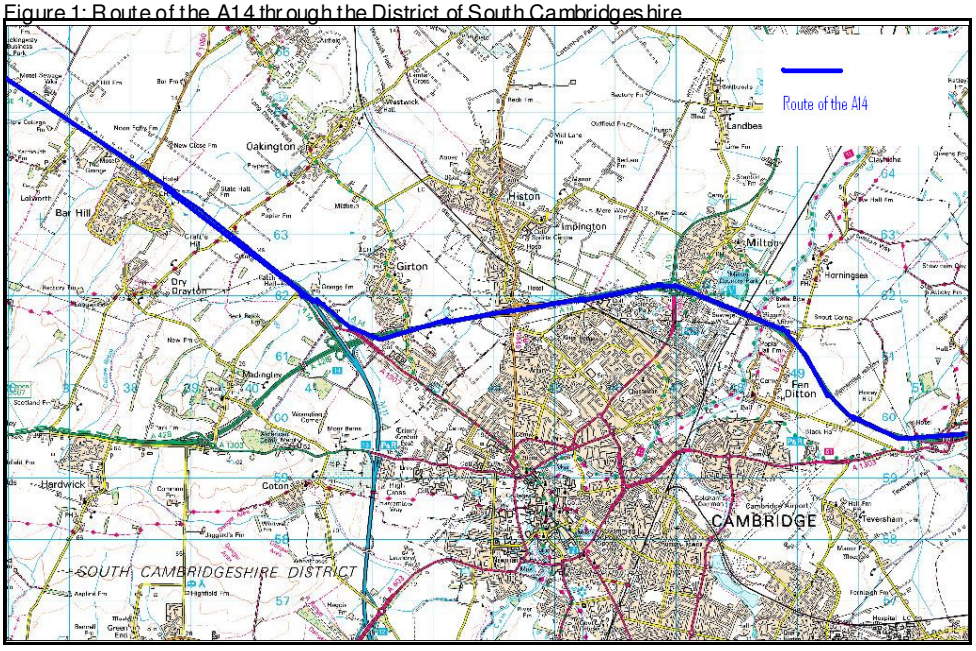
Many sections of the A14 are currently operating close to capacity, with an average of 65 – 90,000 vehicles per day using the route. Up to 25% of the traffic is made up of heavy goods vehicles. The road is subject to severe congestion, particularly during peak hours on a regular basis.

The traffic flows along the A14 are the highest in the County. Over the past 5 years the Highways Agency have undertaken a programme of studies and consultation exercises in order to devise a strategy of improvements for the A14. Substantial improvements are proposed which for the section through South Cambridgeshire comprise:

- Widening of the existing carriageway to 3 lanes in each direction
- Creating local access roads alongside the widened A14 to separate local and strategic traffic
- Realignment of major interchanges at the M11/A428 at Girton.

In addition, Cambridge has been identified as a high growth area, with plans for new housing, employment and infrastructure. Improvements to the trunk road network and to public transport provision should be undertaken with air quality improvements in mind.

Figure 1: Route of the A14 through the District of South Cambridgeshire

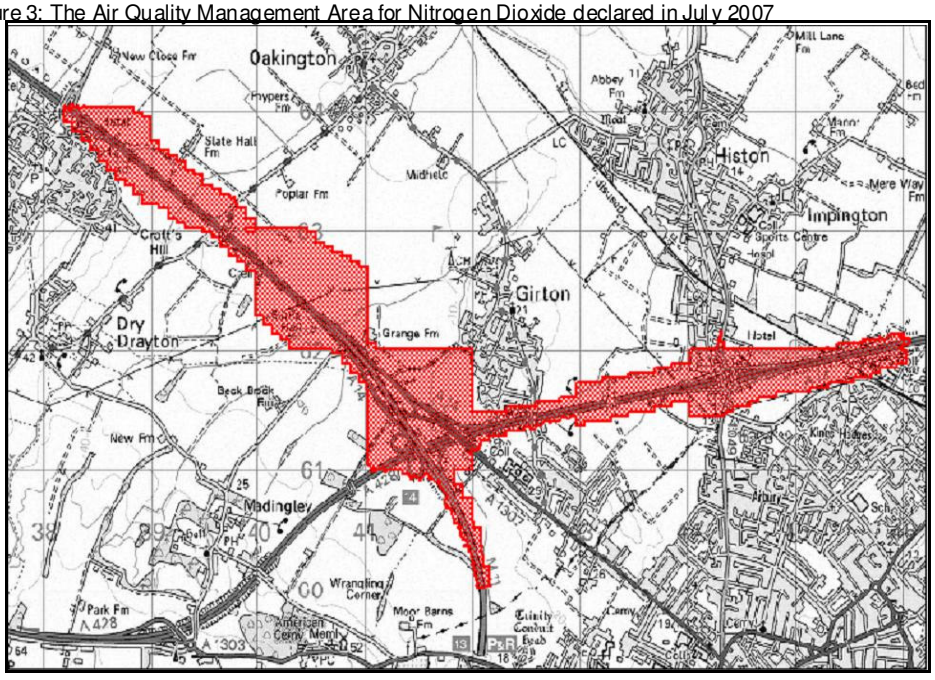


Continuous monitoring has shown levels of PM_{10} to be of concern, particularly with regards to the 24-hour mean objective. The most recent monitoring data obtained in 2006 has shown that the annual mean objective for PM_{10} is being met at both the Bar Hill and Impington monitoring stations, however, at both the monitoring stations, the 24 Hour Mean Objective is not being met.

Figure 2: The A14 from the Bar Hill monitoring station, looking Eastbound.

In July 2007, South Cambridgeshire District Council declared an Air Quality Management Area for Nitrogen Dioxide on the A14 between Bar Hill and Milton. This was as a result of the findings of the Detailed Assessment for Nitrogen Dioxide carried out in 2005.

Figure 3: The Air Quality Management Area for Nitrogen Dioxide declared in July 2007



3.0 Fine Particulate Matter (PM_{10})

3.1 Background

Airborne particulate matter varies widely in its physical and chemical composition, source and particle size. Particles are often classed as either primary (those emitted directly into the atmosphere) or secondary (those formed or modified in the atmosphere from condensation and growth). PM_{10} particles (the fraction of particulates in air of very small size, <10 µm aerodynamic diameter) can potentially pose significant health risks, as they are small enough to penetrate deep into the lungs. Larger particles are not readily inhaled.

A major source of fine primary particles is combustion processes, in particular diesel combustion, where transport of hot exhaust vapour into a cooler tailpipe or stack can lead to spontaneous nucleation of "carbon" particles before emission. Secondary particles are typically formed when low volatility products are generated in the atmosphere, for example the oxidation of sulphur dioxide to sulphuric acid. The atmospheric lifetime of particulate matter is strongly related to particle size, but may be as long as 10 days for particles of about 1 µm in diameter.

Concern about the potential health impacts of PM_{10} has increased very rapidly over recent years. Increasingly, attention has been turning towards monitoring the smaller particle fraction, $PM_{2.5}$, which is capable of penetrating deep into the lungs, and therefore contributing to ill health.

3.2 The National Perspective

National UK emissions of primary PM_{10} have been estimated as totalling 184,000 tonnes in 1997. Of this total, around 25% were derived from road transport sources. It should be noted that, in general, the emissions estimates for PM_{10} are less accurate than those for the other pollutants with prescribed objectives, especially for sources other than road transport.

The Government established the Airborne Particles Expert Group (APEG) to advise on sources of PM_{10} in the UK and current and future ambient concentrations. Their conclusions were published in January 1999 (APEG, 1999). APEG concluded that a significant proportion of the current annual average PM_{10} is due to the secondary formation of particulate sulphates and nitrates, resulting from the oxidation of sulphur and nitrogen oxides. These are regional scale pollutants and the annual concentrations do not vary greatly over a scale of tens of kilometres. There are also natural or semi-natural sources such as wind-blown dust and sea salt particles. The impact of local urban sources is superimposed on this regional background. Such local sources are generally responsible for winter episodes of hourly mean concentrations of PM_{10} above 100 µg m^{-3} associated with poor dispersion. However, it is clear that many of the sources of PM_{10} are outside the control of individual local authorities and the estimation of future concentrations of PM_{10} are in part dependent on predictions of the secondary particle component.

3.3 Latest standards and objectives for PM_{10}

The Air Quality Regulations 1997 set the objective for PM_{10} particulate material of 50µg m^{-3}, measured as the 99th percentile of the daily maximum running 24 hour mean (equivalent to 4 exceedences per year) to be achieved by 31 December 2005. The objective was based on measurements carried out using the TEOM analyser, or equivalent.

The Government published its proposals for review of the National Air Quality Strategy in early 1999 (DETR, 1999). The review presented proposals for revised and additional objectives for PM_{10}. Revised objectives for PM_{10} were proposed because:

- Work carried out by the Airborne Particles Expert Group (APEG) indicated that the original objective was unrealistic;
- The Common Position agreed on the Air Quality Daughter Directive (AQDD) at Environment Council in June 1998 included different objectives for PM_{10}.

These included a 24 hour limit value of 50 µg m^{-3}, not to be exceeded more than 35 times per year and an annual limit of 40 µg m^{-3} to be achieved by 1st January 2005 (EU Stage 1 objectives). The AQDD specifies that the transfer reference method for determining compliance is to be a gravimetric[1] measuring method.

The Air Quality Strategy replaced the original objective for PM_{10} with the AQDD objectives. The current objectives to be achieved by 31st December 2004 are:

- An annual average concentration of 40 µg m^{-3} (gravimetric);
- A 24 hour mean concentration of 50 µg m^{-3} (gravimetric) not to be exceeded more than 35 times a year.

The EU has also set indicative limit values for PM_{10}, which are to be achieved by 1 January 2010. The Stage 2 limit values are considerably more stringent, and are above a limit of 20 µg m^{-3} for the annual mean, and 50 µg m^{-3} as the 24-hour mean to be exceeded on no more than 7 days per year. The Government, the Welsh Assembly Government and the Department of the Environment in Northern Ireland introduced provisional objectives to be achieved by the end of 2010, that are broadly in line with the Stage 2 limit values, although it is not intended that these objectives will be brought into Regulation for the purpose of Local Air Quality Management at this time. The provisional objectives are:

- For all parts of England (except London), Wales and Northern Ireland, a 24-hour mean of 50 µg m^{-3} not to be exceeded more than 7 times per year, and an annual mean of 20 µg m^{-3} to be achieved by the end of 2010;
- For London, a 24-hour mean of 50 µg m^{-3} not to be exceeded more than 10 times per year, and an annual mean of 23 µg m^{-3}, to be achieved by the end of 2010. An annual mean objective of 20 µg m^{-3} to be achieved by the end of 2015 has also been set.

[1] Comparison of UK monitoring data determined with TEOM instruments with the European Union Directive limit values is not straightforward since the EU limits are based on measurements of PM_{10} by other instrumental techniques which yield higher concentrations (APEG, 1999).

4.0 Continuous Monitoring

4.1 Continuous Monitoring Stations

Continuous monitoring is undertaken at two locations: Bar Hill (OS Grid Reference 538685,263760) and Impington (OS Grid Reference 543740,261626) using Beta Attenuation Monitors (BAMs). There approximate locations are shown in Figure 4 at the bottom of this page. Table 1, below, gives further detail and specifications on the monitors used.

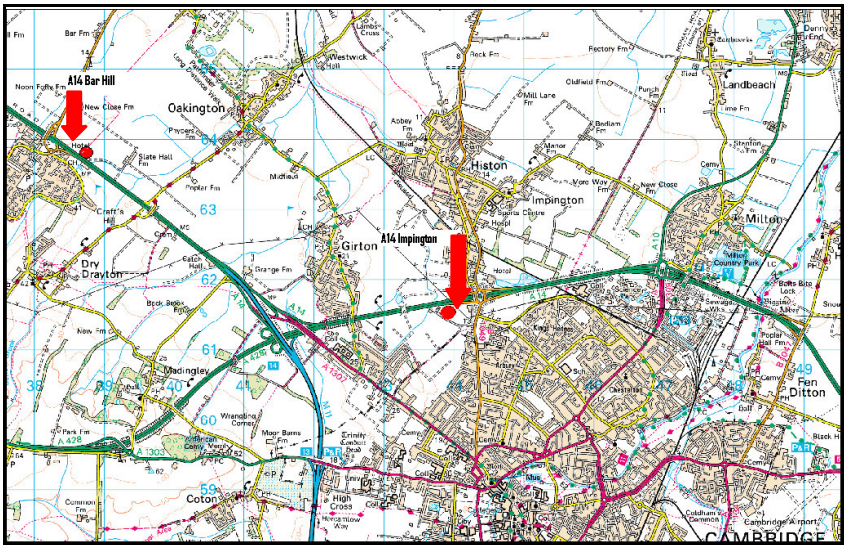
BAMs work by passing a small beta ray (^{14}C) transmission across a clean filter paper. The filter paper is then automatically passed through the sample inlet at which point, particulate matter is drawn onto the filter. The beta ray transmission is then re-measured and the particulate concentration is calculated using the difference between the 1st and 2nd beta ray transmission measurements.

The Bar Hill site has been in operation since 2001 and the Impington site since January 2003. Both locations were chosen due to the closeness to the A14. It is also considered that the sites are similar to the nearby receptors situated alongside the A14. Photographs of the Bar Hill and Impington stations are attached as Appendices 5A and 5B respectively.

Table 1: The Continuous PM10 Monitors within the District

Site name	Monitor type	Detail	Easting	Northing	Distance to road (m)
Bar Hill	Eberline FH62-IR Beta Attenuation	Heated inlet manifold held at 40°C to drive off volatile component. Results multiplied by 1.3 in line with Guidance Document LAQM TG(03)	538685	263760	8
Impington	Eberline FH62-IR Beta Attenuation		543739	261625	12

Figure 4: Monitor Locations


A14 Bar Hill
A14 Impington
Oakington
Histon
Impington
Girton
Dry Drayton
Madingley
Coton
Milton
Landbeach
Fen Ditton
CAMBRIDGE

4.2 Relevant Receptors

There are several isolated properties and farmsteads that are in close proximity to the A14 along its busiest sections, including some residences that are only 20 metres from the kerbside. Additionally pressures are being placed on land take by the regional growth agenda and both Cambridge and the necklace villages continue to encroach on this busy trunk road. In terms of the LAQM process this introduces "receptors" to areas, which are "relevant locations" in terms of expected compliance with the national air quality standards and objectives for annual mean and daily PM_{10}.

Further to this, the parishes of Impington, Girton and Bar Hill have properties that are very close to the A14. Traffic emissions from this major road and surrounding transport network will therefore contribute to PM_{10} concentrations at the façade of dwellings in the area. Continuous monitoring indicates that there may be high enough concentrations of PM_{10} to exceed the daily objective. Therefore monitoring in this area has been on-going for several years.

The monitoring locations are placed at equivalent distances to the road as the residential properties and are situated close to them.

4.3 Continuous Monitoring Data

Tables 2.1 and 2.2, below show the measured concentrations in 2006 from the two monitoring stations. The data has been fully ratified by netcen. The Daily Mean Objective of 50 µg m^{-3} not to be exceeded more than 35 times per year has not been achieved at either of the sites. However, the Annual Mean Objective of 40 µg m^{-3} has been achieved at both sites.

Table 2.1 Summary of continuous PM_{10} ratified data from Bar Hill station (BAM)

POLLUTANT	PM_{10}*
Days with mean> 50 µg m^{-3}	**51**
Average	34 µg m^{-3}
Data capture	98.2 %

Table 2.2 Summary of continuous PM_{10} ratified data from Impington station (BAM)

POLLUTANT	PM_{10}*
Days with mean> 50 µg m^{-3}	**42**
Average	36 µg m^{-3}
Data capture	81.1 %

*Note: All particle concentrations at both stations are measured using Beta Attenuation Monitors (BAMs) with heated inlets. For the purposes of calculating exceedences of the gravimetric PM_{10} objectives a factor of 1.3 has been applied to the PM_{10} data set to obtain 'Gravimetric Equivalent' data.

Data capture for the Impington BAM is lower than the required 90% for 2006. This was down to a series of faults that occurred throughout the year. The missing data is spread over short periods across the year, therefore, it was not deemed appropriate to correct the data in any way.

It can be seen from the above results that PM_{10} concentrations at the two sites achieve the Annual Mean Objective but exceed the Daily Mean Objective. In order to

further investigate the air quality along this corridor, it is necessary to carry out air quality modelling to determine predicted levels for both 2006 and 2010.

By 2010 concentrations may not have declined sufficiently to meet the UK objectives for 2010 (not yet in Regulation) of an annual mean concentration of 20 µg/m^3 and no more than 7 days per year over 50 µg/m^3 (daily mean).

4.4 Comparison of Design Manual For Roads and Bridges (DMRB) Predictions with Measured data

The design Manual for Roads and Bridges has been developed by the Highways Agency and is a tool that can be used to predict future pollutant concentrations using a default Emissions Inventory, created by the Highways Agency.

The model requires accurate traffic data supplied as Annual Average Daily Traffic (AADT) with a percentage split between Heavy Duty Vehicles (HDVs) and Light Duty Vehicles (LDVs) for each road.

In addition, the DMRB model requires details of the distance from the road to the receptor and the road type under consideration.

Finally, background pollutant concentrations are required for the pollutants of concern.

For this assessment, the traffic data was obtained from Cambridgeshire County Council and the background data from the background projection maps located at the web address www.airquality.co.uk/archive/laqm/tools.

DMRB assessments have been carried out for the 2 locations of the monitoring sites. Results can be compared against actual measured data. Table 3, below, shows the comparison between DMRB and the measured results.

Table 3: DMRB Predictions

	Bar Hill	Exceedence of Objective?	Impington	Exceedence of Objective?
2006 Annual Mean Measured µg m^{-3}	34	No	36	No
2006 Annual Mean Predicted µg m^{-3}	36	No	32	No
2010 Annual Mean Predicted µg m^{-3}	32	Yes	29	Yes
2006 Number of days Exceeding the Daily Objective (Measured)	51	Yes	42	Yes
2006 Predicted Number of days Exceeding the Daily Objective (Predicted)	57	Yes	35	Yes
2010 Predicted Number of days Exceeding the Daily Objective (Predicted)	34	Yes	24	Yes

As can be seen from Table 3, the predicted annual mean for 2006 at both monitoring stations is close to the measured values for 2006. The DMRB model has over-predicted at Bar Hill by 2µg/m^3 (6%) and the model for Impington has under-predicted by 4µg/m^3 (12%). DMRB predicts that the annual mean objective is currently being met but concentrations will not have declined enough by 2010 to achieve the 2010 objective.

Table 3 also shows the results of the predicted number of days exceeding the daily objective. DMRB has over-predicted at Bar Hill by 6 days (11%) and has under-predicted by 7 days (17%) at Impington. The model predicts that the daily mean objective is currently not being met (as the measured data shows) and that concentrations of PM10 will not have fallen sufficiently enough by 2010 to meet the 2010 daily objective.

In general, the DMRB model has shown a good correlation with the measured data, with an over prediction of both the annual mean and daily mean objectives at Bar Hill and an under-prediction at Impington for both of the objectives.

The results further confirm the requirement for the detailed assessment.

5.0 Atmospheric Dispersion modelling

5.1 The Dispersion Modelling Concept

Mathematical dispersion modelling is a computer-based technique for showing the dispersion of pollutants across a geographical area. Whereas pollution monitoring can only record the concentration of a pollutant at a single point, dispersion modelling allows these concentrations to be extrapolated over a wider area. They are not lines of absolute values and should not be considered as such. No assumptions of pollutant concentrations can be made on locations outside of the area being modelled. GIS data used was from the Councils' OS Landline database.

5.2 ADMS Urban

ADMS Urban is an air quality management system for P.C use, created by Cambridge Environmental Research Consultants (CERC). It enables the dispersion modelling of pollutants in the atmosphere

The system has a series of key features that are summarised below:

- Gaussian concentration distributions in stable and neutral conditions and non-Gaussian concentration distributions in unstable conditions which takes account of the skewed structure of the vertical component of turbulence,
- Full integration with GIS systems. The GIS system used at South Cambridgeshire District Council is MapInfo.
- A met pre-processor which calculates the required boundary layer parameters
- Calculation of mean concentrations and percentile concentrations for averaging times up to one year.

Within ADMS, certain parameters must be defined that are representative of the area to be modelled and allow for the most accurate modelling scenario.

When modelling PM_{10}, use of the Chemistry module is required, in particular, the Chemical Reaction Scheme. This option uses background files for PM_{10} and Sulphur Dioxide. The choice of this data is discussed in Chapter 7.7.

The surface roughness allows the user to define the land-use of the area under investigation. In this case, the A14 is surrounded by agricultural land with some adjoining urban settlements. With this in mind, a value of 0.3 has been chosen.

The Monin-Obukhov length is the height above ground where mechanically produced turbulence is in equilibrium with negative buoyancy. A determining factor of this height is the size of any surrounding urban settlements. Default values are supplied within the ADMS urban model, which the user must pick depending upon the population size of the settlement.

A value of 10 has been chosen which denotes that the surrounding urban areas have populations of <50,000. Table 4.1, on the following page, shows the general validated settings chosen to run the model.

Table 4.1: General Model Parameters

Model Parameter	Setting
Chemical reactions	Chemical Reactions Scheme
Surface Roughness	0.3
Minimum Monin-Obukhov Length	10
DMRB Data set	2003
Emission Year	2006/2010
Road Type	Various

The remaining model inputs are summarised in Table 4.2, below, and are further discussed on the following pages.

Table 4.2: Sourced Data

Input Data	Source	Year
Base Mapping	Ordnance Survey	2005
MET Information	MET Office (Marham)	2005
Background Concentrations	NAEI	2005
Grid Source PM_{10}	NAEI	2005
Traffic Flows	Cambs County Council	2005/2006
Industrial Sources	NAEI/Operator	2005

5.3 Traffic Modelling Summary

In this study, the concentrations of PM_{10} at receptors close to the roads and junctions of interest have been modelled using ADMS- v3.2 as a dispersion kernel model. Detailed modelling of present and future (2006 and 2010) concentrations of annual average PM_{10} in South Cambridgeshire at the villages of concern was undertaken to predict compliance with the UK objectives for 2004 and 2010. The number of days over 50 $\mu g/m^3$ was assessed by modelling the 90.41st percentile for 2006 and the 98th percentile for 2010.

The roads were defined as volume sources, 3m deep, and were broken up in to a series of adjoining segments. The length of these segments was dictated by the way in which the OS LandLine data was digitised and varied from one or two metres in length (where the road rapidly changed direction) to hundreds of metres in length (where the road was essentially straight). The OS LandLine data was used to provide the co-ordinates of the centre line of the road, and the road widths. Therefore, the position of the volume sources were accurate to approximately one metre.

Where queuing of vehicles was reported, emissions from stationary vehicles exhausts were estimated on the basis that the engine power output and hence emissions were the same as those at a speed of 5 kph.

5.4 Traffic Data

ADMS Urban requires input of various traffic information, including:

- Absolute hourly average traffic flows
- Percentage split between Heavy Duty Vehicles (HDV) and Light Duty Vehicles (LDV)
- Average speed on the roads to be modelled.

Traffic data was obtained from Cambridgeshire County Council. The County Council release the Network Monitoring Report "Traffic Monitoring" annually. The report details traffic flows across the County based on both manual and automatic traffic counts. Data is supplied as 12 hour flows and 16 hour annual average weekday flow (AAWF).

The ADMS Urban model requires that traffic data be supplied as an absolute hourly average. W S Atkins, who carry out the traffic monitoring work on behalf of Cambridgeshire County Council, supplied South Cambridgeshire District Council with conversion factors to allow for the conversion of the 12 hour flows and 16 hour AAWF to hourly flows. Conversion factors are road specific.

In addition, the County Council supply details of the percentage split between Heavy Duty Vehicle (HDV) and Light Duty Vehicle (LDV) on the roads. This information can be obtained from the Network Monitoring Report.

Average speeds have been obtained from Cambridgeshire County Council. Where the Council did not have this information, local knowledge of the roads in the area was used and a conservative estimate given.

The greatest traffic flows reported are on the Bar Hill section at 92,000 vehicles measured as a 16-hour annual average weekday flow (2006) with the proportion of heavy duty vehicles reported as being 16%.

In addition, projections of traffic to 2010 are required for modelling against the 2010 objectives. The National Road Traffic Forecast (NRTF) conversion factors have been to convert primarily from 2001 to 2006 and then from 2006 to 2010. The calculated rise in traffic between 2006 and 2010 is 3%.

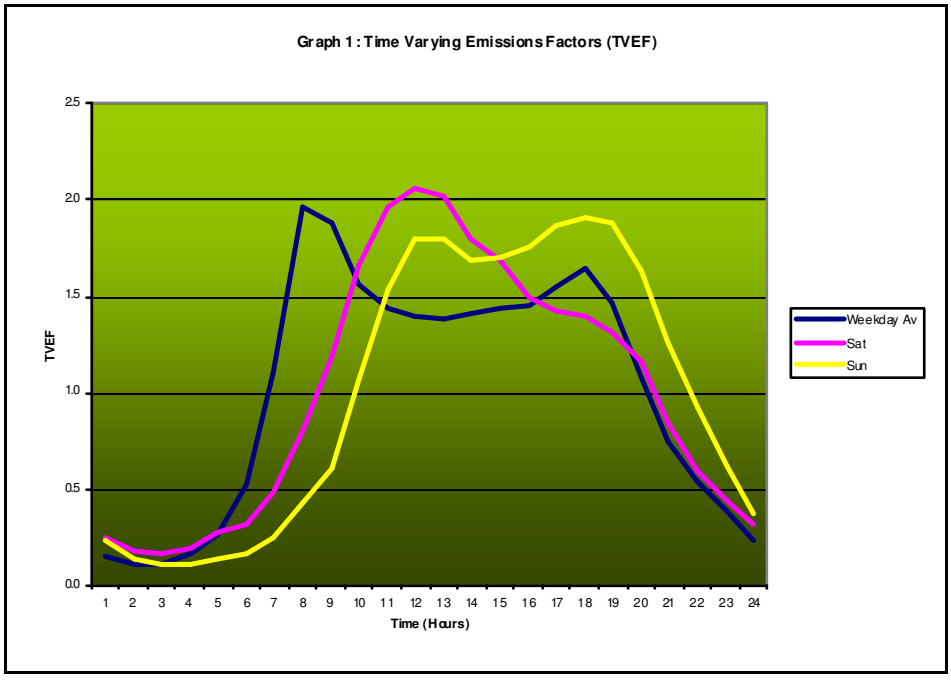
5.5 Time Varying Emissions Factors (TVEF)

When modelling road sources, it is important to consider the variation in traffic flows over a 24 hour period. This allows the model to estimate the changes in emissions from the vehicles during this time.

The road source under investigation and indeed, the main cause of poor air quality in South Cambridgeshire is the A14. With this in mind, hourly traffic data has been obtained from an automatic traffic counter based at Bar Hill. The data has allowed for the assessment of diurnal traffic flows along the busiest stretch of the A14. The calculated TVEF has been used in the model.

It is also important to calculate a TVEF for Saturdays and Sundays each separate to the average weekday TVEF. This allows for the change in driving patterns over the weekends.

Graph 1, below, plots the TVEF against time of day. It clearly shows two rush hour peaks on weekdays and a peak later in the day at weekends. The TVEF values are attached as Appendix 4.



5.6 Grid (non-traffic) Emissions Data

Non-traffic sources were considered in the form of 1km x 1km square grids, with a fixed emission. Each grid contains sources of PM_{10} inclusive of all possible local sources, for example, non-road transport, industrial emissions and agricultural emissions. It was noted that the second largest contributor to PM_{10} in the South Cambridgeshire District is from local agricultural sources.

The National Atmospheric Emissions Inventory (http://www.naei.org.uk) have released a new emissions database for 2005, funded by DEFRA. The database allows download of all estimated emissions for each grid square within a Local Authority District.

The downloaded results are expressed in a spreadsheet as Tonnes/Kilometre Squared/Year (T/Km^2/Y). ADMS requires that the data be converted to Grammes/Metre Squared/Second (G/M^2/S). After this conversion, it is important to remove the road source from the grid emissions, which are modelled as line sources within ADMS.

The procedure detailed above allows for the calculation of the total PM_{10} emissions within a grid. This is in line with the procedures indicated in LAQM.TG(03).

5.7 Sources of Background Data

A source of background information is required when modelling using ADMS-Urban. This can be achieved either by inputting a single background concentration by hand for a particular pollutant or by entering a full year of background data from a suitable automatic rural background site.

Hourly data has been obtained from the Wicken Fen rural background site for 2005. It is located in the neighbouring District of East Cambridgeshire and is considered to be a representative site due to its' closeness to South Cambridgeshire and the fact that it is surrounded by agricultural land, similar to the receptor locations being modelled.

Background concentrations of PM_{10} and SO_2 are both available for Wicken Fen, allowing the model to calculate using the Chemical Reaction Scheme.

5.8 Meteorological Data

Hourly sequential MET data has been obtained for the MET monitoring station at Marham in Norfolk for the year 2005. This MET station is close to the South Cambridgeshire District and is therefore thought to be the most representative of local MET conditions.

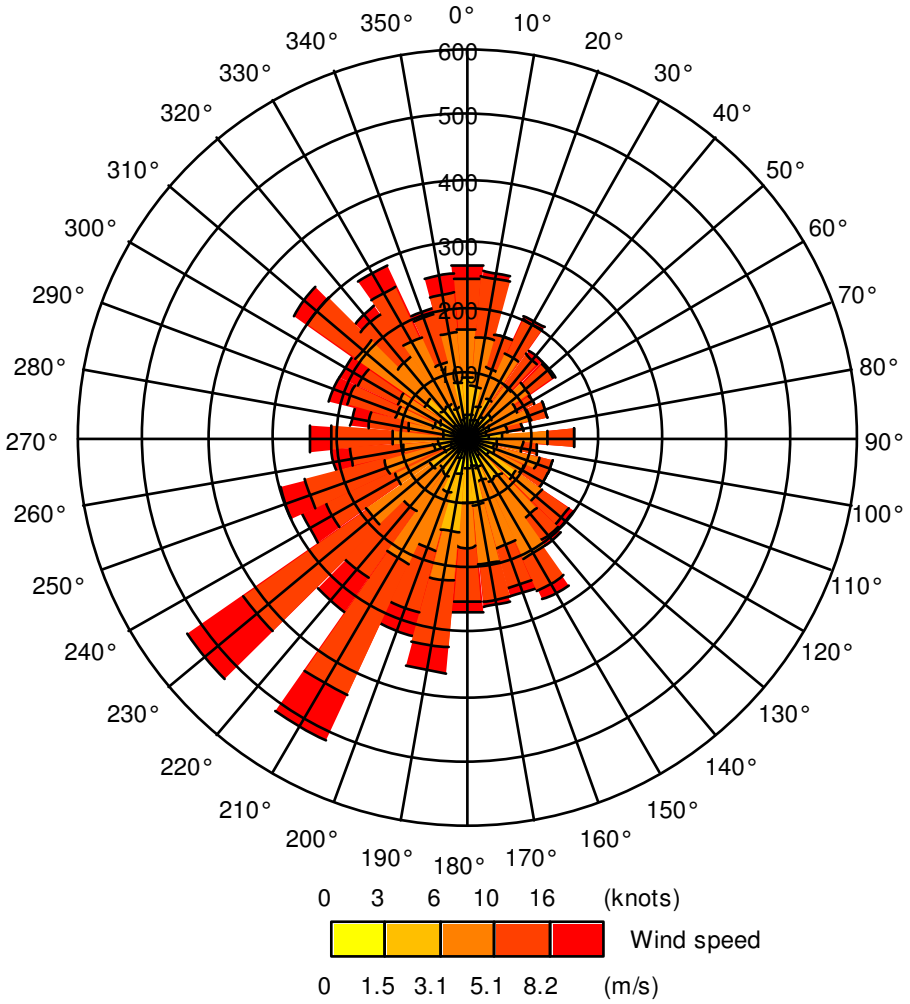
The MET file used contains data on the following hourly parameters for 2005:

- Year
- Julian Day
- Hour
- Temperature (°C)
- Hourly average wind speed (m/s)
- Average wind direction (degrees)
- Hourly precipitation
- Cloud cover (Oktas)

Given that there are 8760 hours in the year, the met file contains 8760 lines. It is considered that hourly sequential met data is more representative of the met conditions over the subject year than statistically averaged met data.

Figure 5, below, shows the wind rose for the MET data obtained.

Figure 5: Marham Meteorological Data 2005



6.0 Model Confidence

6.1 Model Validation

In simple terms, model validation is where the model is tested at a range of locations and is judged suitable to use for a given application. The modelling approach used in this assessment has been validated, and used in numerous **netcen** air quality review and assessments.

The document DoE/HMIP.RR/95/022 - *'Validation of the ADMS Dispersion model and Assessment of its Performance Relative to R-91 and ISC using Archived LIDAR Data'*, written by DJ Carruthers et al, is available from Cambridge Environmental Research Consultants (CERC), who developed the ADMS model. It gives full detail on the validation of ADMS, confirming suitability for use in detailed assessments as required by the National Air Quality Strategy.

Monitoring of PM_{10} concentrations at the automatic monitoring sites were used to predict the model bias as the continuous monitoring stations are within the modelled area.

6.2 Model Verification and Systematic Error

The model has under-predicted PM_{10} concentrations for 2006 at both the Bar Hill and Impington monitoring stations. This is possibly due to systematic error. The NSCA Guidance document "Air Quality Management Areas – Turning Reviews into Action" suggests a method by which systematic error can be accounted for. The process involves taking each monitored value and dividing it by the modelled value. From this, an average scaling factor can be obtained. The scaling factor can then be applied to the model output.

Table 5, below, compares the modelled data with the measured data from which a scaling factor can be obtained. From this, the model output can be scaled so that it relates more closely to the measured data.

Table 5: Systematic Error

	Bar Hill	**Impington**
Measured Annual Mean µg m^{-3}	34	36
Modelled Annual Mean µg m^{-3}	28	30
Measured / Modelled	1.2	1.2
Average Scaling Factor	**1.2**	
Adjusted Modelled Annual Mean µg m^{-3}	34	35

On application of the scaling factor, the modelled results fell to within 3% of the measured value at Impington and equalled the measured value at Bar Hill.

In general, the model showed a good correlation with monitored data at both sites.

7.0 Modelling Results

7.1 Contoured Output

All gridded outputs below have been plotted over South Cambs OS mapping system to define the predicted area of exceedence.

Figure 6: 2006 Daily Mean of 50µg m^{-3} not to be exceeded more than 35 times per year

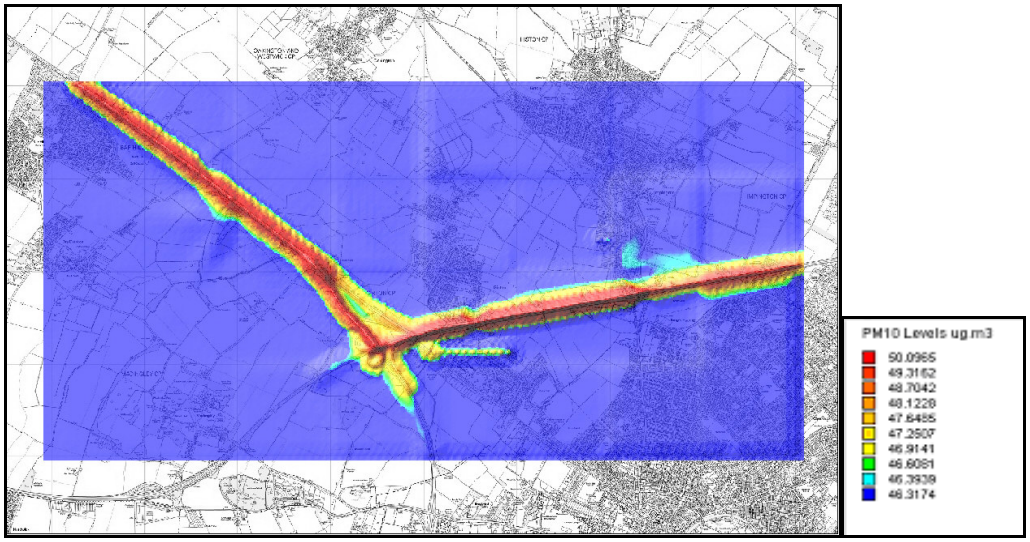


Figure 6, above, shows the output of the daily mean objective as modelled in 2006. The concentrations follow the A14 closely. For the daily mean, the 90th percentile is calculated. This equates to approximately 35 days of exceedences. If the results show that the concentrations modelled are greater than the value in the objective, the daily mean is likely to be exceeded.

As can be seen from the legend, there are exceedences of the objective shaded in the red (>50 µg m^{-3}). Following some fine-tuning of the model output, it will be recommended that an air quality management area be declared to encompass the area shown in red.

Figure 7, on the following page, shows the output of the model run for the 2006 annual mean. In this case, the model agrees with the measured data in that there are no exceedences of the objective.

Figure 7: 2006 Annual Mean of 40 µg m^{-3}

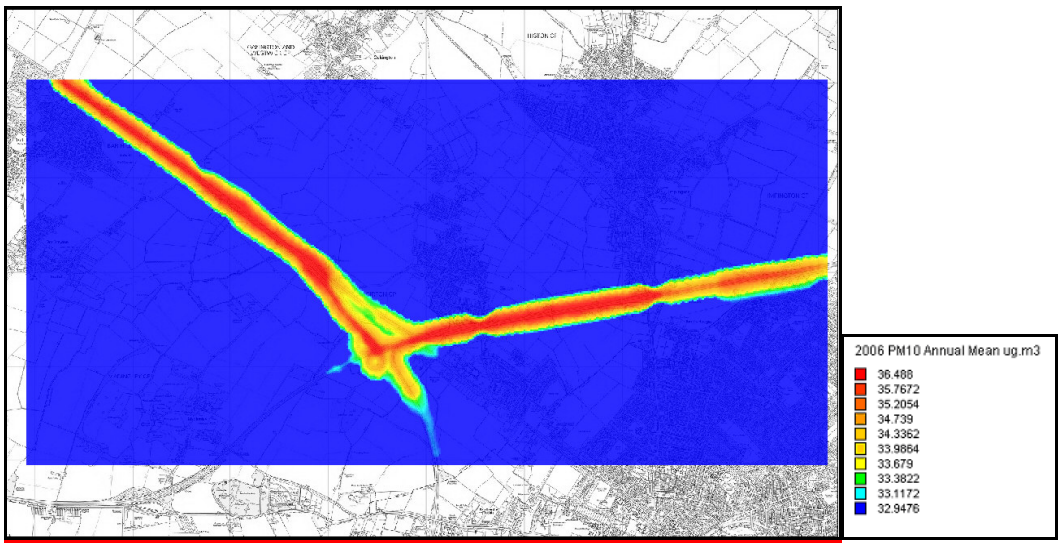


Figure 8, below, shows the 98th percentile output for the PM_{10} daily objective in 2010. The 98th percentile equates to approximately 7 days of exceedence of the objective concentration. Despite this objective not being met in 2006, the model predicts that by 2010, concentrations of PM_{10} will have reduced enough for this objective to be achieved. There are no exceedences of the limit of 50µg m^{-3}.

Figure 8: 2010 Daily Mean of 50µg m^{-3} not to be exceeded more than 7 times per year

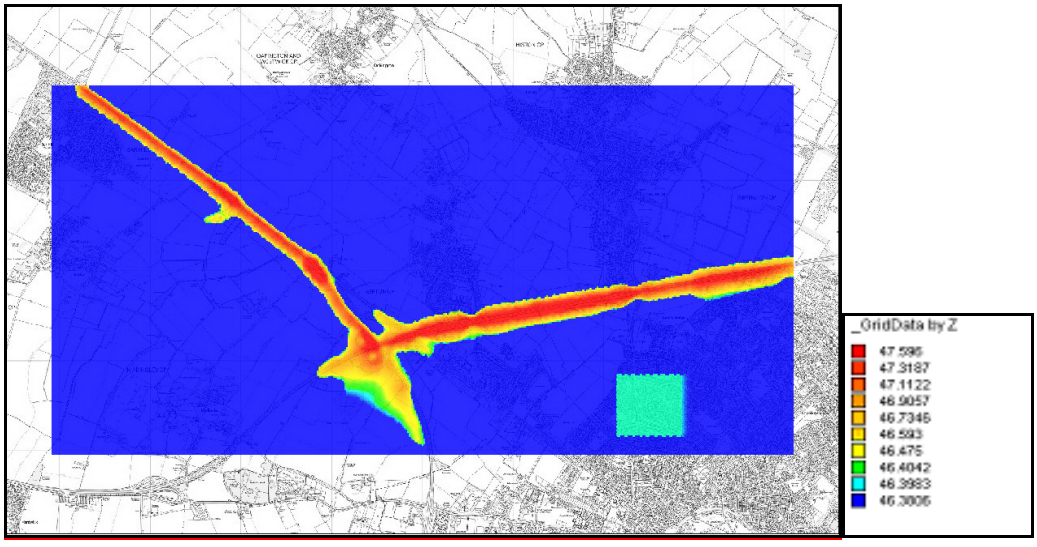
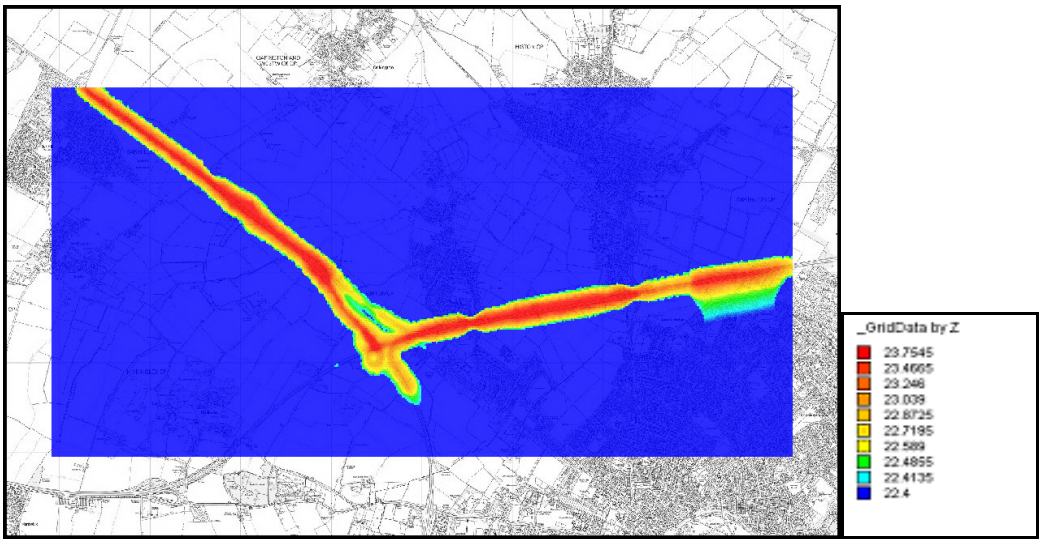


Figure 9, below, shows the predicted annual mean concentrations for 2010. The model predicted that, in 2006, this air quality objective will be achieved which matched the measured values. However, as the contour plot predicts, the 2010 annual mean objective will not be met.

Figure 9: 2010 Annual Mean of 20µg m^{-3}



It should be noted that the new UK objectives for PM_{10} in 2010 (EU Limit Values (Stage 2)), annual mean PM_{10} (20 µg/m^3) is the most stringent. The 2010 objectives are provisional only. It is not yet a statutory duty to show compliance with them.

Tables 6.1 to 6.4 on the following page, show the likelihood of exceeding the objectives in both 2006 and 2010 at both monitoring stations.

Table 6.1: Probability of exceeding the daily objective for PM_{10} in 2006

Location	Probability of exceedence, P of daily objective
Bar Hill	50% <P< 80% Probable
Impington	50% <P< 80% Probable

Table 6.2: Probability of exceeding the annual mean objective for PM_{10} in 2006

Location	Probability of exceedence, P of annual average objective
Bar Hill	5% <P< 20% Unlikely
Impington	5% <P< 20% Unlikely

Table 6.3: Probability of exceeding the daily objective for PM_{10} in 2010

Location	Probability of exceedence, P of daily objective
Bar Hill	20% <P< 50% Possible
Impington	20% <P< 50% Possible

Table 6.4: Probability of exceeding the annual mean objective for PM_{10} in 2010

Location	Probability of exceedence, P of annual average objective
Bar Hill	95% <Very Likely
Impington	95% <Very Likely

The above figures are based on the results of the modelling and confirm that the daily mean objective is not being achieved at present but concentrations could possibly have reduced enough by 2010 to achieve the 2010 objective.

The annual mean objective is being met at present but concentrations may not have decreased sufficiently enough by 2010 to achieve the 2010 objectives. Based on current data, the 2010 objective is not likely to be achieved.

7.2 Likelihood of Exceeding the Objectives for PM_{10}

- The modelling results predict that annual average concentrations of PM_{10} in 2006 would be below the annual objective for PM_{10} in 2006 at the locations modelled. This is in line with measured annual means at the monitoring locations.

- The modelling results showed that it is probable (with probability between 50% and 95%) that an exceedence of the daily objective for PM_{10} in 2006 occurred at both locations. Again, this is in line with the measured results at the two locations.

- The modelling results predicted exceedence of the annual 2010 objectives for PM_{10} at both the Bar Hill and the Impington monitoring stations. It was predicted to be ***very likely*** that the annual mean objective for PM_{10} in 2010 will be exceeded at both Bar Hill and at Impington.

- The model predicts that the concentrations of PM_{10} will have declined sufficiently enough to achieve the daily objective by 2010. However, given the proposed development for the land surrounding the A14 and the North of Cambridge, this result should be treated with caution.

8.0 Conclusions and Recommendation

8.1 Conclusions

- It is concluded that traffic emissions from the A14 in the District of South Cambridgeshire are such that it is likely that the daily mean objective will be exceeded at relevant locations. The model outputs show the area of expected exceedence. It is recommended that an Air Quality Management Area be declared for the extent of the exceedence of the daily mean objective to include an area of uncertainty.

- The Air Quality Management Area (AQMA) for PM_{10} will be located within the existing Air Quality Management Area for Nitrogen Dioxide (NO_2).

- There is a small area of exceedence along the A14 between the Milton and Histon junctions. The area of exceedence does not lie in a region where there are relevant receptors, therefore, this will not be included within the air quality management area.

8.2 Recommendations

- An Air Quality Management Area (AQMA) should be declared along the A14 between the Junctions at Bar Hill and Histon.

- The Air Quality Management Area should be designated by means of an official order under the relevant sections of the Environment Act 1995,.

- The AQMA should, as a minimum, include all areas identified as having a "Probable" likeliness of exceedence, as described in Chapter 7 of this report.

- An air quality action plan should be completed within 18 months of designation of the AQMA. The Action Plan should include a feasible series of actions that will aim to reduce the concentrations of PM_{10} at the relevant receptors.

- Potential developers should be asked to supply an air quality assessment and give necessary consideration and reference to the Air Quality Management Area.

- Further assessment work should be carried out, including the continuation of monitoring at the existing Bar Hill and Impington stations and the addition of further continuous monitoring equipment at relevant locations.

- Progress reports are submitted to DEFRA detailing ongoing assessment and work towards cleaner air, as required in the National Air Quality Strategy.

9.0 Air Quality Management Area (AQMA) Boundary

It is proposed that that an Air Quality Management Area is designated to include areas where exceedence of the daily air quality objective are probable, likely or very likely. These areas have been identified and are shown in Figure 10, Page 31. In addition, the AQMA boundary is attached as Appendix 2.

9.1 Areas Likely to Exceed the Air Quality Objectives

In order to determine the AQMA boundary, it is necessary to assess the probability of exceedence of the Air Quality Objectives within the area. Guidance Document LAQM TG(03)suggests two methods of doing this. The first is to use statistical analysis, as detailed within the NSCA guidance "Air Quality - Turning Reviews Into Action". Given that there are only two PM_{10} monitoring stations with the District, it is not possible to carry out statistical analysis of the results. As an alternative, LAQM TG(03) suggests use of Table A3.9 which gives confidence levels based on the modelled concentrations as to where s are likely, probable, possible or unlikely.

Table 7.1, below, summarises the probability of exceedence of the 2004 daily objective. The descriptions have been assigned to levels of risk of exceeding the objectives. It would be recommended that South Cambridgeshire District Council generally consider declaring an AQMA where the probability of exceedence in 2004 or in 2010 is greater than 50% ("Probable"). It is considered that this is sufficient to take account of model errors, specifically:

- Model errors at the receptor site;
- Model errors at the reference site;
- Uncertainty resulting from year to year variations in atmospheric conditions.

Table 7.1: Uncertainties in the modelled concentrations for PM_{10} in 2006

Description	Chance of exceeding daily objective for 2004	Predicted number of days PM_{10} over 50 $\mu g/m^3$ gravimetric
Very unlikely	Less than 5%	<12
Unlikely	5-20%	12-24
Possible	20-50%	24-35
Probable	50-80%	35-50
Likely	80-95%	50-73
Very likely	More than 95%	>73

In addition, it is possible to assess the likelihood of exceedence in 2010 using the same methodology. Table 7.2, on the following page, shows the probability of exceedence for 2010.

Table 7.2: Uncertainties in the modelled concentrations for PM_{10} in 2010

Description	Chance of exceeding annual mean objective for 2010	Modelled annual average PM_{10} ($\mu g/m^3$ gravimetric)
Very unlikely	Less than 5%	<13
Unlikely	5-20%	13-17
Possible	20-50%	17-20
Probable	50-80%	20-23
Likely	80-95%	23-27
Very likely	More than 95%	>27

The confidence limits have been used to estimate the likelihood of exceeding the objectives at locations close to the roads. They have been calculated for 2004 in terms of the more stringent daily objective, and for 2010 in terms of the more stringent annual mean objective.

The confidence limits for the 'probable' and 'likely' daily objective concentrations have been set equal to those for 'possible' and 'unlikely', respectively.

In reality, the intervals of concentration increase as the probability of exceeding the annual and hourly objective increases from 'unlikely' to 'likely'. The advantage in setting symmetrical concentration intervals is that the concentration contours on the maps become simpler to interpret. This is a mildly conservative approach to assessing the likelihood of exceedences of the PM_{10} objectives since a greater geographical area will be included using the smaller confidence intervals.

Figure 10, on the following page shows the areas where exceedence of the daily PM_{10} objective are either probable or likely. There are 3 areas of exceedence where relevant receptors are located. These are A14 Bar Hill Westbound, A14 at the Girton Interchange and the A14 at the Histon Junction.

9.2 Visual Representation of the AQMA Boundary

The following pages put the Air Quality Management Area into a visual context. Figure 10, on the following page gives a general overview of the location of the AQMA.

Figure 10: The areas of exceedence of the daily mean objective in 2006

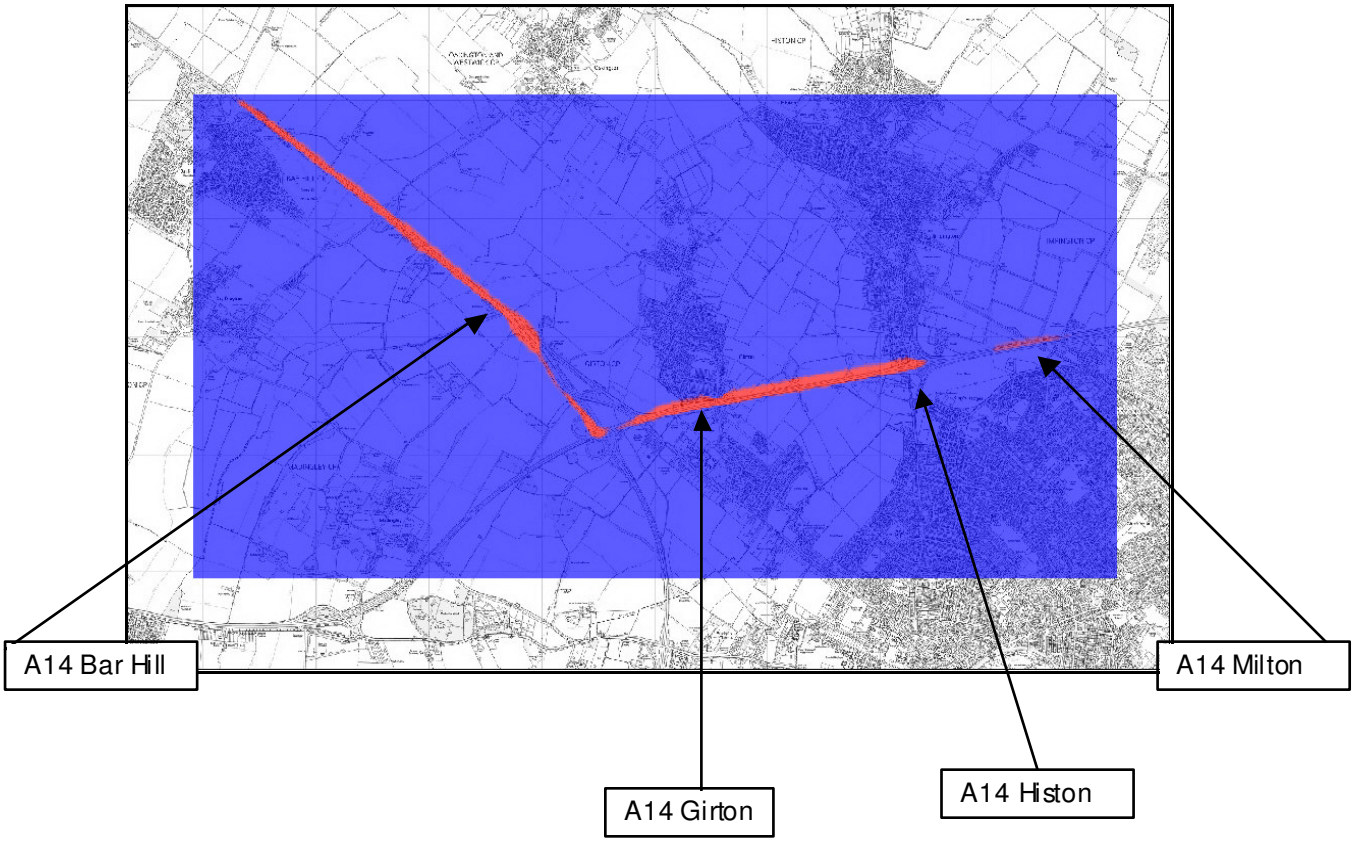
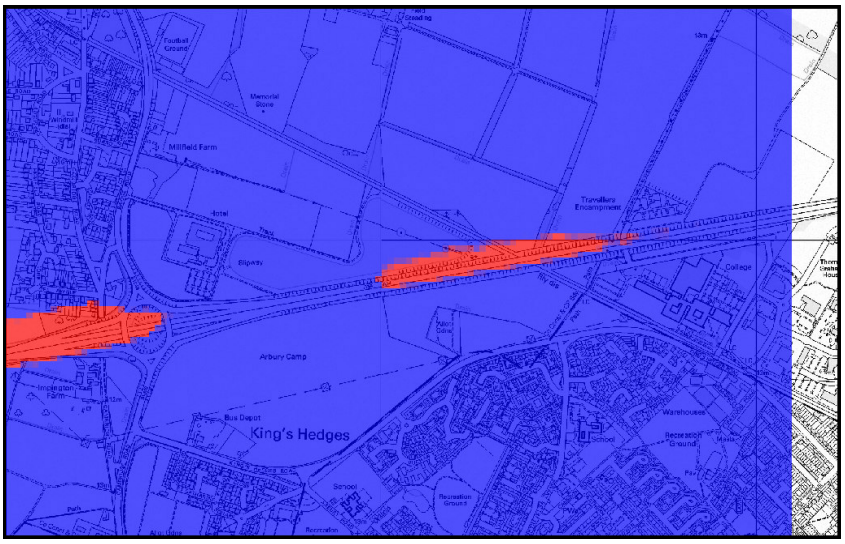


Figure 11: The area of exceedence along the A14 near Milton. There are no relevant receptors along this stretch of the A14, therefore, there is no need to include it within the AQMA.



NB: The traveller encampment noted in Figure 11 is outside the area of probable exceedence , located in the adjoining site.

The following Figures (12-14) show the area of the Daily Mean Objective in further detail.

Figure 12: The area of exceedence at Histon. Some properties close to the junction will be affected. Woodhouse Farm will also be included.

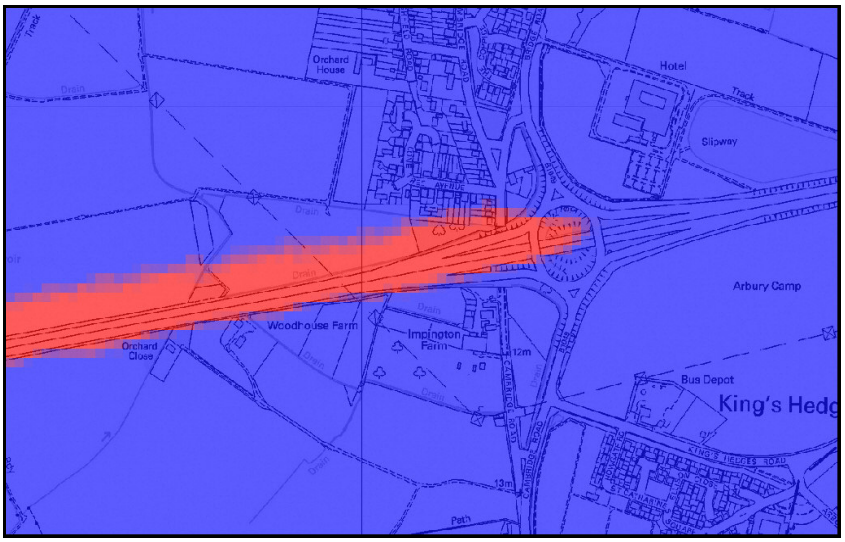


Figure 13: The area of exceedence along the A14 Westbound at Bar Hill. Properties at Catch Hall and Hackers Fruit Farm will be affected.

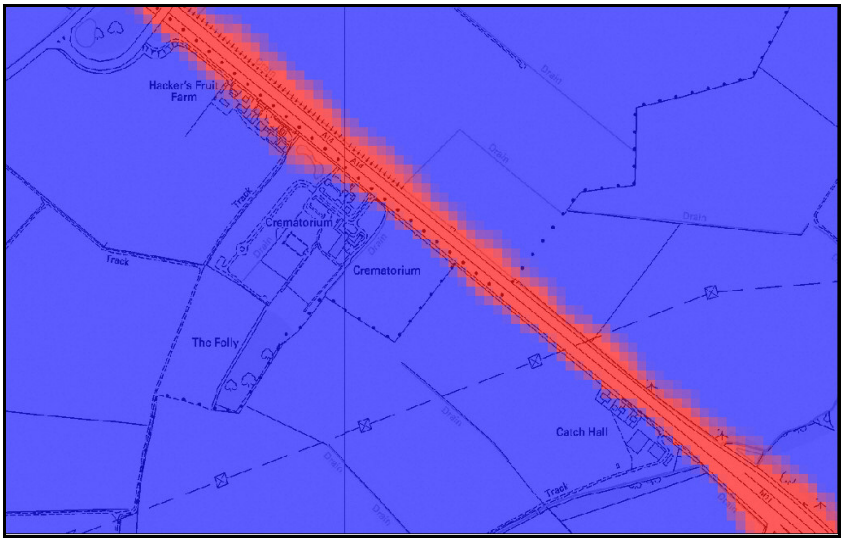


Figure 14: The area of exceedence at Girton. Properties in Weavers Field will be affected.

Appendix 1: The National Air Quality Strategy Objectives

Summary of objectives of the National Air Quality Strategy			
Pollutant	**Objective**	**Measured as**	**To be achieved by**
Benzene All Authorities	16.25 µg/m^3	Running Annual Mean	31 December 2003
Benzene Authorities in England and Wales only	5 µg/m^3	Annual Mean	31 December 2010
Benzene Authorities in Scotland and Northern Ireland only	3.25 µg/m^3	Running Annual Mean	31 December 2010
1,3-Butadiene	2.25 µg/m^3	Running Annual Mean	31 December 2003
Carbon monoxide Authorities in England, Wales and Northern Ireland only	10.0 mg/m^3	Maximum daily running 8 Hour Mean	31 December 2003
Carbon monoxide Authorities in Scotland only	10.0 mg/m^3	Running 8 Hour Mean[a]	31 December 2003
Lead	0.5 µg/m^3	Annual Mean	31 December 2004
	0.25 µg/m^3	Annual Mean	31 December 2008
Nitrogen dioxide[b]	200 µg/m^3 Not to be exceeded more than 18 times per year	1 Hour Mean	31 December 2005
	40 µg/m^3	Annual Mean	31 December 2005
Nitrogen Oxides**	(V) 30 µg/m^3	Annual Mean	31 December 2000
Ozone*	100 µg/m^3	Running 8 hour Mean Daily maximum of running 8 hr mean not to be exceeded more than 10 times per year	31 December 2005
Particles (PM10) (gravimetric)[c] All authorities	50 µg/m^3 Not to be exceeded more than 35 times per year	24 Hour Mean	31 December 2004
	40 µg/m^3	Annual Mean	31 December 2004
Particles (PM10) Authorities in Scotland only[d]	50 µg/m^3 Not to be exceeded more than 7 times per year	24 Hour Mean	31 December 2010
	18 µg/m^3	Annual Mean	31 December 2010
Poly aromatic hydrocarbons[e]	0.25 ng/m^3 B(a)P	Annual Mean	31 December 2010
Sulphur dioxide	266 µg/m^3 Not to be exceeded more than 35 times per year	15 Minute Mean	31 December 2005

	350 µg/m^3 Not to be exceeded more than 24 times per year	1 Hour Mean	31 December 2004
	125 µg/m^3 Not to be exceeded more than 3 times per year	24 Hour Mean	31 December 2004
	(V) 20 µg/m^3	Annual Mean	31 December 2000
	(V) 20 µg/m^3	Winter Mean (01 October - 31 March)	31 December 2000

Notes:

a. The Quality Objective in Scotland has been defined in Regulations as the running 8-hour mean, in practice this is equivalent to the maximum daily running 8-hour mean.

b. The objectives for nitrogen dioxide are provisional.

c. Measured using the European gravimetric transfer sampler or equivalent.

d. These 2010 Air Quality Objectives for PM 10 apply in Scotland only, as set out in the Air Quality (Scotland)Amendment Regulations 2002.

e. Not included in vegulations

µg/m^3 - micrograms per cubic metre

mg/m^3 - milligrams per cubic metre

*Ozone is not included in the Regulations

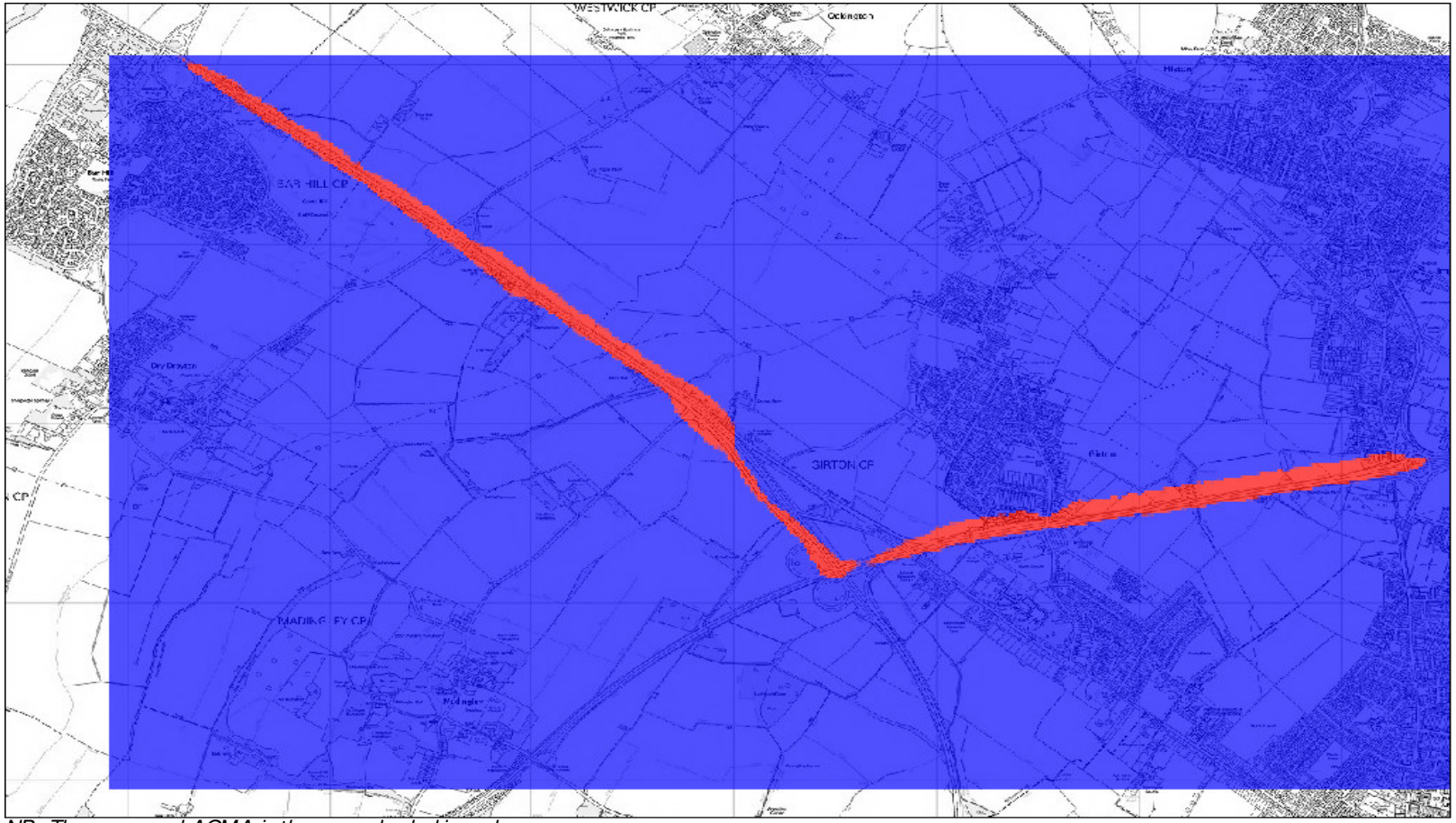
** Assuming NOx is taken as NO2

(V) These standards are adopted for the protection of vegetation and ecosystems. All of the remainder are for the protection of human health.

New particle objectives for England, Wales, Northern Ireland and Greater London not included in Regulations

Region	Objective	Measured as	To be achieved by
Greater London	50 µg/m^3 not to be exceeded more than 10 times per year	24-hour Mean	31 December 2010
Greater London	23 µg/m^3	Annual Mean	31 December 2010
Greater London	20 µg/m^3	Annual Mean	31 December 2015
Rest of England, Wales and Northern Ireland	50 µg/m^3 not to be exceeded more than 7 times per year	24-hour Mean	31 December 2010
Rest of England, Wales and Northern Ireland	20 µg/m^3	Annual Mean	31 December 2010

Appendix 2: The Proposed Air Quality Management Area



NB: The proposed AQMA is the area shaded in red

Appendix 3: Traffic Data

	No. links	% LDV	% HDV	LDV	HDV	Hourly	LDV	/2	HDV	/2	Worst case 06	LDV	HDV
A14 Girton	66800	2	85	15	56780	10020	2683	2281	1140	402	201	1.04	1186	209
A14 Bar Hill	90500	2	84	16	76020	14480	3635	3053	1527	582	291	1.04	1588	302
A14 Milton	59300	2	88	12	52184	7116	2382	2096	1048	286	143	1.04	1090	149
Impington	23700	2	97	3	22989	711	952	923	462	29	14	1.04	480	15
M11	56800	2	85	15	48280	8520	2282	1940	970	342	171	1.04	1009	178
M11 extension	60800	2	87	13	52896	7904	2442	2125	1062	317	159	1.04	1105	165
A428	13800	2	89	11	12282	1518	553	492	246	61	30	1.04	256	32
Longstanton slip	8600	2	96	4	8256	344	346	332	166	14	7	1.04	173	7
Oakington slip	6000	2	95	5	5700	300	241	229	114	12	6	1.04	119	6
Huntingdon Road	21330	1	96	4	20477	853	857	823	[illegible]	34	[illegible]	1.04	856	35
A14 Slip	44015	1	84	16	36973	7042	1768	1485	[illegible]	283	[illegible]	1.04	1544	294
A14 Upper Circle	8985	1	85	15	7637	1348	361	307	[illegible]	54	[illegible]	1.04	319	56
A14 Lower Circle	13250	1	84	16	11130	2120	532	447	[illegible]	85	[illegible]	1.04	465	88
Slip A14 North	11850	1	84	16	9954	1896	476	400	[illegible]	76	[illegible]	1.04	416	79
Slip Road M11	13250	1	85	15	11262	1988	532	453	[illegible]	80	[illegible]	1.04	471	83
Girton Road North			98	2				201		5		1.04	209	5
Girton Road South			98	2				201		5		1.04	209	5

				2006			2010	
LDV	/2	HDV	/2	Worst case	LDV	HDV	Worst case	LDV	HDV
2280.55	1140.275	402.45	201.225	1.04	1186	209	1.09	1243	219
3053.4	1526.7	581.6	290.8	1.04	1588	302	1.09	1664	317
2096.16	1048.08	285.84	142.92	1.04	1090	149	1.09	1142	156
923.44	461.72	28.56	14.28	1.04	480	15	1.09	503	16
1939.7	969.85	342.3	171.15	1.04	1009	178	1.09	1057	187
2124.54	1062.27	317.46	158.73	1.04	1105	165	1.09	1158	173
492.17	246.085	60.83	30.415	1.04	256	32	1.09	268	33
332.16	166.08	13.84	6.92	1.04	173	7	1.09	181	8
228.95	114.475	12.05	6.025	1.04	119	6	1.09	125	7
823	[illegible]	34	[illegible]	1.04	856	35	1.09	897	37
1485	[illegible]	283	[illegible]	1.04	1544	294	1.09	1619	308
307	[illegible]	54	[illegible]	1.04	319	56	1.09	335	59
447	[illegible]	85	[illegible]	1.04	465	88	1.09	487	93
400	[illegible]	76	[illegible]	1.04	416	79	1.09	436	83
453	[illegible]	80	[illegible]	1.04	471	83	1.09	494	87
201	[illegible]	5	[illegible]	1.04	209	5	1.09	219	5
201	[illegible]	5	[illegible]	1.04	209	5	1.09	219	5

Appendix 4: Time Varying Emissions Factors

Site No: 00000923 Site Reference: 00000923

A14 BAR HILL, CAMBRIDGESHIRE (EASTBOUND)

Vehicle Count Summary From 01/04/2007 To 01/05/2007 Channel: E/B

Time Begin	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thur	Friday	Mon-Fri Av.	Sat	Sun
00:00	306	310	326	310	371	400	373	0.1	0.1	0.1	0.1	0.2	0.1	0.24	0.23
01:00	173	227	273	253	273	294	221	0.1	0.1	0.1	0.1	0.1	0.1	0.18	0.14
02:00	167	223	276	256	276	262	164	0.1	0.1	0.1	0.1	0.1	0.1	0.16	0.10
03:00	276	345	358	384	378	323	178	0.1	0.2	0.2	0.2	0.2	0.2	0.19	0.11
04:00	497	596	597	604	562	447	204	0.2	0.3	0.3	0.3	0.3	0.3	0.27	0.13
05:00	1129	1202	1210	1194	970	523	250	0.5	0.5	0.5	0.5	0.5	0.5	0.31	0.16
06:00	2427	2603	2624	2573	2004	811	399	1.2	1.2	1.2	1.1	0.9	1.1	0.49	0.25
07:00	3941	4609	4746	4639	3783	1340	686	1.9	2.1	2.1	2.0	1.8	2.0	0.80	0.43
08:00	3815	4386	4520	4478	3526	1984	967	1.8	2.0	2.0	1.9	1.6	1.9	1.19	0.61
09:00	3316	3700	3572	3605	3061	2776	1699	1.6	1.7	1.6	1.6	1.4	1.6	1.66	1.07
10:00	3255	3176	3210	3118	3083	3278	2452	1.6	1.4	1.4	1.4	1.4	1.4	1.97	1.54
11:00	3229	2992	3014	2996	3165	3432	2861	1.5	1.4	1.3	1.3	1.5	1.4	2.06	1.80
12:00	3012	2949	3022	3009	3199	3359	2873	1.4	1.3	1.3	1.3	1.5	1.4	2.01	1.80
13:00	2967	3057	3057	3122	3272	3007	2679	1.4	1.4	1.4	1.4	1.5	1.4	1.80	1.68
14:00	3116	2965	3074	3236	3472	2814	2715	1.5	1.3	1.4	1.4	1.6	1.4	1.69	1.71
15:00	2883	3160	3224	3364	3335	2495	2795	1.4	1.4	1.4	1.5	1.6	1.5	1.50	1.76
16:00	3051	3480	3554	3534	3447	2381	2970	1.5	1.6	1.6	1.5	1.6	1.5	1.43	1.87
17:00	3399	3620	3851	3850	3454	2334	3048	1.6	1.6	1.7	1.7	1.6	1.6	1.40	1.91
18:00	3067	3185	3354	3405	3156	2178	3003	1.5	1.4	1.5	1.5	1.5	1.5	1.31	1.89
19:00	2202	2198	2414	2644	2483	1926	2603	1.1	1.0	1.1	1.1	1.2	1.1	1.15	1.64
20:00	1587	1431	1588	1814	1760	1395	2010	0.8	0.7	0.7	0.8	0.8	0.7	0.84	1.26
21:00	1213	1048	1116	1330	1179	990	1472	0.6	0.5	0.5	0.6	0.5	0.5	0.59	0.92
22:00	772	808	826	975	824	742	987	0.4	0.4	0.4	0.4	0.4	0.4	0.44	0.62
23:00	481	476	532	594	540	537	595	0.2	0.2	0.2	0.3	0.3	0.2	0.32	0.37
	50281	52746	54338	55287	51573	40028	38204	24.0						24.00	24.00
	2095	2198	2264	2304	2149	1668	1592	120.0							

Appendix 5A: Bar Hill Site Photos

Appendix 5B: Impington Site Photos

Appendix 6: Glossary

AADT – Annual Average Daily Traffic

AAWF – Annual Average Weekday Flow (Mon-Thurs)

ADMS – Atmospheric Dispersion Model Simulation

AQMA – Air Quality Management Area

CERC – Cambridge Environmental Research Consultants (creators of ADMS)

Continuous monitor – electronically operated pollutant monitor that logs data to a set or specified time scale (e.g hourly data)

DEFRA – Department for the Environment, Food and Rural Affairs

DETR – Department of the Environment, Transport and Regions

Discrepancy – Difference between the modelled and monitored data

DMRB – Design Manual for Roads and Bridges. A tool used for the prediction of current and future pollutant levels

GIS – Geographical Infomration System

NAQS – National Air Quality Strategy

NAQSO – National Air Quality Strategy Objectives

PM_{10} – Fine Particulate Matter no bigger than 10 microns

NAEI – National Atmospheric Emissions Inventory

NO_2 – Nitrogen Dioxide

NRTF – national Road Traffic Forecast

TVEF – Time Varying Emissions Factors

Validation – Comparison of predicted (modelled) and observed (measured) data

$\mu g/m^3$ – Micrograms per cubic metre