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# Round 2 DETAILED ASSESSMENT OF AIR QUALITY IN CHARNWOOD

**AUGUST 2003**

# EXECUTIVE SUMMARY

Local Authorities are under a statutory duty to undertake periodic rounds of review and of assessments of air quality within their areas. The purpose of these review and assessments are to determine whether EU and UK standards for various types of air pollutants are predicted to be achieved by set compliance dates at al relevant locations within the local authorities areas. The relevant locations generally relate to areas where human 'receptors' are likely to be exposed to the relevant pollutant for a given exposure period.

The first round review and assessment of air quality in Charnwood was completed, later than programmed, in March 2004. This established that there were predicted to be breaches of the air quality objectives for nitrogen dioxide at various locations in the borough primarily due to emissions from road traffic.

The second round review and assessment commenced in 2003. A screening assessment published in April 2003 established that, beyond those sources of pollution identified in the first round, there were other sources of pollution which due to increasing knowledge and improved air pollution monitoring were also in need of more detailed review and assessment. This report presents the results of this detailed review and assessment.

This report was originally published in May 2004 when it was submitted to DEFRA (The Department of Environment, Farming & Rural Affairs) for their appraisal. DEFRA issued their response in early August and the original report has been subsequently amended to take account of the comments made.

The detailed review and assessment considers the likely contribution of two potential sources of air pollution to breaches of the air quality objectives:

1. Emissions of sulphur dioxide from steam locomotives from the Great Central Railway (GCR) engineering sheds in Loughborough contributing to breaches of the 15 minute and 1 hour air quality objectives for SO2.
2. Emissions of PM10 from quarrying and processing of quarry products at the Mountsorrel granite quarry contributing to breaches of the 24 hour air quality objective for PM10.

The report concludes that emissions of SO2 from the GCR are likely to breach the 15 minute and 1 hour air quality objectives. It does not reach a firm conclusion as to whether emissions of PM10 from the Mountsorrel quarry are likely to breach the 24 hour objective.

The report recommends that an area around the GCR engine sheds be declared as an Air Quality Management Area and that further air quality monitoring be carried out around Mountsorrel quarry to inform a report due in April 2005 as to whether to declare an Air Quality Management Area needs to be declared.

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# 1.INTRODUCTION

## *1.1 Background*

From the mid 1980's there has been a growing public awareness of environmental issues which, combined with increasing incidence of childhood asthma, and traffic congestion, has led to general concern regarding air quality. In recognising this concern the scientific community also appreciated that there is a multiplicity of factors, which determine air quality in a given area. The 'simple' solutions applied to preventing the 'pea-soup' smog prevalent in urban areas up until the 1950s and 1960s are no longer available and any solution to the air quality dilemma of the new millennium requires a coherent national strategy applied flexibly at a local level. Addressing the issues will also require the participation of all members of the community and specialist input from many professional groups.

In the early 1990s the Expert Panel on Air Quality Standards (EPAQS) was set up by the Secretary of State for the Environment following the publication of the Government White Paper "Our Common Inheritance". The remit of the Panel was to advise on the establishment and application of Air Quality Standards based on the effects of pollutants on human health and the wider environment.

The Environment Act 1995 required the Secretary of State to produce a National Air Quality Strategy (NAQS), and this was initially published in April 1997. The NAQS was reviewed in 1999 with the amended revision being published in January 2000. It contained air quality objectives for 7 key airborne pollutants, which are to be achieved in all areas of the UK by various target dates. The objectives have been subject to further changes since 2000 and are summarised below in table 1.3.

Various actions are being undertaken at national and international levels to address some of the common air quality issues across the UK and the EU. However many air quality problems are due to particular local circumstances which these broad policies may not necessarily address. Therefore the Secretary of State incorporated within the Environment Act a variety of legal duties for local authorities to undertake review and assessments of air quality within their boroughs to identify all areas where the objectives in the NAQS would not be met. Moreover the Act imposes a duty on the local authority to develop Action Plans produced "in pursuit of the achievement of air quality standards".

The duty to undertake these assessment is a rolling requirement. Section 82 of the Environment Act states that "every local authority shall from time to time cause a review to be conducted… of air within the authorities area".

## *1.2 Air Quality Review and Assessments*

In order to assist local authorities to deliver on its air quality duties the UK government has developed guidance to allow the review and assessments to be undertaken in a coherent and structured manner. This guidance created a staged approach to the process, the intention being that local authorities should only undertake a level of assessment commensurate with the risk of an air quality objective being exceeded. Originally the guidance advocated a four stage approach to the process and this was how the first round of review and assessments were completed. Following a review of the guidance further rounds of review and assessments will only be subject to a two stage approach.

Following the completion of the first round of air quality review and assessments the government has set out a three year cycle for the delivery of the statutory rolling programme of review and assessments. The timescales for the delivery of the rolling programme is dependant upon two factors. Firstly, whether, as part of the first round review and assessment, the local authority established that the air quality objectives were **likely** to be breached in its area, and secondly, whether in the first stage (Updating and Screening) of subsequent rounds, information came to light that indicated a **risk** of further breaches of the objectives that had not previously been identified.

## *1.3 History of Air Quality Review and Assessments in Charnwood*

**Round 1**

The first three stages of the first round review and assessment was completed for Charnwood in December 2000. This concluded that there was a likelihood that there would be breaches of the air quality objectives within the borough. Specifically the review and assessment concluded that the annual average nitrogen dioxide objective was likely to be breached in three areas primarily due to emissions from road traffic vehicles.

In June 2001 three Air Quality Management Areas (AQMA) were declared in Charnwood, one in Loughborough, one in Syston and one in Birstall. Maps of the 3 AQMAs are attached in Appendix 1. A stage 4 assessment of the air quality in each of these areas was due for completion by mid 2002, although it was not finally completed until March 2004. The draft stage 4 report confirms the findings of the original report, quantifies the extent of the predicted breaches of the annual average nitrogen dioxide level in each of the AQMAs and provides some information on source apportionment of the pollutant emissions. These findings have recently been approved by the Department of Environment, Farming and Rural Affairs (DEFRA).

As a consequence of these findings the boundaries of the 3 AQMAs are being reviewed and an Air Quality Action Plan is in the process of being developed that will seek to ensure that the air quality objectives are complied with in each of the AQMAs.

**Round 2**

In June 2003 the Council published a round 2 stage 1 report otherwise known as an Updating and Screening Assessment (USA). The purpose of this report was to establish the risk of breaches of the air quality objectives which were *not* identified in round 1 either due to:

- Any significant changes in the sources of pollution in Charnwood since the first review and assessment or
- New guidance on how to identify possible pollution hot spots which had been developed over the past three years on the basis of experience from the first round of review and assessments.

The key conclusions of the USA report were as follows;

***Table 1.1***

| Pollutant | Areas that require a more detailed assessment of air quality |
|---|---|
| Nitrogen dioxide | **1. Properties very close (within 10 meters of the kerb) to the A6 corridor on Derby Road, High Street and Leicester Road in Loughborough.**<br><br>**2. Properties on Ratcliffe Road in Loughborough.**<br><br>**3. All roads within the current Loughborough AQMA that will be affected by the Epinal Way extension and any other roads outside the AQMA that are predicted to experience significant traffic increases due to the new road.**<br><br>**4. The A6 corridor through the village of Birstall.**<br><br>**5. The Melton Road corridor through the village of Syston.** |
| Sulphur dioxide | **6. Receptor points close to the engine sheds of the Great Central Railway in Loughborough** |
| Respirable particles | **7. All roads within the existing Air Quality Management Areas in Charnwood.**<br><br>**8. Properties around the Lafarge Aggregates quarry in Mountsorrel.** |

The round 1 stage 4 report published in March 2004 has addressed the detailed assessments of points 1 to 5 in the table above. The Actions which flow from this will be designed not only to pursue the achievement of the air quality standards for nitrogen dioxide in these areas, but will also achieve those for respirable particles. A more detailed assessment of respirable particles in these areas is not therefore considered to be of any benefit.

Therefore the round 2 stage 2 Detailed Assessment needs to address points 6 and 8.

## *1.4 Aims and Objectives of the Detailed Review and Assessment*

To provide an accurate assessment of the likelihood of air quality objectives being exceeded at locations subject to relevant exposure to;

1. Sulphur dioxide emissions from locomotives standing at the vicinity of the Great Central Railway engine sheds, Empress Road, Loughborough.

2. Respirable particle emissions in the vicinity of the LaFarge Aggregates granite quarry, Loughborough Road, Mountsorrel.

## *1.5 Further Progress of Air Quality Management in Charnwood*

Section 1.2 outlined how the air quality management system has evolved in to a three year rolling programme. The table below outlines the timescales for the further implementation of air quality management in Charnwood.

***Table 1.2***

| Round and Phase of the Review & Assessment Process | Due Completion Date |
|---|---|
| Round 1 Phases 1, 2 & 3 | ***complete*** |
| Round 1 Phase 4 | ***complete*** |
| Round 2 Updating & Screening Assessment | ***complete*** |
| Round 2 Detailed Assessment | ***complete*** |
| Round 2 Progress Report | 1 May 2005 |
| Round 3 Updating & Screening Assessment | 1 June 2006 |
| Round 3 Detailed Assessment | 1 May 2007 |
| Round 3 Progress Report | 1 May 2008 |
| Round 4 Updating & Screening Assessment | 1 May 2009 |
| Round 4 Detailed Assessment | 1 May 2010 |
| Round 4 Progress Report | 1 May 2011 |

## *1.6 National Air Quality Objectives*

The table below provides a summary of the air quality objectives contained within the National Air Quality Strategy.

***Table 1.3 Objectives for Protecting Human Health***

| Pollutant | Concentration Limit | Measured As | Date to be achieved By |
|---|---|---|---|
| Benzene ($C_6H_6$) | **16.25µg $m^{-3}$**<br><br>**5µg $m^{-3}$** | **Running annual mean**<br>**Annual mean** | **31 December 2003**<br><br>**31 December 2010** |
| 1,3 Butadiene | **2.25µg $m^{-3}$** | **Running annual mean** | **31 December 2003** |
| Carbon Monoxide (CO) | **1160µg $m^{-3}$** | **Maximum daily running 8 hour mean** | **31 December 2003** |
| Lead (Pb) | **0.5µg $m^{-3}$**<br><br>**0.25µg $m^{-3}$** | **Annual mean**<br><br>**Annual mean** | **31 December 2004**<br>**31 December 2008** |
| Nitrogen Dioxide ($NO_2$) | **200µg $m^{-3}$** (Not to be exceeded more than 18 times a year)<br><br>**40µg $m^{-3}$** | **1 hour mean**<br><br>**Annual mean** | **31 December 2005**<br><br>**31 December 2005** |
| Respirable particulates ($PM_{10}$) | **50µg $m^{-3}$** (Not to be exceeded more than 35 times a year)<br>**40µg $m^{-3}$** | **24 hour mean**<br><br>**Annual mean** | **31 December 2004**<br><br>**31 December 2004** |
| Sulphur Dioxide ($SO_2$) | **350µg $m^{-3}$** (Not to be exceeded more than 24 times a year)<br><br>**125µg $m^{-3}$** (Not to be exceeded more than 3 times a year)<br><br>**266µg $m^{-3}$** (Not to be exceeded more than 35 times a year) | **1 hour mean**<br><br>**24 hour mean**<br><br>**15 minute mean** | **31 December 2004**<br><br>**31 December 2004**<br><br>**31 December 2005** |

## *2. THE BOROUGH OF CHARNWOOD*

The Borough of Charnwood is located in Leicestershire in the heart of the East Midlands and is situated on the northern county boundary with Nottinghamshire. The Borough covers an area of 108 square miles and consists of a mix of urban settlements and rural farmland.

### *2.1 The Borough of Charnwood Map*


The population of the Borough totals approximately 156,000 residents distributed between the northern towns of Shepshed and Loughborough, the southern towns and villages on the outskirts of the city of Leicester including Anstey, Birstall, Thurmaston and Syston and the villages located along the Soar and Wreake river valleys.

Charnwood has a wide range of commercial and industrial activities. Loughborough is traditionally associated with the engineering sector, whilst the villages along the Soar and Wreake have long associations with the footwear, hosiery and knitwear industries. High technology industries are being rapidly attracted into the Borough, mirroring the national experience of the contraction of the traditional heavy industries. The changing industrial infrastructure of the Borough will continue to create challenges in relation to air quality management.

A substantial and varied transport network serves the Borough. The major road links include the M1 motorway, the A6 and the A46 all of which run to a greater or lesser extent through the Borough. The Ivanhoe and Great Central railway lines run through the central spine of the Borough, and the Nottingham East Midlands airport is located approximately three miles from the north western boundary of Charnwood.

Generally ambient air pollution has never been considered to be of excessive concern for local residents in the Borough. However, as is the case in many parts of the country, the atmospheric emissions from certain individual point sources have caused considerable nuisance for those residents in the immediate vicinity. Some of these individual point sources will not have been highlighted through this report, as they are not producers of any of the seven key pollutants highlighted in the National Air Quality Strategy. This does not indicate a lack of concern by the authors of the report to generate solutions to these problems, but is simply due to the fact that they fall outside the remit of this report.

# 3. REVIEW AND ASSESSMENT OF SULPHUR DIOXIDE EMISSIONS FROM STEAM LOCOMOTIVES AT THE GREAT CENTRAL RAILWAY

## *3.1 Introduction*

Sulphur dioxide ($SO_2$) is a soluble gas consisting of one sulphur and two oxygen atoms. On dissolving in water it gives rise to an acidic solution of sulphuric acid.

The principal source of $SO_2$ is the electricity generating power stations (71%) followed by other industrial combustion plant - in particular refineries and iron and steel processes. Domestic sources of $SO_2$ can be significant in areas where there is still extensive use of solid fuel fires.

Sulphur dioxide gives rise to concerns due to its local and global effect. Trans-national transportation of $SO_2$ in the atmosphere followed by its dry and wet deposition ("acid rain") has accounted for deforestation and lake acidification in continental Europe. In terms of its health effects the acidic nature of dissolved $SO_2$ causes irritation to lung tissue and may provoke attacks of asthma. The onset of these clinical effects can be very rapid after exposure to a sufficiently high concentration of the gas. With these points in mind, the following air quality standards were set that incorporate a short averaging time and an ambient concentration below which levels of $SO_2$ are unlikely to have any significant health effects.

266µg $m^{-3}$ expressed as a 15-minute mean, which must not be exceeded more than 35 times a year by 2006.

350µg $m^{-3}$ expressed as a 1-hour mean, which must not be exceeded more than 24 times a year by 2005.

125µg $m^{-3}$ expressed as a 24-hour mean, which must not be exceeded more than 3 times a year by 2005.

## 3.2 *Conclusions of the Updating & Screening Assessment*

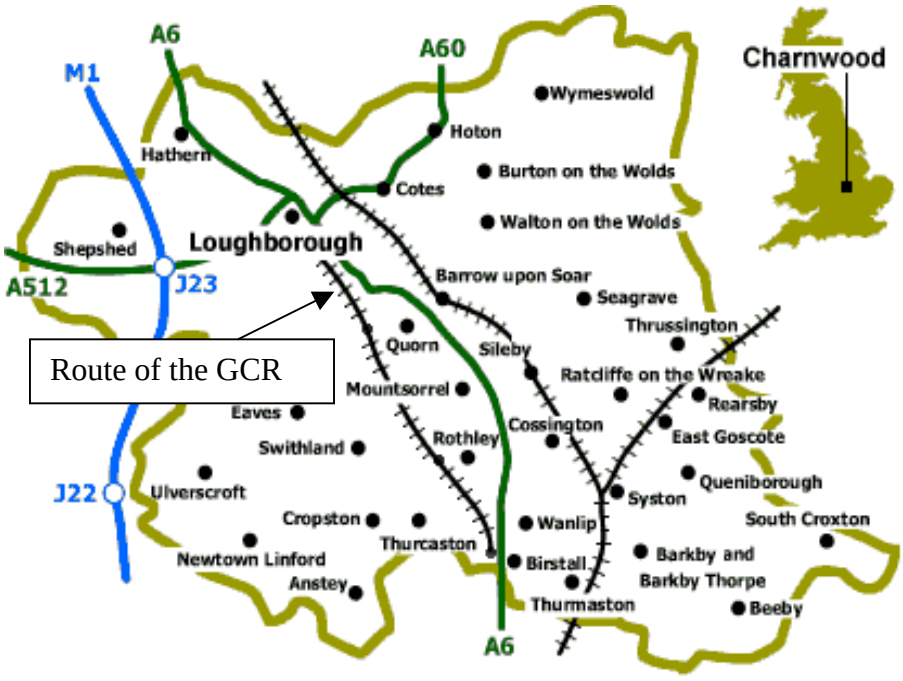
The USA indicated a risk that receptor points close to the engine sheds of the Great Central Railway in Loughborough would be subject to breaches of the air quality objective for sulphur dioxide. This was mainly based on the fact that domestic properties are within approximately 15 meters of locations where steam locos are stationary for more than 15 minutes.

## 3.3 *Description of the Source*

The Great Central Railway is a private limited company and registered charity. It's main business objective is to recreate the experience of travelling on steam locomotives and it is the only mainline steam railway in the UK. It runs daily passenger services as well as hosting numerous other themed events and supporting railway conservation groups.

Both steam and diesel locos operate on the line, which runs for a length of approximately 8 miles from Loughborough to Birstall. Along the line are stations at Loughborough, Quorn, Rothley and Birstall as well as there being engineering workshops at Loughborough and Rothley.

***Map 3.1 Route of the Great Central Railway***



The Updating and Screening Assessment identified that emissions of sulphur dioxide in smoke emitted from the Loughborough engineering shed may pose a risk of breaching the air quality objectives for this pollutant.

On the whole emissions from the railway are not considered to cause any significant problems from the air quality management perspective as the source of the emissions (namely coal fired boilers serving the locos) are mobile and so exposure times for any receptor of the smoke is limited. This is not the case in the area of the Loughborough engineering shed. At this location all of the steam locos are brought "into steam". This involves the boilers of the steam locos being fired up from cold each day to allow sufficient steam power to be provided to bring them into operational service. The fires are lit using timber and coal and steadily built up manually using coal to a point when steam pressure is adequate. The lighting up process takes approximately three hours during which time the dispersion characteristics of the plume is poor due to the low efflux temperature, the relatively inefficient combustion characteristics and the fact that the efflux velocity is natural draft driven.

From officers knowledge of the railways activities it was considered that short term breaches of the 15 minute and 1 hour air quality objectives for sulphur dioxide are possible at receptor locations close to the lighting up location of locomotives.

## *3.4 Monitoring*

### 3.4.1 Background Monitoring

Charnwood currently monitors sulphur dioxide at three locations in the borough. One location has a UV flourescence real time analyser and a diffusion tube. The second location has both a diffusion tube and a real-time electrochemical analyser and the third location only a diffusion tube.

The UV analyser is located in a position in the borough which modelling by the Environment Agency suggests is likely to be most significantly affected by emissions from the Ratcliffe on Soar power station. Data from the last three years is summarised below and there have been no breaches of the air quality objectives within this time.

***Table 3.1 Summary of sulphur dioxide monitoring data at Durham Road, Loughborough***

| 2001 | Diffusion tube | UV Fluorescence analyser |
|---|---|---|
| Maximum 15 minute mean concentration | N/A | 296.2 μg $m^{-3}$ |
| Maximum 1 hour mean concentration | N/A | 180.8 μg $m^{-3}$ |
| Maximum 24 hour mean concentration | N/A | 42.5 μg $m^{-3}$ |
| Annual average | 8.4μg $m^{-3}$ | 7.4μg $m^{-3}$ |
| Data capture | 67% | 93.1% |
| 2002 | | |
| Maximum 15 minute mean concentration | N/A | 226.3 μg $m^{-3}$ |
| Maximum 1 hour mean concentration | N/A | 190.4 μg $m^{-3}$ |
| Maximum 24 hour mean concentration | N/A | 56.9 μg $m^{-3}$ |
| Annual average | 6.3μg $m^{-3}$ | 5.7μg $m^{-3}$ |
| Data capture | 83% | 97.7% |
| 2003 | | |
| Maximum 15 minute mean concentration | N/A | 206.5μg $m^{-3}$ |
| Maximum 1 hour mean concentration | N/A | 169.6μg $m^{-3}$ |
| Maximum 24 hour mean concentration | N/A | 51.8μg $m^{-3}$ |
| Annual average | 7.8μg $m^{-3}$ | 5.4μg $m^{-3}$ |
| Data capture | 100% | 97.7% |

The monitoring has not indicated any short term exceedences of any of the objectives for sulphur dioxide. The power station has a seemingly negligible impact on sulphur dioxide levels at the monitoring location. We have therefore taken this location as providing a reasonable representation of local background levels.

Diffusion tubes are located at two sites. The first site is in Loughborough town centre. An 8 port sampler for measuring smoke and sulphur dioxide was previously located here until 2001. It has been the location for a diffusion tube sampler since mid 1999. This, like the Durham Road, site seems to be a good monitoring location for background sulphur dioxide levels given the lack of local $SO_2$ emissions sources.

The other location is on the front façade of the nearest residential property to the

Great Central Railway engine sheds (see the map in Appendix 2) which is approximately 20 meters from the usual stationary location of steam locos.

***Table 3.2 The annual average data in µg $m^{-3}$ for the two locations is summarised below.***

| | Durham Road, Loughborough | Cattle Market, Loughborough | Wolsey Way, Loughborough |
|---|---|---|---|
| 2000 | | 7.3 | 26 |
| 2001 | 8.4 | 6.9 | 23.6 |
| 2002 | 6.3 | 6.5 | 13.7 |
| 2003 (raw) | 7.8 | 9.0 | 20.2 |
| 2003 (bias corrected) | 5.4 | 6.2 | 14 |

The data indicates a reasonably close correlation between the two 'background' sites at Durham Road and Cattle Market. It also indicates that annual average SO2 levels at the Wolsey Way site are consistently above those of the background sites.

## Quality Assurance/ Quality Control of Monitoring data

### *Real time*

The continuous analyser is a Monitor Labs ML9850B which is an approved type tested model. It is maintained and serviced by ETI Casella every 6 months including the supply of calibration gases and consumables. Full maintenance records are kept. All QA / QC procedures meet LAQM.TG(03) standards and manufacturers instructions. The analyser self calibrates daily using a BS reference gas daily. Officers manually recalibrate every two weeks in accordance with the manufacturers instructions. Full records are kept of any equipment malfunctions.

Data ratification is carried out every two months by members of the Environmental Protection team using Envidas software to filter out data that falls outside preset parameters. As part of this process the data is scrutinised in order to establish possible causes of any peaks or objective breaches that are observed.

### *Diffusion tubes*

Diffusion tubes are supplied and analysed by Gradko Ltd. Analysis is carried out using ion chromatography to Gradko internal procedures.

It would appear that the diffusion tube results provide a reasonable degree of similarity with the real time analyser data. The low data capture rates for 2001 and 2002 prevent any bias correction analysis of the two monitoring datasets. However bias correction of the 2003 data based on a similar method for that used for nitrogen

dioxide in box 6.4 of LAQM.TG(03) suggests the following accuracy:

Dm (annual average diffusion tube reading) = 7.8
Cm (annual average UV flourescence reading) = 5.4
Cm/Dm = 0.6923
(Dm – Cm) / Cm = (7.8 – 5.4) / 5.4 = 0.444
Therefore the diffusion tube bias in 2003 was +44.4%. In other words the bias correction calculation estimates that the diffusion tube data over reads that of the more accurate UV analyser by 44.4% in determining annual average concentrations.

This calculation cannot be viewed with the same level of confidence as a bias correction calculation for comparing real time and diffusion tube NO2 data as described in LAQM.TG(03). It has only been included here for illustrative purposes to allow a rough calculation to be made for the annual average SO2 concentrations at the other SO2 diffusion tube locations.

### 3.4.2 Real Time Monitoring at the Great Central Railway

The data from the diffusion tubes clearly indicates that there are elevated levels of annual average sulphur dioxide at the nearest residential property to the Great Central Railway. The nature of the emissions from this source are such that we would expect short term exposure to sulphur dioxide from the smoke to be a more likely cause of breaches of the Air Quality Objectives than long term exposure.

In the absence of resources for another type tested UV analyser we installed a portable electro-chemical analyser at one of the nearest residential properties to the engineering sheds. This is capable of measuring 15 minute mean concentrations, but is not type tested and as far as we can tell its performance has not been subject to any national comparisons against type tested equipment. The equipment was therefore installed with the understanding that it would not be able to conclusively demonstrate whether the air quality objectives are being met or not. It was hoped that the equipment would be able to indicate the extent and frequency of acute sulphur dioxide episodes and therefore provide evidence of the number of likely breaches of the short term SO2 objectives.

Monitoring was undertaken between September 2003 and March 2004. The table below outlines the number of breaches of the 15 minute and one hour objective at the monitoring location based on validated data from the monitoring equipment. The validation techniques used on the data are not approved in LAQM.TG(03) and must be taken in context as a best estimate in the absence of any more reliable monitoring data.

***Table 3.3 Summary of Air Quality Objective breaches at Wolsey Way, Loughborough. Number of breaches of the 15 minute and 1 hour mean objectives for each monitoring period***

| | Number of breaches of the 15 minute mean objective (266 $\mu gm^{-3}$) | Number of breaches of the 1 hour mean objective (350 $\mu gm^{-3}$) |
|---|---|---|
| September | 0 | 0 |
| October | 0 | 0 |
| November | 7 | 1 |
| December | 21 | 7 |
| January | 0 | 0 |
| February | 8 | 1 |
| March | 9 | 2 |
| | | |
| **Total** | **45** | **11** |

The total data capture rate for the monitoring period 5 September to 30 March was 82%. This equates to a total data capture rate over a year of 40%. The Air Quality Objectives permit 35 breaches each year of the 15 minute mean and 24 of the 1 hour mean. This data suggests that there is a likelihood that the 15 minute mean air quality objective is being breached and that there is a possibility that the 1 hour mean objective may also be being breached.

## Quality Assurance/ Quality Control of Monitoring data

The continuous analyser is a Streetbox manufactured by Lerian Designs Ltd containing a sulphur dioxide electrochemical sensor. It is not a type tested piece of apparatus. The equipment is subject to an annual maintenance check by the manufacturers and maintained in accordance with manufacturers instructions. Following the completion of the checks an operating profile is obtained for the sensor from –10 to 50 °C which is then incorporated into the sensors calibration file and ensures that throughout the calibration period the sensor operates in accordance with the values initially recorded.

Following the annual maintenance check the monitor is co-located adjacent to the type tested UV analyser for a representative period of time - usually a week. The monitor is deployed on approximately a monthly basis, after which time it is collected, the data downloaded and the monitor redeployed

The data is assessed by members of the Environmental Protection Team. It is firstly subject to a baseline correction factor based on the method quoted by the manufacturers and then to a validation factor obtained from direct comparison of data from the co-location monitoring period next to the UV analyser.

The baseline correction is carried out by comparing the respective mean readings from the Streetbox and the background UV analyser over the monthly monitoring period. The difference between them is taken to be the baseline correction factor and this is applied to all of the data from the Streetbox.

This baseline correction method assumes that the average SO2 levels at the two locations over a monitoring period will be the same – which the data from table 3.2 clearly demonstrates is not the case. In general over long monitoring periods the mean SO2 reading at the monitoring location at Wolsey Way seems to be about 2.2 to 2.8 times greater than that at Durham Road. However given that the purpose of the monitoring exercise was to identify peaks of SO2 this method is considered appropriate to allow us a reasonable way of correcting and filtering data to identify the frequency of, and approximate extent of, the short term SO2 peaks.

The validation factor is based on direct comparison of data from the co-location exercise, based itself on a similar method to that used for bias correction of nitrogen dioxide diffusion tubes. Most recently for the analyser the factor was as follows:

Lm (Streetbox reading) = 5.01
Cm (UV analyser reading) = 2.11
Cm/Dm (Validation factor) = **0.42**

## *3.5 Modelling*

In order to support the monitoring information an exercise was undertaken to try to model emissions from the steam locomotives. There are a number of variables about the activities at the engine sheds that made accurate modelling of emissions almost impossible. However it was felt that modelling would at least identify the likely geographical spread of the plume and therefore allow possible receptors to exposure from emissions to be more readily established. The accuracy of the modelling would invariably be compromised by the absence of any real-time type tested monitoring near to the source.

Information to support the model was obtained from the GCR covering an operational period of one year. The information obtained related to:

- Sources of their coal (colliery and supplier).
- Sulphur content or range of all coals used on locos using the line.

- Mass of coal used per loco per unit of time at the engineering sheds.
- Average stack discharge temperature profile from locos coming into steam.
- Loco boiler flue height and diameter characteristics.
- Loco boiler flue discharge velocity .

Much of this information is unknown or unobtainable and so a fair amount of educated guesswork was required by both the GCR and Council officers to derive the data for modelling. The model run itself involved profiling the emissions from the engine sheds over the daily period of 06.00 to 09.00 when locos are normally in steam. Default loco boiler stack dimensions were used as were the emissions characteristics of temperature and velocity. Many different locos are used on the line and modelling for the characteristics of each of these would have been extremely time consuming to undertake individually.

Four modelling scenarios were undertaken to establish the likelihood of breaches of the 15 minute and 1 hour mean objectives when the railway use high and low sulphur content fuels. The outputs of the modelling are reproduced in Appendix 2.

AIRVIRO, the model used, is a Swedish dispersion model, originally developed by INDIC, but now distributed, supported, and further developed by the Swedish Meteorological and Hydrological Institute (SMHI). The model is capable of grid, Gaussian, or canyon dispersion calculations. The model operates on a UNIX workstation, and includes modules for data collection, dispersion calculations and an emissions database. Dispersion calculations are performed in the Dispersion Module, using meteorological data collected from the Leicester meteorological mast together with emissions data from the emissions database. Emission sources for modelling using AIRVIRO are defined as point (e.g. industrial and commercial buildings), line (roads), or area (residential estates, or large industrial) sources.

The Leicester AIRVIRO model can be run on either a City or County map, zooming into a smaller area where greater detail is required. Emissions from sources within the entire selected map area are used for the dispersion calculations: even where the zoom function has been used to select a smaller area for any subsequent post modelling display.

## *3.6 Conclusions*

Evidence from monitoring in the vicinity of the GCR Loughborough Engineering sheds indicates that long term average sulphur dioxide levels are between 2.2 to 2.8 times above that of a background location. The real time monitoring also indicates a likelihood that there will be more than 35 breaches of the 15 minute air quality objectives.

Modelling of the emissions indicates a likelihood that there will be breaches of both the 15 minute and 1 hour air quality objectives for SO2. The geographical extent of these breaches is significantly related to the sulphur content of the fuel used. However even using the lowest sulphur content fuel there is still a wide geographical breach of the 15 minute objective.

## *3.7 DEFRAs response to the conclusions*

"On the basis of the evidence provided by the local authority, the conclusions reached are accepted for sulphur dioxide."

"The measurement methods for SO2 in the vicinity of the railway line are not ideally suited to the purpose you (the local authority) have deployed them. However the measurement studies have been carefully controlled and there are indications supported by the modelling, that exceedences of the 15 minute and 1 hour objective might be expected."

"A declaration for SO2 is likely to be precautionary and further continuous monitoring is needed in the vicinity of the proposed AQMA in order to confirm the risk of exceeding the 1 hour and 15 minute SO2 objectives. This monitoring can be conducted as part of the Further Assessment"

## *3.8 Recommendations*

Given the evidence to date it is recommended that an Air Quality Management Area be declared relating to predicted sulphur dioxide levels.

Further refinement of the modelling is necessary before the boundaries of the proposed AQMA can be determined although it is likely that the area will mainly consist of properties on Wolsey Way and Holbien Close. Appendix 2 contains a OS map of the area to allow cross reference with the model output information.

Further monitoring of both SO2 and PM10 is also recommended using type tested monitoring equipment in order to provide more robust data to inform the Further Assessment.

# 4. REVIEW AND ASSESSMENT OF PARTICLES (PM10) AROUND MOUNTSORREL QUARRY

## *4.1 Introduction*

A wide range of emission sources contributes to PM10 (respirable dust) in the UK. Sources can be roughly divided into three main categories. *Primary particle emissions* come directly from combustion sources such as power generation and road traffic. *Secondary sources* are formed by chemical reactions in the atmosphere and consist mainly of sulphates and nitrates. *Course particles* come from a wide range of sources such as road traffic, construction work, mineral extraction, wind blown dusts, soils sea salt and pollen.

The National Air Quality Strategy has two objectives for respirable particles. The Objectives are 40 $\mu g/m^3$ as an annual mean and 50 $\mu g/m^3$ as a 24 hour mean to be exceeded on no more than 35 days a year. Both are to be achieved by 31 December 2004 and both are based upon measurements carried out using the European gravimetric transfer reference sampler or equivalent.

More stringent provisional Objectives have also been introduced to be achieved by 31 December 2010 although these are not formally due for adoption until after the review of the EU First Daughter Directive in 2004. These Provisional Objectives are a 24-hour mean of 50 $\mu g/m^3$ to be exceeded on no more than 7 days a year and an annual mean of 23 $\mu g/m^3$.

## *4.2 Conclusions of the Updating & Screening Assessment*

The USA suggested that locations immediately in the vicinity of the Lafarge Aggregates quarry in Mountsorrel may be subject to more than 35 exceedences of the 24 hour mean PM10 objective.

## *4.3 Description of the Source*

Mountsorrel Quarry is the largest Granite quarry in Europe. The quarry excavation is approximately 1 kilometre in diameter and is capable of producing 10 million tonnes of aggregate per annum. However, current production is around 5 million tonnes per annum. The operators, Lafarge Aggregates, estimate that there are some 180 million tonnes of reserves yet to be quarried.

The rock bed is drilled and blasted to release it from the ground. From there the material is hauled up to the Primary crusher that reduces the rock to more manageable size fractions. Additional processing is carried out to further crush, screen, and separate the rock into sizes suitable for industry. Aside from the main quarry operation the site incorporates 2 road stone coating plants and 1 concrete batching plant.

Mountsorrel village lies adjacent to the southeast edge of the quarry with the closest residents living around 100m from the nearest site boundary. Other nearby villages are Quorn some 500m away to the northwest and Barrow on Soar approximately 1600m away to the northeast

## *4.4 Monitoring*

### 4.4.1 Real Time Monitoring

Following the completion of the Round 1 Stage 3 Review and Assessment suspicions remained about the possibility of activities at the granite quarry generating significant quantities of PM10.

During 2001 a portable light scatter device was located at one of the nearest residential properties to the quarry to undertake an initial screening monitoring exercise. A summary of the results of this monitoring exercise is contained in box 1. Unfortunately, following a change in ownership the site no longer became available for monitoring in early 2002 and so the monitoring had to cease.

**Box 1**

Monitoring using a light scatter device was carried out at a nearby property on Hawcliffe Road, Mountsorrel throughout 2001. This property is located approximately 100 meters from the boundary of the quarry.

Over the period of the calendar year the monitor detected 33 breaches of the air quality objective for PM10s. The total data capture rate for the year was 65%. On further analysis of the data and by comparing results against other TEOM type PM10 monitors in Loughborough (7.5km to the NE) and Leicester (15km south) the following conclusions were drawn:

8 of the exceedences were due wholly or largely to regional pollution episodes.
3 episodes could not be clearly attributed to regional or local sources.
1 episode was due to a local source that could not have been the quarry.
21 episodes were due to a local source that may have been wholly or largely attributable to the quarry.

Of the 33 exceedences, 13 occurred in a 30 day period in August, 11 of which were due to a local source that may have been wholly or largely attributable to the quarry. A further 8 occurred in a 14 day period in November of which 4 were due wholly or largely to regional pollution episodes and 3 were due to a local source that may have been wholly or largely attributable to the quarry.

The results highlighted a need for further monitoring.

During the latter part of 2001 a few complaints were received by Charnwood Borough Council about dust emissions from the quarry. In the absence of a more suitable monitoring site and to respond to the complaints a further light scatter device was purchased and monitors were sited at

- The rear garden of a residential property at The Pastures, Barrow On Soar from 23

March 2002 to 13 March 2003 and

- The rear garden of a residential property at Paddock Close, Quorn from 3 August 2002 to 31 January 2003.

The property at the Pastures is approximately 1.5km to the north west of the nearest part of the quarry. The property on Paddock Close is approximately 840 meters north of the nearest operational part of the quarry. The property at the Pastures was not considered particularly indicative of an exposure location for receptors of the quarry dust but it was considered a useful location as a downwind background monitoring location. The Paddock Close property is a reasonable receptor exposure location to provide indicative data for the residents of the village of Quorn.

A summary of the results of this screening monitoring location is contained in box 2.

**Box 2**

At the Pastures, Barrow monitoring location there were 11 breaches of the 24 hour mean objective over the eleven and a half month monitoring period. The total data capture rate for daily averages for the monitoring period was 100%. Of these breaches:

10 were due wholly or largely to regional pollution episodes.
1 was due to a local source that may have been wholly or largely attributable to the quarry.

The annual average over the March to March monitoring period was 21.1 $\mu g/m^3$ compared to 22.9 $\mu g/m^3$ at the Loughborough TEOM monitoring location.

At the Paddock, Quorn monitoring location there was one breach of the 24 hour mean objective. During the 6 month monitoring period the data collection rate was 98%.The one breach occurred on the same day as one of the breaches at the Pastures which was wholly or largely to a regional pollution episode. The monitor was not present at the Paddock monitoring location for any of the other 10 breaches detected at the Pastures.

The average PM10 level at the Paddock was 17.5$\mu g/m^3$ over the monitoring period. Over the same monitoring period the level at the TEOM monitor in Loughborough was 22.3 $\mu g/m^3$

This monitoring exercise concluded that receptors in Quorn and Barrow were not subject to PM10 exposure levels from the quarry that exceeded the air quality objective.

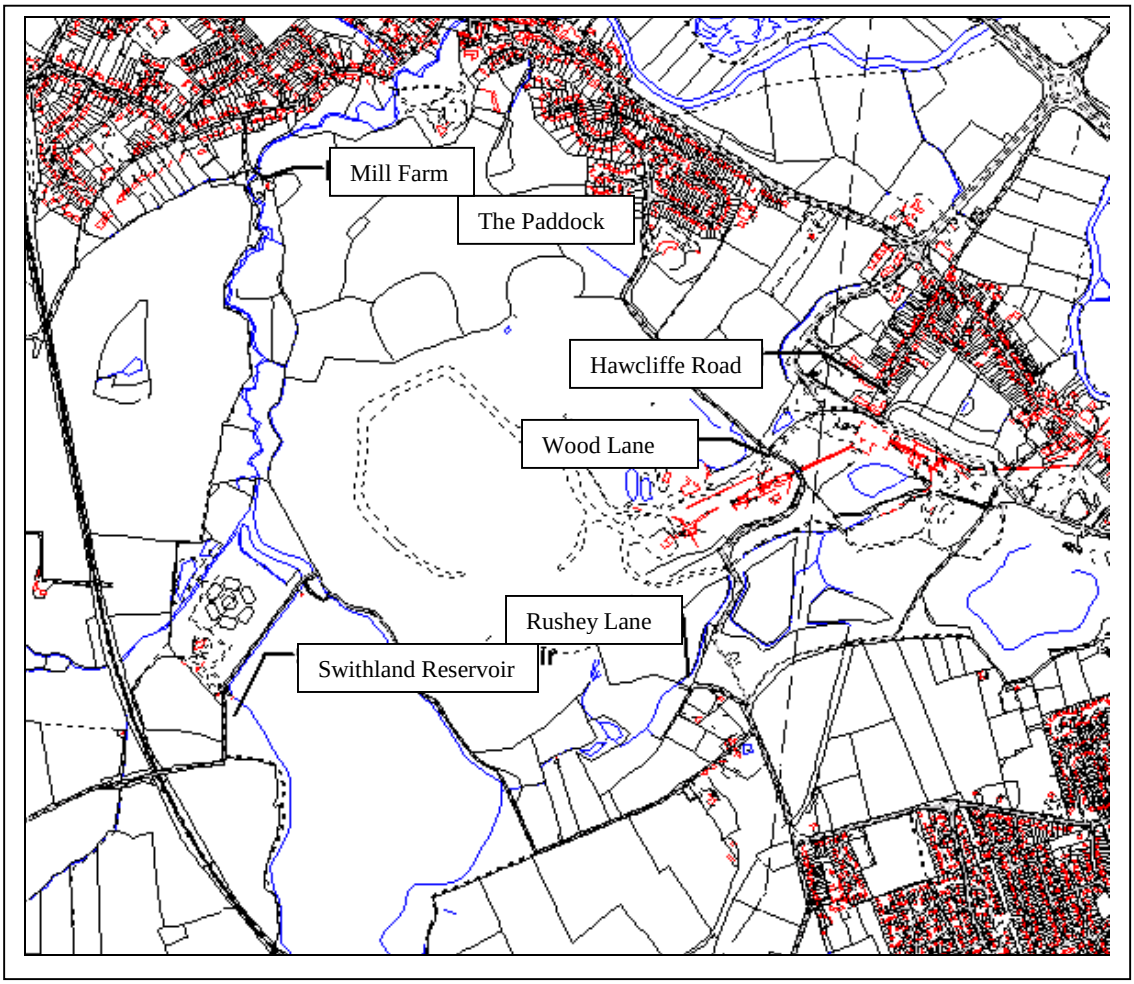
**Quality Assurance / Quality Control**

The laser scatter analysers are both Osiris airbourne particle monitors manufactured by Turnkey Instruments Ltd. It is not a type tested unit. It is subject to an annual service by the manufacturer. The equipment is maintained in accordance with the

manufacturers instructions and all maintenance checks are documented.

The data ratification was undertaken at the end of each monitoring exercise by staff within the Environmental Protection Team.

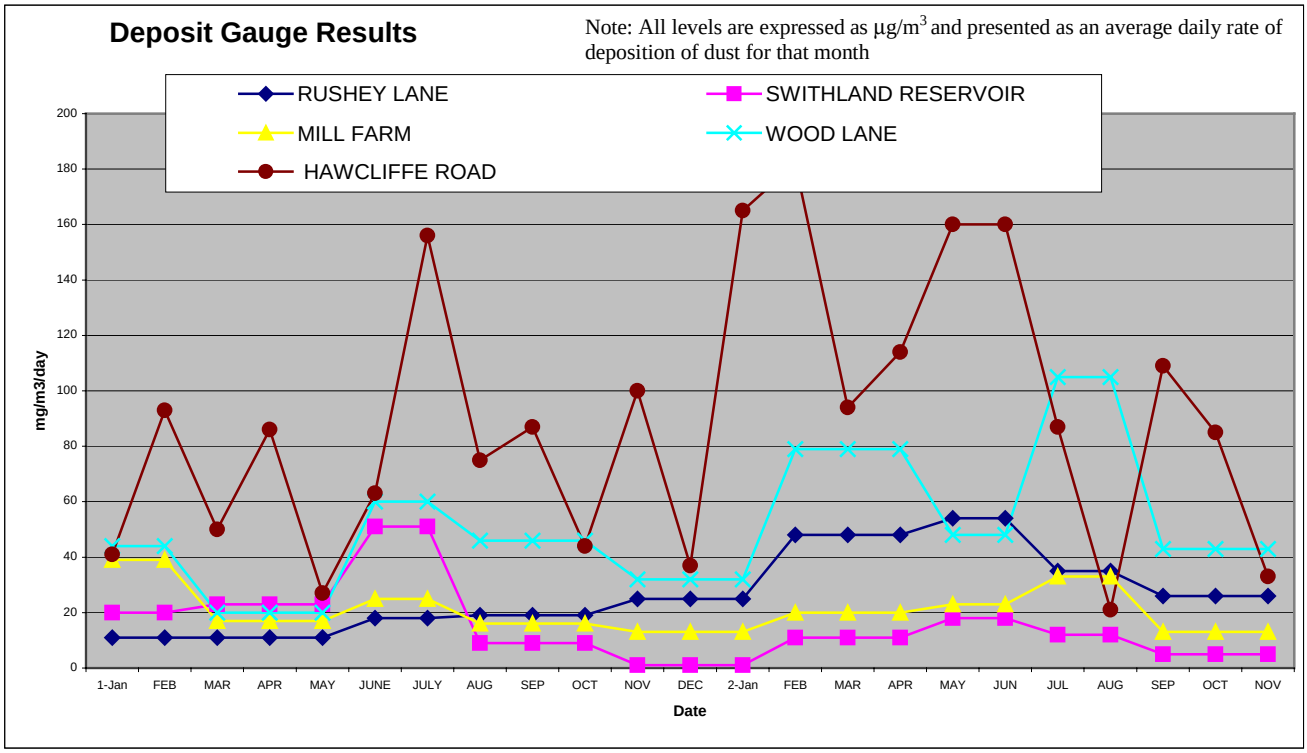
***Map 4.1 Air Quality Monitoring Locations near the Mountsorrel Quarry***




### 4.4.2 Dust Deposition Monitoring

As part of the planning consent relating to the site, dust deposition gauge monitoring has been carried out for some years. Readings obtained from dust gauges are ***not in any way*** representative of levels of respirable dust at the monitoring location. However deposit gauges do produce data relating to nuisance dust and the long term trends that they produce can be used to identify geographical areas that are affected by quarry dust emissions. This can be useful in providing information about relevant receptor locations.

The graph below indicates the mass of deposited dust collected at various receptor points around the quarry in 2002 and 2003:




The highest dust readings are derived from those sites downwind from the quarry.

## 4.5 *Conclusions of the Detailed Assessment*

The evidence from monitoring data gathered around the quarry suggests that there is a possibility that there will be more than 35 breaches per annum of the 24 hour average PM10 Air Quality Objective and a likelihood that there will be more than 7 breaches of the 24 hour average PM10 Air Quality Objective.

The need for the creation of an Air Quality Management Area due to possible breaches of the Air Quality Objective for 2004 are uncertain. However given that there are not likely to be any significant changes in emissions from the quarry, and that the existing EU Air Quality Objective for 2010 is likely to be made into UK law fairly soon, it seems prudent to declare an Air Quality Management Area now on the basis of a likely future breach of the 2010 Objective.

The monitoring does not provide enough information to establish either the geographical extent of this impact, the total contribution of the quarry (or any other local sources) to the likely breach, or the relative contribution of each of the individual activities undertaken at the quarry to PM10 levels. All of these will require further research.

## *4.6 DEFRAs response to the conclusions*

"On the basis of the evidence provided by the local authority…it is considered that more monitoring is required before reaching a conclusion about the declaration for PM10."

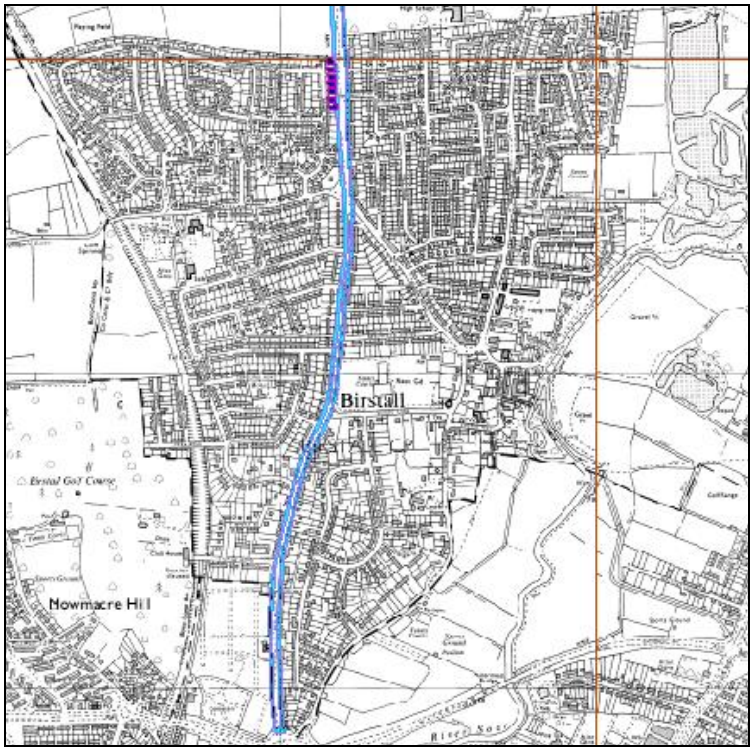
"The evidence suggests, but does not confirm, the risk of exceeding the 24 hour 2004 PM10 objective in the vicinity of Mountsorrel quarry. Further monitoring is advised ideally using a gravimetric sampler or a TEOM in order to confirm the scale and magnitude of the exceedence risk. It would not be appropriate at this stage to declare an AQMA on the basis of the 2010 PM10 objectives which are not yet in regulations in England."

## *4.7 Recommendations*

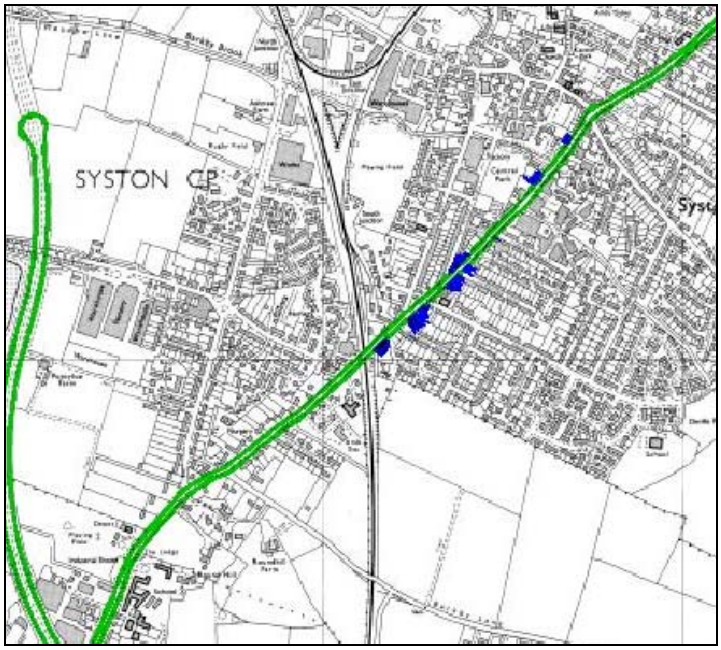
Given the evidence to date and DEFRAs comments it is recommended that more monitoring be undertaken prior to making a decision about the need to declare an Air Quality Management Area.

## *1.1 Appendix 1. Current Air Quality Management Areas in Charnwood*

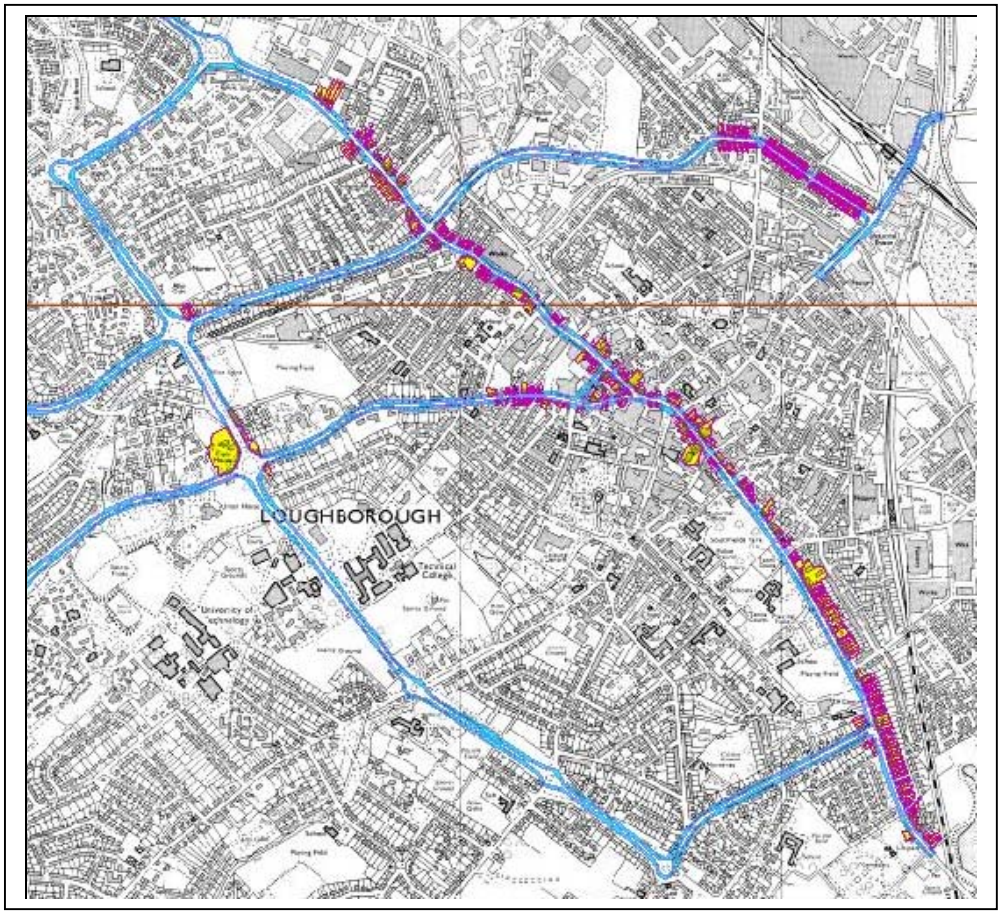
### Birstall AQMA




### Syston AQMA



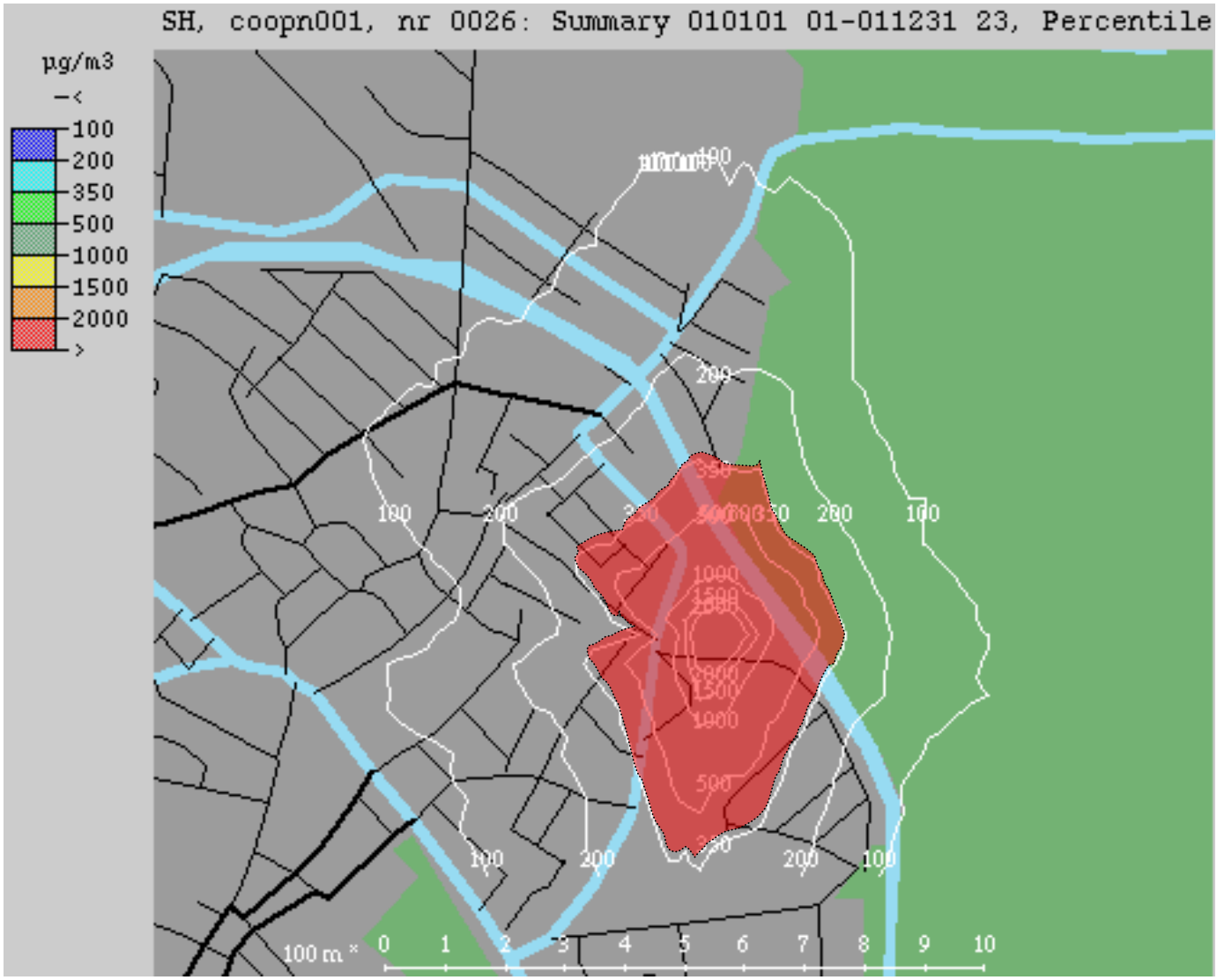
## Loughborough AQMA



## *1.2 Appendix 2. Modelling Outputs for Emissions from the GCR Engine Sheds*

**99.7th percentile of hourly means of SO2 (µg/m$^3$), Great Central Railway station, Loughborough – source of emissions: highest sulphur content coal.**

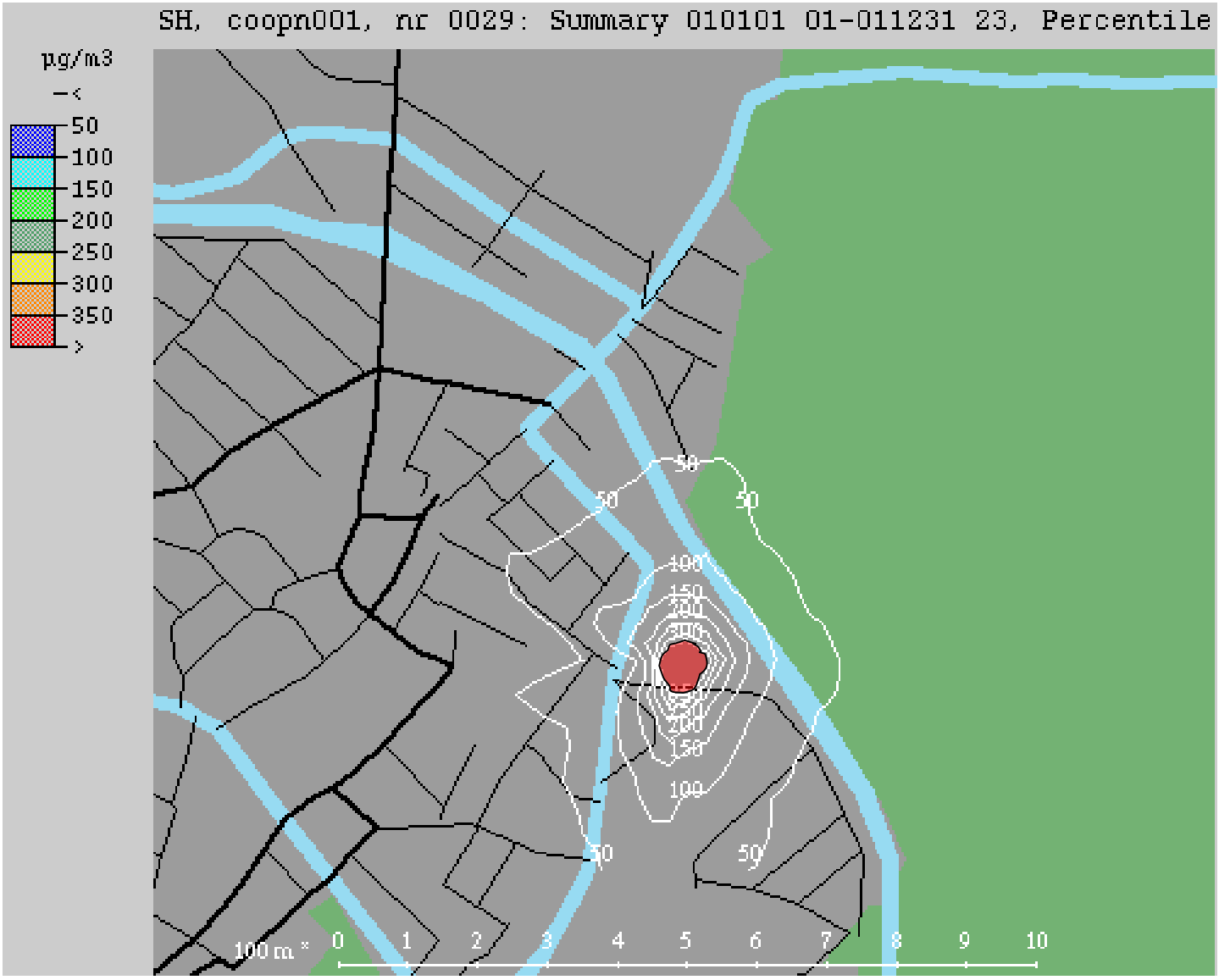
Met year: 2001. Database: Chnwd05
The result does not include background SO2.
The dispersion calculation is not verified against monitoring data.




The area highlighted in red indicates the extent of the predicted breach of the 1 hour mean objective for sulphur dioxide when using high sulphur content coal.

**99.7th percentile of hourly SO2 (µg/m$^3$), Great Central Railway station, Loughborough – source of emissions: lowest sulphur content coal.**

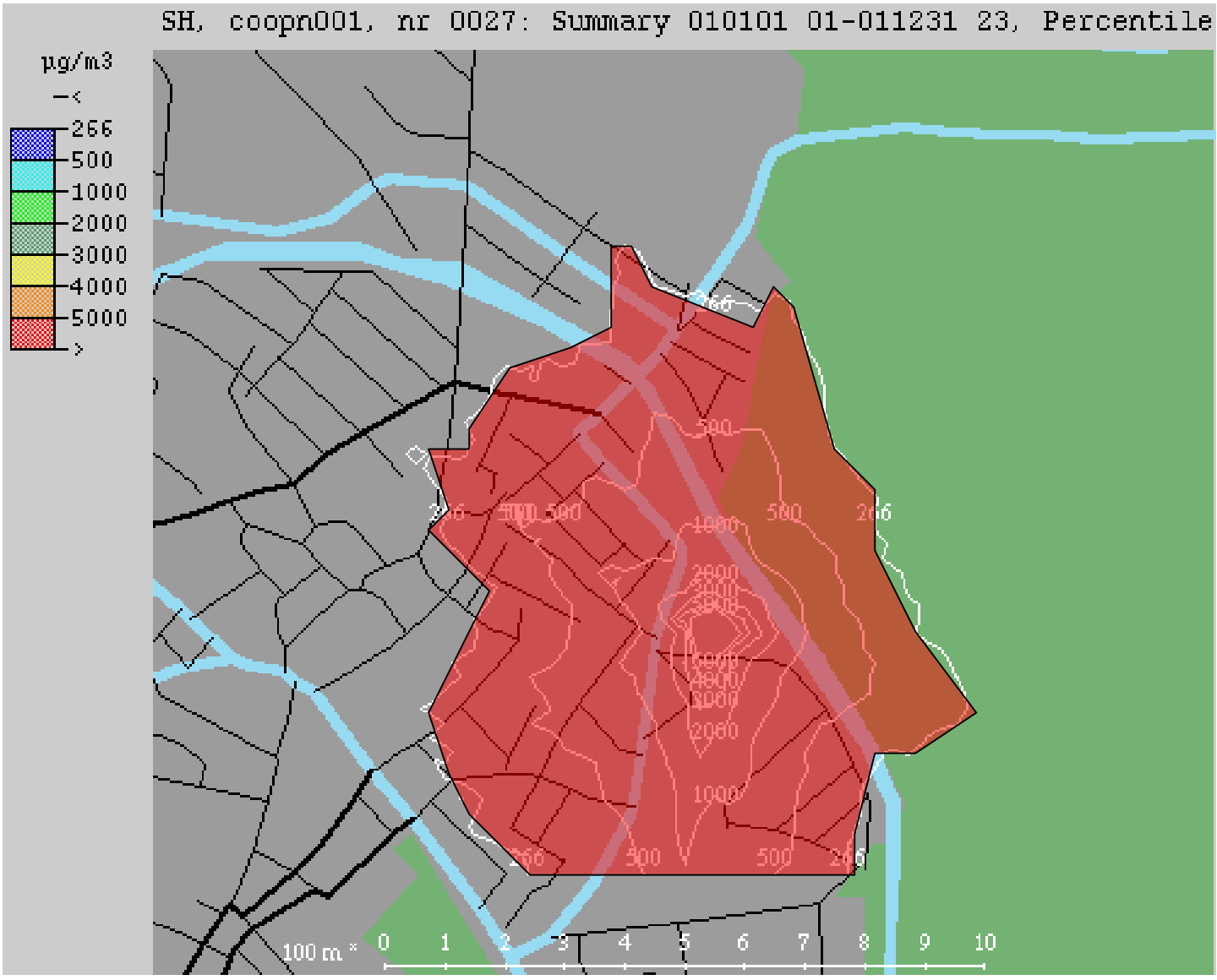
Met year: 2001. Database: GCRLowS
The result does not include background SO2.
The dispersion calculation is not verified against monitoring data.




The area highlighted in red indicates the extent of the predicted breach of the 1 hour mean objective for sulphur dioxide when using low sulphur content coal.

**99.9th percentile of 15 minute means of SO2 (µg/m$^3$), Great Central Railway station, Loughborough – source of emissions: highest sulphur content coal.**

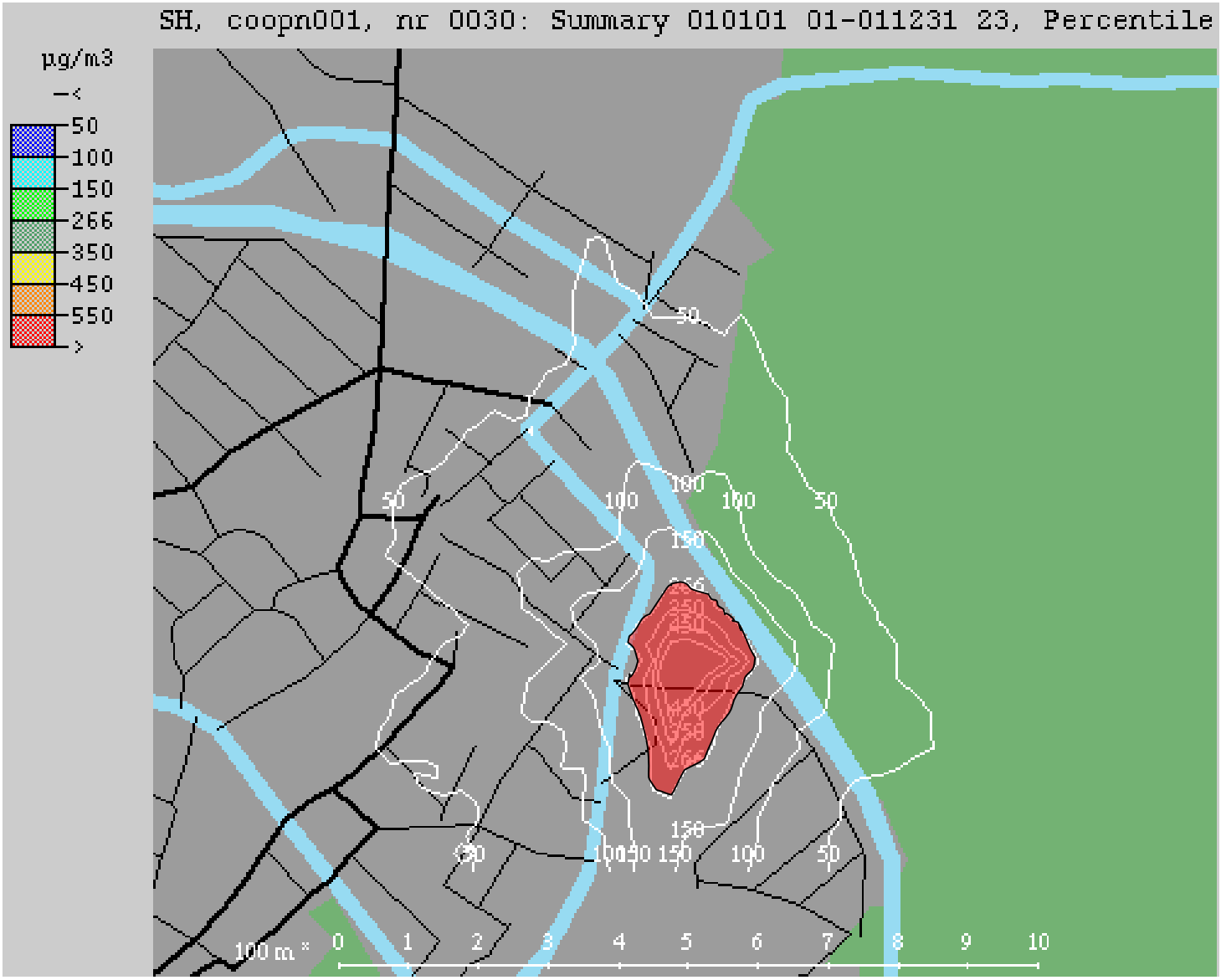
Met year: 2001. Database: Chnwd05
Percentile of 15 minute means calculated using percentile of hourly x 1.34.
The result does not include background SO2.
The dispersion calculation is not verified against monitoring data.




The area highlighted in red indicates the extent of the predicted breach of the 15 minute mean objective for sulphur dioxide when using high sulphur content coal.

**99.9th percentile of 15 minute means of SO2 (µg/m$^3$), Great Central Railway station, Loughborough – source of emissions: lowest sulphur content coal.**

Met year: 2001. Database: GCRLowS
Percentile of 15 minute means calculated using percentile of hourly x 1.34.
The result does not include background SO2.
The dispersion calculation is not verified against monitoring data.




The area highlighted in red indicates the extent of the predicted breach of the 15 minute mean objective for sulphur dioxide when using low sulphur content coal.