Detailed Assessment of Air Quality in Wyre Forest District Council

Sulphur Dioxide

Document Control

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Job Number	J633

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Document Status and Review Schedule

Issue No.	Report No.	Date	Status	Reviewed by
1	633/2/D1	27th November 2008	Draft Report	Prof. Duncan Laxen
2	633/2/F1	29th January 2009	Final Report	Prof. Duncan Laxen
3	633/2/F2	16th April 2009	Final Report	Prof. Duncan Laxen

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1 Introduction

1.1 Air Quality Consultants has been commissioned by Wyre Forest District Council to undertake a Detailed Assessment for sulphur dioxide as a result of coal-fired locomotive emissions at Bewdley Station.

1.2 The Severn Valley Railway Line in the vicinity of Bewdley was badly damaged as a result of flooding across large areas of Worcestershire and surrounding areas in the summer of 2007. Once the heritage railway line was repaired and service resumed, monitoring at a local property was commenced. This report presents the results of three months of monitoring carried out during the period 11th August to 30th October 2008, and a modelling study carried out to confirm whether there are any likely exceedences of any of the relevant objectives at worst-case locations.

The Review and Assessment Process

1.3 The Government's most recent Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Defra, 2007) sets out a framework for air quality management, which includes a number of air quality objectives. National and international measures are expected to achieve these objectives in most locations, but where areas of poor air quality remain, air quality management at a local scale has a particularly important role to play. Part IV of the Environment Act 1995 requires local authorities to periodically review and assess the current, and likely future air quality in their areas. The role of this process is to identify areas where it is unlikely that the air quality objectives will be achieved. These locations must be designated as Air Quality Management Areas (AQMAs) and a subsequent Air Quality Action Plan developed in order to reduce pollutant emissions in pursuit of the objectives.

1.4 Review and Assessment is a long-term, ongoing process, structured as a series of 'rounds'. Local authorities in England, Scotland and Wales have now largely completed the first three rounds of Review and Assessment, with the fourth round to commence in 2009.

1.5 Local Air Quality Management Technical Guidance (LAQM.TG(03) and LAQM.TG(08); Defra, 2003 and 2008) sets out a phased approach to the second, third and fourth rounds of Review and Assessment. This prescribes an initial Updating and Screening Assessment (USA), which all authorities must undertake. It is based on a checklist to identify any matters that have changed since the first round. If the USA identifies any areas where there is a risk that the objectives may

be exceeded, which were not identified in the previous round, then the local authority should progress to a Detailed Assessment.

1.6 The purpose of the Detailed Assessment is to determine whether an exceedence of an air quality objective is likely and the geographical extent of that exceedence. If the outcome of the Detailed Assessment is that one or more of the air quality objectives is being or is likely to be exceeded, then an Air Quality Management Area must be declared. Subsequent to the declaration of an Air Quality Management Area, a Further Assessment should be carried out to confirm that the Air Quality Management Area declaration is justified; that the appropriate area has been declared; to ascertain the sources contributing to the exceedence; and to calculate the magnitude of reduction in emissions required to achieve the objective. This information can be used to inform an Air Quality Action Plan, which will identify measures to improve local air quality.

1.7 This report represents a Detailed Assessment within the third Round of Review and Assessment, following findings from Wyre Forest District Council's Updating and Screening Assessment published in 2006 (Wyre Forest District Council, 2006).

The Air Quality Objectives

1.8 The Government's Air Quality Strategy (Defra, 2007) provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment. It also sets out how the different sectors: industry, transport and local government, can contribute to achieving the air quality objectives. The objectives are prescribed within The Air Quality (England) Regulations 2000 (The Stationery Office, 2000) and The Air Quality (England) (Amendment) Regulations 2002 (The Stationery Office, 2002). This latter publication set more stringent objectives for benzene and carbon monoxide. The 'standards' are set as concentrations below which health effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of a particular pollutant. The 'objectives' set out the extent to which the Government expects the standards to be achieved by a certain date. Table 1 summarises the objectives which are relevant to this report.

1.9 The air quality objectives only apply where members of the public are likely to be regularly present for the averaging time of the objective (i.e. where people will be exposed to pollutants). For the 24-hour objective, these locations include the façades of residential properties, schools and hospitals. The 1-hour objective also applies at these locations, as well as at any outdoor location where a member of the public might reasonably be expected to stay for 1 hour or more, such as shopping streets, parks and sports grounds, as well as bus stations and railway stations that are not fully

enclosed. The 15-minute objective applies to those locations where a member of the public might reasonably be expected to remain for 15 minutes or more.

Table 1: Air Quality Objectives for Sulphur Dioxide.

Pollutant	Status	Time Period	Objective / Value	To be Achieved by
Sulphur Dioxide	Statutory UK Objective	1-hour mean	350 μg/m^3 not to be exceeded more than 24 times a year	2004
		24-hour mean	125 μg/m^3 not to be exceeded more than 3 times a year	2004
		15-minute mean	266 μg/m^3 not to be exceeded more than 35 times a year	2005

Key findings of previous Review and Assessment work

1.10 As part of the first round of assessment work, Wyre Forest District Council submitted a Stage 3 Assessment for nitrogen dioxide in June 2002. This assessment concluded that the nitrogen dioxide annual mean objective would be exceeded in two locations. The Council therefore declared Air Quality Management Areas in Welch Gate in Bewdley and at the Horsefair (Blackwell Street) in Kidderminster in 2002. Both Air Quality Management Areas remain in place, and are shown in Figure 1 and Figure 2.

1.11 Monitoring presented in Wyre Forest District Council's 2006 USA identified exceedences of the nitrogen dioxide annual mean objective at a monitoring location at 69 Coventry Street. A Detailed Assessment was therefore required at this location which confirmed the need for an Air Quality Management Area in the vicinity of this monitoring location. This is currently in the process of being declared.

1.12 The Council's 2006 USA also identified a need to proceed to a Detailed Assessment for sulphur dioxide on the basis of a potential risk of exceedences of the 15-minute mean objective in relation to emissions from idling locomotives at Bewdley station. The line is part of the Severn Valley Railway, which is classed as an historic railway. Relevant exposure exists within approximately 15m of where idling locomotives stand at the platform.

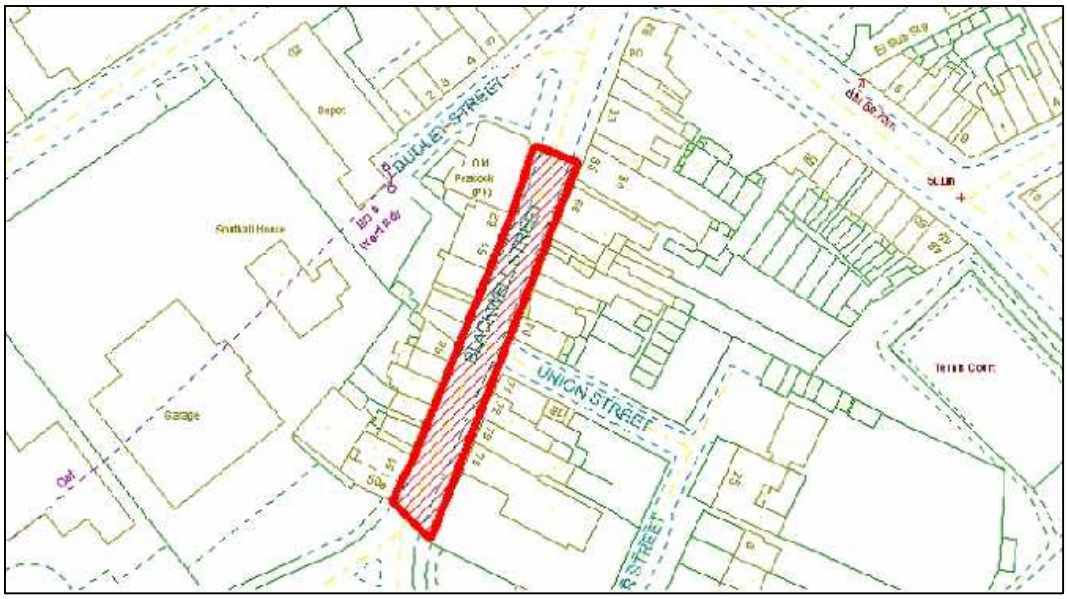

Figure 1: Horsefair AQMA, Blackwell Street, Kidderminster (© Crown Copyright. License No. 100018317 2008)

Figure 2: Welch Gate AQMA, Kidderminster (© Crown Copyright. License No. 100018317 2008)

2 Assessment Methodology

Sulphur dioxide monitoring

2.1 Monitoring for sulphur dioxide was carried out in the front garden of 5 Maypole Close for a three month period between 11th August and 30th October 2008. Sulphur dioxide concentrations were measured using an API M100E SO_2 analyser, which returned 15-minute average concentrations in parts per billion (ppb). The data were then fully ratified by the monitoring service provider, and converted to $\mu g/m^3$.

2.2 The monitoring site location, nearby residential properties and receptor locations for modelling are shown in Figure 3.

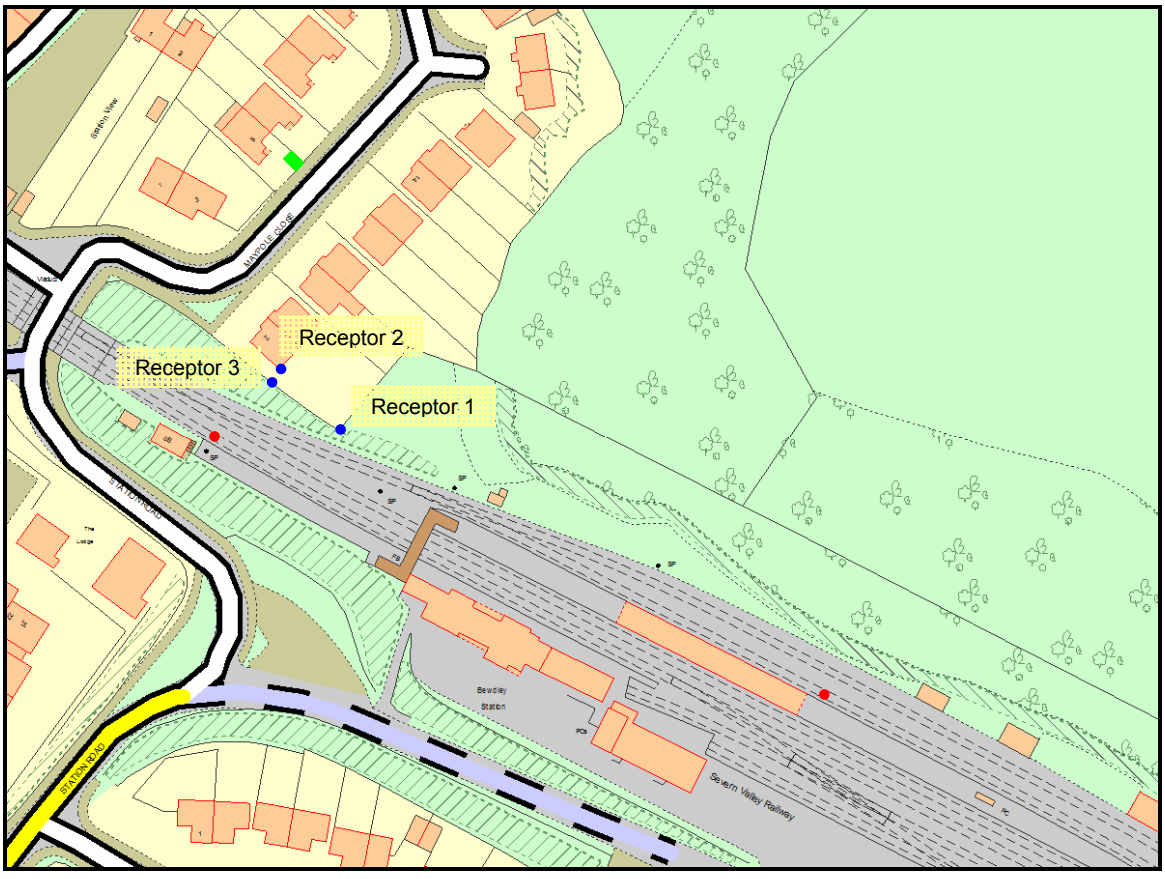

Figure 3: Monitoring Location (Green rectangle), Receptors (Blue dots) and Location of Locomotives (Red dots). (© Crown Copyright. License No. 100018317 2008)

3 Monitoring Results

Table 2: SO_2 Data Summary 11th August – 30th October 2008

Pollutant	SO_2	Exceedences	Objectives
Number Very High[a]	0	-	-
Number High[a]	0	-	-
Number Moderate[a]	0	-	-
Number Low[a]	7104	-	-
Maximum 15-minute mean	93 µg/m^3	0	266 µg/m^3; fewer than 35 exceedences in a year
99.9th Percentile of 15-minute means	51 µg/m^3	0	266 µg/m^3 [b]
Maximum hourly mean	53 µg/m^3	0	350 µg/m^3; fewer than 24 exceedences in a year
99.7th Percentile of hourly means	27 µg/m^3	0	350 µg/m^3 [b]
Maximum 24-hour mean	12 µg/m^3	0	125 µg/m^3; fewer than 3 exceedences in a year
99th Percentile of 24-hour means	10 µg/m^3	0	125 µg/m^3 [b]
Period mean	3 µg/m^3	-	-
Data capture	93%	-	-
Data capture as percentage of 2008	20%		

[a] Number of 15-minute values
[b] Equivalent objective for the specified percentile

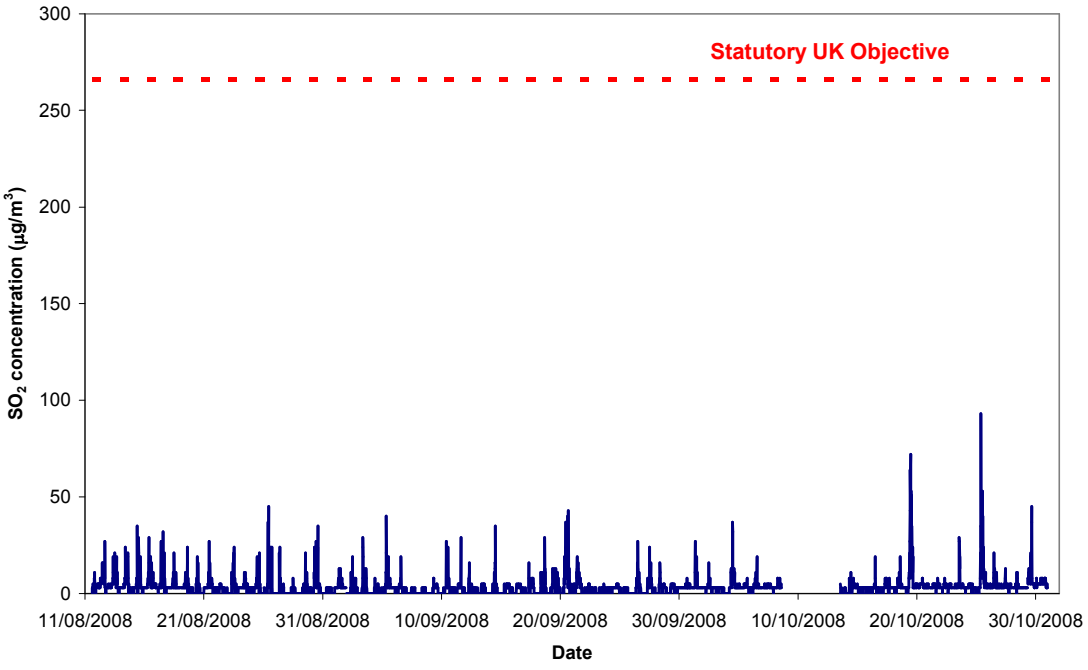

Figure 4: Mean 15-minute SO_2 concentrations

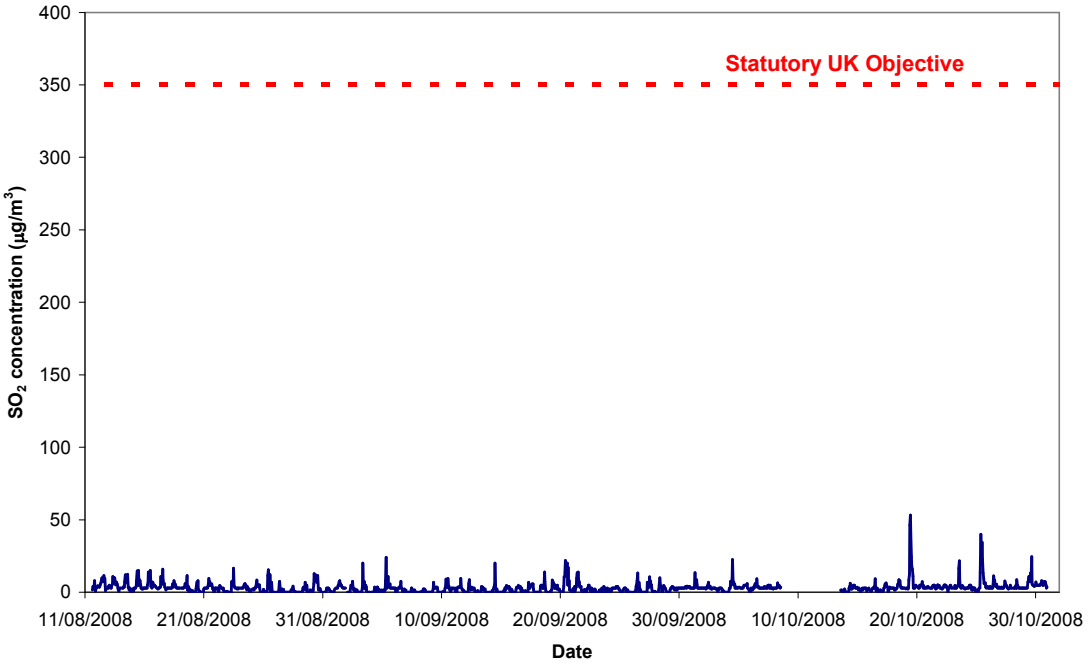

Figure 5: Mean 1-hour SO_2 concentrations

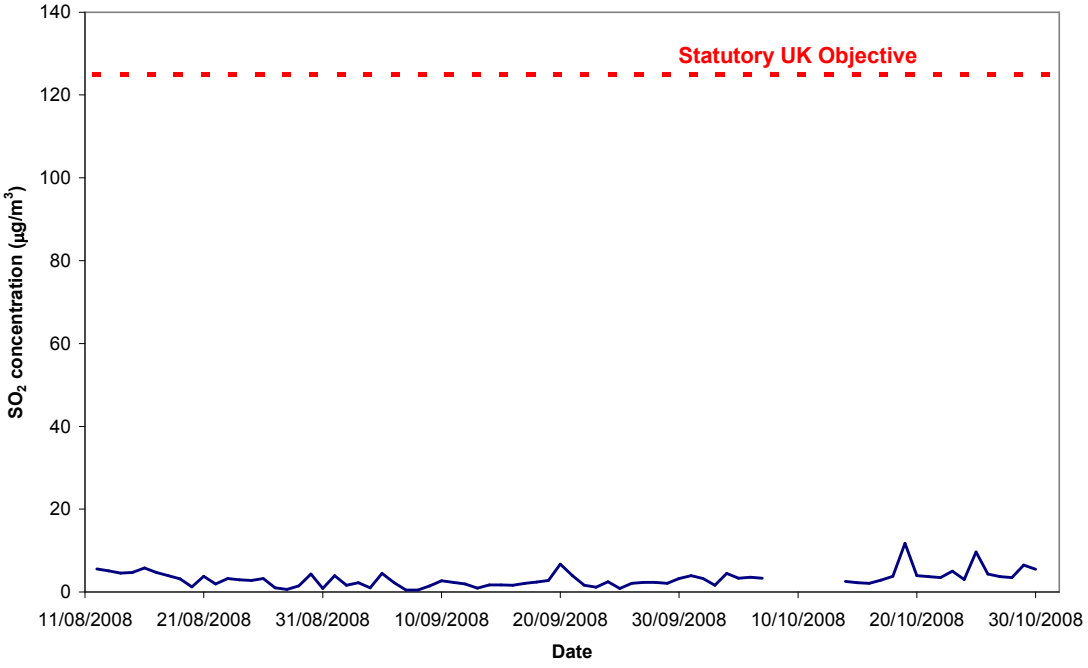

Figure 6: Mean 24-hour SO_2 concentrations

3.1 The objectives allow for a number of exceedences within a calendar year. As the monitoring data do not represent a full calendar year, the 99.9th, 99.7th and 99th percentiles have been determined, as appropriate, to determine whether there is a likelihood of exceeding each objective. In each case the concentration is well below the level of the objective, and thus an exceedence of any of the objectives is unlikely.

4 Modelling

4.1 Whilst there were no measured exceedences of any of the sulphur dioxide objectives, the monitoring site is not positioned at the worst-case location in terms of exposure to the emissions. There are locations representative of relevant exposure for each of the sulphur dioxide objectives closer to the source of emissions than the monitoring location. A modelling exercise was therefore carried out to determine the likelihood of the objectives being met at these locations (described in Table 3 and shown in Figure 3).

Table 3: Receptor locations

Receptor	Description
Receptor 1	Garden of No. 2 Maypole Close; closest to tracks
Receptor 2	Garden of No. 2 Maypole Close; closest to engine (westbound direction)
Receptor 3	No. 2 Maypole Close; closest point to tracks / engine

4.2 Modelling was carried out using the ADMS 4 dispersion model. ADMS 4 is a new generation model that incorporates a state-of-the art understanding of the dispersion processes within the atmospheric boundary layer. The precise emission rates for the coal-fired locomotives, which are the source of sulphur dioxide at this location, are unknown. Modelling was therefore carried out assuming a simple scenario, with a nominal emission rate of 1 g/s SO_2 from two locomotives (one at each platform; stack locations shown in Figure 3), and with locomotives operational 24 hours a day for the entire year. The model was run to predict the maximum hourly concentration at the monitoring site, to allow a simple scaling factor to be determined. The emission rate was then scaled and the model re-run using an emission rate for each locomotive of 0.23 g/s. Model input parameters, and the calculation of the scaling factor are presented in Appendix 1.

4.3 Concentrations predicted for each of the worst-case locations are presented in Table 4, for modelling carried out using both Elmdon and Pershore meteorological data. The scaled results show that the maximum hourly predicted concentrations at all three worst-case receptors are well below the hourly mean objective. The 15-minute mean objective however is the most stringent. An estimate of the maximum 15-minute concentration has therefore been made based on the ratio of the measured maximum hourly and 15-minute means presented in Table 2. The maximum measured 15 minute concentration is 1.75 times greater than the maximum measured hourly mean (93 $\mu g/m^3$ / 53 $\mu g/m^3$). An estimate of the maximum 15-minute mean is presented in Table 4 for each of the worst-case receptors. The maximum 15-minute mean concentrations are also well below the objective. It is therefore unlikely that either objective would be exceeded.

Table 4: Predicted Maximum Concentrations at Worst-Case Receptors ($\mu g/m^3$)

Receptor	Hourly Concentration	15-Minute Concentration
11th August – 30th October 2007		
Receptor 1	79.6 – 84.0	139.7 – 147.4
Receptor 2	70.6 – 78.8	123.9 – 138.3
Receptor 3	53.0 – 62.8	93.0 – 110.2
2007		
Receptor 1	87.5 – 87.6	153.6 – 153.7
Receptor 2	81.3 – 81.4	142.7 – 142.9
Receptor 3	69.0 – 69.8	121.1 – 122.5
Objectives	**350**	**266**

4.4 In addition, a contour plot of maximum predicted hourly concentrations modelled for 2007 (using Elmdon meteorological data) is presented in Figure 7. This shows that maximum concentrations at locations of relevant exposure are no higher than those predicted for Receptor 1.

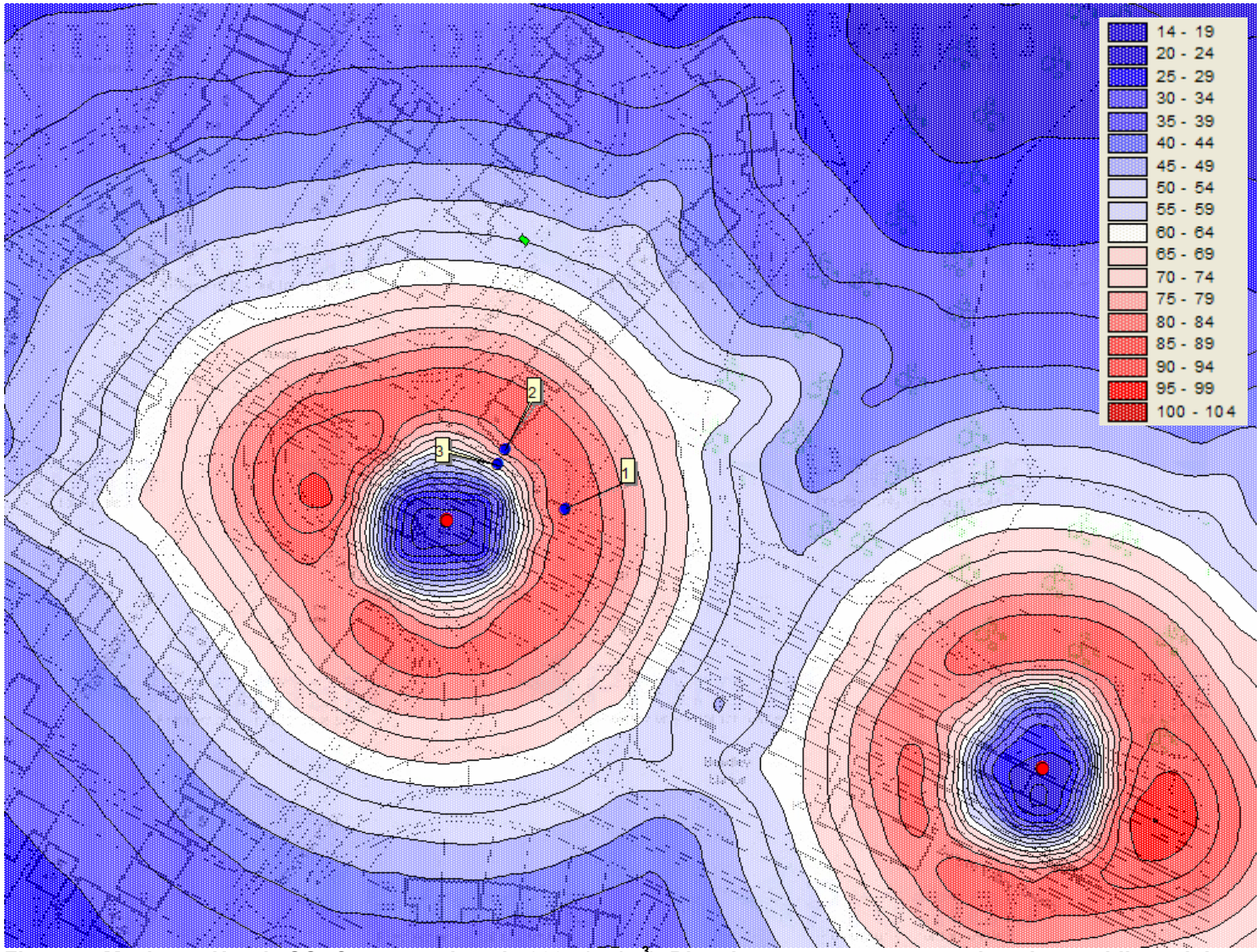

Figure 7: Maximum Hourly SO_2 Concentrations in 2007 (µg/m^3). Blue dots represent receptor locations, whilst red the stack locations.

5 Conclusions

5.1 A Detailed Assessment of air quality has been carried out for properties located in close proximity to the platform of Bewdley Station. These areas were identified as being at risk of exceeding the air quality objectives for sulphur dioxide in the Updating and Screening Assessment.

5.2 The Detailed Assessment has been carried out using a combination of monitoring data and modelled concentrations. Concentrations of sulphur dioxide have been modelled using the ADMS 4 dispersion model at the monitoring location (for the purposes of model verification) and for worst-case receptors within 15 m of the emissions sources.

5.3 Monitoring has shown that each of the three sulphur dioxide objectives were met during the three month monitoring period. Determining the appropriate percentiles confirmed that this is also likely to be the case for a full calendar year period. Modelling shows the objectives are also likely to be met at the worst-case locations closest to the locomotives. There is therefore no requirement to declare an Air Quality Management Area.

6 References

Air Quality Expert Group, 2007. Trends in Primary Nitrogen Dioxide in the UK. December 2007.

Defra, 2003. Review & Assessment: Technical Guidance LAQM.TG(03).

Defra, 2007. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. July 2007. Cmd Paper No. 7169.

Defra, 2008. Review & Assessment: Technical Guidance LAQM.TG(08) Consultation Draft.

Stationery Office, 2000. Air Quality Regulations, 2000, Statutory Instrument 928.

Stationery Office, 2002. The Air Quality (England) (Amendment) Regulations 2002. Statutory Instrument 3043

Wyre Forest District Council, 2006. Updating and Screening Assessment. Bureau Veritas, May 2006. 23pp.

7 Glossary

Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal.
Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date, taking into account costs, benefits, feasibility and practicality. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides.
Exceedence	A period of time where the concentration of a pollutant is greater than the appropriate air quality objective.
AQMA	Air Quality Management Area
SO_2	Sulphur dioxide.
$\mu g/m^3$	Microgrammes per cubic metre.

8 Appendix 1 - Model Input Parameters and Scaling Factor

Table A1: Point Source Model Input Parameters

Source	Stack Location	Stack Height (m)	Stack Diam. (m)	Efflux Velocity (m/s)	Temp. (°C)	Nominal SO_2 Emission Rate (g/s)	Scaled SO_2 Emission Rate (g/s)[a]
Stack 1	379137, 275386	4	0.5	15	200	1.0	0.23
Stack 2	379251, 275339	4	0.5	15	200	1.0	0.23

[a] Determined as nominal emission rate / Scaling Factor presented in Table A2.

8.1 The model was run using two sets of meteorological data for comparative purposes. Separate model runs were performed utilising meteorological data for both the Elmdon (~39 km east of Bewdley) and Pershore (~33 km southeast of Bewdley) stations during 2007. Figures A1 and A2 indicate that both sets of meteorological data have a similar southwesterly contribution (the wind direction that would result in highest concentrations at the receptors of interest).

8.2 This maximum predicted hourly concentration (in 2007), assuming a 1g/s emission rate from the two locomotives, is 4.4 times greater than the maximum hourly value measured at the monitoring location during the same time in 2008 (Table A2).

Table A2: Calculation of Scaling Factor 11th August – 30th October

	Measured Maximum Hourly Concentration ($\mu g/m^3$)	Modelled Maximum Hourly Concentration ($\mu g/m^3$)	Factor
Monitoring Station 5 Maypole Close	53	232	4.4

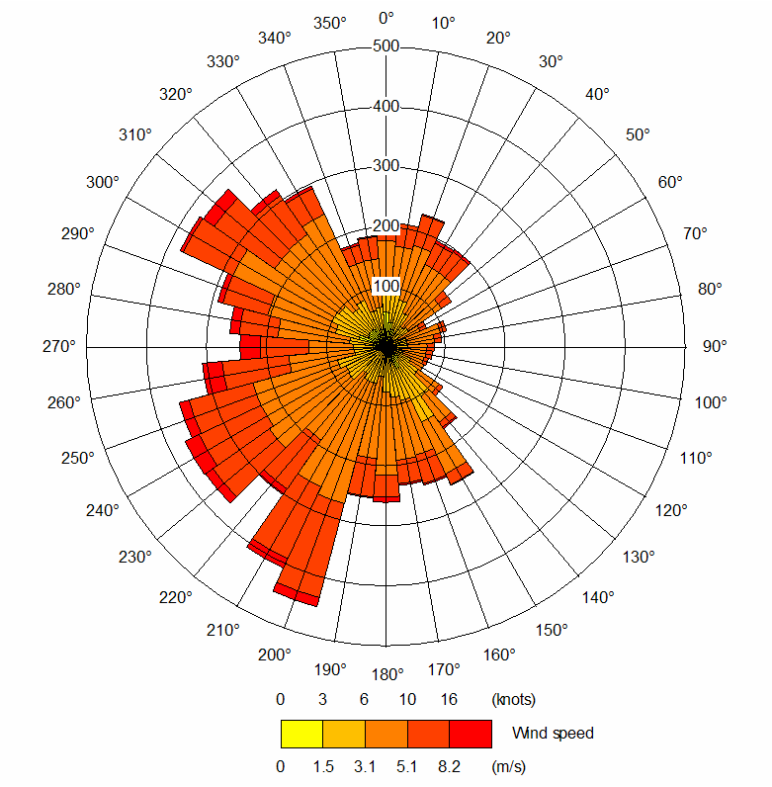

Figure A1: Elmdon Wind Rose 2007

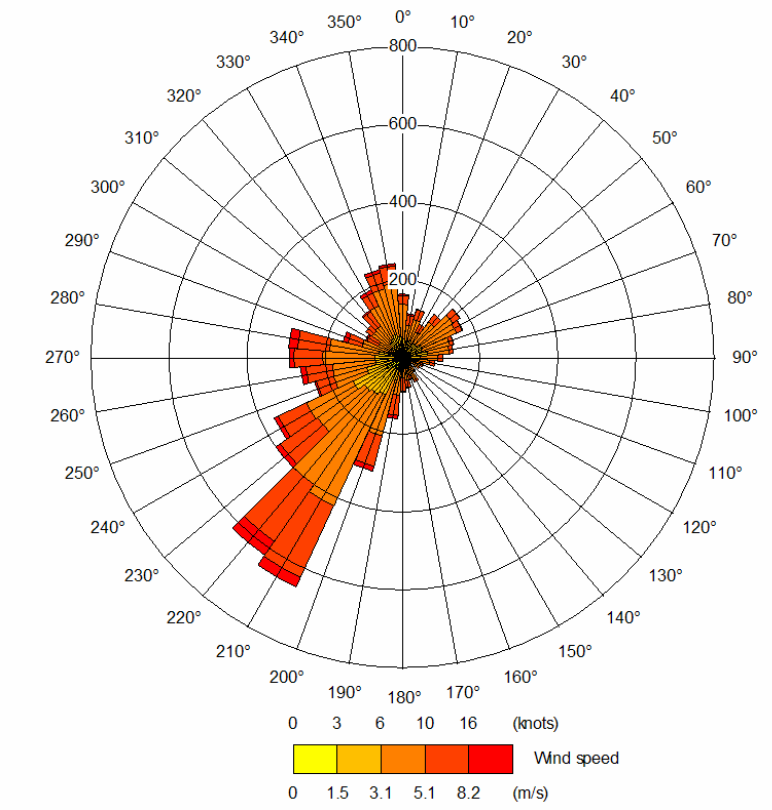

Figure A2: Pershore Wind Rose 2007

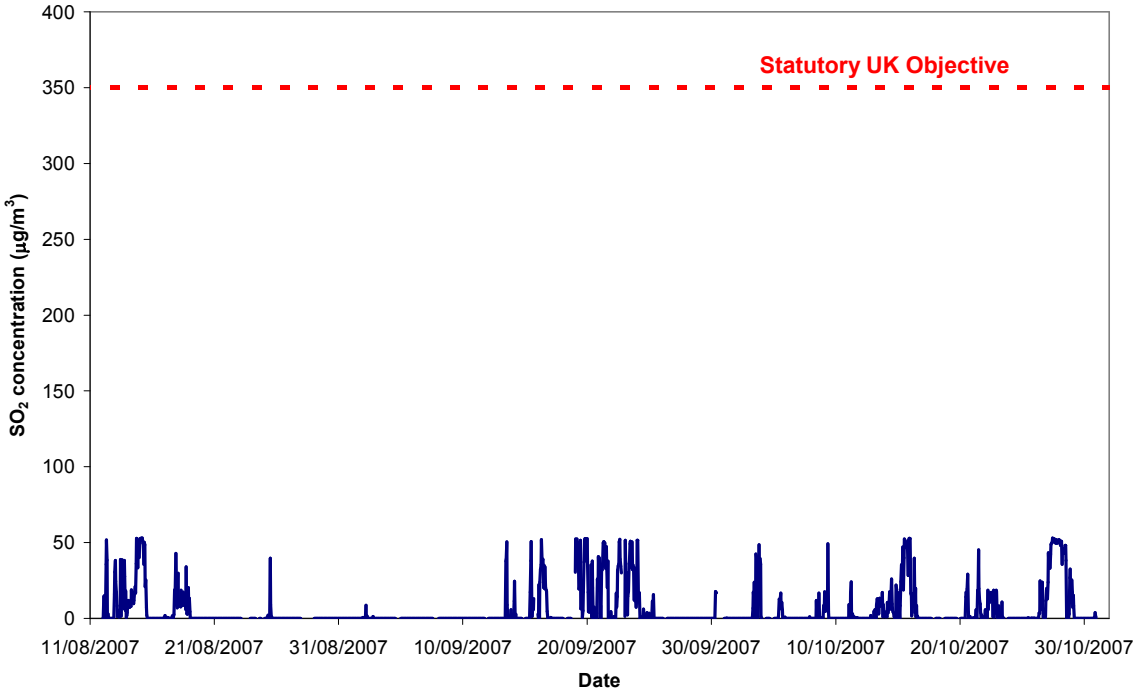

Figure A3: Scaled Modelled Hourly Concentrations at Monitoring Station for the period 11th August – 30th October 2007 (Elmdon Met Data)

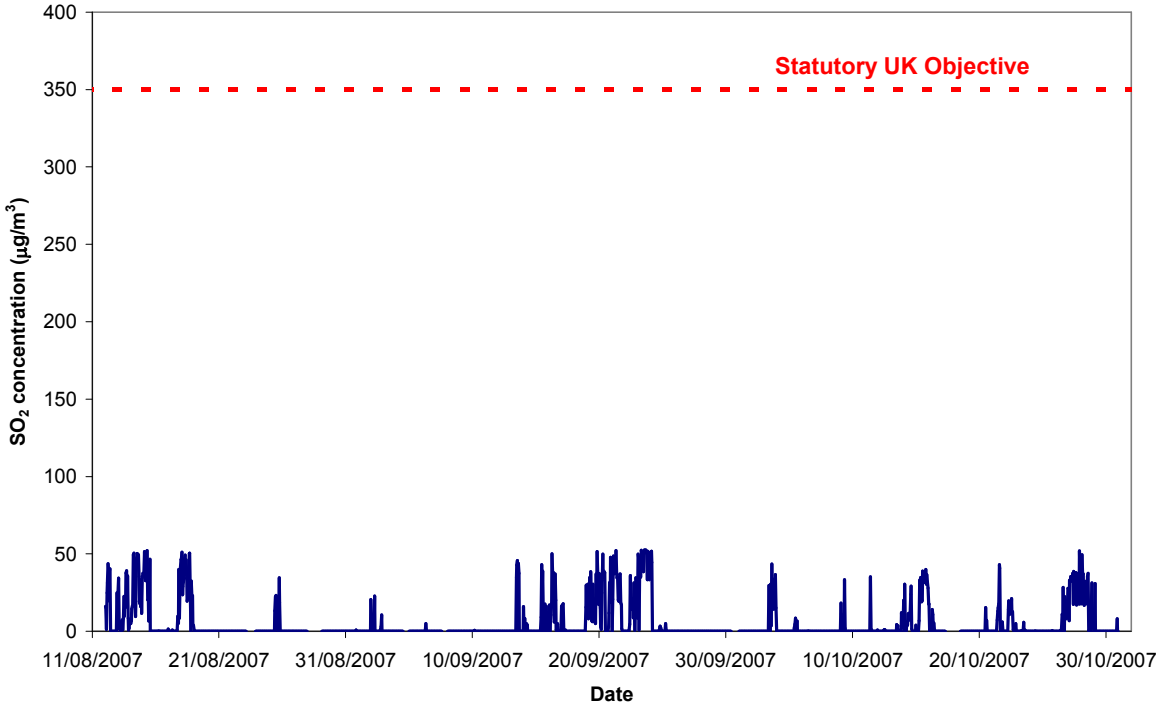

Figure A4: Scaled Modelled Hourly Concentrations at Monitoring Station for the period 11th August – 30th October 2007 (Pershore Met Data)

8.3 Both sets of adjusted modelled data presented in Figures A3 and A4 show a similar pattern of concentrations at the monitoring station. The pattern of concentrations is different from that measured at the same location (Figure 5), because the locomotives have been assumed in the model to be emitting constantly over the entire period. In reality, the trains operate between the hours of 9 am and 6 pm on the busiest days, when up to 20 trains use the station during the day.