Local Air Quality Management

Final Stage Review and Assessment

This Document is for Public Consultation.

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Review and Assessment of Air Quality

City of Sunderland and Borough of South Tyneside

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Summary

The City of Sunderland and South Tyneside Metropolitan Borough Council have undertaken a joint 3rd stage review and assessment of air quality in close collaboration with the other Tyne & Wear authorities.

The most significant sources of air pollution were identified and using monitoring data and modelling techniques the future concentrations of key pollutants were forecast to determine whether or not they will comply with the national air quality standards and objectives.

The conclusions to the review and assessment are as follows: -

- The annual running average concentration of benzene already meets the air quality objectives and should still do so in 2003.
- The annual running average concentration of 1,3 butadiene already meets the air quality objective and should still do so in 2003.
- The maximum 8 hourly running average concentration of carbon monoxide already meets the air quality objective and should still do so by 2003.
- The annual average concentration of lead already meets the air quality objective and should still do so in 2004.
- The 35th highest daily concentration of PM_{10} particles already meets the air quality objective and should still do so in 2004.
- The 35th highest 15-minute concentration of sulphur dioxide already meets the air quality objective and should still do so in 2005.
- The 24th highest hourly concentration of sulphur dioxide already meets the air quality objective and should still do so in 2004.
- The 3rd highest daily concentration of sulphur dioxide already meets the air quality objective and should still do so in 2004.
- The 18th highest hourly concentration of nitrogen dioxide already meets the air quality objective and should still do so in 2005.
- The annual average objective for nitrogen dioxide is met at present by busy roads and should still do so in 2005.

The air quality in Sunderland and South Tyneside is therefore likely to meet all the air quality objectives set out in the Air Quality Regulations 2000 and therefore Air Quality Management Areas will not have to be declared.

The City of Sunderland and Borough of South Tyneside therefore consider that: -

The air quality in Sunderland and South Tyneside, in 2005, is likely to meet all the air quality objectives set out in the Air Quality Regulations 2000.

The City of Sunderland and Borough of South Tyneside will therefore not need to take any local action under the Environment Act 1995, to control air quality within its area.

Local Authorities in England and Wales are required to carry out a further assessment of air quality by the end of 2003.

The City of Sunderland and Borough of South Tyneside will begin this second review immediately in order to build on the existing information and provide more robust information on traffic emissions and roadside pollution levels.

This report will be presented for public consultation in early 2001.

Introduction

UK air Quality has improved dramatically since the 1950's and 1960's and levels of pollutants are expected to continue to decrease as a consequence of national and EU policies. However, some areas remain at risk of experiencing high pollution levels, in particular those adjacent to heavily trafficked roads and certain industrial sources. Air pollution does not normally have a serious effect on healthy people, but there is some evidence that premature death, chronic illness and discomfort may be experienced in sensitive groups such as the old and very young.

Existing legislation was not capable of providing satisfactory air quality without placing stringent constraints upon certain sectors. As a result the system of Local Air Quality Management was introduced under the Environment Act 1995 to assess air quality in a particular area and instigate local improvement or action plans.

The Character of Tyne & Wear

The Tyne & Wear region covers an area of 54,006 hectares, with a population of 1.134 million. The conurbation centres around two major rivers with a mixture of large urban and rural areas.

A substantial rail and road network covers the region, which includes a number of motorways and trunk roads, primary roads, principal roads and other classified and non-classified routes. A comprehensive network of bus services operates in Tyne & Wear, as well as a Metro light rail network. Both regional and national rail systems and freight also operate. Passenger ferries and freight shipping services operate from the Port of Tyne and cargo traffic enters and leaves the Port of Sunderland.

Cars form the bulk of traffic on the roads - car ownership in Tyne & Wear increased by about 44% between 1980 and 1996, broadly in line with national trends. If existing trends continue, further substantial increases in car ownership can be anticipated. This, together with the expected increase in commercial traffic will lead to greater pressure on the road system. Traffic flows vary throughout the region and build up in the inner urban areas.

Air quality in Tyne & Wear may also be influenced by sources external to the region, notably power generation and metal refining activities. The region is bounded to the east by the North Sea, which is considered to be a source of natural particulates - sea salt- that contribute to the overall particulate level in the region.

The National Air Quality Strategy

During the 1990's, the Department of the Environment, Transport and the Regions (DETR) investigated the need for a framework for air quality management. This has been fuelled by recent episodes of poor air quality in many of the UK's major urban areas and increasing concerns expressed by the public and scientific community. The need to reconcile rising demands in living standards with better environmental quality has already been recognised in Local Agenda 21 (a local plan on how to make development socially, economically and environmentally sustainable), and is now taken further with the National Air Quality Strategy.

The main elements of the strategy are: -

> Health based air quality standards and objectives, to act as reference points by which policies are directed
>
> A target of between 2003 and 2008 for achievement of the objectives
>
> Policies for meeting those objectives including an assessment of the improvements already expected under current policies, and how those policies need to be supplemented
>
> The contribution key sectors, in particular industry, transport and local authorities, can make towards the cost effective achievement of these objectives
>
> A commitment to review the strategy every three years

National Air Quality Standards

The air quality standards set acceptable concentrations of the pollutants in the atmosphere, based on an assessment of the effects of each pollutant on public health. In setting these standards the Government has accepted the judgement of the Expert Panel on Air Quality Standards regarding the levels of pollutants at which there would be an extremely small or no risk to human health. Where no recommendation has been made by the Panel, the standards have been derived from work undertaken by the World Health Organisation

Review and Assessment of Air Quality

Under Part IV of the Environment Act 1995 local authorities are required to review and assess air quality in their areas to identify areas where air quality is unlikely to meet the objectives prescribed by the Air Quality Regulations 2000 within the relevant periods

The Government has recommended a phased approach to the review and assessment process, the intention being that local authorities only undertake as much work as necessary dependent upon the extent of the air quality problems in their area.

The Act requires that local authorities review the air quality in their areas with regard to seven specified pollutants; nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon dioxide (CO), lead, fine particles (PM_{10}), benzene, and 1,3-butadiene. The Governments Expert Panel on Air Quality Standards (EPAQS) has recommended air quality standards for these pollutants based upon their health effects. These have been translated into a set of statutory objectives, which must be met between 2003 and 2008 dependent upon the pollutant.

Where a local authority finds that a prescribed objective is likely to be exceeded it must declare an Air Quality Management Area and draw up an action plan identifying changes that will be necessary to improve air quality.

Objectives laid down in Regulations for the purposes of LAQM

Pollutant	**Objective Concentration**	**To be achieved by Measured as**	
Benzene	16.25ug/m^3 (5ppb)	running annual mean	31 Dec 2003
1,3-Butadiene	2.25ug/m^3 (1ppb)	running annual mean	31 Dec 2003
Carbon Monoxide	11.6mg/m^3 (10ppm)	running 8 hour mean	31 Dec 2003
Lead	0.5ug/m^3 0.25ug/m^3	annual mean annual mean	31 Dec 2004 31 Dec 2008
Nitrogen Dioxide	200ug/m^3 (105ppb) not to be exceeded more than 18 times a year	1 hour mean	31 Dec 2005
	40ug/m^3 (21ppb)	annual mean	31 Dec 2005
Particles (PM_{10})	50ug/m^3 not to be exceeded more than 35 times a year	24 hour mean	31 Dec 2004
	40ug/m^3	annual mean	31 Dec 2004
Sulphur dioxide	350ug/m^3 (132ppb) not to be exceeded more than 24 times a year	1 hour mean	31 Dec 2004
	125ug/m^3 (47ppb) not to be exceeded more than 3 times a year	24 hour mean	31 Dec 2004
	266ug/m^3 (100ppb) not to be exceeded more than 35 times a year	15 minute mean	31 Dec 2005

Review and Assessment in Tyne & Wear

During 1998 all UK local authorities commenced reviews of their air quality to identify any local problems arising from these pollutants. The five local authorities in Tyne & Wear commenced an initial, first stage screening process reviewing the potential significant sources of each of the identified pollutants.

The first stage review and assessment of local air quality eliminated certain sources of atmospheric pollution and one pollutant from the review and assessment process. Sources of relevant pollutants, which may be significant because of their locations and emission characteristics, were identified for further assessment.

It was established that for one of the relevant pollutants, 1,3-butadiene, no further investigation or assessment was necessary and therefore this pollutant was not subjected to further study during the second stage process.

The remaining six pollutants of local interest and possible significance to be further assessed were identified as nitrogen dioxide, sulphur dioxide, carbon monoxide, benzene, lead and fine particulates (PM_{10}).

The identified pollutants result from emissions to air from road traffic and also originate from fixed industrial and other sources both within and outside the region. Emissions of lead and benzene in significant quantities and concentrations are known to be associated primarily with industrial processes and activities, and are localised as a result. The remaining pollutants, in addition to their possible industrial origins are also associated with major road systems with high traffic flows or which suffer from severe congestion.

The second stage review and assessment involved additional monitoring, simple modelling of road traffic sources, completion of an emission inventory, GIS mapping of significant sources and sensitive receptors together with further discussions with process operators. Where the second stage screening indicated that the relevant air quality objective may not be met by the relevant future year then a third stage review and assessment was undertaken.

Where the third stage was found to be necessary, the pollutants and their significant sources were examined by the use of continued monitoring, emissions inventories and the use of a more complex urban atmospheric dispersion modelling system (ADMS –Urban version 1.53).

Following the framework laid down in the DETR’s technical guidance document: *Local Air Quality Management* (LAQM) TG1. (00), the third stage review and assessment of local air quality is presented in this study for Sunderland and South Tyneside.

Review and Assessment of Benzene

Introduction

Benzene is a volatile aromatic hydrocarbon, which at normal ambient temperatures is a liquid but evaporates readily and is known to be a human carcinogen. The main sources of benzene in the atmosphere in Tyne and Wear are:

- Motor vehicle exhausts
- Emissions from petrol stations
- Emissions from petrol storage and distribution depots

Emissions from petrol transfer at retail and distribution sites are now effectively controlled by vapour recovery equipment and are regulated via authorisations issued under LAPC.

Air Quality Standard and Objective

The Government has adopted a running annual mean of 16.25 $\mu g/m^3$ (5ppb) as an Air Quality standard for benzene with the objective of achieving this by the end of 2003. For the annual objective, the focus of the review and assessment should be on non-occupational exposure at near ground level outdoor locations including:

- Background locations
- Roadside locations
- Other locations where people may be regularly exposed, such as in the vicinity of housing schools and hospitals.

The National Perspective

Motor vehicles accounted for 64% of total UK benzene emissions in 1996 and industrial processes accounted for 15%. The National Air Quality Strategy lays out the government's expectation that existing national policies, such as improvements in engine design and vehicle emission controls, together with petrol station and storage terminal vapour-recovery systems, will deliver the air quality objective even adjacent to the most heavily trafficked routes. Areas that may be affected by local industrial sources will, however, require further investigation.

Background benzene concentrations

The map (Figure 3.1) below illustrates the variations in estimated benzene background concentrations across the UK. These maps are published by the DETR on their web site and are based on work by Stedman, Linehan *et al* (1998). The benzene concentrations have been calculated on a 5 x 5 km scale.

The data identifies background concentrations for Sunderland and South Tyneside as lying in the range 0.83 to 4.875 µg/m3 (0.255 to 1.50 ppb).

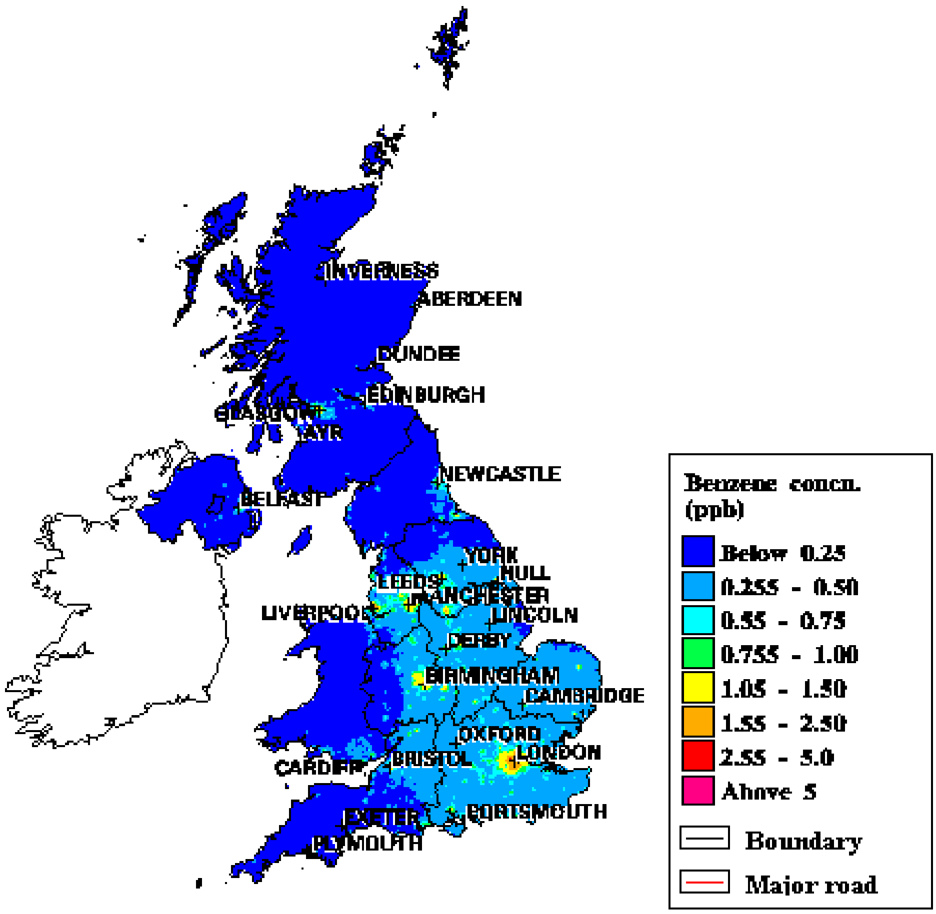


Figure 3.1: Background Benzene Concentrations in the UK

Sources of benzene in Tyne and Wear

The urban emissions inventory commissioned in 1998 by the Tyne and Wear authorities quantified the spatial distribution of benzene emissions across the urban area.

Figure 3.2 sets out the results of the exercise plotted over a map of the three southern authorities of Gateshead, South Tyneside and Sunderland.

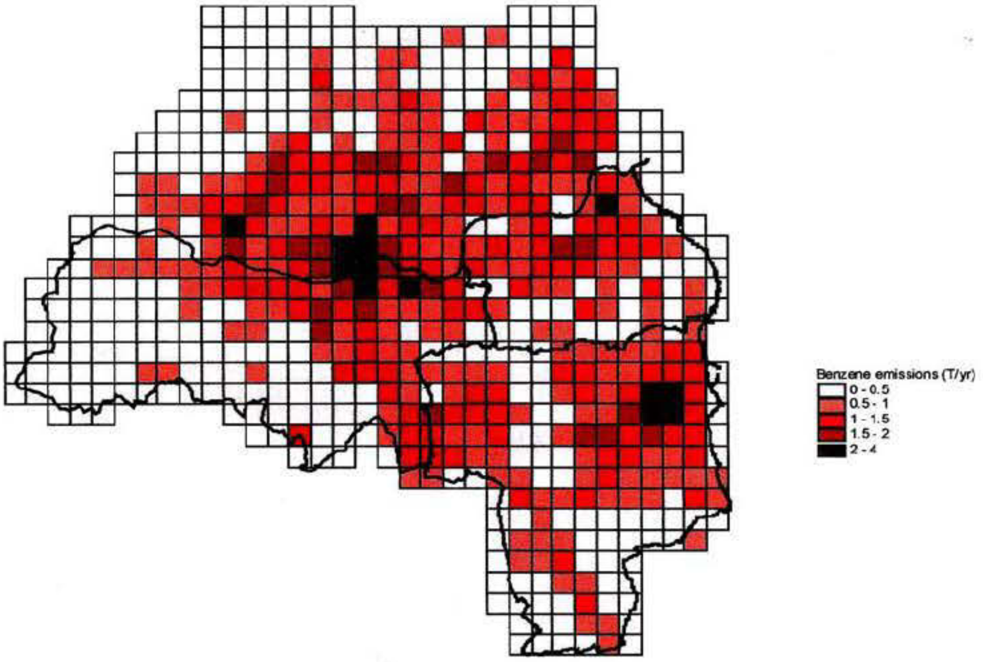


Fig 3.2 Emissions of benzene in Tyne and Wear - 1998

Examination of the Inventory suggests that whilst road traffic makes up the greatest proportion of benzene emissions, there are areas where industrial and other sources contribute to a noticeable extent. Only by inputting the actual emission data into a dispersion model can these figures be turned into meaningful information. To aid interpretation the darkest squares, represent emissions of greater than 2-tonnes/ sq km/annum and are mainly the result of road traffic sources.

The apportionment of total benzene emissions by category across Tyne and Wear is set out in Figure 3.3 below.

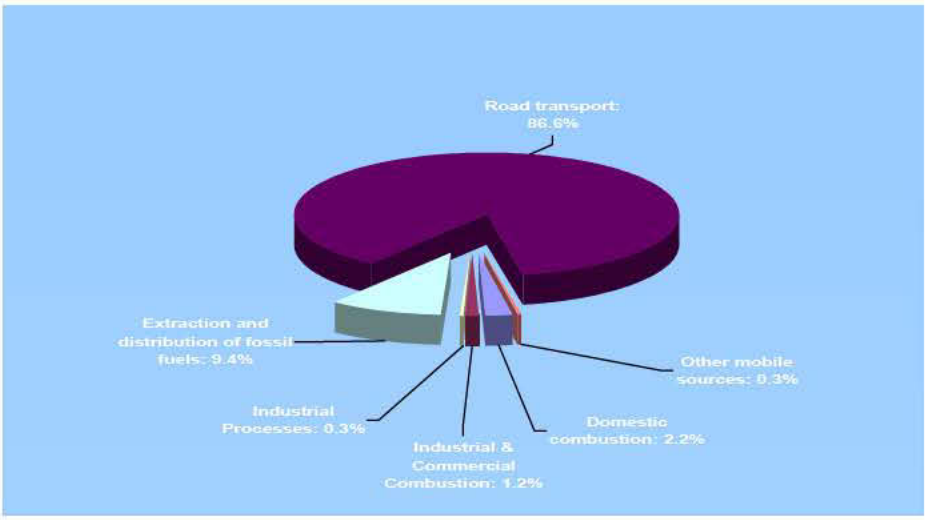


Figure 3.3: Benzene Sources in Tyne and Wear in 1998

The Situation in the City of Sunderland and the Borough of South Tyneside

The first stage review concluded that the air quality objective was unlikely to be exceeded due to emissions from road transport and petrol filling stations, but it did identify one Part A process (a waste solvent reprocessing plant) and a petrol storage facility in the Sunderland area, and another petrol distribution depot in South Tyneside as being potential significant point sources.

Stages 2 and 3 of the review have involved a more accurate and detailed review of pollutant levels in the vicinity of these sites, the examination of past monitoring data across the area, and the prediction of future benzene concentrations using ADMS-Urban and utilising the emissions data from the Tyne and Wear urban emissions inventory.

Previous work as part of the Phase One research study for DETR focused on petrol retail and distribution sites, and confirmed short term (10 weeks) mean values well below 16.25 $\mu g/m^3$.

Table 3.1: Diffusion tube data for 1996-99

SITE LOCATION	1999	RUNNING ANNUAL MEANS (ug/m^3) 1998	1997	1996	Site Classification
Westoe Rd, S/S	3.40	4.47	4.97	2.79	**Roadside**
Front St, E/B	2.50	4.97	4.04	2.15	Roadside
Central Library	2.25	2.54	2.97	2.18	Backgnd
Market S/S	1.97	2.50	2.65	2.11	Roadside
Front St, Whitburn	4.11	5.97	4.89	3.90	Roadside
Follonsby Lne, Wardley	1.61	1.75	3.15		Backgnd
Follonsby Tce, Wardley	2.61	2.65	2.75	1.65	Roadside
Priory Rd, Jarrow	3.86	5.54	3.36	3.54	Petrol storage
Salcombe Ave	2.25	2.29	2.54		Backgnd
Mill Dam, S/S	3.75	2.40	2.65		Backgnd
Tyne Dock	3.47	4.86			Roadside
Newcastle Rd	2.79	3.22			Roadside
Jarrow Civic			2.15	2.22	Backgnd
Broughton Rd			1.61	1.72	Backgnd
Hebburn Civic			4.11	2.25	Backgnd

Table 3.1 presents the results of diffusion tube monitoring for several sites over the period 1996 to 1999, with site classification. The original data has been corrected to represent the running annual mean, and data highlighted in

yellow represents the max value for the monitoring period. The site highlighted in blue sets out the results for the petrol distribution depot identified in the first stage review for South Tyneside, and it can be seen that benzene levels fall well below that specified in the air quality objective.

This monitoring has been supplemented in 2000 by short term (5 months) ambient assessment of benzene concentrations using diffusion tubes and gas chromatography. The work confirmed mean values no higher than 2.47 μg/m3 (0.76 ppb).

Table 3.2 below sets out the results of monitoring in the vicinity of the South Tyneside petrol storage depot for 1999.

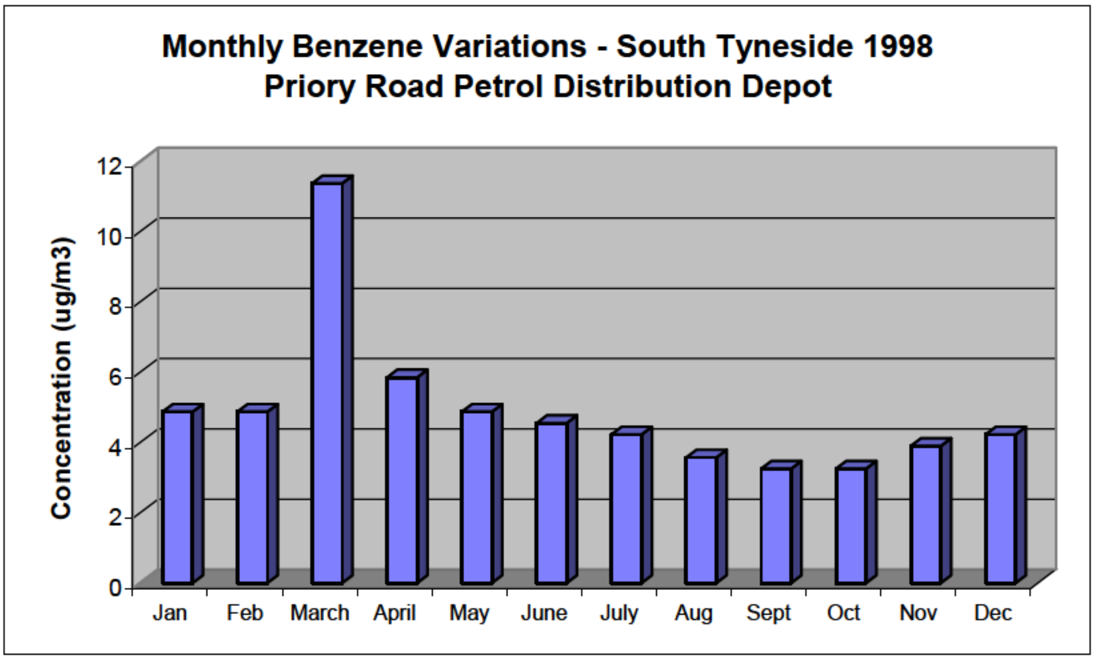
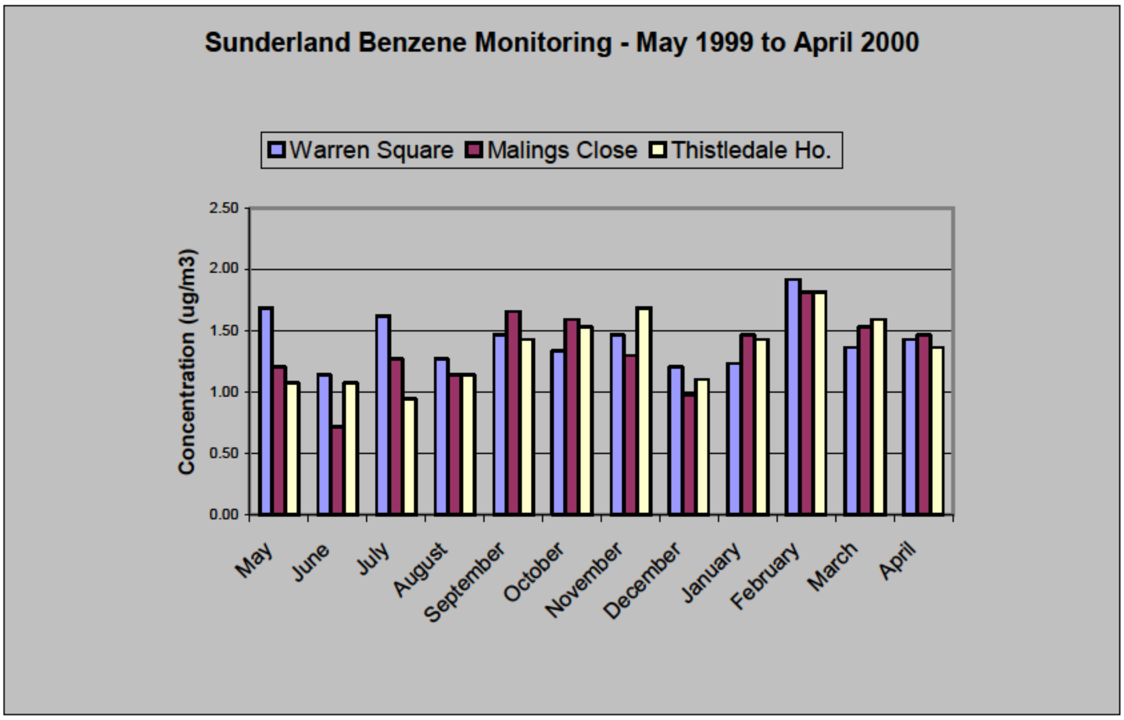


Table 3.2 Priory Road benzene levels

Diffusion tube surveys were undertaken during 2000 at three residential locations adjacent to the Port area of Sunderland, where both potential significant sources are located. The results are shown in Table 3.3 below; the highest monthly mean is 1.92 $\mu g/m^3$.

Table 3.3

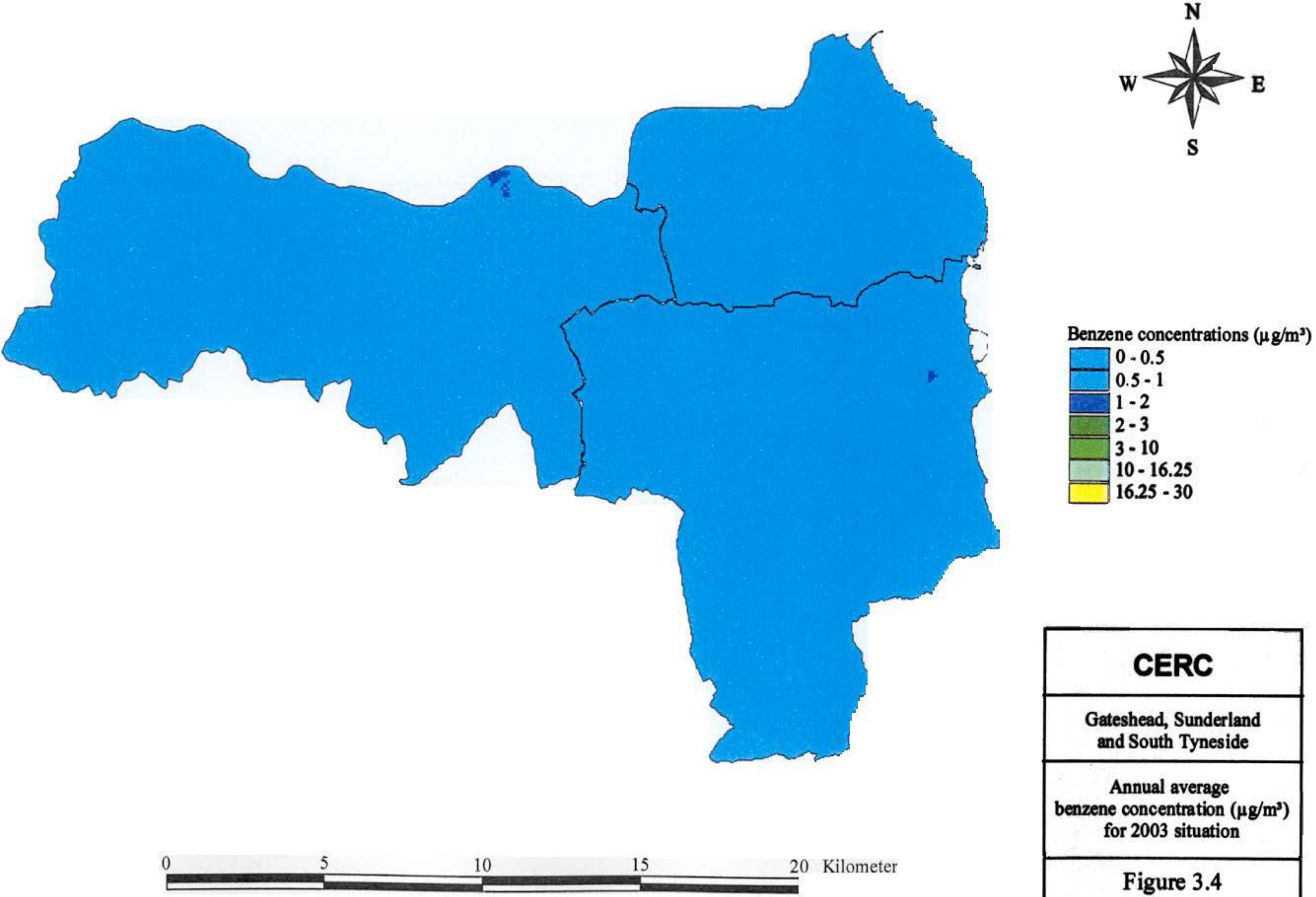


Atmospheric Dispersion Modelling

Following the construction of the Tyne and Wear Urban Emissions Inventory data was inserted into ADMS-Urban version 1.53 and predictions calculated for 2003. Table 3.3 demonstrates that the Air Quality Objective for Benzene in Sunderland and South Tyneside will be achieved; levels for Sunderland City Centre are predicted to fall to below 2.0 μg/m3 by 2003, with no variations above the range 0.5 to 1.0 μg/m3 in all other areas of the two Authorities This is shown in Fig 3.4. The modelled predictions for the current situation are reasonably close to actual measured values, and there is a degree of confidence in the predictions for 2003.

Conclusion

The investigation of ambient benzene concentrations within Tyne and Wear prior to, and during, the first stage of the review process generally ruled out the possibility of any breach of the air quality objective due to emissions from road transport and petrol filling stations. This conclusion is supported by work elsewhere, by the National Air Quality Strategy predictions, and by the results of ambient monitoring within South Tyneside in 2000 when short term surveys (including gas chromatography) confirmed mean values no higher than 2.47 ug/m^3. Estimated reductions in traffic emissions would reduce this to approximately 1.6 ug/m^3 by 2003.



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Annual average benzene concentration (µg/m³) for 2003 situation

Figure 3.4

The Stage 1 review identified only three potential significant point sources of benzene in the two authorities' areas. Assessment of operational practices indicates that emissions are adequately controlled and are unlikely to pose any risk in relation to the air quality objective. This presumption is supported by the results of monitoring in the vicinity of the sites and by the results of the dispersion modelling exercise.

Monitoring within the areas of the City of Sunderland and the Borough of South Tyneside has broadly supported the predictions of ADMS-Urban, which predicts that the statutory air quality for benzene will be met within all areas of the two Authorities.

Thus the City of Sunderland and the Borough of South Tyneside conclude that there will be no need for local action in relation to ambient benzene concentrations.

Review and Assessment of Carbon Monoxide

Introduction

Carbon monoxide (CO) is an atmospheric pollutant normally emitted as a result of incomplete combustion of carbon fuels. It may also be formed by the oxidation of hydrocarbons and other compounds. In urban areas carbon monoxide is most significantly produced by road traffic and may survive in the atmosphere for around a month before being oxidised to carbon dioxide (CO_2). At lower concentrations CO may carry a risk of heart problems in certain vulnerable individuals due to the reduction in the oxygen carrying capacity of the blood. Outdoor concentrations can increase to levels sufficient to affect human health.

Standards and Objectives for Carbon Monoxide

The Government has adopted an 8-hour running average of 11.6 mg/m3 (10ppm) as an air quality standard for CO, with the statutory objective being achievement of this target by 31 December 2003. The focus of the review and assessment for carbon monoxide is non-occupational, near ground level outdoor situations including background locations, roadside locations, and other areas where a person might reasonably expect to be exposed over an 8-hour period (e.g. in the vicinity of housing, schools and hospitals.)

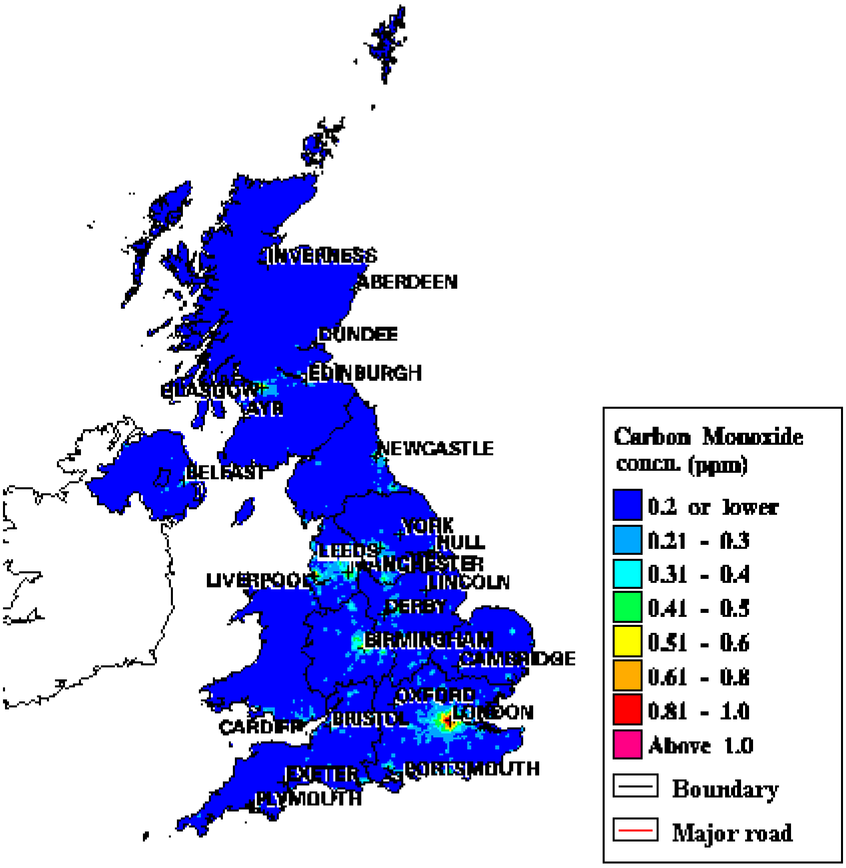
National Perspective

In the UK, road transport accounted for 71% of the total emission of 4.6 million tonnes of carbon monoxide in 1996. Such sources contribute a large proportion of the total carbon monoxide levels in large cities and higher 8-hour average concentrations are therefore expected near busy and congested roads. There is a large year-to-year variability in the maximum running 8-hour average and exceedances of the air quality standard for CO were observed in one or more years at Belfast, Birmingham, Glasgow, Manchester and London. Levels have decreased over the period 1990-1997 and, in 1996, there were no exceedances of the standard at these sites. Existing national policies are expected to deliver the national air quality objective by the end of 2003, except near heavily used roads, or in the vicinity of certain stationary sources. Industrial emissions account for only a small proportion of the total, though this would not discount their impact if in the close proximity of vulnerable receptors.

Background carbon monoxide concentrations

The map (Figure 4.1) below illustrates the variations in estimated background concentrations of CO across the UK. The map is published by DETR on their web site, being based on work by Stedman, Linehan *et al* (1998).

Fig. 4.1 Background CO concentrations in the UK



Examination of the map in finer detail reveals background concentrations for Sunderland and South Tyneside lie in the range 0.24 to 0.58 mg/m^3 (0.21 to 0.5 ppm).

Sources of carbon monoxide in Tyne & Wear

The 1998 Tyne and Wear Emission Inventory has identified the emissions of CO across the region, quantifying in terms of tonnes/sq. km/annum, and apportioning total emissions against certain source categories. The results of the inventory are summarised in Figures 4.2 and 4.3. Closer examination of the maps reveals that the most significant areas of emission (ie greater than 400 tonnes/sq km/annum) are attributable to road traffic.

Fig 4.2 CO sources in Tyne and Wear

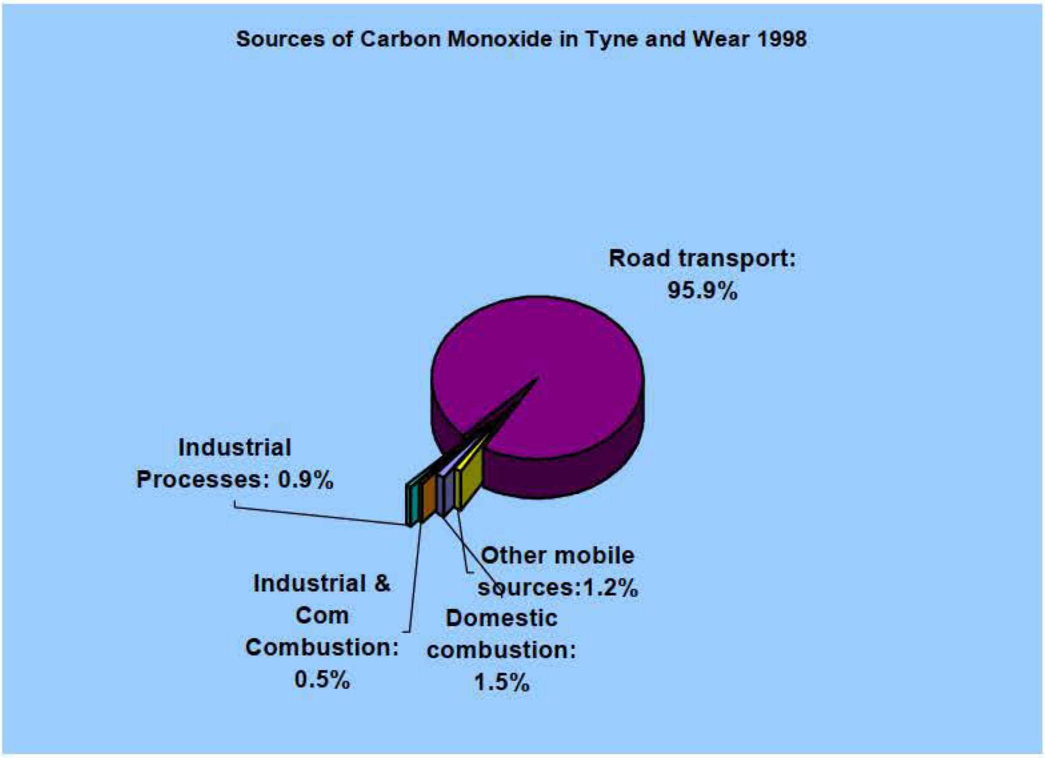
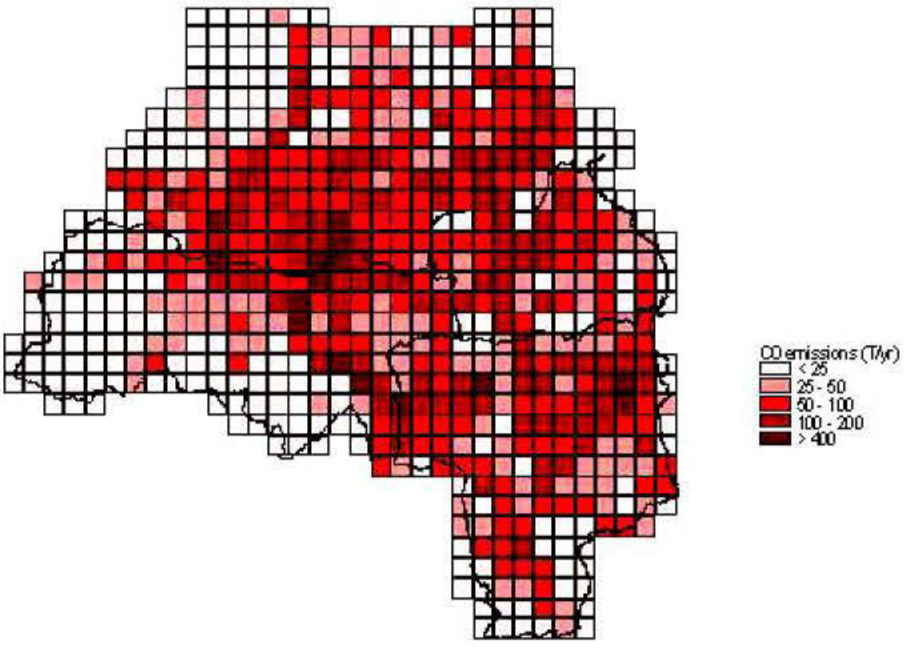


Fig 4.3 Tyne and Wear Emissions 1998



The Situation in Sunderland and South Tyneside

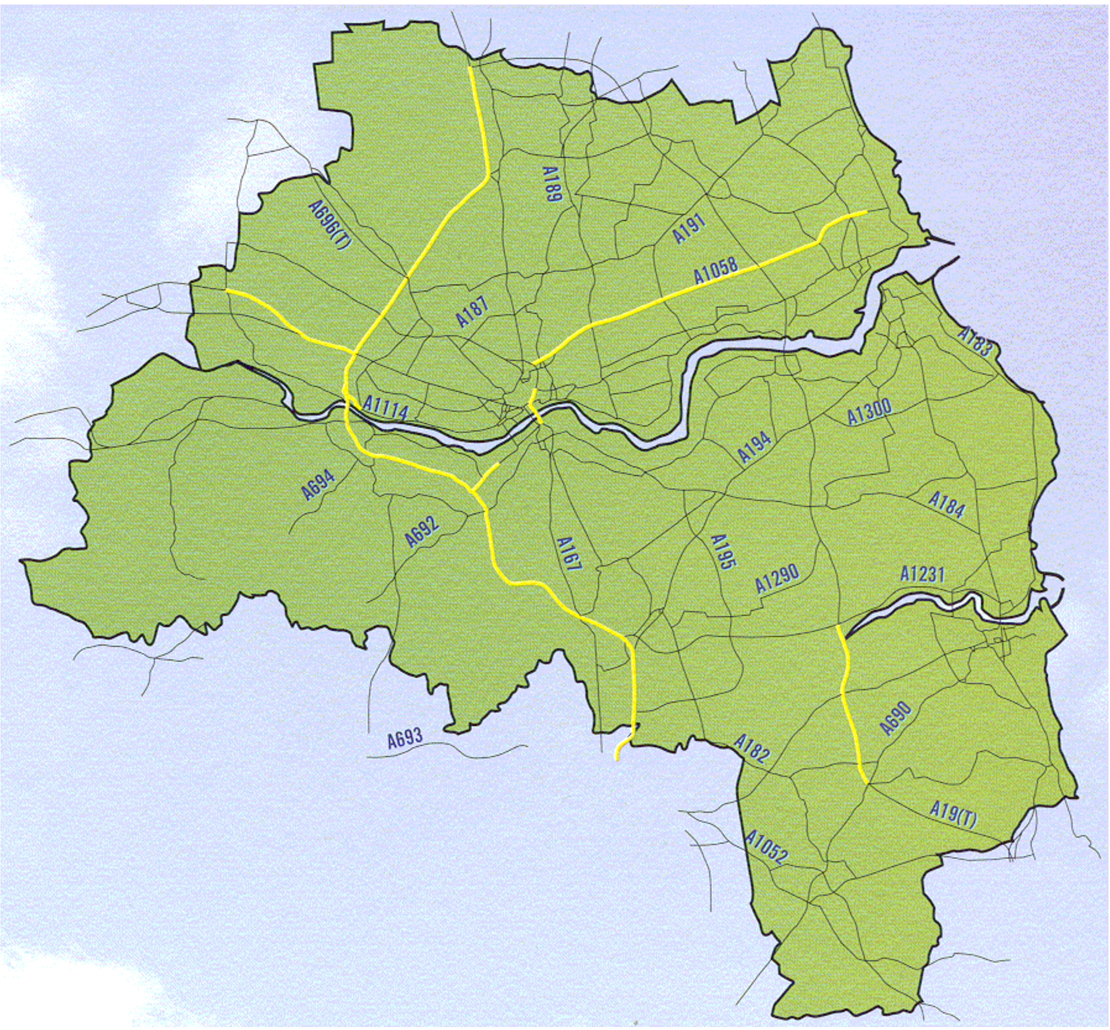
The conclusions of the Stage 1 Review in relation to Tyne and Wear generally were:

- A number of part A and B processes and car parks have the potential to emit significant quantities of CO
- There are a number of existing roads with existing or forecast average daily traffic flows above the 50,000 vehicles per day threshold

Due to these factors, and the lack of monitoring data, it was decided to proceed to a further stage of the review and assessment.

In relation to Sunderland and South Tyneside stage 1 identified only three potential significant sources of CO and the emissions inventory identified three $1km^2$ sectors where carbon monoxide emissions exceed 400 tonnes per annum. Additionally, it was possible to identify the following highways exceeding the threshold for investigation:

Figure 4.4 Roads in Tyne and Wear exceeding 50,000 vehicles a day aadt in 2005



Stage 2 and 3 of the review process has focused upon these issues, further investigating both current (measured) levels of CO, establishing the emission sources from the results of the Urban Emissions Inventory, and predicting future levels through atmospheric dispersion modelling (using ADMS Urban version 1.53).

During Stage 1 it was recognised that there was little local data within Tyne and Wear relating to ambient CO concentrations. However, analysis of data obtained from the Newcastle Centre AURN station illustrates that typical levels fall well below that specified within the Air Quality Regulations 2000. Additionally, whilst the Stage 1 conclusions raised issues in relation to certain point sources, and high-flow traffic routes, within the boroughs of Sunderland and South Tyneside these are extremely limited in extent. Only three point sources lie within our boundaries (Nissan, CMR and Viasystems) together with only three links of the A19 trunk road. Investigations (both through local enquiries, screening and inclusion of emission profiles within the ADMS dispersion model) have satisfied the authorities that these sources are very unlikely to contribute to exceedances of the statutory objective for CO. The highway links were included explicitly with the traffic model which supported the development of the Inventory and provided data for ADMS-urban.

Over recent years the Tyne and Wear Air Quality Management Group have invested much effort in developing several mobile continuous monitoring stations, though not all are provided with the ability to monitor CO concentrations. However, effort has been made to both verify, in part, the Model's forecast and to provide a clearer picture of actual ambient carbon monoxide concentrations. The Tyne and Wear authorities supported limited investigations, using continuous automatic analysers. The data acquired is set out in figures 4.5 and 4.6, and shows comparisons of the AURN station at Newcastle Centre with the South Tyneside mobile station (sited on Western Approach in South Shields – 35,000 vehicles aadt) and identifies the results of monitoring on the A1 Western By-pass (approximately 110,000 vehicles aadt).

Fig. 4.5 Comparison of 24 hr mean values

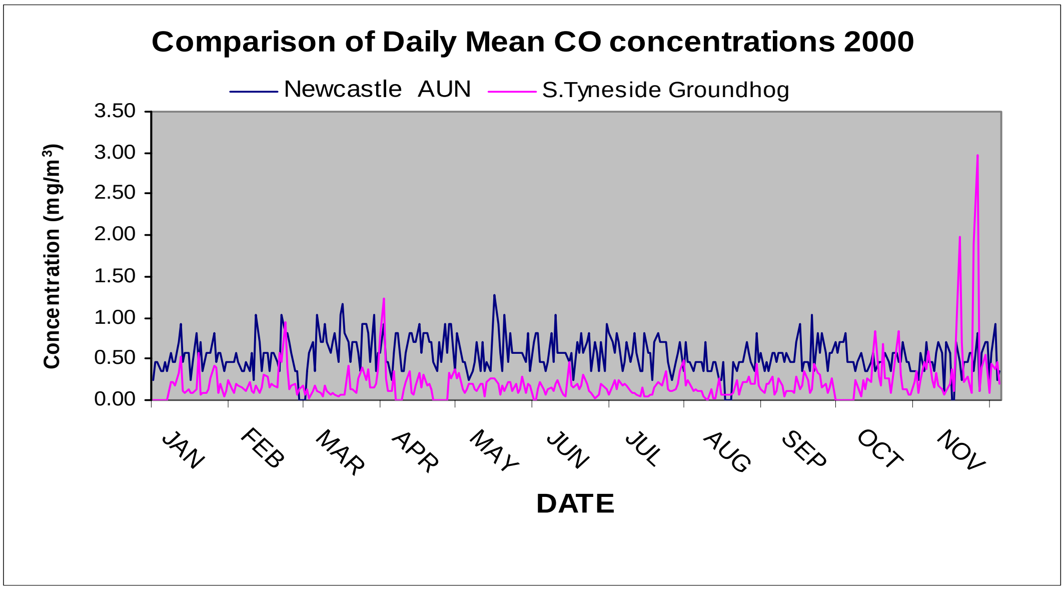


Fig. 4.6 Real-Time Monitoring of CO adjacent to the A1 Team Valley, May – Oct 1999

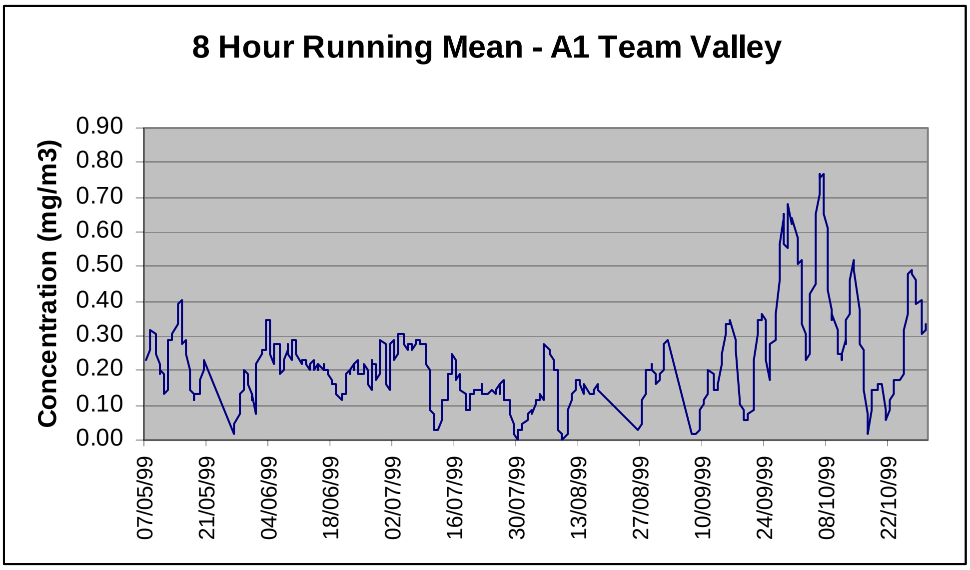


Figure 4.7 sets out the year on year monthly means for the AURN site at Newcastle Centre, and figure 4.8 confirms the overall downward trend in maximum 8 hr running means.

Figure 4.7 Newcastle Centre AURN monthly means – variation by year

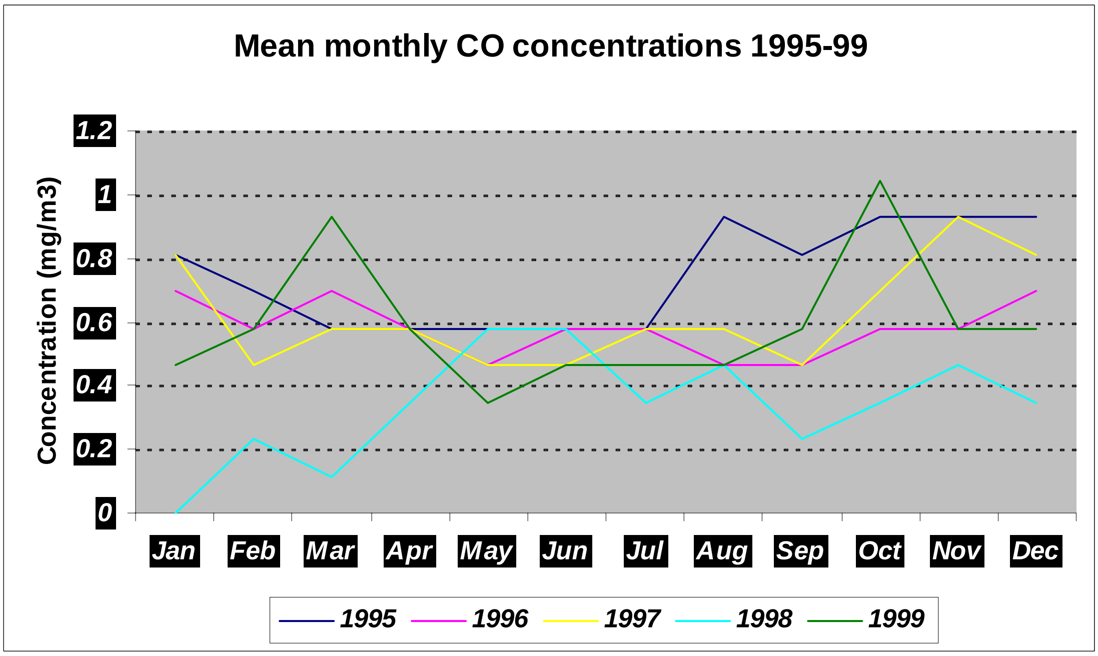
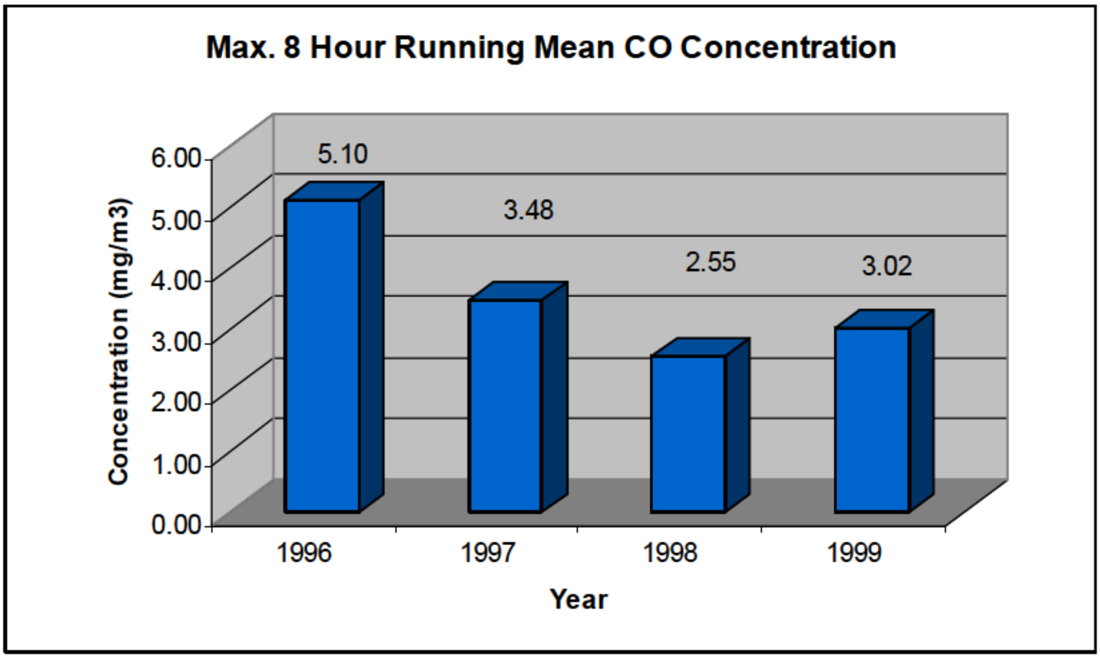


Figure 4.8: Newcastle Centre AURN yearly max. values



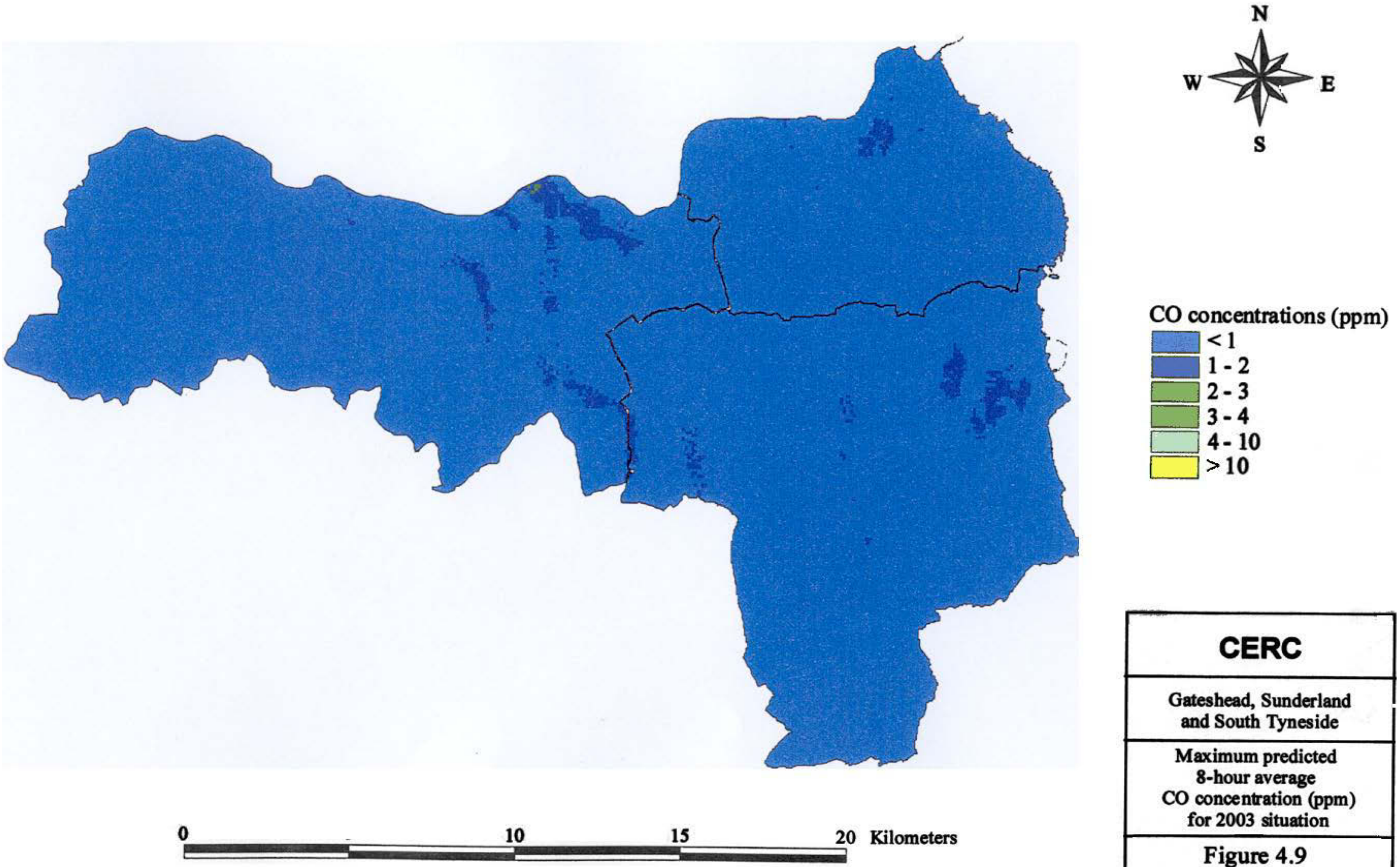
Data capture 1999= 91%; 1998= 95%; 1997= 96.5%; 1996= 97%

Additionally, data obtained from the Sunderland Bridge Street station over the period August 1998 to February 1999 highlights the maximum 8 hr running mean as 6.03 mg/m^3, measured in December 1998.

Atmospheric dispersion modelling

The utilisation of the 1998 Urban Emissions Inventory data for the development of a dispersion model for the southern authorities of Tyne and Wear has provided a relatively up to date base of information from which to predict future levels of CO. CERC were contracted to carry out the necessary work, reporting on predicted concentrations of CO against the current AQ objective.

The resultant map is included as Fig 4.9. Predicted concentrations for the current year fall below the Air Quality objectives. Comparison with average 8 hour values for the Western Approach Road site show the model to overestimate by a factor of four, predicting values in the range 1.16 to 3.48 mg/m3 compared to measured concentrations of approximately 0.45 mg/m3. The maximum running 8-hour mean for this site is 4.33 mg/m3, being still well below the objective.



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Maximum predicted 8-hour average CO concentration (ppm) for 2003 situation

Figure 4.9

Conclusion

Analysis of the available monitoring data for stations within Sunderland and South Tyneside, together with the Newcastle Centre AURN site and the Gateshead monitoring station on the A1 Western By-Pass indicates that there should be no areas of Sunderland or South Tyneside which come near to breaching the air quality objective, either now or in 2003.

The continuous carbon monoxide monitoring carried out at the Newcastle AURN site and the Gateshead groundhog unit show that currently there is no exceedance of the 8-hour running mean in the City Centre or along the A1 corridor where there is a daily flow of 110,000 vehicles. The last AUN exceedance was in 1995.

Dispersion modelling work also confirmed that there is not likely to be any exceedance of the 8-hour mean in 2003 for any of the road links identified in the stage 1 review as being potential sources of excursion from the NAQS objective. The modelling work also showed that there was not likely to be a breach of the carbon monoxide standard at any other location within the two boroughs.

It is therefore concluded that air quality within the areas of the City of Sunderland and the Borough of South Tyneside will meet the statutory air quality objective, and no local action will be necessary with respect to this pollutant.

Review and Assessment of Airborne Lead

Introduction

Lead is the most widely used non-ferrous metal occurring as an element or as alloys and compounds. Emissions of lead are in the form of fume or particulates with diameters ranging from 0.015 μm (as emitted by petrol engines) to between 0.1 and 5.0μm depending upon source. A proportion of lead in the atmosphere is due to the erosion of mineral ore, however the greatest proportion of lead found near ground level in Britain is directly as a result of human activity.

Sources of airborne lead include industrial processes such as manufacturing of batteries, paints and pigments and the refining of metals. Combustion of coal and other fossil fuels have also contributed to the levels of airborne lead but by far the greatest contribution until the late 1990's has been from the combustion of tetraethyl lead, an additive used to improve the combustion efficiency of motor vehicle petrol engines.

Air Quality Standard and Objective

The Government has adopted a running annual mean of 0.5 $\mu g/m^3$ as an air quality standard for Lead, with the objective of meeting that standard by the end of 2004. In addition, a tighter Air Quality Objective of 0.25 $\mu g/m^3$ is to be achieved by the end of 2008. The review and assessment has focused on non occupational exposure at near ground level outdoor locations including:-

- Background locations
- Other locations where people may be regularly exposed, such as in the vicinity of housing, schools or hospitals.

The National Perspective

The adverse effect on human health has been recognised nationally and was the motivation for the reduction and final prohibition of the use of lead as an additive in petrol at the end of 1999. The Government policy of supporting unleaded petrol has meant that the objective for lead at all rural and urban background and roadside sites is likely to be met. However, areas which may be affected by local industrial sources require further investigation.

Background Lead Concentrations

The map (Figure 5.1) illustrates the variations in estimated lead background concentrations across the UK. The maps were published by the DETR on their web site and based on work by Stedman, Linehan *et al* (1998). The lead concentrations have been calculated on a 5 x 5km scale. The data places background concentrations of lead in Sunderland and South Tyneside in the range 0.01 to 0.04 $\mu g/m^3$.

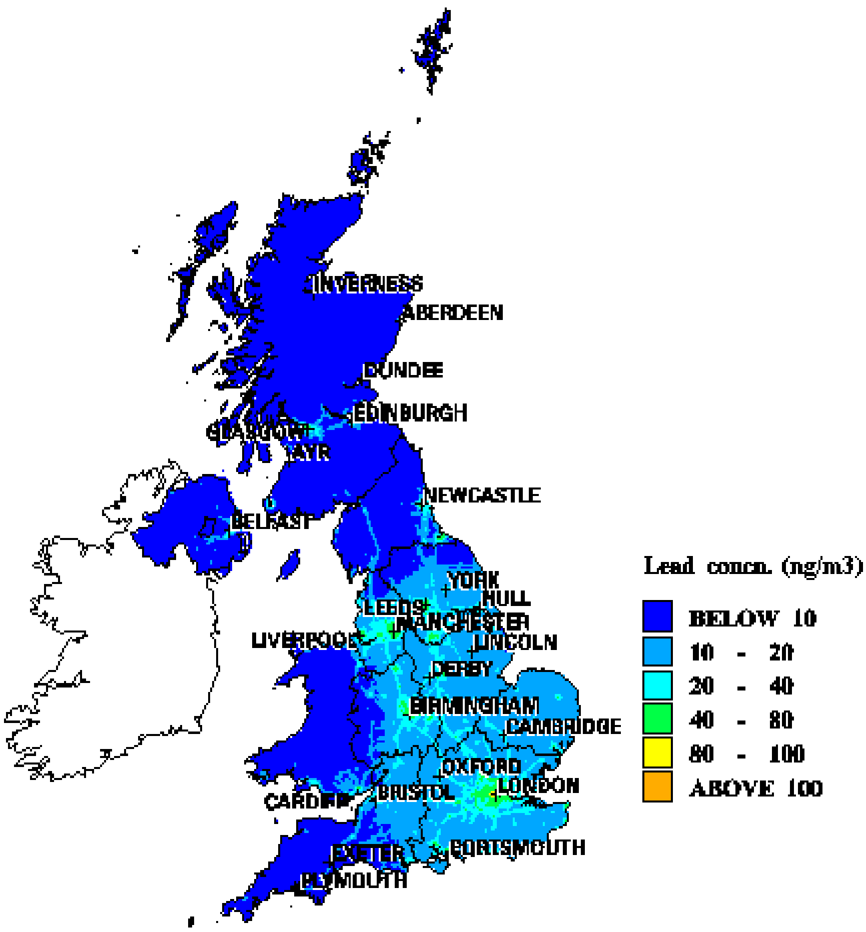


Fig. 5.1: Background Lead concentrations in the UK

Sources of Lead in Tyne and Wear

The emissions inventory identified the spatial distribution of lead emissions in the urban area, and this is set out in Figure 5.2 below.

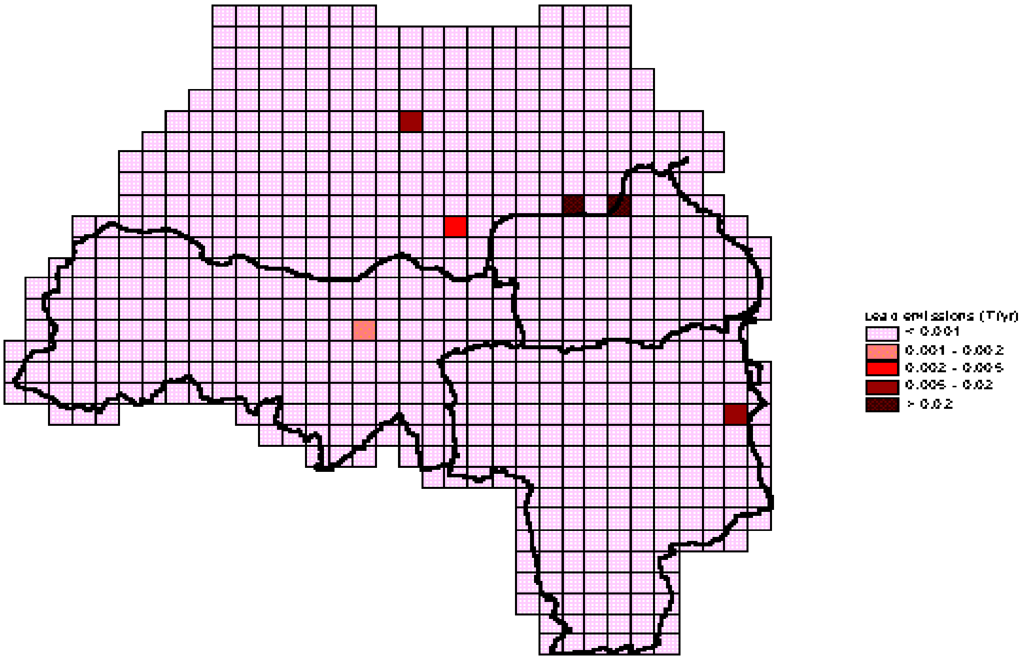
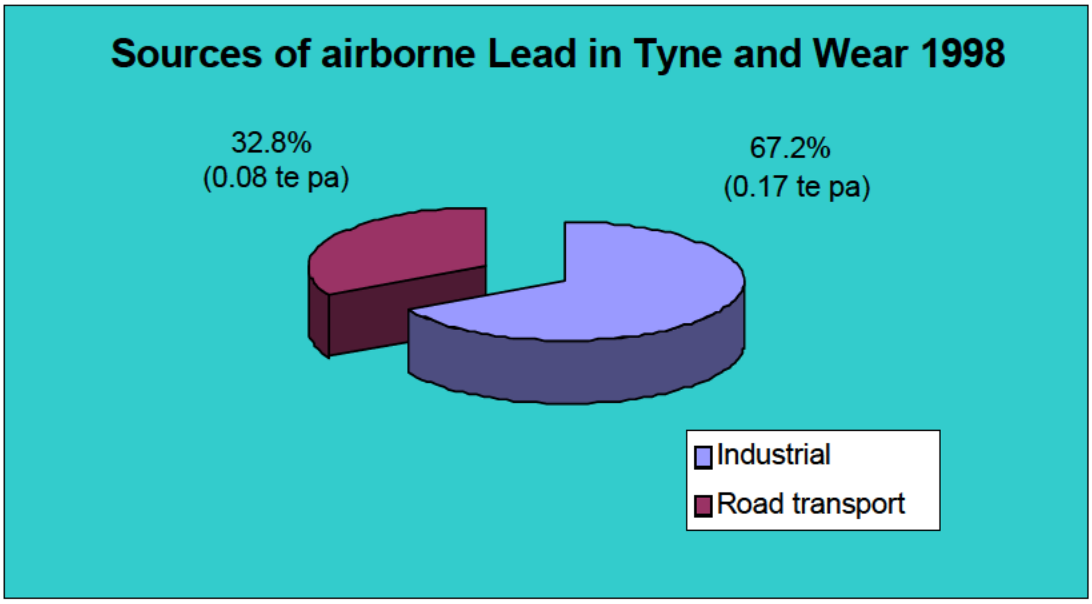


Figure 5.2: Emissions of Lead in Tyne and Wear in 1998

Examination of the Inventory reveals that, as expected, the main contributors are industrial rather than traffic sources, with total traffic emissions of lead expected to fall to between 0 and 0.0001 tonnes per annum per kilometer square by 2005.

The apportionment of total lead emissions in Tyne and Wear by source category is illustrated in Figure 5.3.

Figure 5.3: Sources of Lead in Tyne and Wear



The Situation in the City of Sunderland and the Borough of South Tyneside

The first stage review identified only two Part B processes in the Sunderland area as being potential significant sources of airborne lead - George New and Son, a non-ferrous metal melting process (this has since ceased to operate) and Jennings Winch & Foundry Company Ltd, a ferrous foundry located close to the City Centre and adjacent to a primary school and residential accommodation.

Additionally, the emission inventory indicated the need to examine the impact of lead emissions attributable to the Chemson Works in North Tyneside; this carried the potential to affect ambient levels within South Tyneside.

Stages 2 and 3 of the review involved a detailed examination of lead levels in the vicinity of the one remaining industrial operator and a reassessment of previous work undertaken as part of the Phase One exercise in 1997 (this focused upon Chemson site emissions).

Since most of the emissions from the ferrous process are fugitive it was considered appropriate to monitor lead at the closest non-occupational location where people may be regularly exposed, this being a Primary School. An M-Type sampler was set up to sample over seven-day periods for a total duration of 9 months. To comply with QC requirements the sampler was installed and operated in accordance with the methodology in EC Directive (1999/30/EC).

Monitoring data is shown in Figure 5.4. The results show the levels to be well below the Air Quality Objective with the highest measured concentration being 0.62 $\mu g/m^3$ and the mean to be 0.017 $\mu g/m^3$ at the nearest appropriate location.

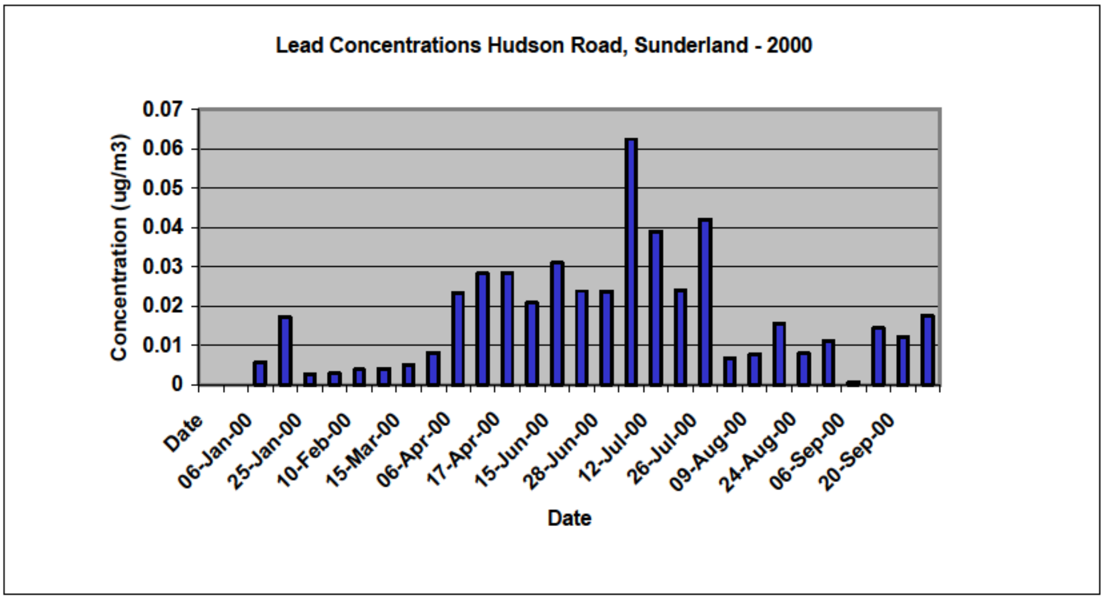
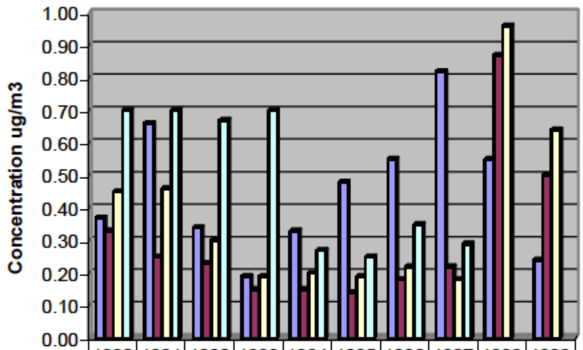


Figure 5.4: Lead monitoring in City of Sunderland

The impact of the Chemson Plant, North Tyneside is demonstrated by the model which identifies an increase in ambient levels in an area to the very north of South Shields, but only to the extent of 10 ng/m3 (one fiftieth of the objective). Previous work on this lead source during the Phase One research exercise utilised ADMS version 2, and M-Type sampling. The conclusions were that emissions would only have a noticeable impact within a 500 metre radius of the plant, and monitoring 520m to the east revealed a mean lead concentration (23 weeks) of 0.04 μg/m3 (corresponding to predicted background concentrations).

Finally, the monitoring results and predictions compare favourably to the results obtained from the national network monitoring sites in Elswick, and the Newcastle urban background site, see Figure 5.5.

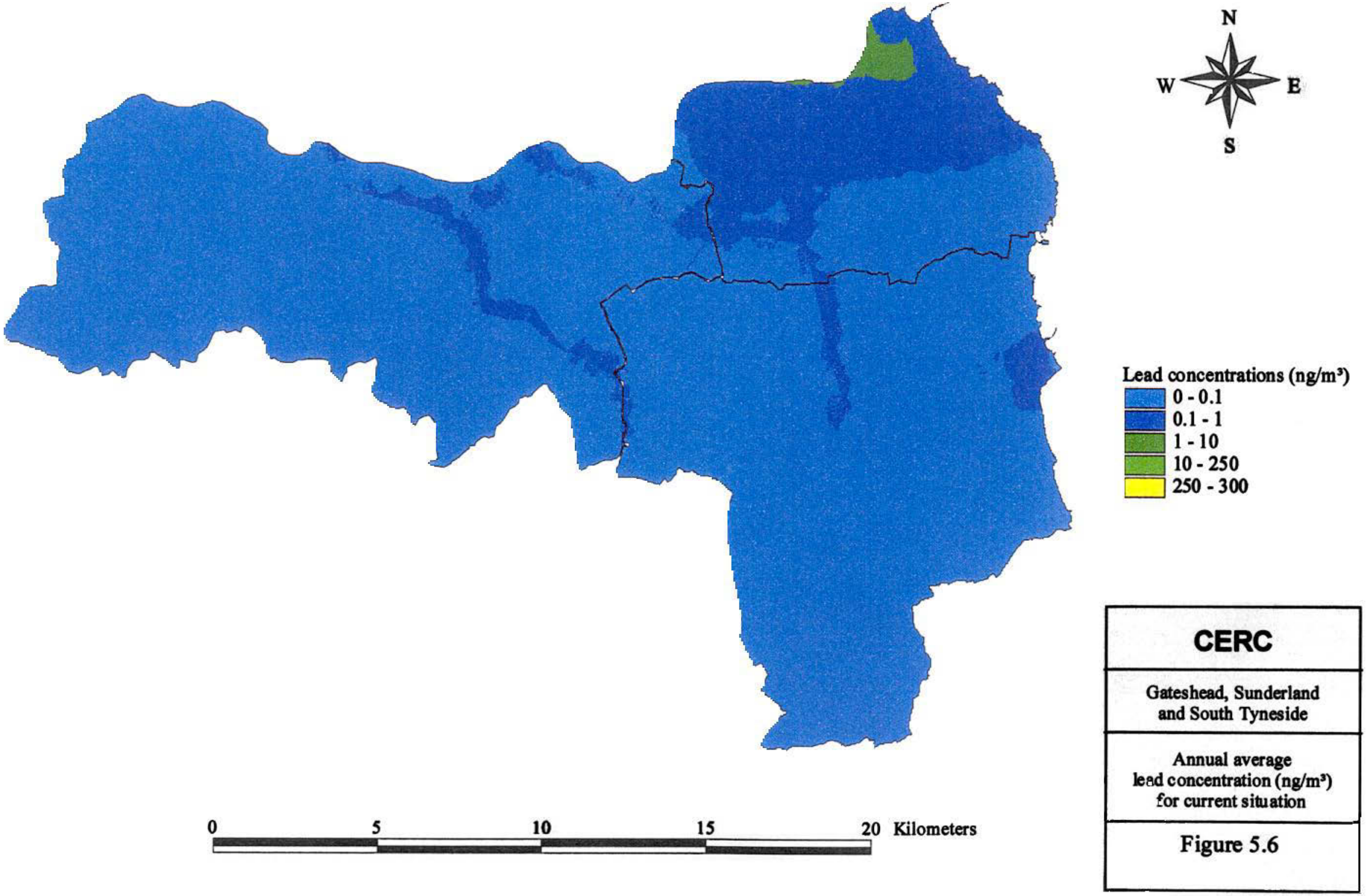
Figure 5.5 National Network Results - Newcastle



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Elswick 1	0.37	0.66	0.34	0.19	0.33	0.48	0.55	0.82	0.55	0.24
Elswick2	0.33	0.25	0.23	0.15	0.15	0.14	0.18	0.22	0.87	0.50
Elswick 6	0.45	0.46	0.30	0.19	0.20	0.19	0.22	0.18	0.96	0.64
Newcastle Urban Background	0.70	0.70	0.67	0.70	0.27	0.25	0.35	0.29		

Atmospheric Dispersion Modelling

Following the construction of the Urban Emissions Inventory data was inserted into ADMS-Urban and predictions calculated for the current situation. The Authorities' consultants (CERC) have taken the view that as existing levels are so low, and emissions from road traffic are predicted to be eliminated by 2005, the future situation need not be modelled. Figure 5.6 identifies the current airborne lead concentrations determined by the model and suggests that the air quality objective for Lead in Sunderland and South Tyneside is currently being achieved; modelled levels are generally below 0.001 $\mu g/m^3$, with only a small area of South Tyneside exceeding that (as already discussed). Even there, levels are likely to remain below 0.01 $\mu g/m^3$ compared to the 2008 objective of 0.25 $\mu g/m^3$ (being a factor of 25 below the tightest objective).


N
W
E
S
Lead concentrations (ng/m³)
0 - 0.1
0.1 - 1
1 - 10
10 - 250
250 - 300
0
5
10
15
20 Kilometers
CERC
Gateshead, Sunderland and South Tyneside
Annual average lead concentration (ng/m³) for current situation
Figure 5.6

Conclusion

Whilst recent monitoring adjacent to the potential significant source in Sunderland could only be carried out for a nine month period, TG (4) requires a minimum of 12 months), measured levels are much lower than the air quality objective and compare favourably with the national network sites in Newcastle. The model also predicts very low levels throughout the area.

Local monitoring and the predictive work of the atmospheric dispersion model identify levels of airborne lead to be substantially below the Air Quality Objective, with background levels measured in Newcastle City exhibiting a significant downward trend since 1990.

It is therefore concluded that lead concentrations within the Borough of South Tyneside and the City of Sunderland currently meet the level specified in air quality objectives for both 2004 and 2008, and should continue to do so in future years.

The City of Sunderland and Borough of South Tyneside conclude that there will be no need for local action in relation to airborne lead.

Review and Assessment of Nitrogen Dioxide

Introduction

Oxides of nitrogen – nitric oxide and nitrogen dioxide, collectively known as NO_x - are formed as a result of high temperature combustion. Nitrogen dioxide tends to form over time from the oxidation of the primary form of the pollutant, nitric oxide, and hence the two pollutants will be found together. The main sources of NO_x in non-occupational environments tend to be emissions from the combustion of fossil fuels in road transport, power generation and industrial processes. Within Tyne and Wear the most significant source by far is the road vehicle (Tyne and Wear Urban Emissions Inventory 1998).

Nitrogen dioxide (NO_2) can be a respiratory irritant at certain concentrations and individuals with for instance chronic bronchitis and asthma may exhibit reaction to episodes of high ambient NO_2 concentrations.

Standards and Objectives for nitrogen dioxide

The statutory air quality objectives for nitrogen dioxide are set out by SI 928, which came into force on 6 April 2000. They are:

- An annual mean of 40 ug/m^3 (21ppb) to be achieved by 31.12.2005
- An hourly mean of 200 ug/m^3 (105 ppb) not to be exceeded more than 18 times in any calendar year (approximately equivalent to the 99.8^{th} percentile of the total annual hourly values), also to be achieved by the end of 2005.

For the one-hour mean the focus of the review has been on any non-occupational exposure at near-ground-level outdoor locations, including roadside sites. The focus for the annual mean objective has additionally included background locations and locations where the population may be exposed for longer periods, such as the vicinity of housing, schools and hospitals.

The National Perspective

In the UK road transport accounted for about 50% of total emissions in 1997, though there is an expectation that the progressive implementation of national policy measures and improvements in vehicle emission controls will see a marked reduction in transport-related contributions. Additional measures for large combustion plant will also aid achievement of the air quality objectives, though it is anticipated that some urban areas may identify problems in achieving the annual mean component by 2005.

Background concentrations of NO_2 in the UK

Figure 6.1 illustrates the variations in background levels of NO_2 throughout the UK. Examination of the map in finer resolution suggests that the concentrations for Sunderland and South Tyneside should lie in the range 9.74 to 38.2 ug/m^3 (5.1 to 20 ppb).

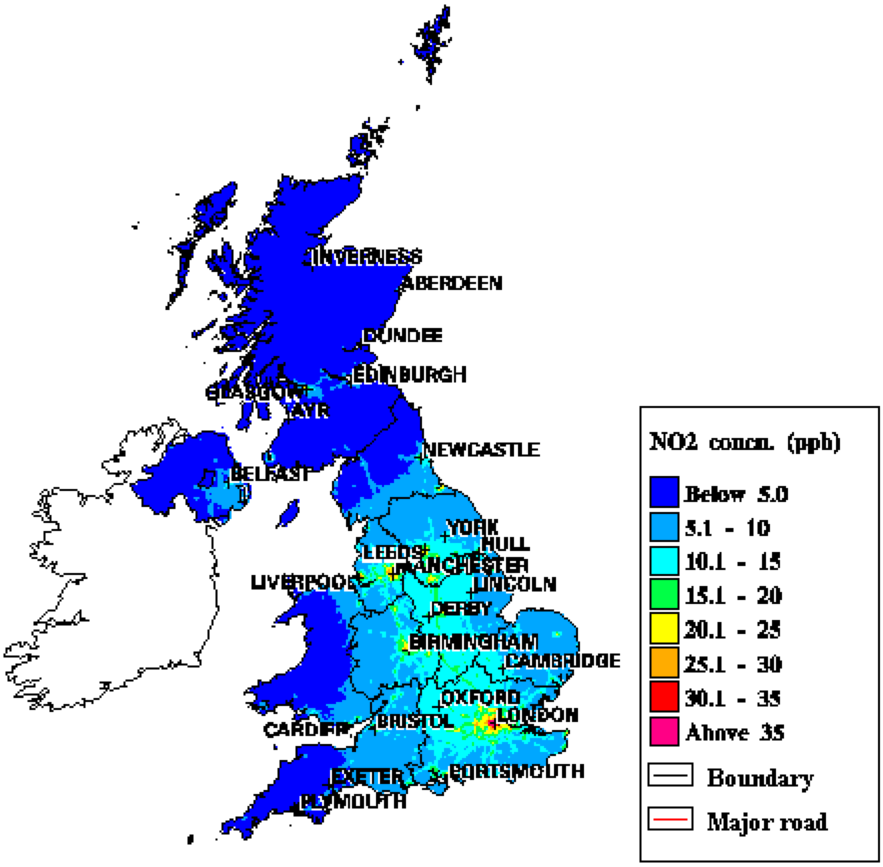


Figure 6.1: NO_2 background concentrations in the UK

This estimation is supported by data acquired from a large number of background monitoring sites across the two local authority areas, as will be seen when examining the diffusion tube monitoring data set out later in this chapter.

Sources of Oxides of Nitrogen in Tyne and Wear

The 1998 Tyne and Wear Urban Emission Inventory clearly identifies that the great majority of the two Boroughs, as well as the region as a whole, is influenced primarily by road traffic emissions. This is reflected in the breakdown of total NO_x emissions by source for Tyne and Wear.

Figure 6.2: NO_x Source apportionment

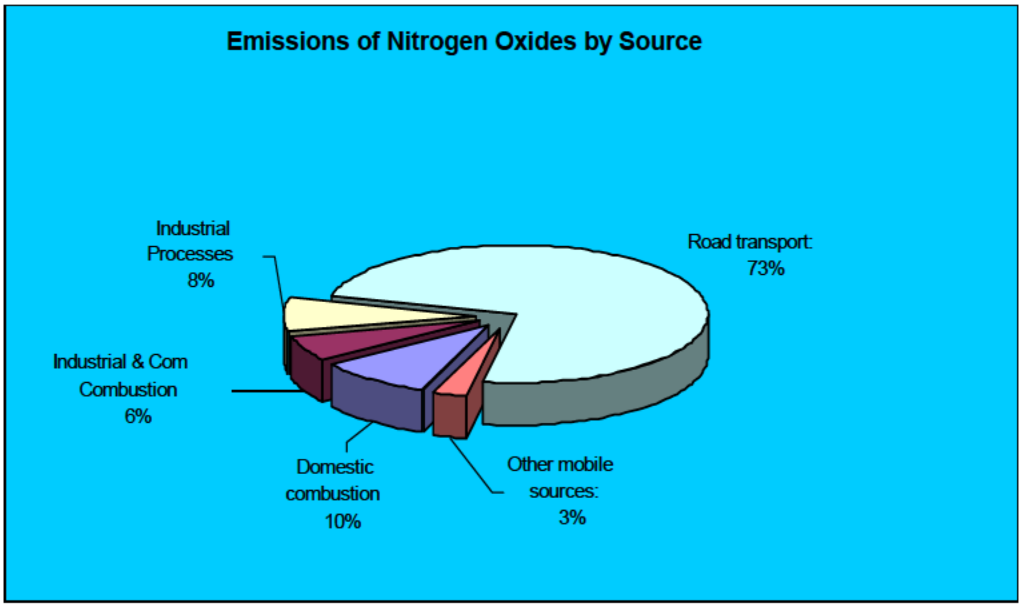
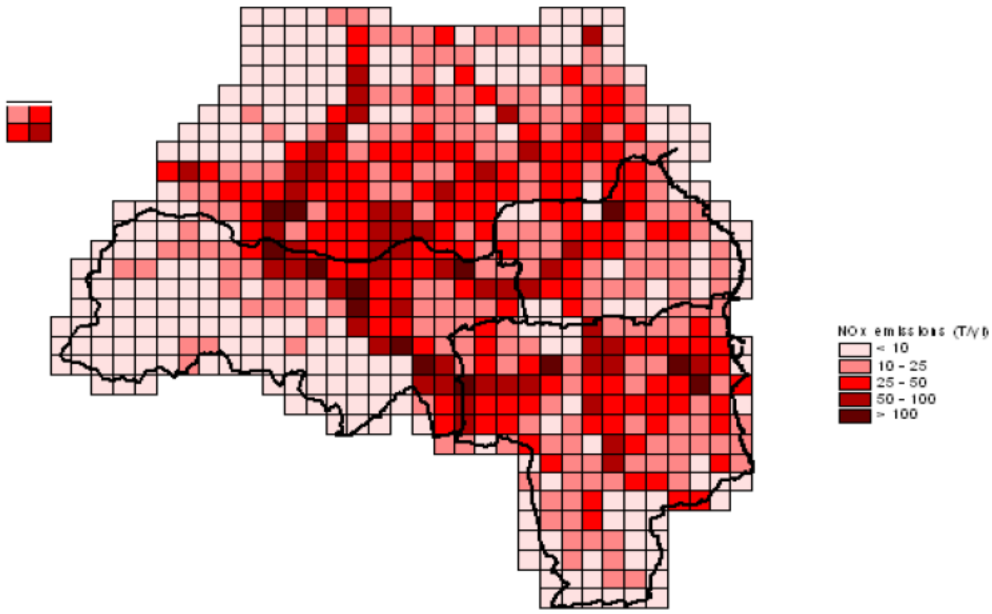


Figure 6.3 sets out the results of the Inventory quantified as tonnes/sq km/annum over kilometre square grids for road traffic and all other sources within the region. Certain main transport corridors are clearly highlighted.

Figure 6.3 Map of NO_x emissions across Tyne and Wear



The two local authority areas to the east of the grouping (i.e. South Tyneside in the North East sector and the City of Sunderland to the south of that) demonstrate only a few areas of high emissions of NO_x 50 tonnes/sq km/yr.

The Situation in Sunderland and South Tyneside

The conclusions of the Stage 1 Review are equally applicable to the Boroughs of Sunderland and South Tyneside as for Tyne and Wear generally, i.e.:

Available monitoring data indicated that the 1-hour mean value for NO_2 was being met at the current monitoring locations, but these locations did not provide sufficient information to enable the assessment of all potential sources of NO_2, in many cases having been selected to assess the impact of traffic on background levels.

The urban background concentrations identified by national statistics do not forecast exceedances in 2005.

The region contains a number of industrial sources that may have the potential to emit significant quantities of the pollutant, either singly or in combination, and therefore require further investigation.

There are a number of planned or existing roads with current or forecast average daily traffic flows above the 20,000 vehicles per day (aadt) threshold

The Stage 1 review identified a number of sources within the region that were considered to carry the potential to emit significant quantities of NO_2. Stage 2 and 3 of the review process has focused upon these issues, further investigating both current (measured) levels of NO_2, establishing the emission sources from the results of the Urban Emissions Inventory, and predicting future levels through atmospheric dispersion modelling (using ADMS Urban version 1.53).

Several potential significant point sources of nitrogen dioxide were identified within the two Boroughs during Stage 1. Investigations (both through local monitoring and inclusion of emission profiles within the dispersion model) and examination of process characteristics and practices have satisfied the Authorities that these sources are unlikely to contribute to exceedances of either of the statutory objectives for NO_2.

NO_2 has been monitored for several years within the two Boroughs, most extensively through the use of diffusion tubes. In the last two years the Tyne and Wear Air Quality Management Group have invested in the development of several continuous (and mobile) monitoring stations. The data acquired is proving useful in demonstrating the relationship between levels of NO_2 across

the region, and has assisted in confirming the conclusions on existing conditions that have emanated from the diffusion tube exercises.
Whilst all data has been included in Tables for completeness, we have focused upon 1999 as providing the most recent set of diffusion tube data by which we can predict 2005 levels in accordance with the guidance set out within TG4.

Annual means

Figures 6.4 and 6.5 show the 1999 and 2005 levels for background and roadside sites respectively within the two Boroughs. They confirm that current concentrations of NO_2 at these locations fall below the target of 40 ug/m^3 set for the end of 2005, and clearly illustrate the expected reductions in ambient levels by that date.

Fig 6.4: Background data / predictions for Sunderland and South Tyneside

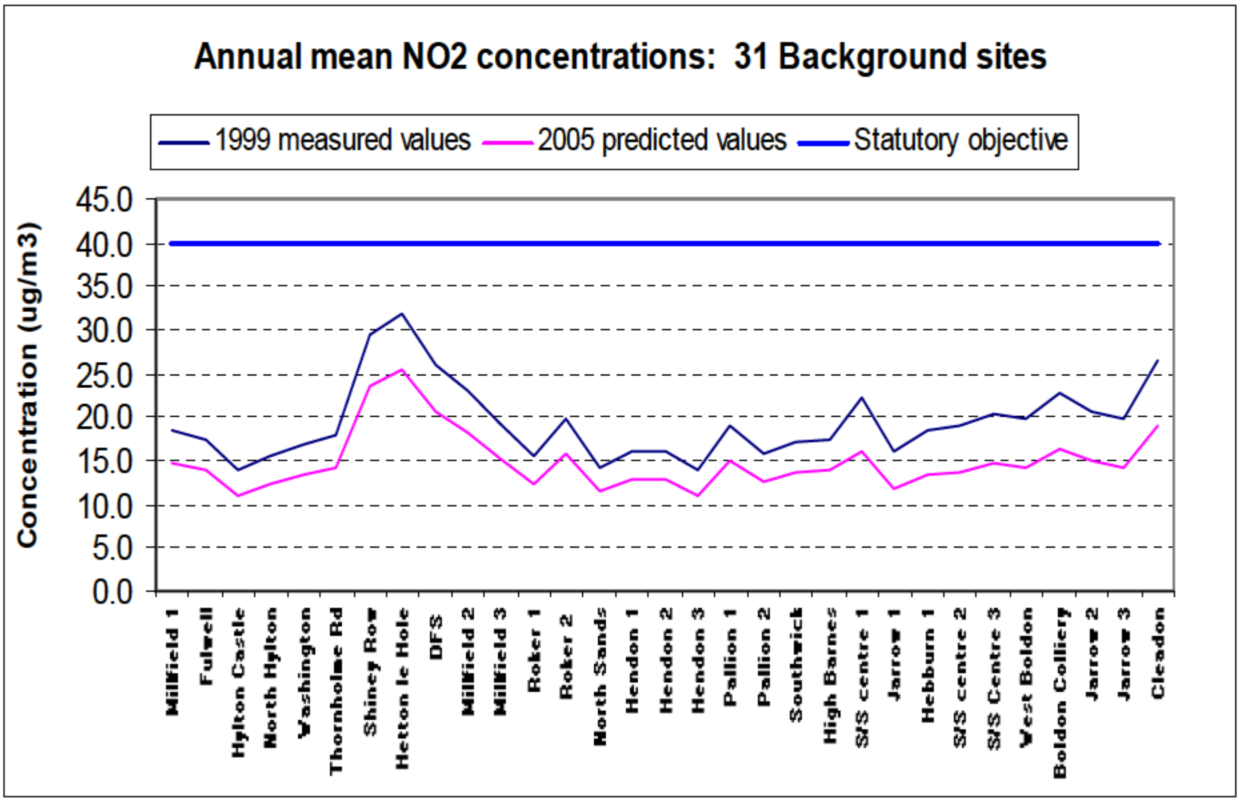
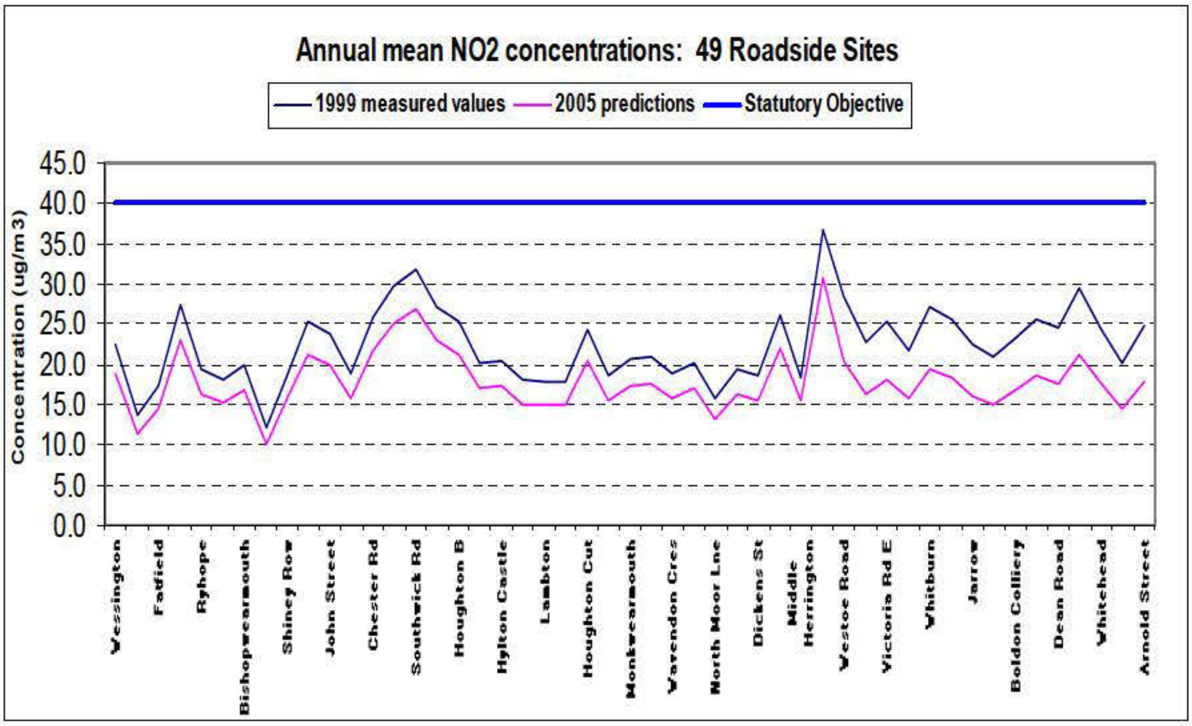
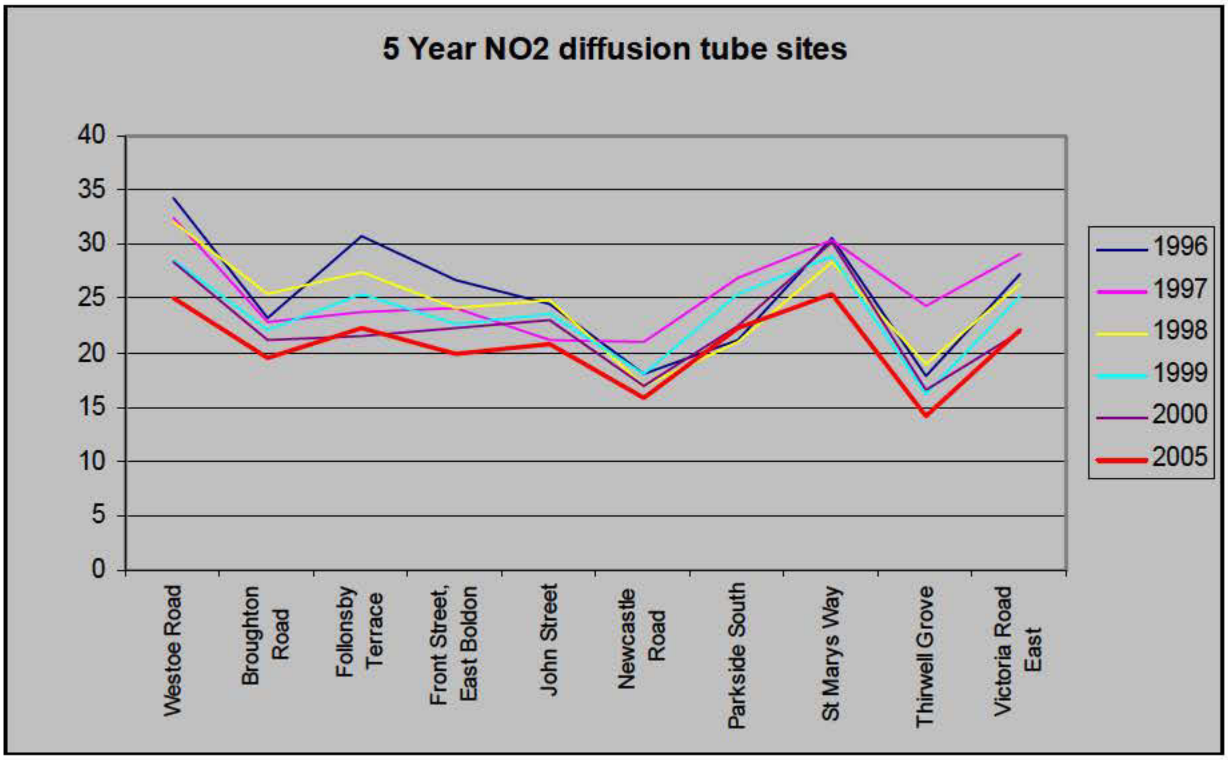


Fig 6.5: Roadside data / predictions for Sunderland and South Tyneside



Additionally, figure 6.6 sets out the year on year annual means for certain long term sites, with an extension using the 2005 prediction.

Fig 6.6: Long term NO_2 sites in South Tyneside and Sunderland



Analysis confirms the overall downward trend in NO_2 concentrations:

Site	Slope
Westoe Road	0.10
Broughton Road	-0.73
Follonsby Terrace	-1.64
Front Street, East Boldon	0.02
John Street	-0.32
Newcastle Road	-0.27
Parkside South	-0.06
St Marys Way	-0.11
Thirwell Grove	-0.43
Victoria Road East	-0.75

The two sites not exhibiting a downward trend are relatively low flow (12,000 to 14,000 vehicles/day aadt) but congested at peak hours. Traffic management measures have already been implemented at one, and the impact of this action will become clear over the coming year.

Hourly mean

The equivalent 99.8th percentile values have been calculated for the same sites for comparison with the hourly objective. Error associated with diffusion tubes has been set at 24.5%. The results are set out in figures 6.7 and 6.8 and confirm that there should be little risk of breaching the hourly mean objective within the two Boroughs.

Figure 6.7

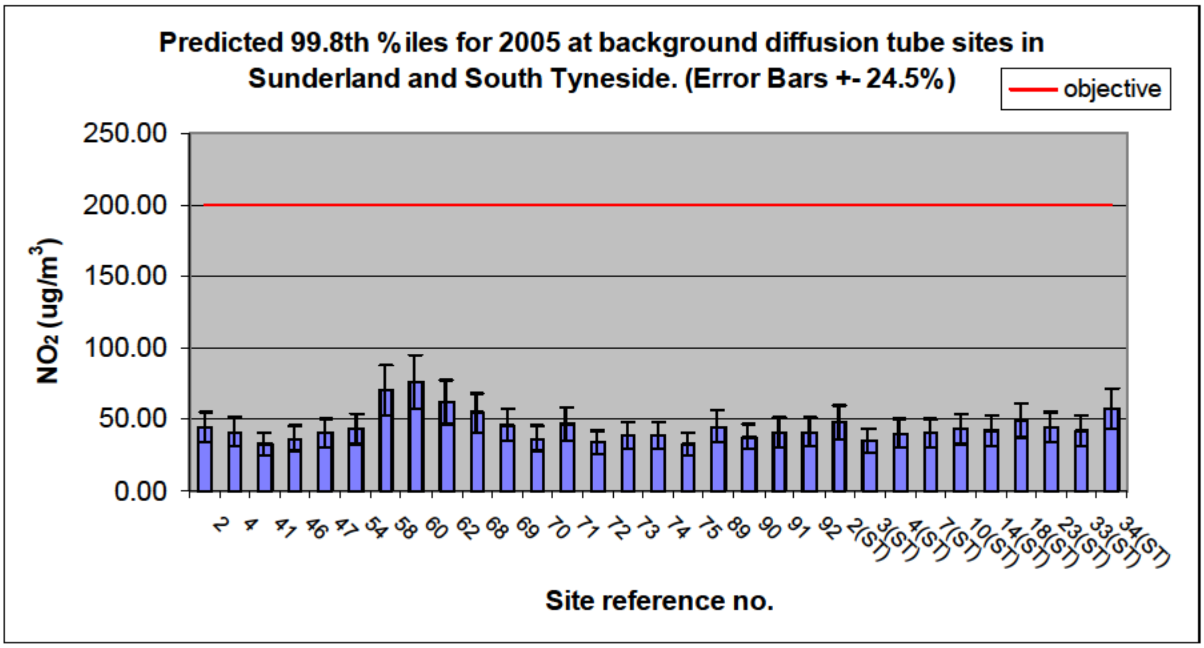
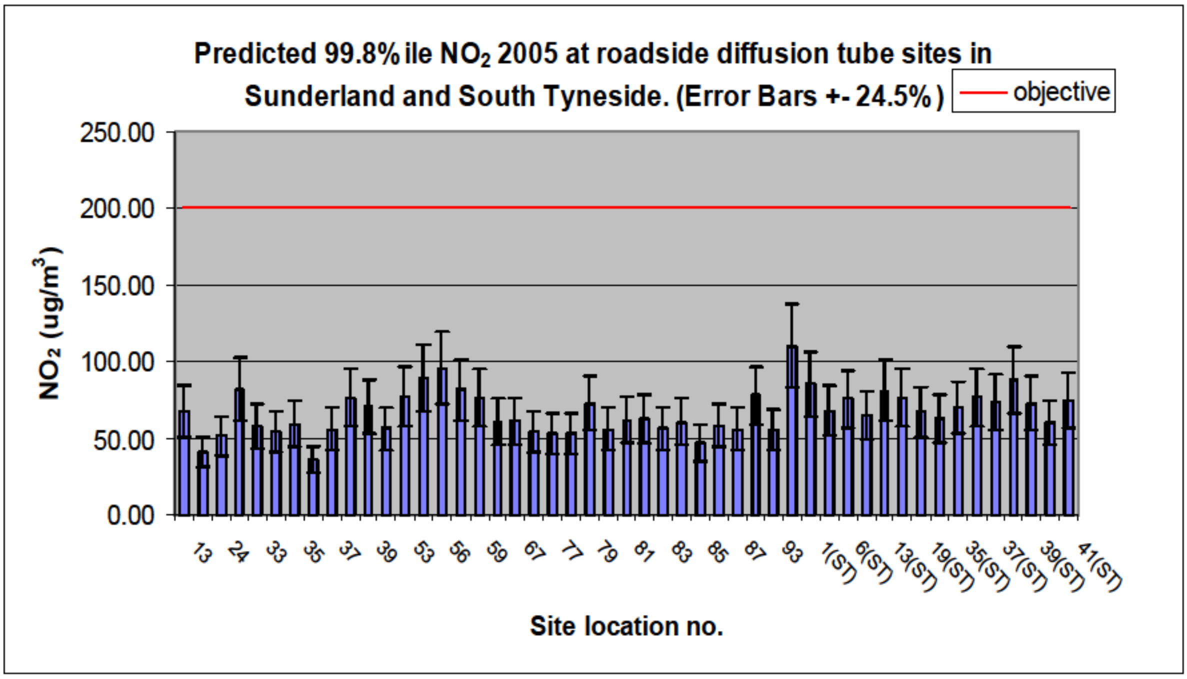


Fig 6.8



The data from the roadside continuous monitoring station at Western Approach Road, South Shields (traffic flows approximately 35,000 vehicles/day aadt) is displayed in fig 6.9. There is one exceedance of the hourly mean objective during 2000 (at a data capture of 72.3%) this being 238 ug/m3 on 14 May 2000. Data from Sunderland's roadside continuous monitoring station at Trimdon Street is shown in Fig 7.0. There were no exceedances of the hourly mean objective in the period Nov 2000 – May 2001 (data capture 93.4%).

Fig. 6.9

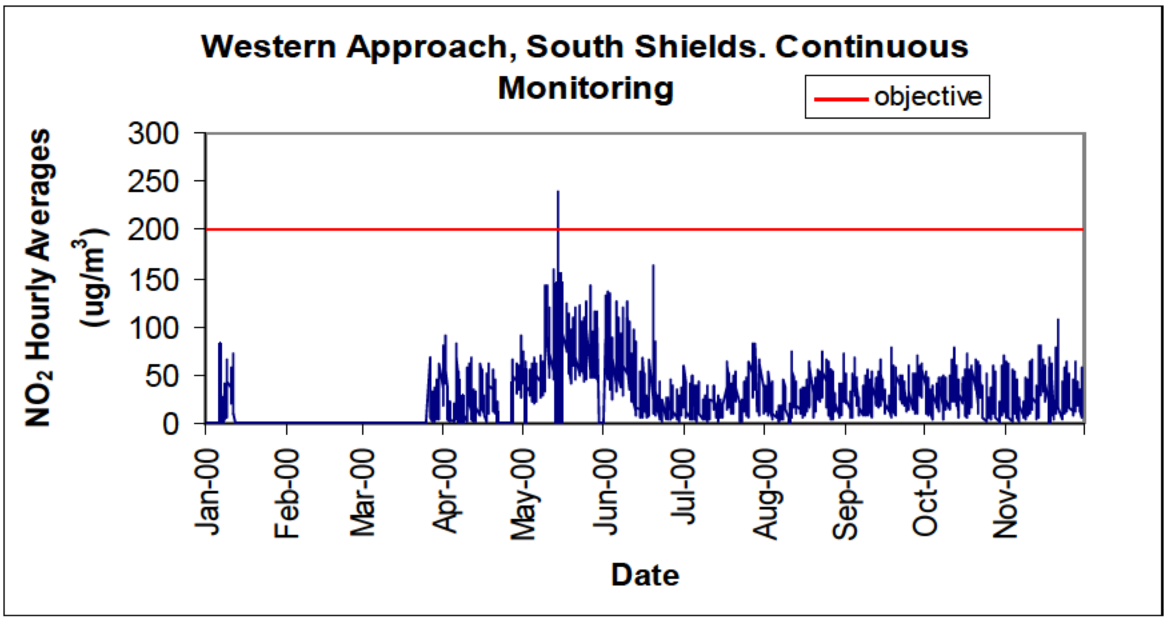
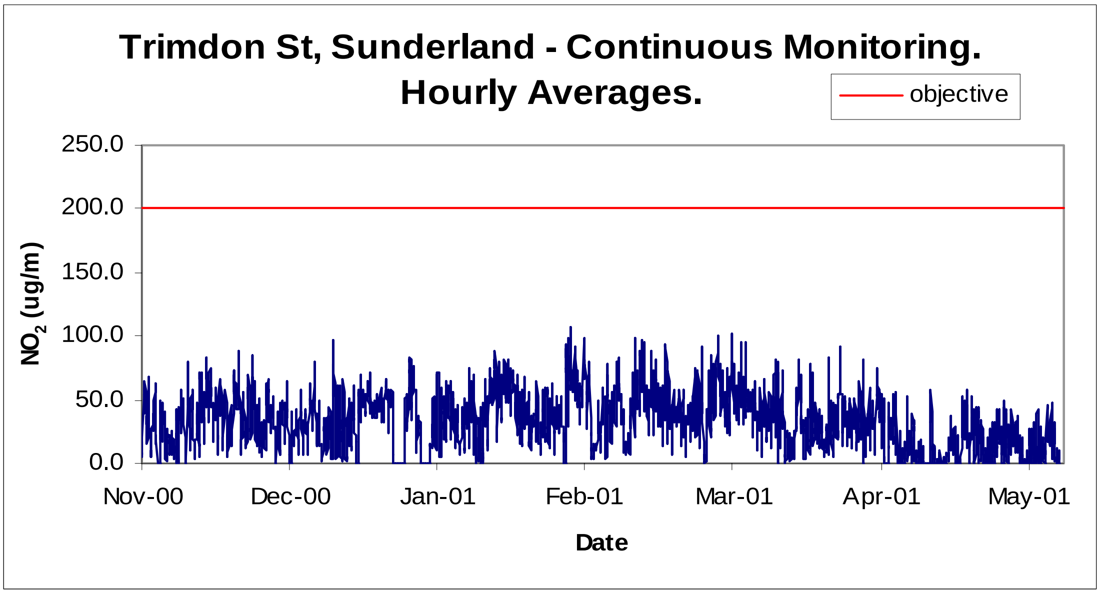


Fig 6.10



Dispersion modelling

The utilisation of the 1998 Inventory data for the development of an urban dispersion model for the southern authorities of Tyne and Wear has provided a relatively up to date base of information from which to predict future levels of NO_2. CERC were contracted to carry out the necessary work, reporting on predicted concentrations of NO_2 against the current Air Quality objectives.

The resultant maps are included as Figs 6.11 and 6.12.

Conclusion

Predicted concentrations clearly fall below the Air Quality Objectives. Broadly, the model supports the conclusions obtained from the monitoring data and indeed was validated against them.

Detailed investigations into the potential significant industrial sources of NO_2 within the area, both by examination of processes and emission controls and by dispersion modelling, supports the conclusion that they do not carry a risk of contributing to any breach of the objectives. Traffic sources have been the subject of extensive monitoring and modelling and, whilst it is considered that monitoring and other work must go on to ensure ambient levels continue to fall, it is concluded that there is again little risk of a breach of either of the objectives for NO_2.

The objective for the annual mean for NO_2 is 40 $\mu g/m^3$ to be achieved by 31st December 2005. Data collected from diffusion tubes at both background and roadside locations shows that current and predicted 2005 levels fall below the Objective.

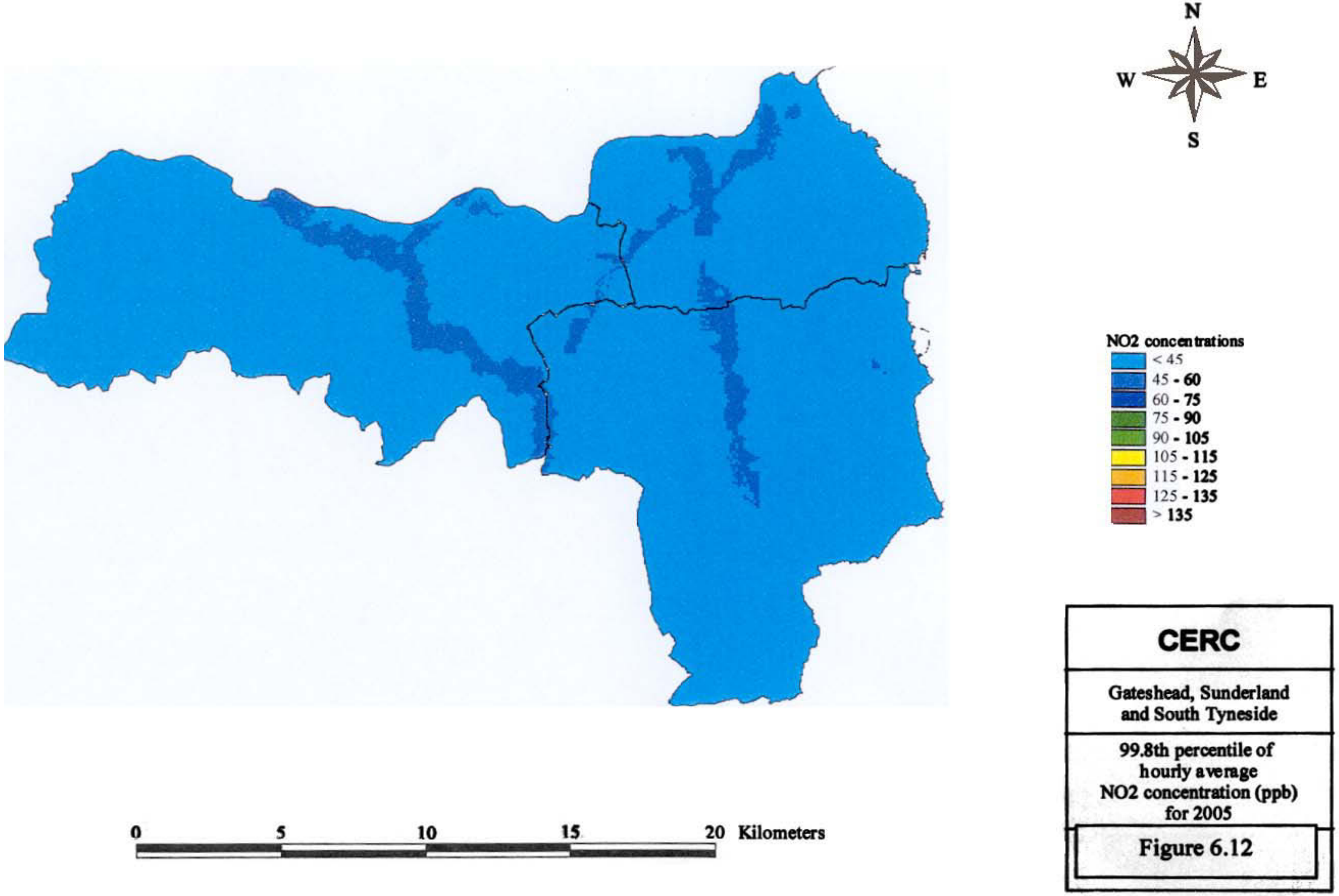

N
W
E
S
NO2 concentrations
< 45
45 - 60
60 - 75
75 - 90
90 - 105
105 - 115
115 - 125
125 - 135
> 135
0
5
10
15
20 Kilometers
CERC
Gateshead, Sunderland and South Tyneside
99.8th percentile of hourly average NO2 concentration (ppb) for 2005

Figure 6.12

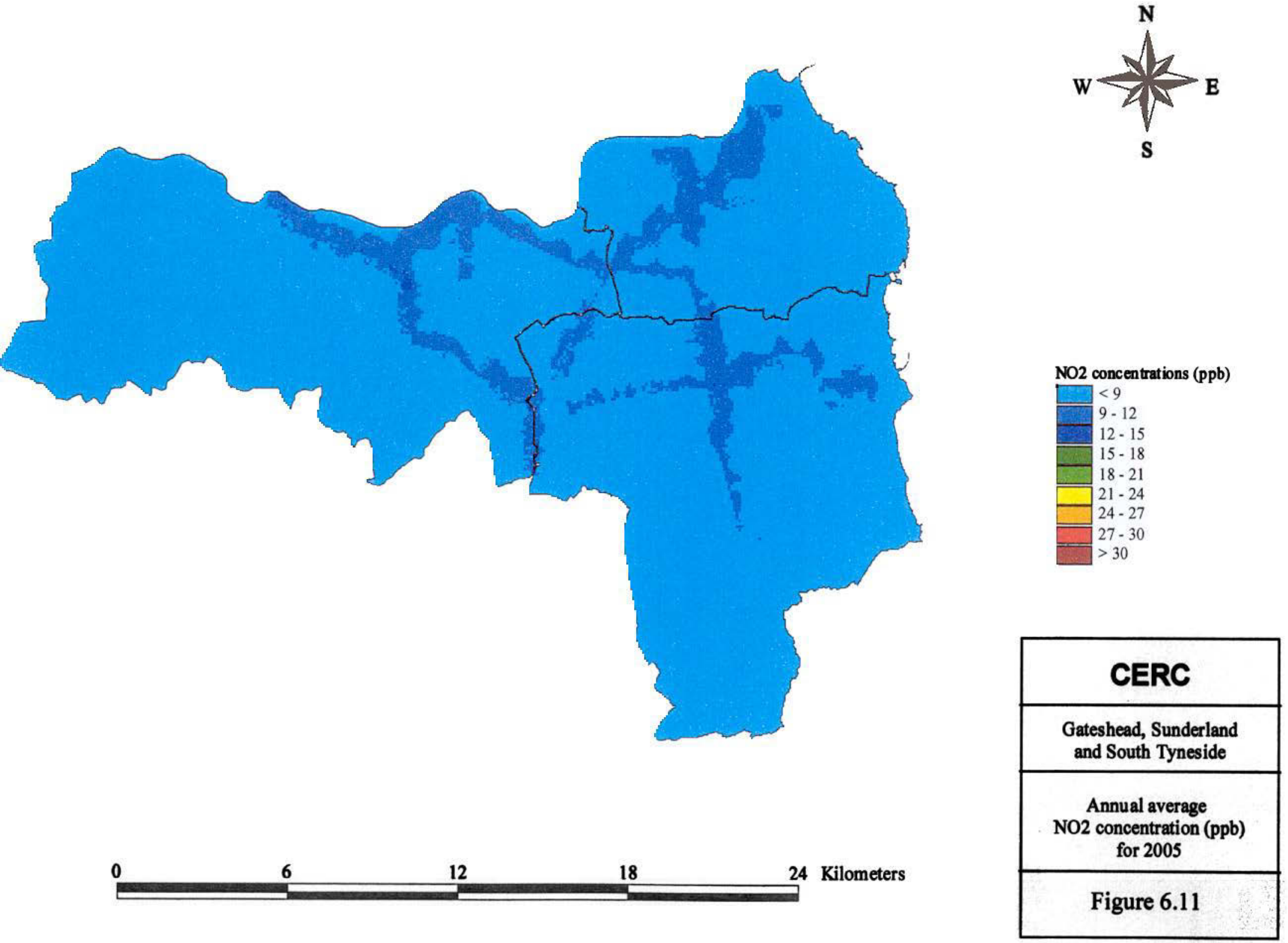

N
W
E
S
NO2 concentrations (ppb)
< 9
9 - 12
12 - 15
15 - 18
18 - 21
21 - 24
24 - 27
27 - 30
> 30
0
6
12
18
24 Kilometers
CERC
Gateshead, Sunderland and South Tyneside
Annual average NO2 concentration (ppb) for 2005

Figure 6.11

Modelled results carried out for the Sunderland and South Tyneside areas demonstrate that the Air Quality Objectives for NO_2 will be met. Modelled values for the annual average in 2005 are below 9ppb (17.2 $\mu g/m^3$) in the majority of the area with more elevated levels of between 9-12 ppb (17.2 - 22.9 $\mu g/m^3$) on the main traffic routes and in urban centres.
Annual averages from roadside continuous monitors in Sunderland and South Tyneside also fall below the Air Quality Objective with results of 34 $\mu g/m^3$ and 37$\mu g/m^3$ respectively.

The objective for the hourly mean for NO_2 is 200 µg not to be exceeded more than 18 times in any calendar year which is approximately equivalent to the 99.8th percentile of the total hourly values.
Diffusion tube data has been used to calculate the equivalent 99.8th percentile values for both roadside and background sites for comparison with the hourly objective. Theses results show that values fall below the objective for both roadside and background locations.
Continuous monitoring data for hourly averages in both Sunderland and South Tyneside was plotted. Values fall below the objective apart from one occasion.
Predicted 99.8th percentile of hourly averages for 2005 were below 45 ppb (86 $\mu g/m^3$) across the majority of the two regions. Higher levels are predicted on major traffic routes with concentrations predicted to be between 45 - 60 ppb (86 - 115 $\mu g/m^3$) but still remain below the Air Quality Objective.

It is therefore considered that the air quality within the city of Sunderland and the Borough of South Tyneside will meet the statutory objectives for Nitrogen Dioxide and therefore no further local action is required.

Review and Assessment of Fine Particles (PM_{10})

Introduction

Particulate matter in the atmosphere is composed of a wide range of materials from a variety of sources. Man-made sources include carbon particles from incomplete combustion, ash, recondensed metallic vapours and secondary particles or aerosols formed from chemical reactions in the atmosphere. In addition, particles can be emitted from mining, quarrying and construction operations, transport sources such as diesel emissions, brake and tyre wear and road dust. Natural sources of particles include wind-blown dust, sea salt, pollen and fungal spores.

How long a particle stays suspended in the air depends on its size, shape and density. This also governs where the particle remains in the lung tissue after being inhaled. Smaller, spherical particles below 10um in diameter PM_{10} are more likely to penetrate the furthest spaces in the lungs (the alveoli). Studies have shown a connection between PM_{10} levels and health effects such as respiratory and cardio-vascular illnesses.

As indicated above, particulate matter is derived from a wide range of sources: it can be primary or secondary, man-made or natural in origin. Particulate matter can be roughly divided into three categories:-

- Fine, *"Primar*y" particulates to a large extent comprise those derived from incomplete combustion in motor vehicle engines or stationary combustion plant. Much, but not all of this material is likely to be of fairly local origin, although such particles can be transported over large distances under appropriate meteorological conditions.

- Fine, *"Secondar*y" particulates consist largely of ammonium sulphate, ammonium nitrate and secondary organic aerosols. Sulphates and nitrates form from industrial and traffic emissions of sulphur dioxide and oxides of nitrogen in two ways:

◊ Homogeneous nucleation: coalescence of the gaseous species particles.
◊ Heterogeneous nucleation: adsorption of gaseous species onto an existing particle.
These complex processes also involve sunlight and the presence of agricultural ammonia particles and sea-salt particles. Such aerosols take time to form and can be transported over considerable distances, in particular from sources in continental Europe. There is therefore a tendency for elevated levels of secondary particulates to be associated with a prevailing easterly wind. In particular, 1996 experienced longer than usual periods of easterly winds associated with markedly elevated levels of what were demonstrated to be secondary particulates of the kind described.

· *"Coars*e" particles include a variety of natural and anthropogenic material, e.g. wind-blown dust and biological matter such as spores.

[Source Apportionment of Airborne Particulate Matter in the United Kingdom, Report of the Airborne Particles Expert Group, January 1999; *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, 200*0].

Air Quality Standard and Objective

The Government has adopted an air quality standard for PM_{10} of 50 $\mu g/m^3$ (microgrammes per cubic metre of air) measured as a 24-hour mean, with the objective not to be exceeded more than 35 times a year by the end of 2004. Additionally, an annual mean has been adopted of 40 $\mu g/m^3$ also to be met by the end of 2004.
For the daily and annual objectives, the focus of the review and assessment should be on non-occupational exposure at near ground level outdoor locations including:

- Background locations
- Roadside locations
- Other locations where people may be regularly exposed, such as in the vicinity of housing, schools or hospitals.

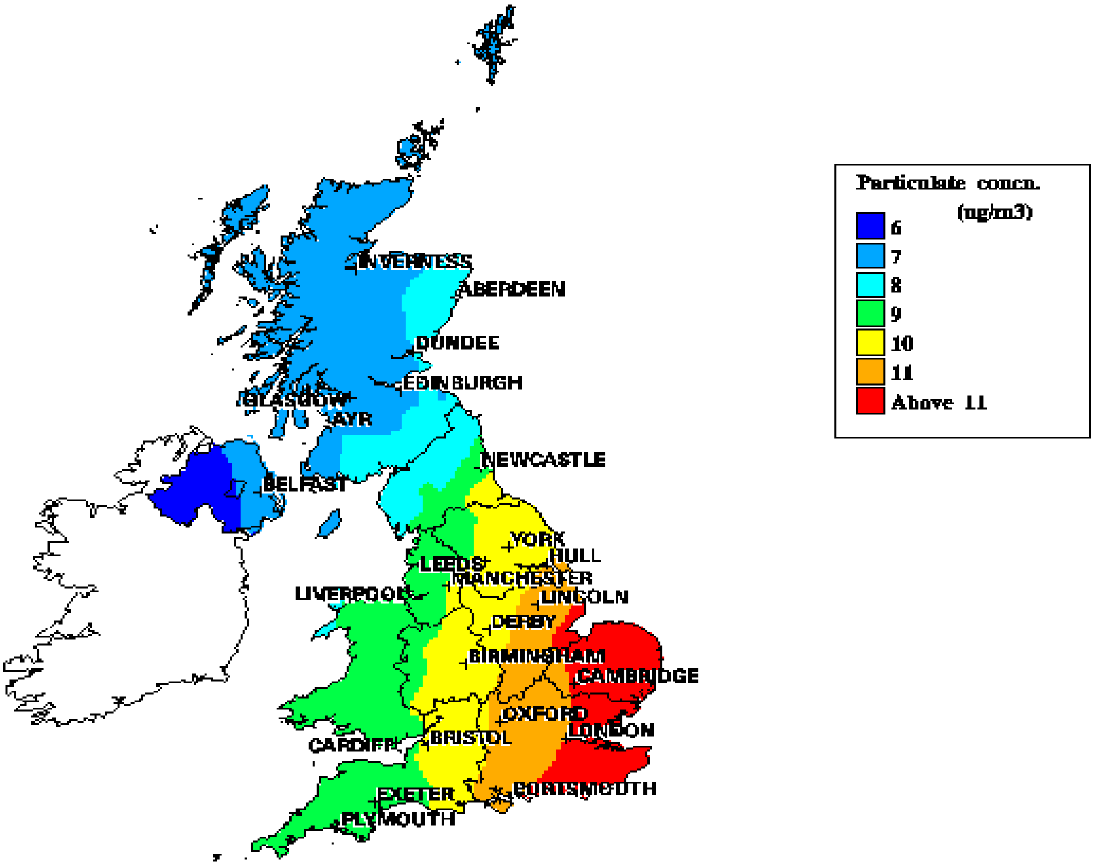
The National Perspective

National UK emissions of PM10 have been estimated as totaling 232,000 tonnes in 1996. PM_{10} levels are generally higher in winter than in summer, with the contribution from transport sources rising to approximately 40-50% of the urban background at this time of year. Where levels rise to above $50\mu g/m^3$, the contribution from traffic can be in the range of 75-85%.
PM_{10} levels can also exceed $50\mu g/m^3$ in summer when vehicle emissions will also contribute to the total. Another important component is that arising from secondary particles. Such particles, typically composed of ammonium sulphate and ammonium nitrate, are formed from industrial and transport emissions across Europe and the UK. Secondary particles can travel long distances in the atmosphere being regional scale pollutants, the annual concentrations of which do not vary greatly over distances of ten kilometres.
Clearly, many of the sources of PM_{10} cannot be controlled or reduced by local authorities, as future concentrations will in part depend upon the contribution of the secondary and natural particle components. The Government has established the Airborne Particles Expert Group to advise on sources of PM_{10} in the UK and current and future ambient concentrations.

Background PM_{10} concentrations

The map below (figure 7.1) shows estimated Particulate background concentrations across the UK, the map was published by the DETR on their web site and based on work by Stedman, Linehan *et al* (1998). The particulate matter concentrations have been calculated on a 5x5km scale.

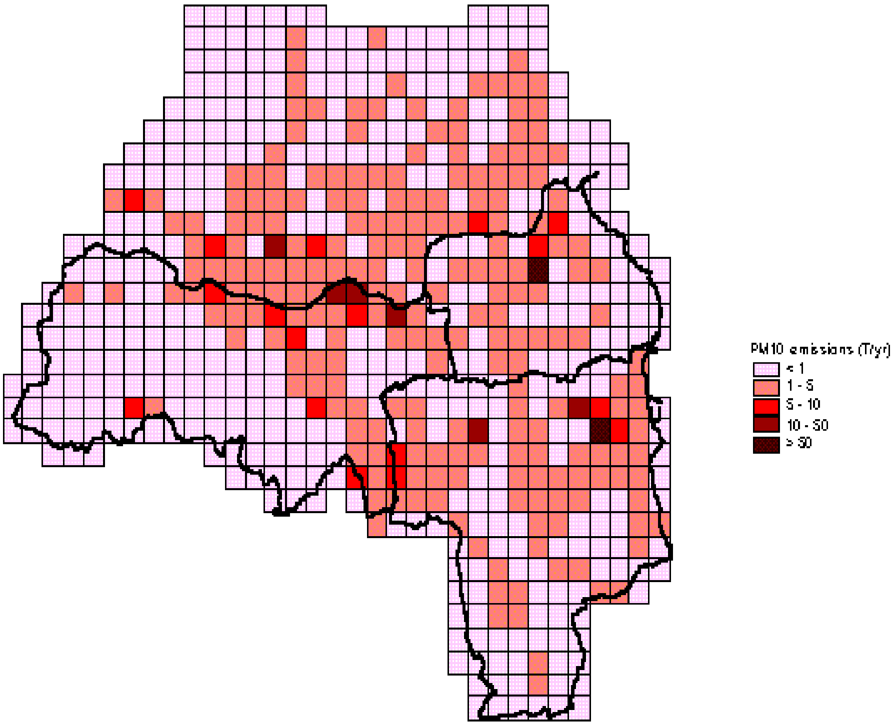
Figure 7.1 Map of estimated annual mean background PM_{10} in 2005



Sources of PM_{10} in Tyne & Wear

The urban emissions inventory commissioned in 1998 by the Tyne and Wear authorities quantified the spatial distribution of benzene emissions across the urban area. Figure 7.3 sets out the results of the exercise plotted over a map of the three southern authorities of Gateshead, South Tyneside and Sunderland. Results show that a number of 1km x 1km grid squares within Tyne & Wear register particulate emissions greater than 10 tonnes per annum and a number of adjacent grid squares have average emissions of PM_{10} exceeding 50 tonnes pa.

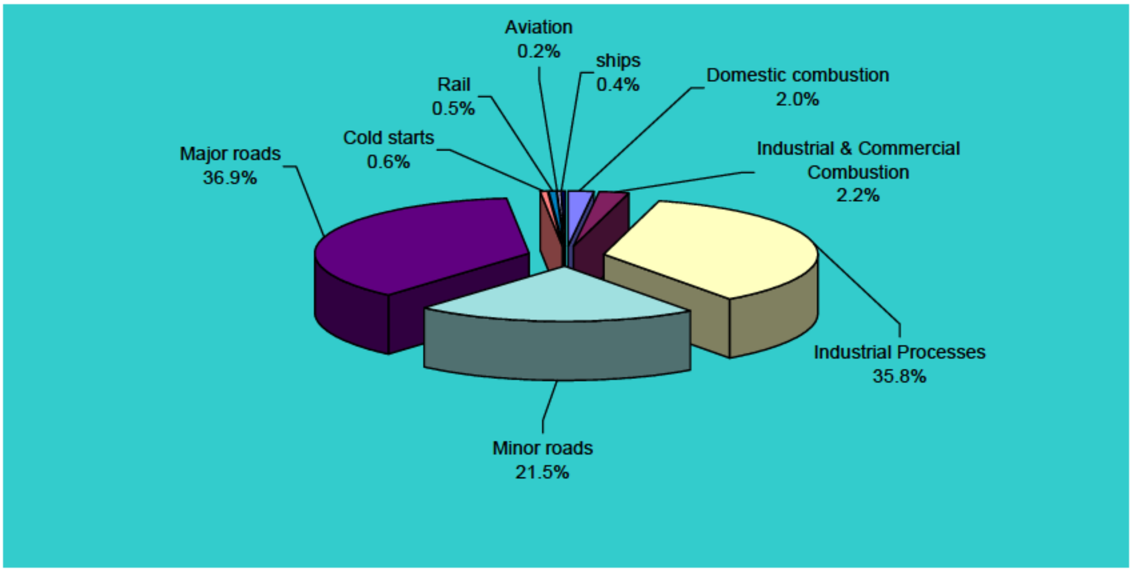
Figure 7.3: Particulate Matter (Tonnes/year) Emissions Map for Tyne and Wear



Examination of the results of the inventory identifies a noticeable split between road traffic and other PM_{10} sources, with only limited correlation between high emission sectors and major traffic routes such as the Gateshead Western By-pass.

The emissions inventory apportioned the following localised contributors to levels of ambient particulate matter.

Figure: 7.4 Source apportionment of PM_{10} in Tyne and Wear – 1998.

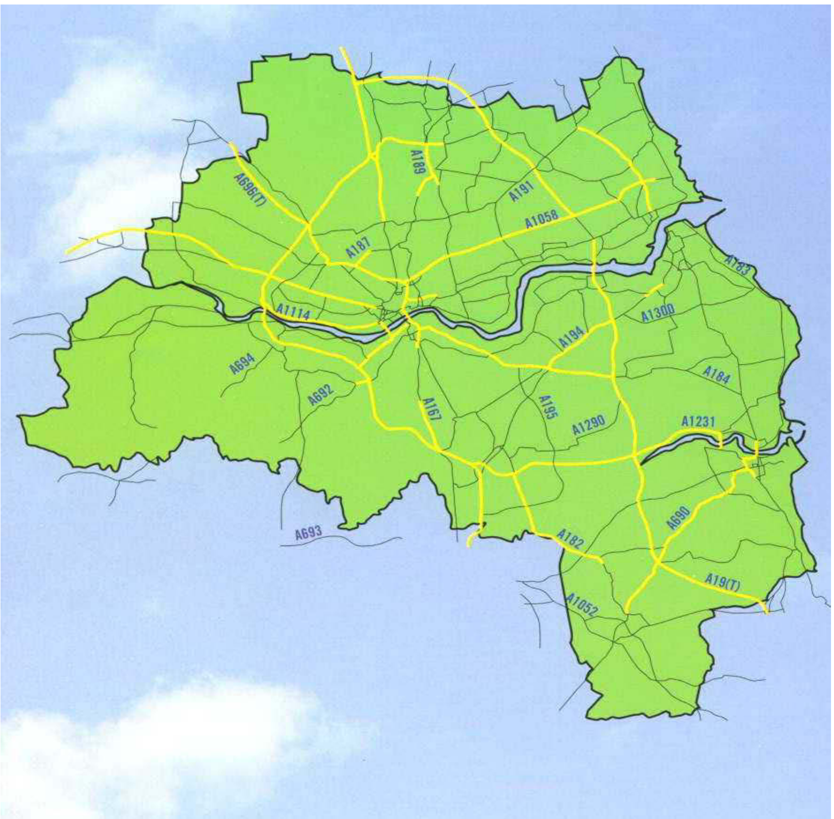


The Situation in Sunderland and South Tyneside

The 1996 national background concentration map was used to assess secondary particles contributing to annual average background PM_{10} concentrations for Tyne and Wear; this indicated a level of 9 and 10 $\mu g/m^3$. Based on the then DETR Pollutant Specific Guidance (LAQM.TG4 (98)) a decision was made that further review and assessment of particulate matter within the region was required because the predicted annual average secondary particle concentrations were greater than 8 $\mu g/m^3$ and therefore were at risk of exceeding the objective.
The stage I review also identified that the results from the Newcastle Centre AURN site for 1996 and 1995 exceeded the (previous) standard on 27 days and 20 days respectively.

As part of the stage one review an assessment was undertaken of all existing and planned Part A and B processes within Sunderland and South Tyneside using the guidelines in DETR's "Pollutant Specific Guidance". Thirty processes were identified as having the potential to emit significant quantities of PM_{10} within the area.

Figure: 7.5 Roads in Tyne and Wear with current and forecast (2005) annual average daily traffic flows greater than the 25,000 vehicle threshold



Stages 2 and 3 of the review have involved a more accurate and detailed review of pollutant levels in the vicinity of these sites, the examination of past monitoring data across the area, and the prediction of future PM_{10} concentrations using ADMS-Urban and utilising the emissions data from the Tyne and Wear urban emissions inventory.

Particulate matter has been monitored at a number of locations across Tyne and Wear. All of the short-term sites have been monitored using mobile units containing Tapered Element Oscillating Microbalances (TEOM) and the results have been compared to the AURN monitoring site in Newcastle.

The AUN quality assurance procedures have been applied to the mobile unit TEOM analysers. Records are kept on the routine performance of the analysers and any long-term response drifts. All analysers are serviced once every six months.

All the TEOM data quoted in this report has been corrected by a factor of 1.3 to give a gravimetric result.

Figures 7.6 – 7.13 are the results of the roadside monitoring carried out in the area. The 24-hour mean objective is a more stringent objective to meet than the annual mean objective. The Pollutant Specific Guidance LAQM TG4 (00) suggested that the 90th percentile of the daily means in a calendar year is approximately equivalent to 35 exceedance days a year. Figure 7.14 gives the 90th percentile of the above results and the predicted annual mean, based on the relationship given in the guidance of:

$$PM_{10}\ (90^{TH}\ \text{percentile of daily means}) = PM_{10}\ (\text{annual mean}) \times 1.79$$

Figure 7.6: City of Sunderland

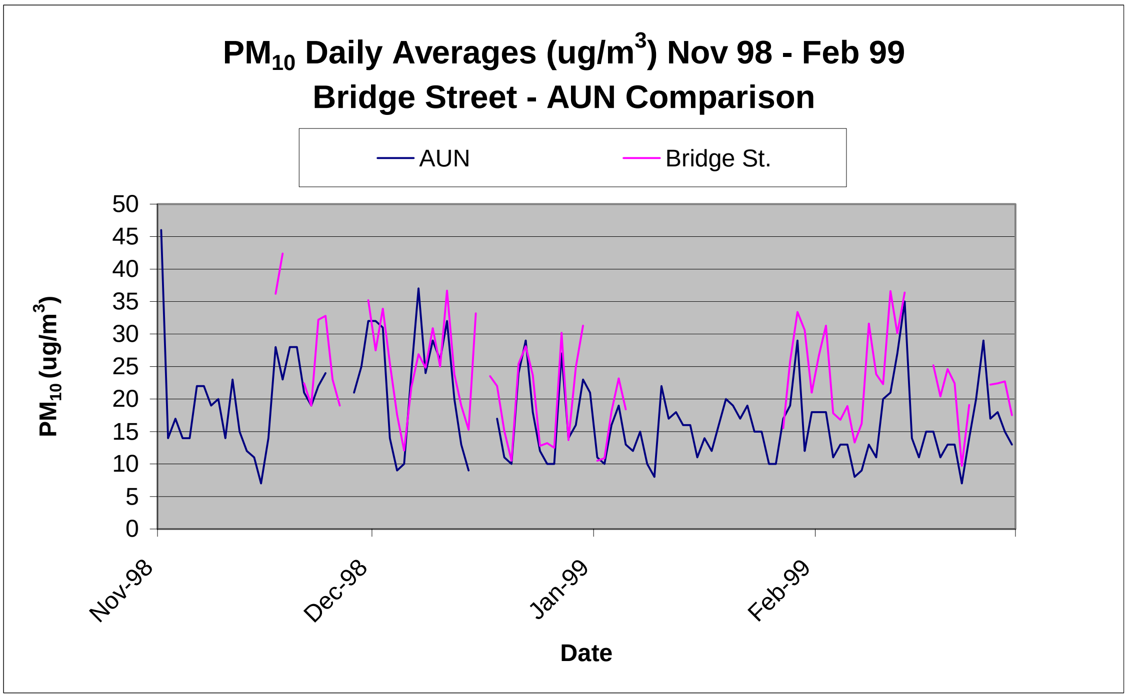


Figure 7.7: Borough of South Tyneside

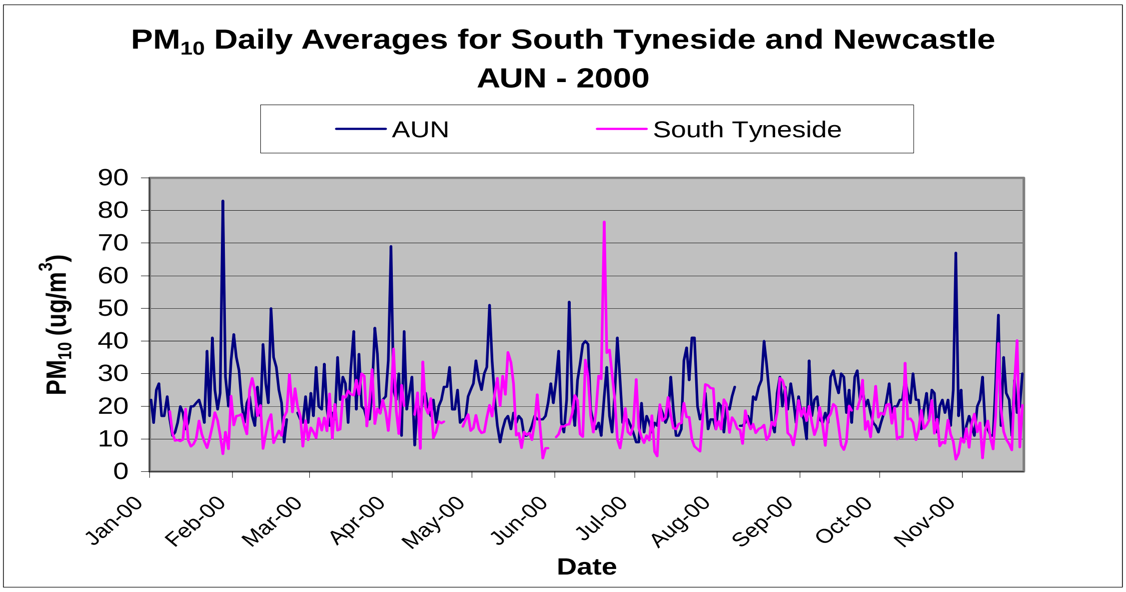


Figure 7.8: Newcastle upon Tyne

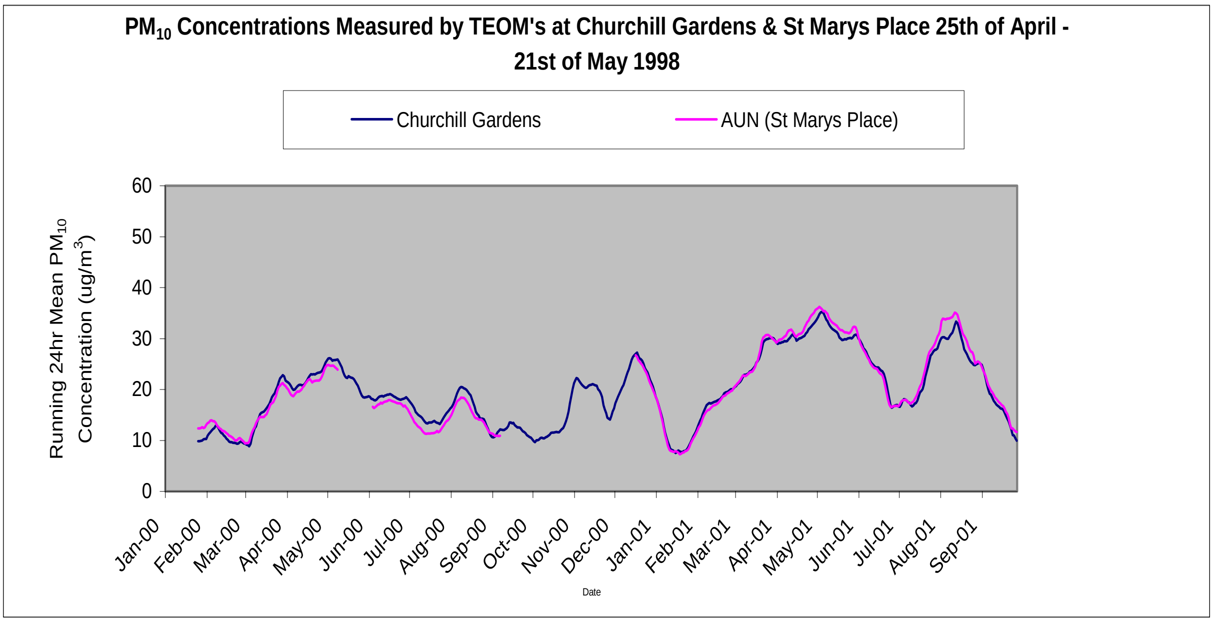


Figure 7.9: Newcastle upon Tyne

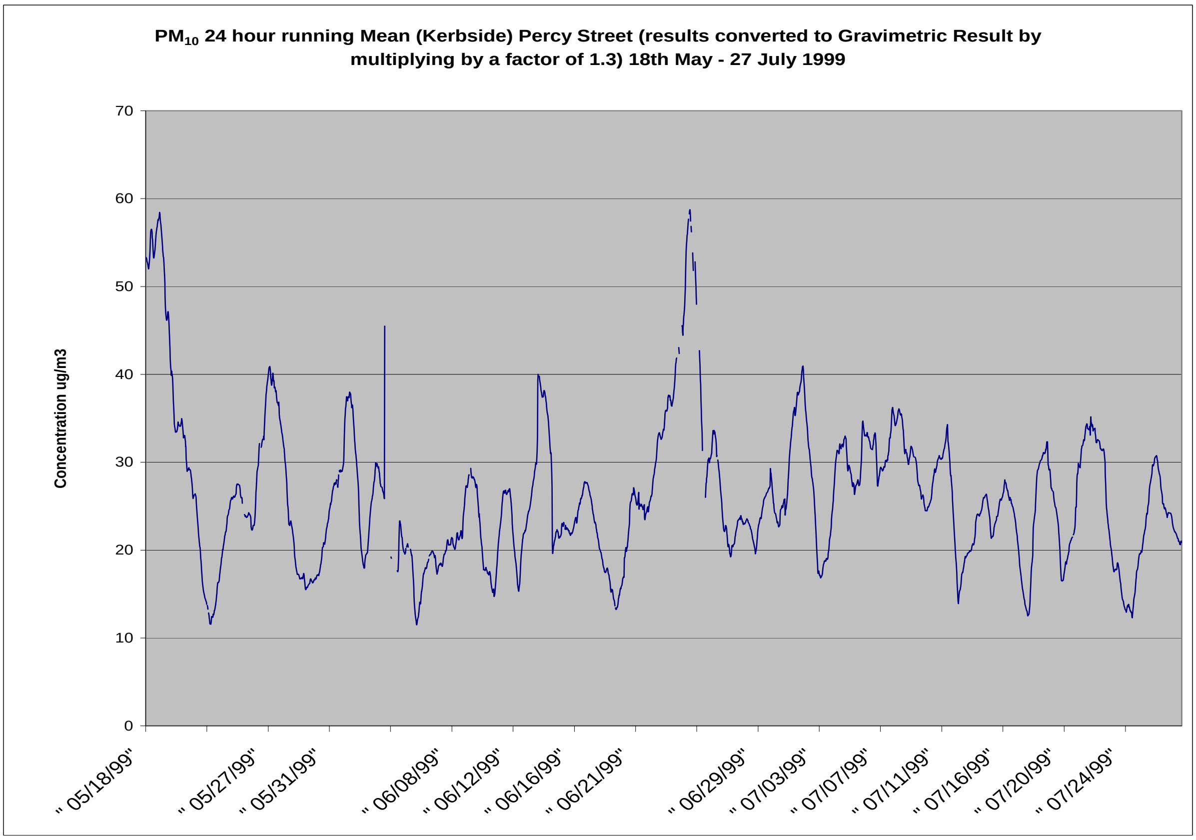


Figure 7.10: Newcastle upon Tyne

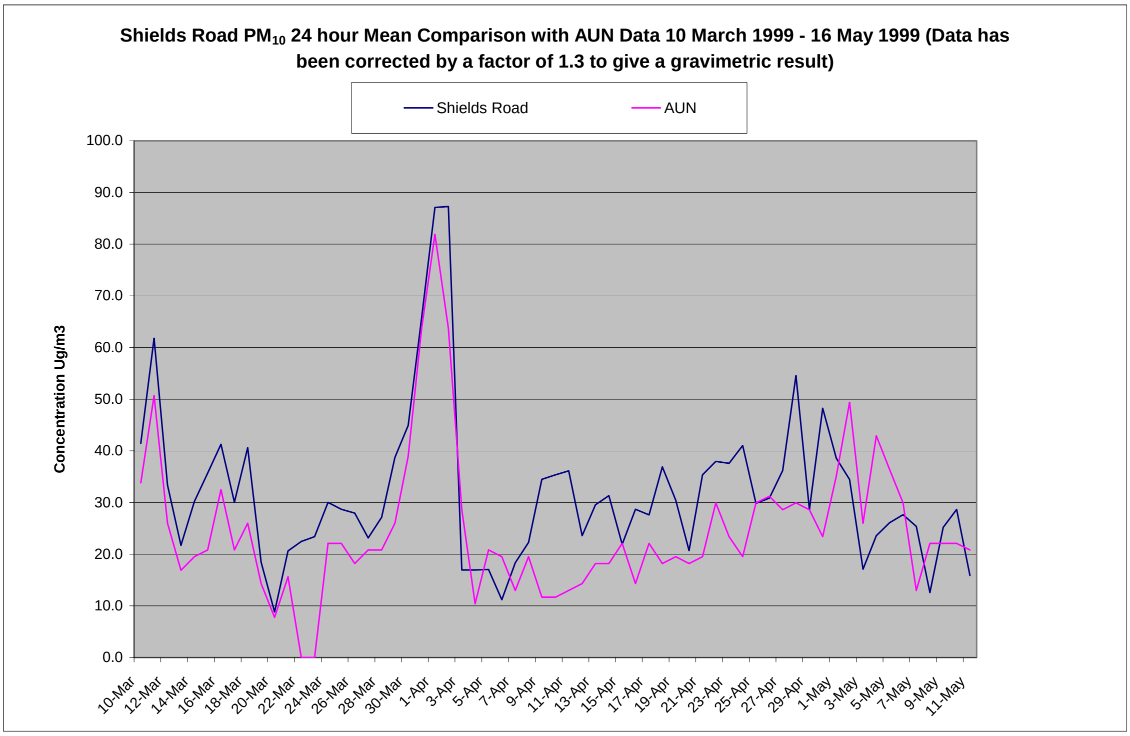


Figure 7.11: Newcastle upon Tyne – City Centre

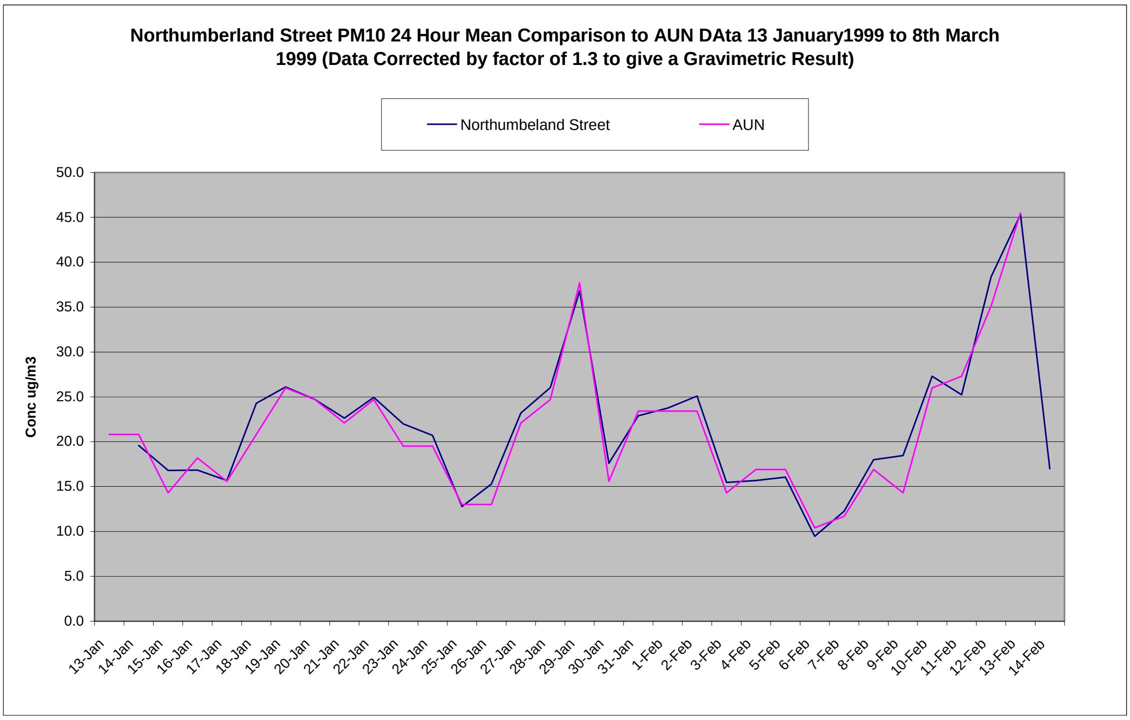


Figure 7.12: Gateshead

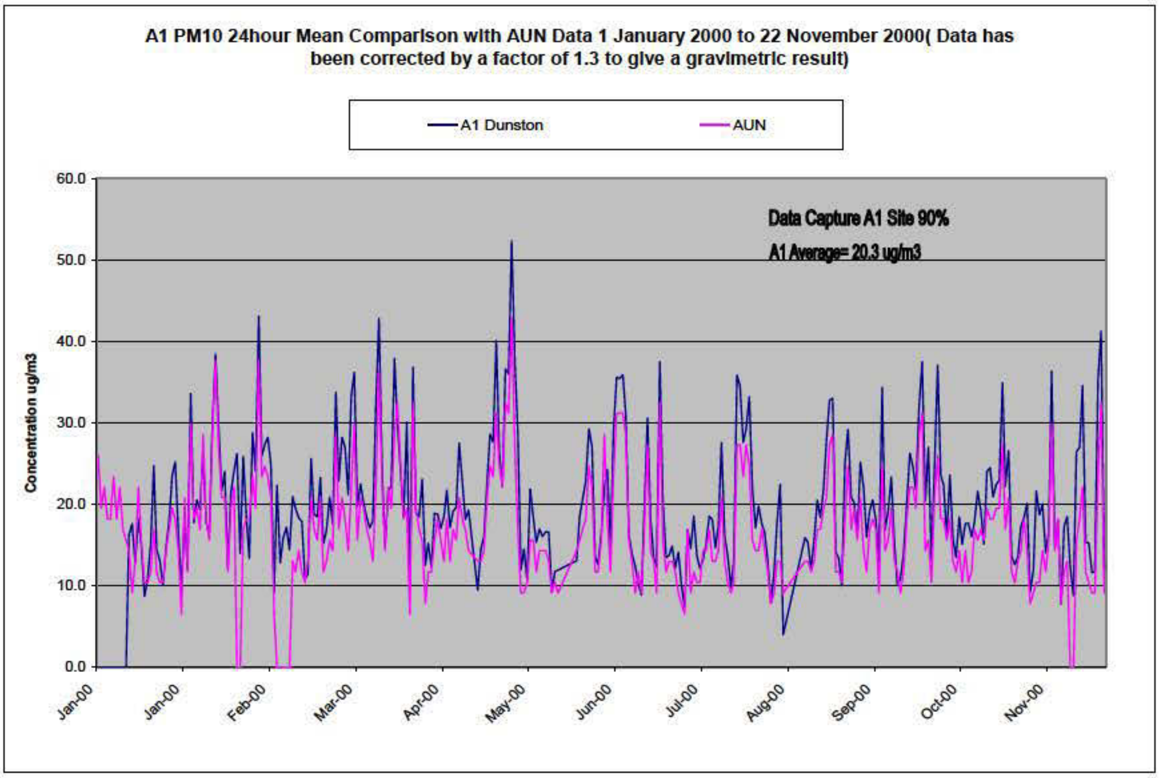
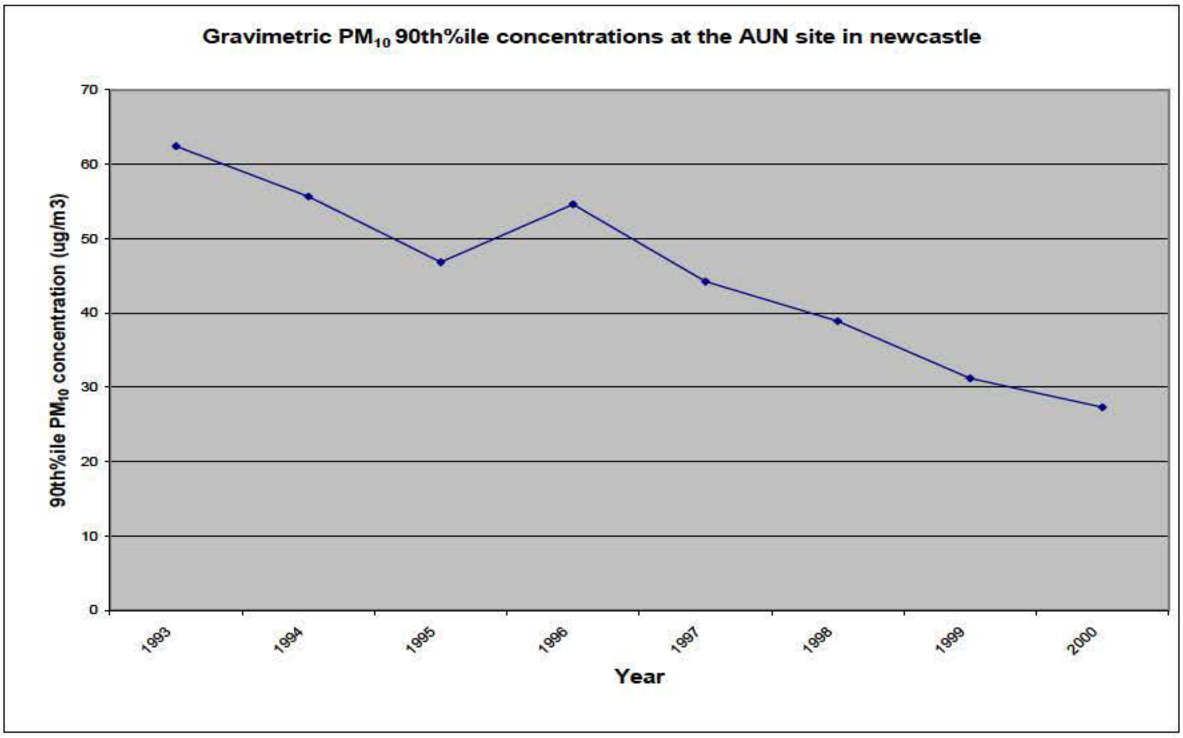


Figure 7.13: Predicted Annual Mean and 90th Percentile of Monitored Results

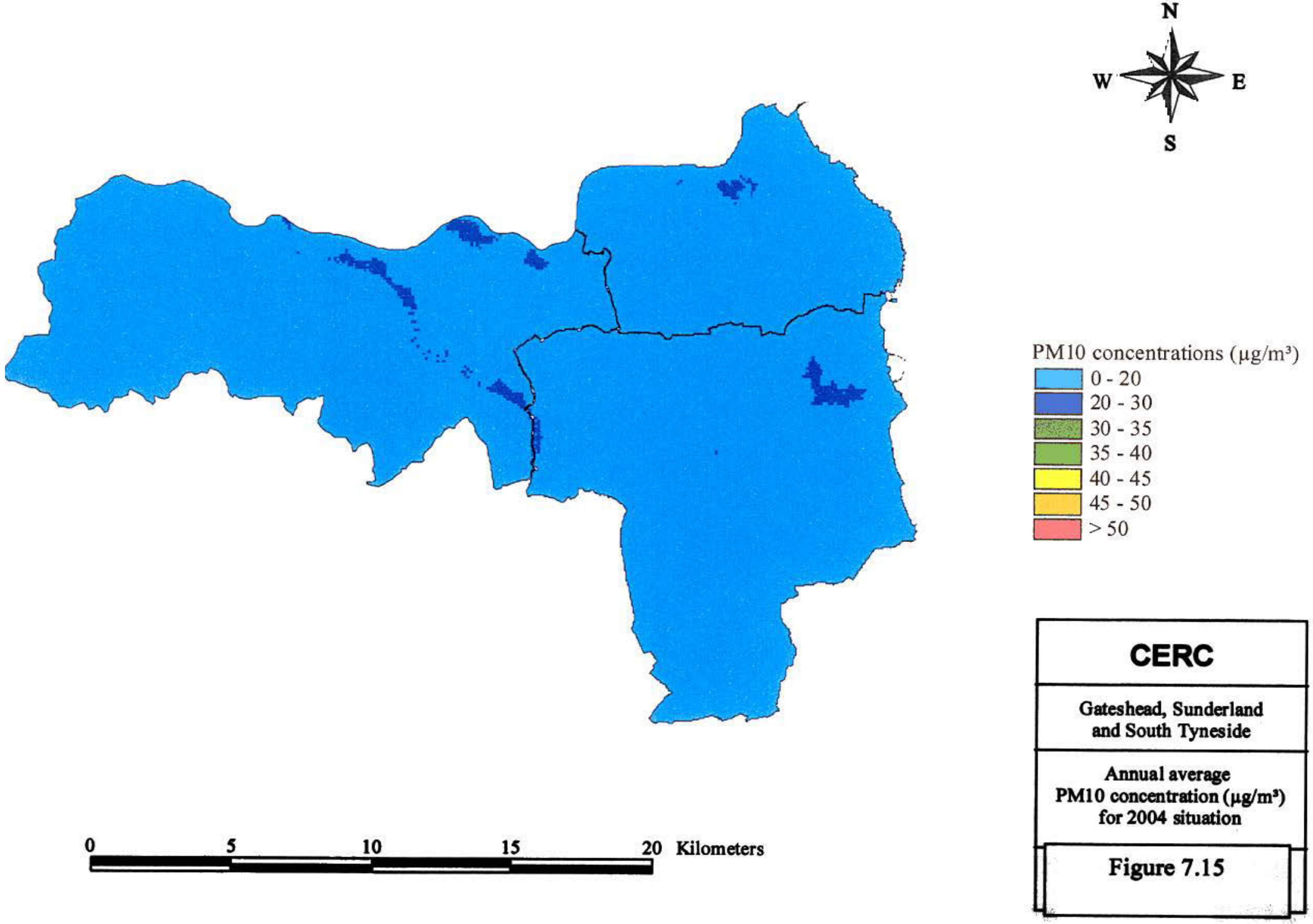


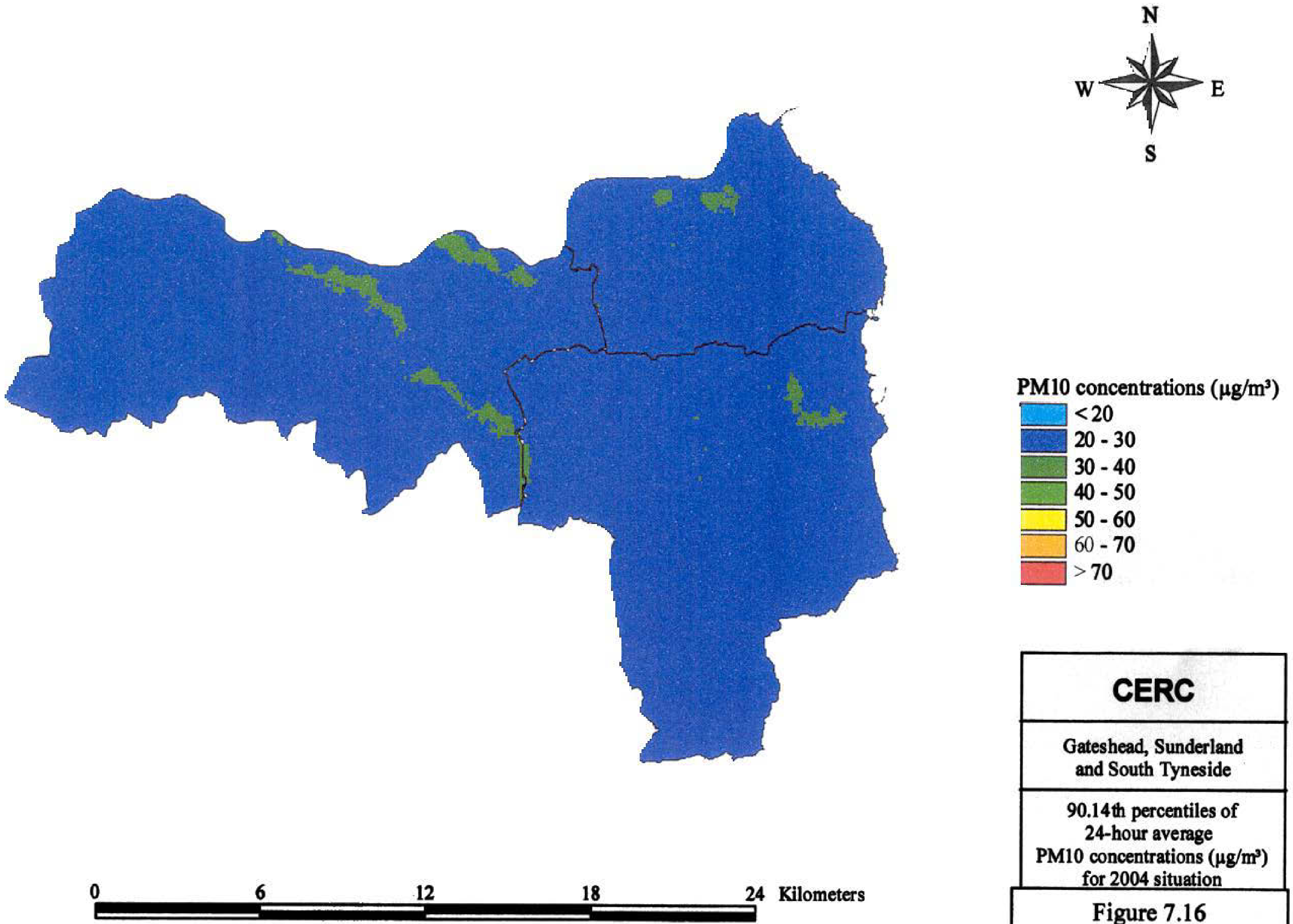
Site	Annual Mean (ug/m3)	90th Percentile of daily means (ug/m3)
Western Approach, South Shields	16.36	26.38
Bridge Street, Sunderland	16.6	39.26
Churchill Gardens (A1058)	16.7	30
Percy Street (1999	25.4	45.5
Shields Road (1999)	24.6	44.2
Northumberland Street (1999)	14.5	26.05
A1 (Dunston) (2000)	18.2	32.7
AUN 1999	21	31
AUN (2000)	17	27

The National Air Quality Strategy contains projected PM_{10} predictions for the Newcastle AUN site and these are presented in figure 7.13. The original data was presented by Stedman (Stedman 1998). Local primary particle concentrations are expected to be about half their current value in 2005 and secondary particles will reduce by a factor of 0.81. The results show that the City Centre background results in Newcastle will comply with the National Air Quality Objectives for PM_{10}.

Atmospheric Dispersion Modelling

Following the construction of an Urban Emissions Inventory emissions data was inserted into ADMS-Urban Version 1.53 and contour maps for annual average PM_{10} and 90^{th} percentiles of the 24-hour values for 2004 were produced. Figures 7.15 and 7.16 demonstrate that the Air Quality Objective for PM_{10} in Sunderland and South Tyneside will be achieved, levels for Sunderland City Centre and South Shields Town Centre are below 30μgm3
The modelled results for current emissions are concurrent with the actual measured values and there is confidence therefore in the predictions.


N
W
E
S
PM10 concentrations (µg/m³)
0 - 20
20 - 30
30 - 35
35 - 40
40 - 45
45 - 50
> 50
0
5
10
15
20 Kilometers
CERC
Gateshead, Sunderland and South Tyneside
Annual average PM10 concentration (µg/m³) for 2004 situation
Figure 7.15



CERC

Gateshead, Sunderland and South Tyneside

90.14th percentiles of 24-hour average PM10 concentrations (µg/m³) for 2004 situation

Figure 7.16

Conclusion

Monitoring data was available for some short term monitoring sites around the area. Ideally the monitoring should have been carried out for a minimum period of a year. However, the data has been compared to data from Newcastle Centre background AURN site in St. Mary's Place. All the monitoring data shows a very close correlation with that from the AURN station, demonstrating that levels of particulate matter in the area are strongly influenced by secondary particulates from external sources.

The 90^{th} percentile of the daily means in a calendar year is approximately equivalent to 35 exceedance days a year - none of the monitoring sites exceeded this criteria over the monitoring period and the predicted annual means were below the objective.

The AURN monitoring results, corrected to give a gravimetric comparison, show that the 90^{th} percentile of the 24hour means has consistently reduced since 1993 and that there has been no exceedance of the objective since 1996 at the monitoring site. The annual objective has been consistently met at the AURN site. The AURN results for 2000 indicate that the predictions made by Steadman et al for 2005 are an under estimate of the particulate background levels in Newcastle City Centre.

Gateshead MBC has made available data from their monitoring unit on the A1 at Dunston. The results again show a very strong correlation with the Newcastle AURN data. The A1 at this point has a traffic flow in excess of 100,000 vehicles a day, and the flow exceeds any other road in Tyne and Wear. The monitoring results indicate compliance with the objective.

The results of modelling carried out for the areas of Sunderland and South Tyneside demonstrate that the Air Quality Objectives for PM_{10} will be met.

Predicted levels for the annual average in 2004 in the majority of the area are below 20μg/m^3 with slightly elevated, but below 30.0μg/m^3, concentrations in the main urban centres probably due to a mix of heavily trafficked roads and industrial sources. The two locations specifically highlighted have been subjected to continuous monitoring (TEOM) and the measured annual averages are below 20μg/m^3 (Bridge Street, Sunderland 16.6μg/m3 and Western Approach 16.36μg/m^3).

Predicted levels for the 90^{th} percentile of the 24-hour means are in the main below 30μg/m^3 with the above highlighted areas ranging up to 40μg/m^3. Again continuous monitoring in these areas supports the models conclusion, with actual concentrations being (Bridge Street, Sunderland 39.26μg/m^3 and Western Approach 26.38μg/m^3). It is also likely that national measures, such as the regulation of tighter emission standards for new vehicles will reduce further the PM_{10} levels across the area without the need for local action.

It is considered that air quality within the City of Sunderland and the Borough of South Tyneside will meet the statutory objectives for PM10, and therefore no local action is currently required.

Review and Assessment of Sulphur Dioxide

Introduction

Sulphur Dioxide is a pollutant formed by the combination of one sulphur and two oxygen atoms mainly as a result of fossil fuel combustion. The gas dissolves in water to give an acidic solution which readily oxidises to produce sulphuric acid and as a result acts as an irritant to cause breathing difficulties and vegetation damage.

The main sources of sulphur dioxide are emissions arising from the combustion of sulphur-containing fossil fuel. Coal and heavy fuel oils generally contain higher proportions of sulphur than light fuel oil or diesel. Petrol and natural gas contain substantially less sulphur and are not a significant source of sulphur dioxide.

Air Quality Standard and Objective

The Government has adopted three standards for sulphur dioxide: -
A 15-minute mean of 266μg/m^3 (100ppb) as an air quality standard for sulphur dioxide, with the objective for the standard not to be exceeded more than 35 times per year by the end of 2005 (approximately equivalent to the 99.9th percentile of the total annual 15-minute values).
A 1 hour mean of 350μg/m^3 (132ppb) as an air quality standard for sulphur dioxide, with the objective for the standard not to be exceeded more than 24 times per year by the end of 2004 (approximately equivalent to the 99.7th percentile of the total annual hourly values).
A 24- hour mean of 125μg/m^3 (47ppb) as an air quality standard for sulphur dioxide, with the objective for the standard not to be exceeded more than 3 times per year by the end of 2004 (approximately equivalent to the 99th percentile of the total annual daily values).

For the 15-minute and 1-hour objectives, the focus of the review and assessment should be on any non-occupational exposure at near ground level outdoor locations.
For the 24-hour objective, the focus of the review and assessment should be on non occupational exposure at near ground level outdoor locations including:-

- Background locations
- Other locations where people may be regularly exposed, such as in the vicinity of housing, schools or hospitals.

The National Perspective

Coal-fired power stations and combustion of heavy fuel oil dominate emissions of sulphur dioxide. The total UK emission in 1996 was estimated as two million tonnes made up from 65% power generation, 24% other industry, 6% domestic heating and 5% road transport. Significant concentrations of sulphur dioxide continue to affect areas where domestic coal burning takes place and where industrial processes use coal or heavy fuel oil.

Background Sulphur Dioxide Concentrations

The map below (Figure 8.1) shows estimated sulphur dioxide background concentrations across the UK, the maps were published by the DETR on their web site and based on work by Stedman, Linehan *et al* (1998). The sulphur dioxide concentrations have been calculated on a 5 x 5km scale.

The data identifies background concentrations for Sunderland and South Tyneside as lying in the range 5.6 – 10.6μg/m^3 (2.1 – 4.0ppb).

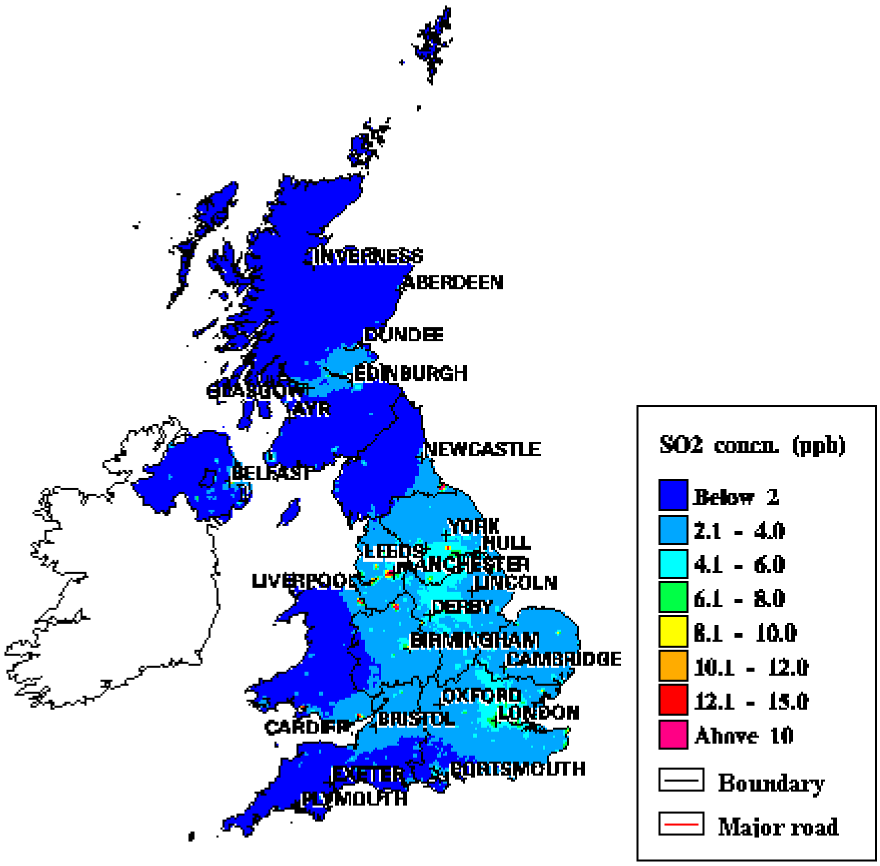


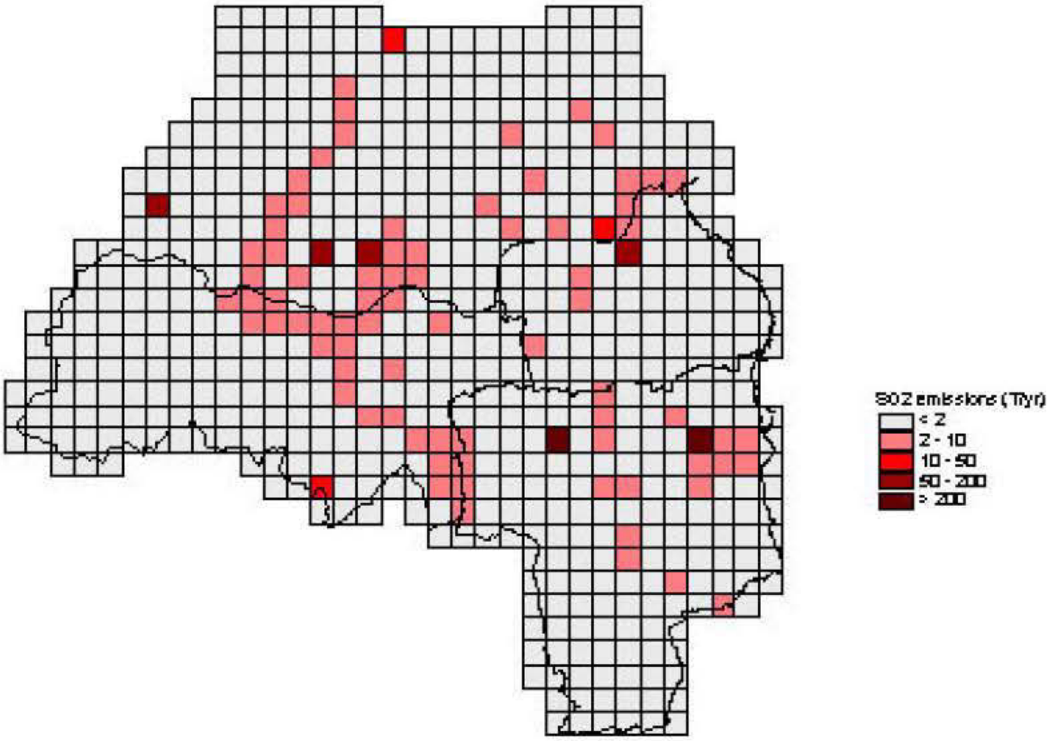
Fig 8.1 Background Sulphur Dioxide concentrations in the UK

Sources of Sulphur Dioxide in Tyne and Wear

The urban emissions inventory commissioned in 1998 by the Tyne and Wear authorities quantified the spatial distribution of sulphur dioxide emissions across the urban area.

Figure 8.2 sets out the results of the exercise plotted over a map of the three southern authorities of Gateshead, South Tyneside and Sunderland.

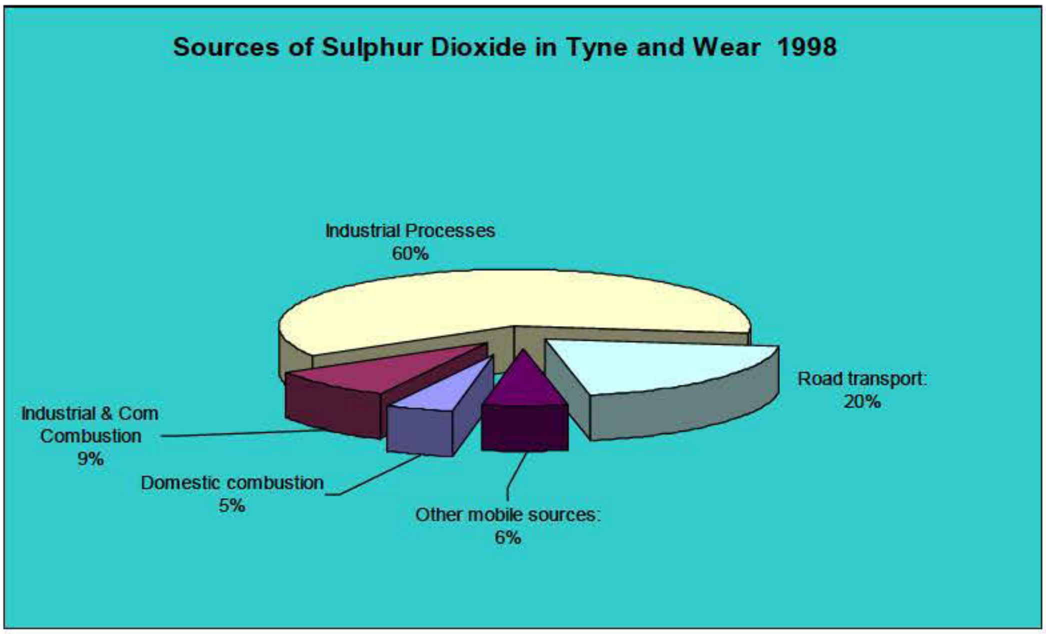
Figure 8.2:Emissions of Sulphur Dioxide in Tyne and Wear 1998



Examination of the inventory suggests that industrial sources are the major contributor to the current concentrations. To aid interpretation the darkest squares represent emissions of between 50 – 200 tonnes/sq/km/annum.

The apportionment of total sulphur dioxide emissions by category across Tyne and Wear is set out in Figure 8.3 below.

Figure 8.3: Sources of Sulphur Dioxide in Tyne and Wear 1998



The Situation in the City of Sunderland and South Tyneside

A number of potential significant sources of sulphur dioxide were identified during the first stage review and assessment in the region. These sources include Corning Limited, a glass manufacturer, CMR a Part A organic solvent recovery process together with a number of heavy fuel oil standby boilers.

Stages 2 and 3 of the review have involved a more accurate and detailed review of pollutant levels in the vicinity of these sites, the examination of past monitoring data across the area, and the prediction of future sulphur dioxide concentrations using ADMS-Urban and utilising the emissions data from the Tyne and Wear urban emissions inventory.

Sulphur Dioxide is measured at a number of sites in the Tyne and Wear Region. Sunderland has one site, which has operated as part of the Government's Automatic Urban and Rural Network (AURN) for 8 years. In addition a number of further sites have recently been installed as a result of the air quality review process and the results are included to compare with the more established AURN site.

In addition to these sites a number of mobile monitoring sites have been installed at locations throughout the area for six-month periods. The method of analysis was ultra violet fluorescence, the equipment Monitor Labs ML 9850 Sulphur Dioxide Analyser which is covered by ISO 7996 (EC directive 85/203/EEC). The results of these automatic real time monitors are shown in figures 8.5 – 8.10.

An independent central management closely monitors the data from the AURN sites and coordination unit, procedures, record keeping and calibrations are compatible with the UK National Measurement System.

Mobile Tyne and Wear monitoring units were situated in

- Bridge Street Sunderland
- Tyne Dock, South Tyneside

These units were automatically calibrated daily, gases used for calibration were certified and traceable with automatic calibration records being logged and stored on computer.

Figure 8.4: Sunderland and Newcastle AURN Results

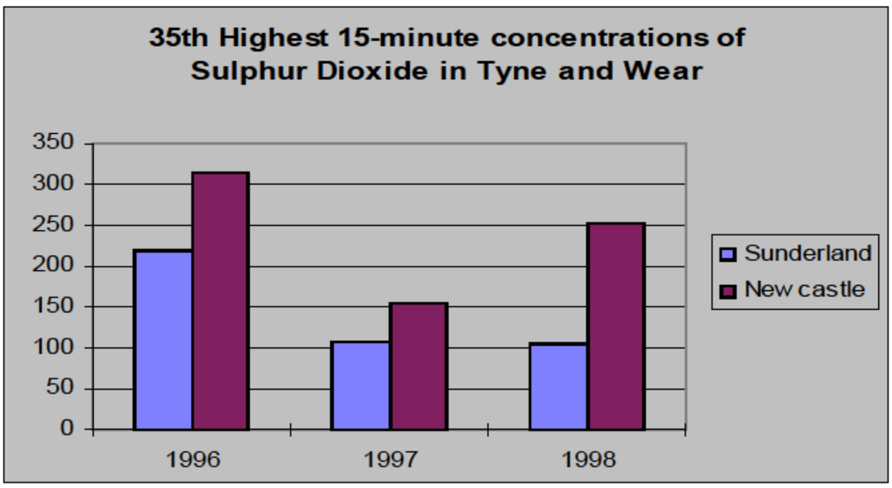


Figure 8.4 shows the 99.9th percentile of 15-minute sulphur dioxide concentrations measured at the AURN sites in Sunderland and Newcastle, in each year Sunderland meets the Air Quality Objective.

The Sunderland site had no exceedances of the hourly 350µg/m^3 and only one exceedance of the daily 125µg/m^3 and so complied with the 1-hour and daily air quality objectives for sulphur dioxide.

The trend has been that of steady decline over the last 5 years.

The figures 8.5 – 8.10 present the results of continuous monitoring in Sunderland and South Tyneside. Both sites show a close correlation with the local AURN monitoring sites and demonstrate compliance with the Air Quality Standards see table 8.4.

Table 8.5: Percentiles

South Tyneside

Averaging period	Percentile	Value (ppb)	Value (ug/m^3)	Objective (ug/m^3)	Data Capture
15 min.	99.9th	26.03	69.24	266	91.1%
1 hour	99.7th	16.4	43.62	132	92.7%
24 hour	99th	6.34	16.86	125	92.5%

City of Sunderland

Averaging period	Percentile	Value (ppb)	Value (ug/m^3)	Objective (ug/m^3)	Data Capture
15 min.	99.9th	26.5	70.5	266	83.2%
1 hour	99.7th	25.0	66.5	132	83.3%
24 hour	99th	9.1	24.2	125	83.3%

Figure 8.6: City of Sunderland Daily Averages

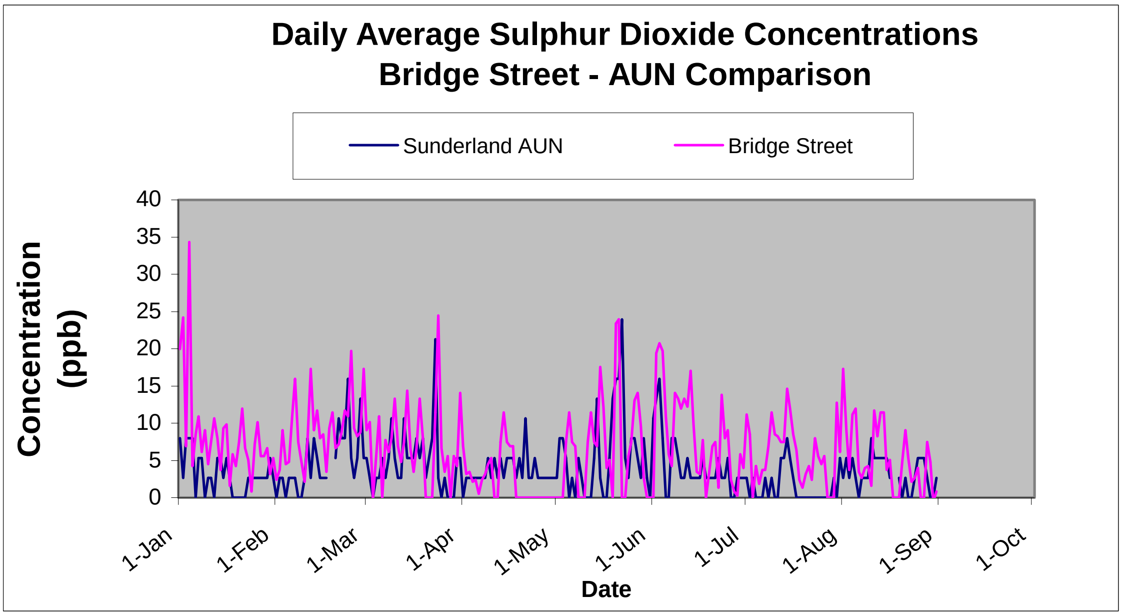


Figure 8.7: City of Sunderland Hourly Averages

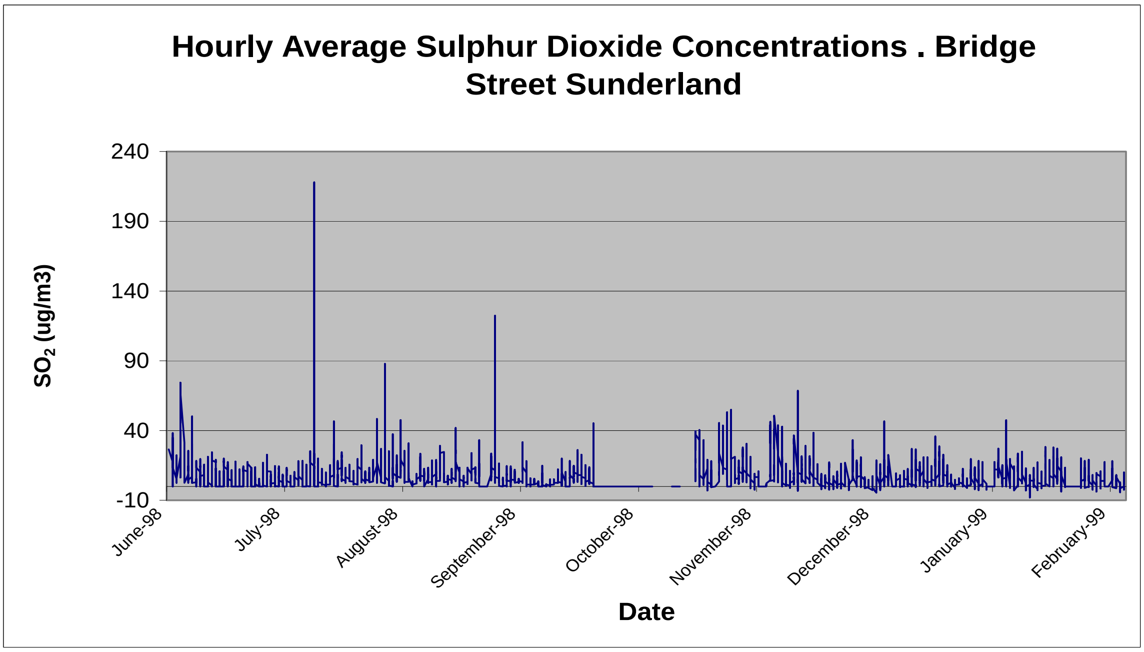


Figure 8.8: City of Sunderland 15 minute averages

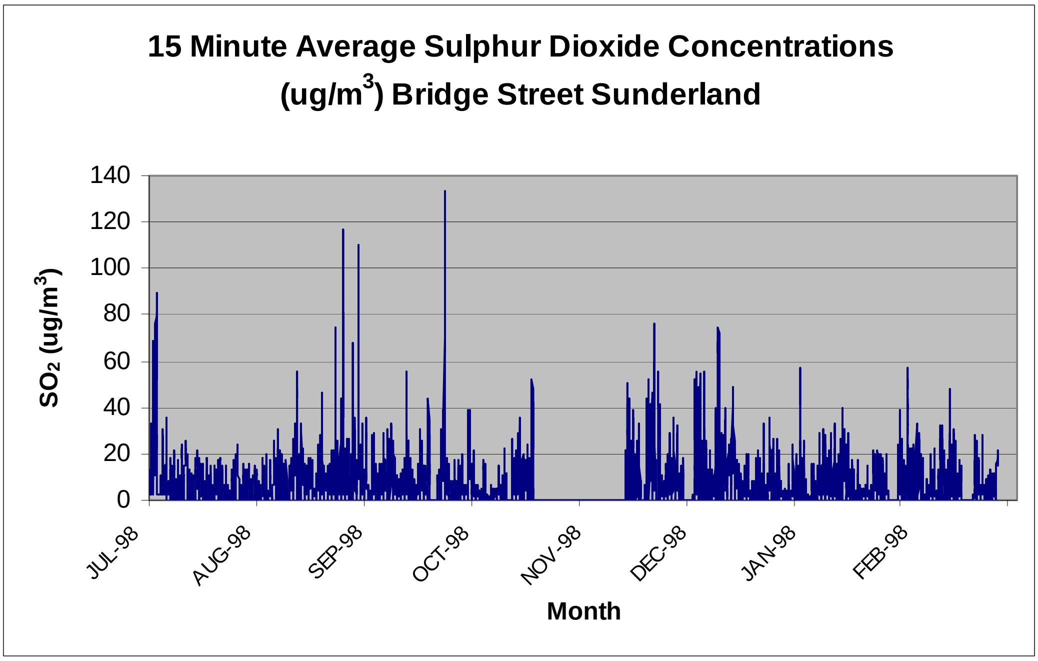


Figure 8.9: South Tyneside Daily Averages

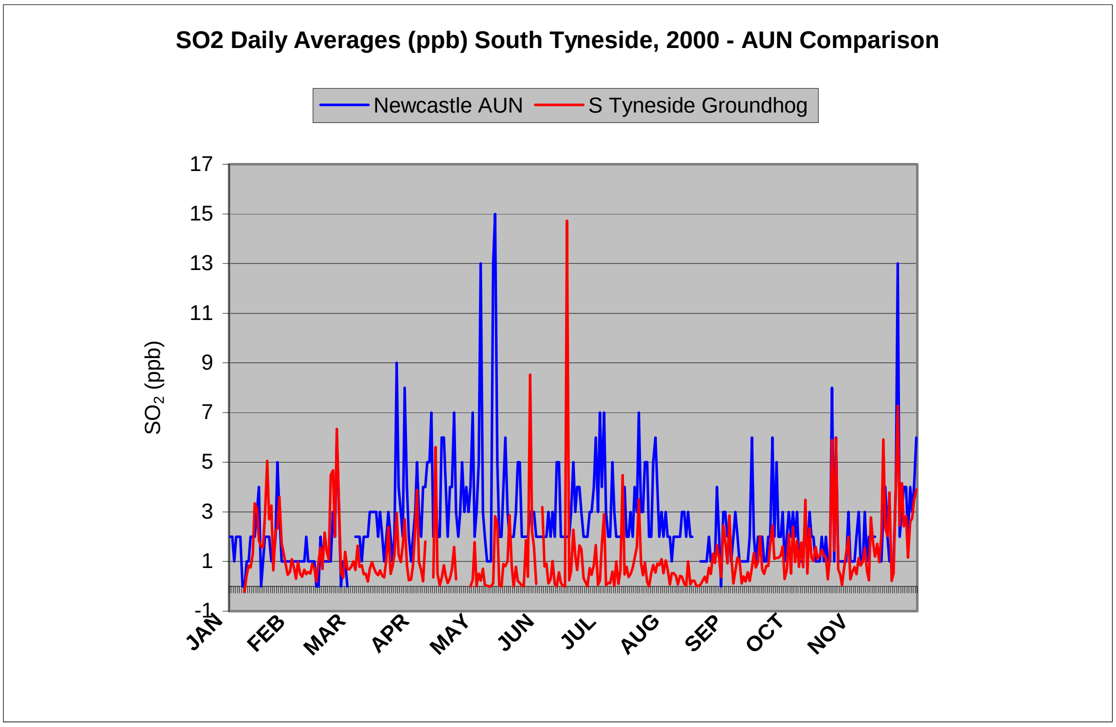


Figure 8.10: South Tyneside 15 minute averages

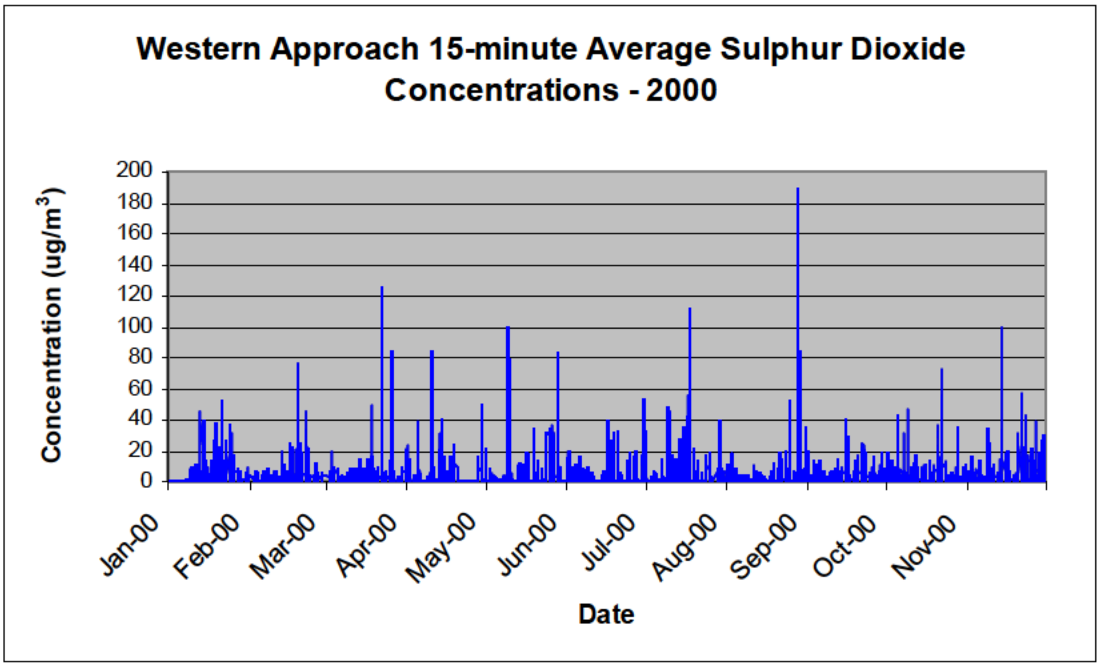
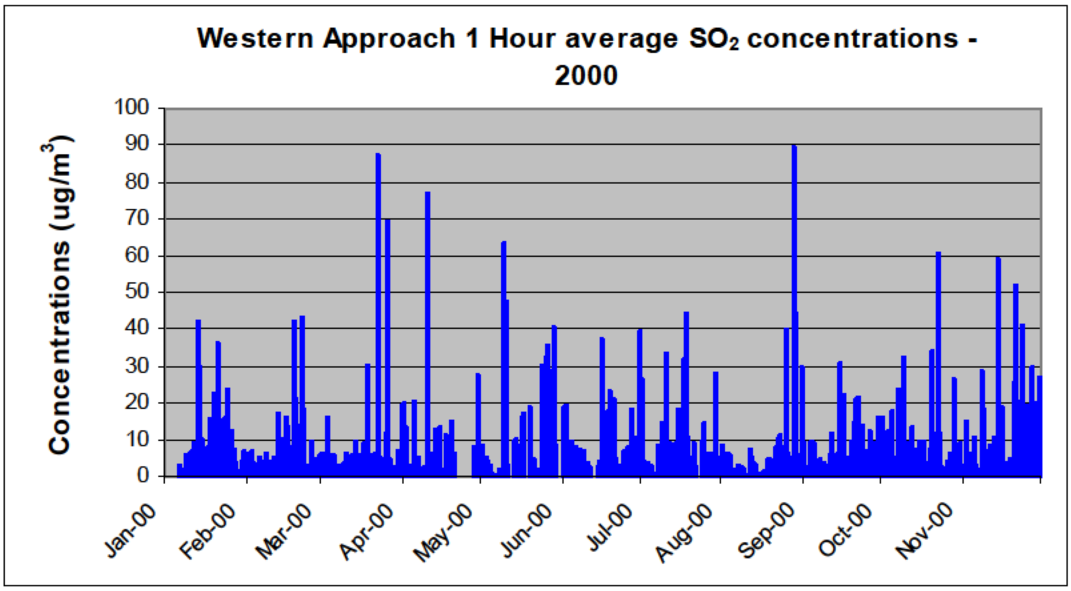


Figure 8.11: South Tyneside Hourly Averages



Atmospheric Dispersion Modelling

Following the construction of an Urban Emissions Inventory current emissions data was inserted into the modelling software ADMS-Urban version 1.53 and contour maps for 2005 were produced, Figures 8.12, 8.13, 8.14.

A number of point sources were identified in the stage 1 review as having the potential to exceed the sulphur dioxide objective. Advanced dispersion modeling of these potentially significant sources using ADMS Urban version 1.53 has found that none of these sources are likely to cause exceedances for any vulnerable receptors around the site.

Conclusion

A small number of potential significant sources of SO_2 were identified by the Stage 1 review, but further investigations into the exact details of emissions, operational profiles of the industrial processes, and discharge characteristics enable the specific sources to be discounted individually. The outcome of subsequent dispersion modelling using ADMS-Urban has supplemented this information.

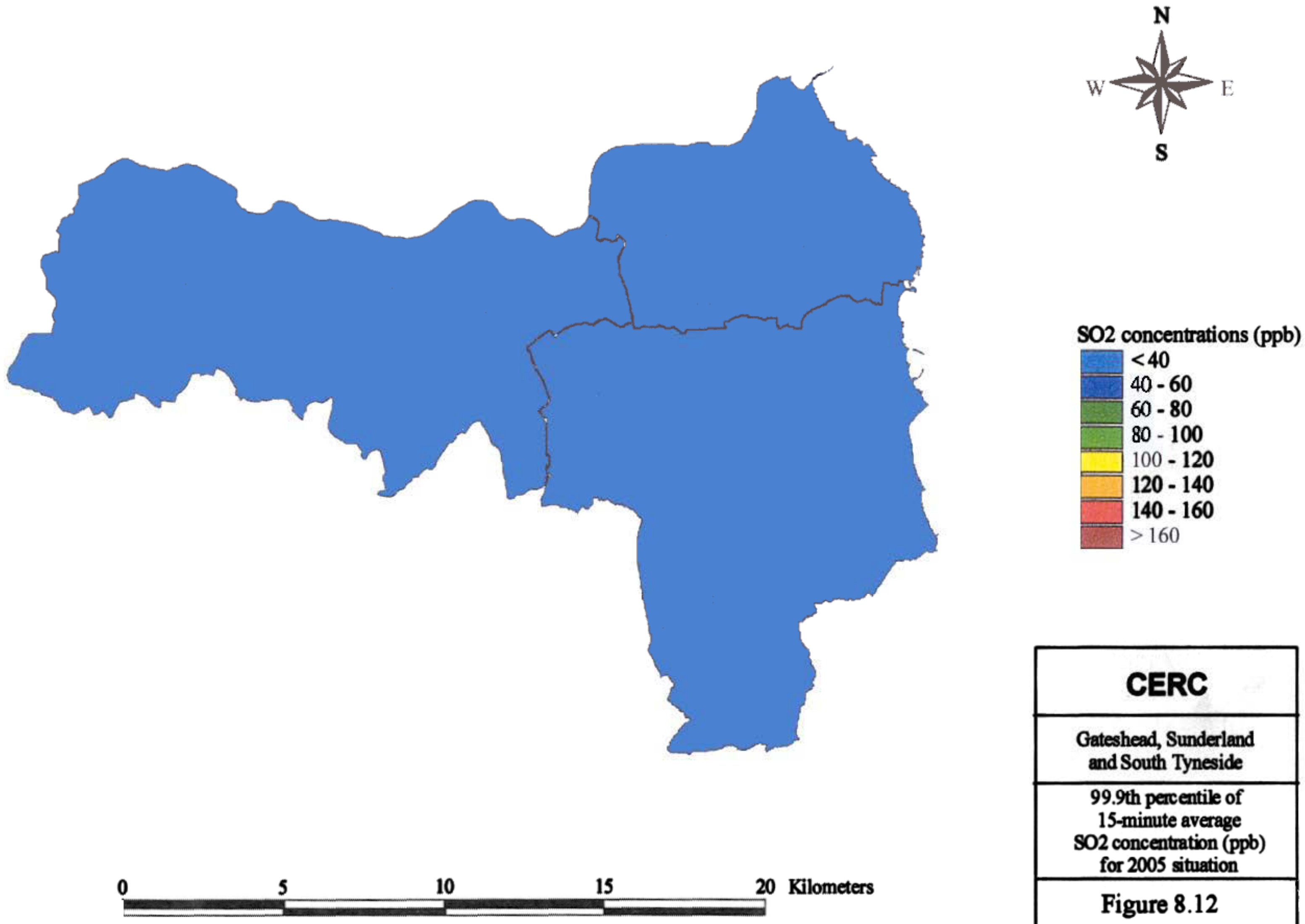
Monitoring data was available for some short term monitoring sites within Sunderland and South Tyneside. Ideally monitoring should have been carried out for a minimum period of 12 months but to support this data comparisons have been drawn with data from the Sunderland and Newcastle Centre background AURN sites. All the monitoring data shows a very close correlation with that from the AURN stations.

The AURN monitoring results show that the 99.9th percentile of the 15-minute means has consistently reduced since 1996 and that there has been no exceedance of the hourly objective since that date. The annual objective has been consistently met at both sites.

The results of modelling carried out for the areas of Sunderland and South Tyneside demonstrate that the Air Quality Objectives for sulphur dioxide will be met.

Predicted levels for the 99.9th percentile of **15-minute means** for 2005 are all below 106μg/m^3; the statutory objective being 266μg/m^3. Monitoring indicates that none of the sites exceeded this criterion over the relevant monitoring periods, with Western Approach returning a value of 69.2μg/m^3 and Bridge Street 70.2μg/m^3.

Predicted levels for the 99.7th percentile of all **hourly means** for 2005 are below 213μg/m^3; the statutory objective being 350μg/m^3. None of the monitoring sites exceeded this criterion over the monitoring period with Western Approach returning a value of 43.6μg/m^3 and Bridge Street 66.5μg/m^3.

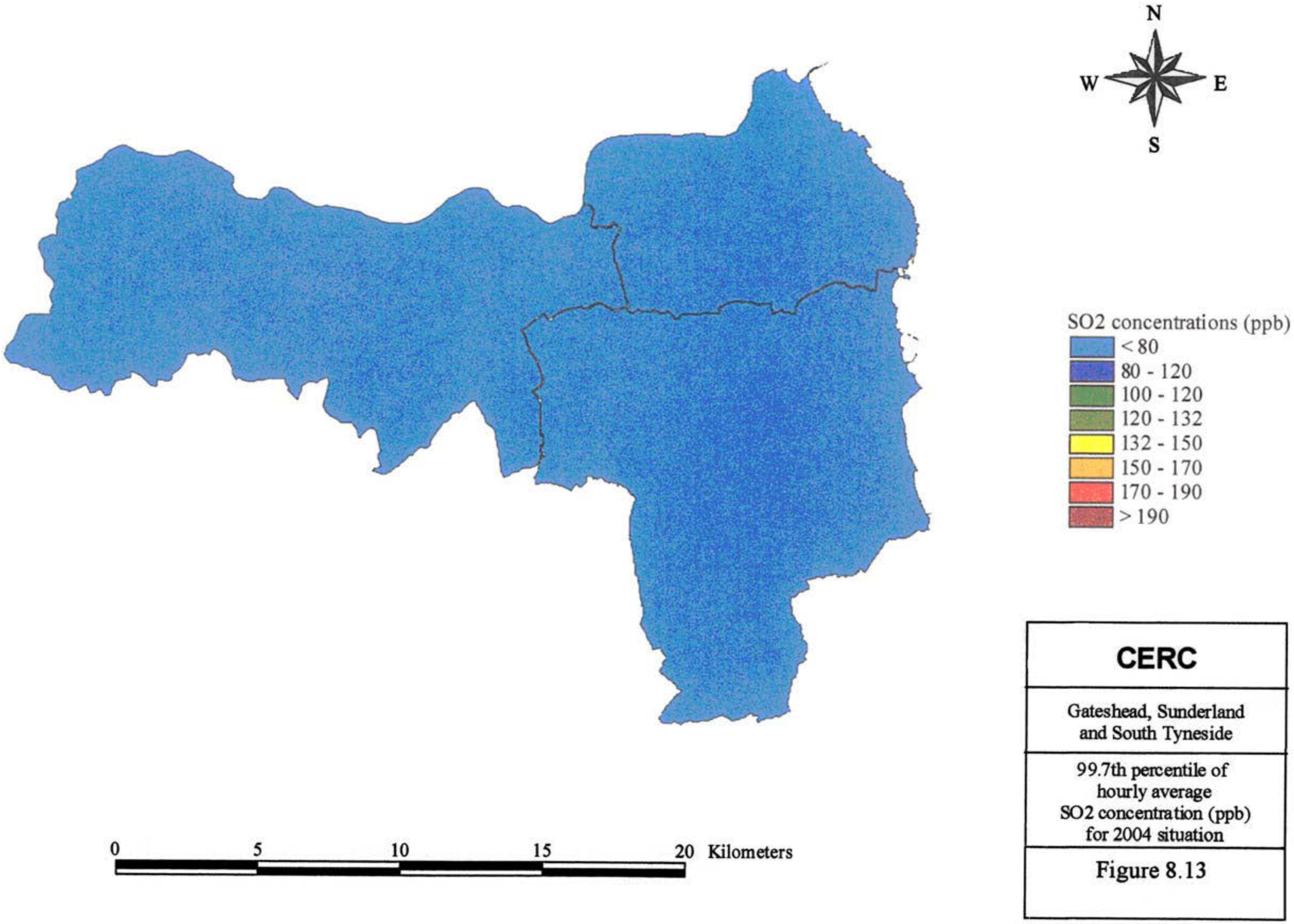


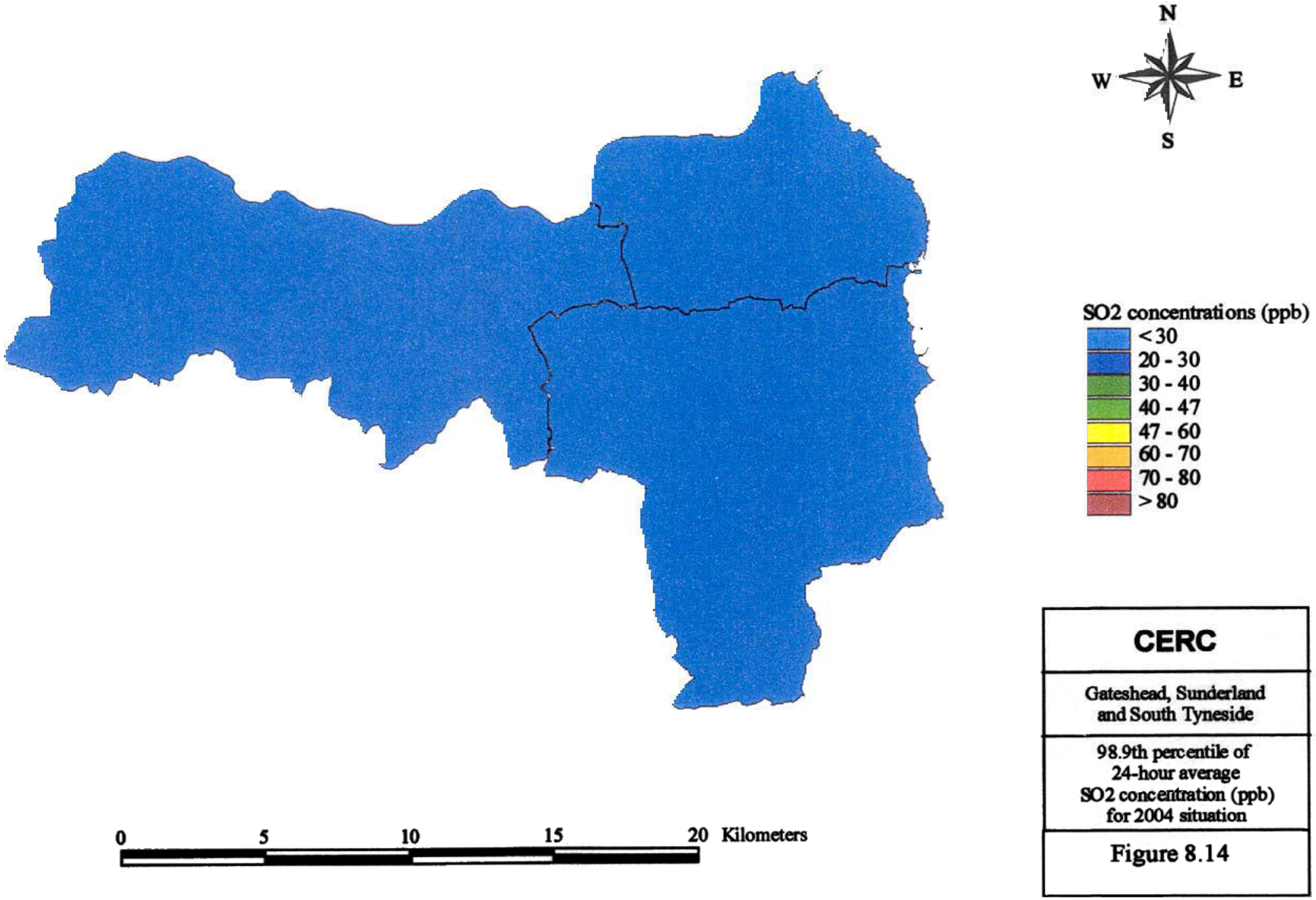
CERC

Gateshead, Sunderland and South Tyneside

99.9th percentile of 15-minute average SO2 concentration (ppb) for 2005 situation

Figure 8.12


N
W
E
S
SO2 concentrations (ppb)
< 80
80 - 120
100 - 120
120 - 132
132 - 150
150 - 170
170 - 190
> 190
0
5
10
15
20 Kilometers
CERC
Gateshead, Sunderland and South Tyneside
99.7th percentile of hourly average SO2 concentration (ppb) for 2004 situation
Figure 8.13



Gateshead, Sunderland and South Tyneside

98.9th percentile of 24-hour average SO2 concentration (ppb) for 2004 situation

Figure 8.14

Predicted levels for the 99th percentile of **24-hour means** for 2005 are below 80μg/m3, against an objective of 125μg/m3. None of the monitoring sites exceeded this criterion over the monitoring periods with Western Approach returning 16.8μg/m3 and Bridge Street 24.2μg/m3.

It is considered that air quality within the City of Sunderland and the Borough of South Tyneside will meet the statutory objectives for Sulphur Dioxide and therefore no local action is currently required.


City of
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