

Stage 2 Review of Air Quality in South Norfolk 2000

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Stage 2 Review of Air Quality in South Norfolk 2000

Local Authorities are required by section 82(1) of the Environment Act 1995 to carry out periodic reviews of air quality in their areas, and to assess present and likely future air quality against the air quality standards prescribed by the Air Quality Regulations 1997. These objectives are based on those set out in the National Air Quality Strategy. Where the objectives are not likely to be achieved by 2005, an authority is required to designate an Air Quality Management Area (AQMA), and make an action plan for improvements in air quality.

Guidance issued by the Department of the Environment Transport and the Regions (DETR) outlines the way in which such reviews are to be carried out. This is in three stages, the first being a rough screening method, the second focusing on those pollutants that are identified in the first stage using modelling and any monitoring information available, and the third, if necessary, a detailed investigation into any which are shown likely to exceed the air quality standards by 2005.

The stage 1 review carried out by South Norfolk District Council¹ identified 3 pollutants which would be looked at further in a stage 2 assessment:

- Nitrogen Dioxide
- Sulphur Dioxide
- Particles (particulate or PM₁₀)

(NOTE the stage 1 review was carried out using the standards and objectives pertaining at the time. Since the publication of the stage 1 review the National Air Quality Strategy has been amended and some standards and objectives revised. This stage 2 review uses the National Air Quality Strategy standards as at January 2000).² The standards and objectives are reproduced as Appendix {A}

This second stage review uses data from monitoring equipment which is sited at various locations across the district and also modelling using methods recommended in the Guidance Notes provided by the Department of Environment Transport and the Regions.

¹ A Review of Local Air Quality in South Norfolk - EH & L Dept. South Norfolk Council

² The Air Quality Strategy for England, Scotland, Wales and Northern Ireland- DETR

Modelling for road traffic sources

The model used in this review is the Design Manual for Roads and Bridges, Volume 11, Section 3 produced by the Highways Agency³ as suggested in the Pollutant Specific Guidance notes (para 6.9 page 23) produced by DETR.⁴ The model is generally accepted as adopting a precautionary approach to estimations.

The Design Manual for Roads and Bridges (DMRB) provides a step-by-step procedure for calculating the contribution of traffic on nearby road links to the concentration of air pollutants at a particular site location.

The procedure involves dividing the network of roads within 200m radius of the particular location of interest - the receptor point - into as few continuous sections (links) as possible. For each separate road link the user inputs peak hour traffic flows and uses conversion factors to convert the traffic flow into the emissions-equivalence of the flow of average 1995 light duty vehicles travelling at a speed of 100 kilometres per hour. A set of curves and look up tables is provided for the appropriate conversion factors. The conversion factors depend upon :

- the pollutant
- the average speed of the vehicles travelling on the road link
- the mix of the vehicle fleet (e.g. % heavy goods vehicles in the traffic flow)
- the year (1996, 2000 etc.)

The contribution made by the traffic on a particular road link to the concentration of pollutant at the receptor point is derived using the shortest distance between the receptor and centre of the road, and the look up tables. The look up tables give the pollutant concentration which would be produced by 1000 vehicles/hour travelling at 100 kph as a function of the distance from the road.

The contribution made by each separate road link are then summed. Finally, the average peak hour concentration at the receptor point is converted into the terms of a particular air quality standard criteria using further empirically based correction factors given in curves and look up tables.

The DMRB has been translated to a simplified spreadsheet to enable quick calculations to be made and this method is used in this review.

³ Design Manual for Roads and Bridges - Volume 11, Section 3, Part 1, Highways Agency

⁴ Review and assessment - Pollutant specific guidance LAQM.TG4(98) DETR,

NITROGEN DIOXIDE

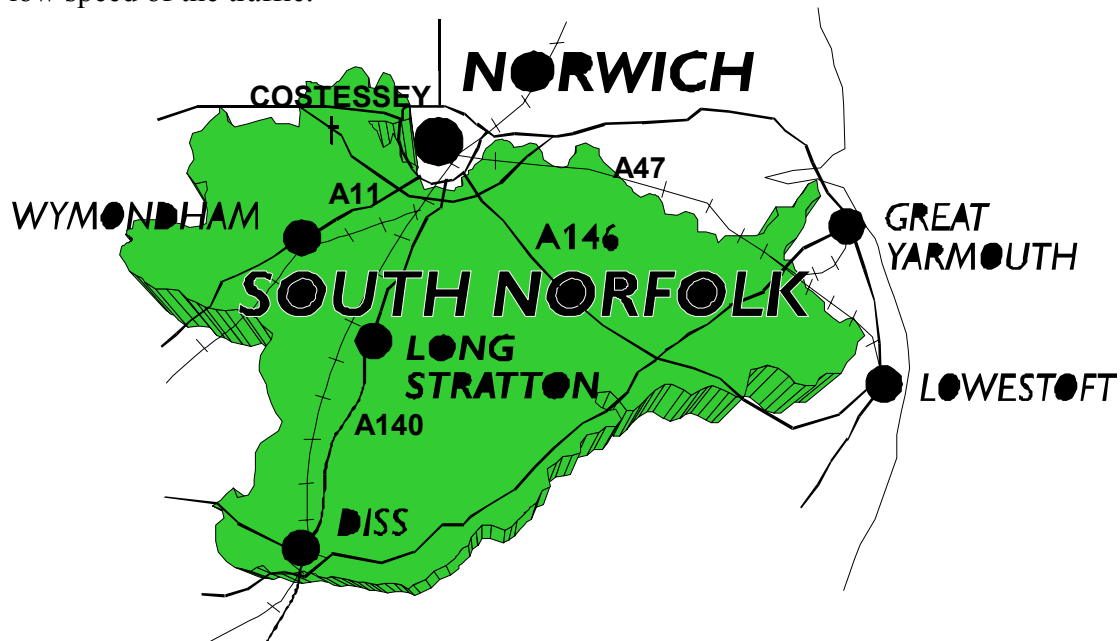
The Government has adopted an annual mean of $40\mu\text{g}/\text{m}^3$ (21 ppb), and a 1-hour mean of $286\mu\text{g}/\text{m}^3$ (150 ppb), as the air quality standards for nitrogen dioxide. The objectives are for the annual mean standard to be achieved by the end of 2005, and a 1-hour mean of $2000\mu\text{g}/\text{m}^3$ (105 ppb) not to be exceeded more than 18 times per year, to be achieved by the end of 2005 (approximately equivalent to the 99.8th percentile of hourly means).

The focus of the review and assessment for the annual mean assessment should be the following locations:

- background locations
- roadside locations
- other locations where potentially significant groups might be regularly exposed, such as schools or hospitals.

For the 1-hour mean objective the focus of the review and assessment must include any non-occupational, outdoor locations (including kerbside sites).

The first stage review identified certain roadside locations within South Norfolk where levels of NO_2 could be high due to flows of vehicles in excess of 20,000 on average per day. These were the southern bypass (A47) at Trowse, Bawburgh, Little Melton, Keswick and Caistor, and the A11 at Wymondham and Colney. In addition the A140 at Long Stratton has predicted traffic flows just in excess of 20,000 vehicles per day and should be considered because of the proximity of the road to dwellings and the relative low speed of the traffic.



In addition to traffic related sources of NO₂, the first stage review identified the only fixed source of NO₂ which could impact upon the district of South Norfolk as Bacton gas terminal.

The Environment Agency have commented on the likely impact of the Bacton site on air quality generally as follows⁵:

“According to air dispersion modelling which is already on record and substantiated by air quality monitoring there is no likelihood of potential for exceedences of NAQS objectives arising from releases from these processes as currently operated. Furthermore, due to the continuing BATNEEC review of operations at the four sites releases for a given production output should generally decline over time, thus affording greater margins of comfort.

Should additional production facilities be considered for these sites then their provision would have to have regard for not prejudicing the achievement of NAQS objectives.”

The Sugar Beet refinery at Cantley across the river from the South Norfolk District in a north easterly direction is an industrial source which could affect the South Norfolk Council area. The emissions were discounted in the stage 1 review but have been revisited as part of this assessment. Consultation⁶ with Broadland District Council indicate that no exceedences of the UKNAQS objectives for NO₂ are predicted.

A new gas fired combined heat and power (CHP) plant is proposed, to replace the existing boiler house and chimney with a completely new installation. An Air Dispersion Study of the Proposed new CHP plant including the existing animal feed dryers has been undertaken by Cambridge Environmental Research Consultants. The Atmospheric Dispersion Modelling System 2, version 2.2 was applied using data over 1 year in order to assess the estimated contribution of the existing process, and proposed plant, to oxides of nitrogen emissions. The model assumes that all emitted NO_x is NO₂ and consequently the predictions are overestimates.

The poultry manure power station at Eye

This process is within the District Council of Mid-Suffolk. It is a Part A process under the Environmental Protection Act 1990 Part 1 and as such is controlled by an authorisation issued by the Environment Agency.

Mid-Suffolk District Council has assessed the emissions from the power station as part of their Stage 1 and stage 2 assessment and determined that Nitrogen Dioxide from the plant will have no significant impact upon ground level concentration within their district. In the circumstances it is reasonable to assume that a similar conclusion can be drawn in relation to the impact from this plant within the South Norfolk District.

⁵ Letter from V Whiteley, Environment Agency to Mrs C Bye at North Norfolk District Council dated 27th March 2000

⁶ Broadland District Council “Air Quality Review and Assessment Stages 1 and 2 (Draft Report) January 2000

Monitoring

Nitrogen Dioxide has been measured in different areas of the district by the use of diffusion tubes for several years and quite extensive data is available. The location of the monitoring points was chosen for a variety of reasons not specifically for the review now under consideration. Some background monitoring has taken place, but for the purposes of the calculations for this review the data for background levels will be that taken from the DETR website as instructed by their guidance on review and assessment.

The monitoring locations are as follows:

1997 Wymondham, Diss, Long Stratton, Old Costessey and Harleston.

Monitoring was carried out at these locations at near road sites, intermediate sites and background sites.

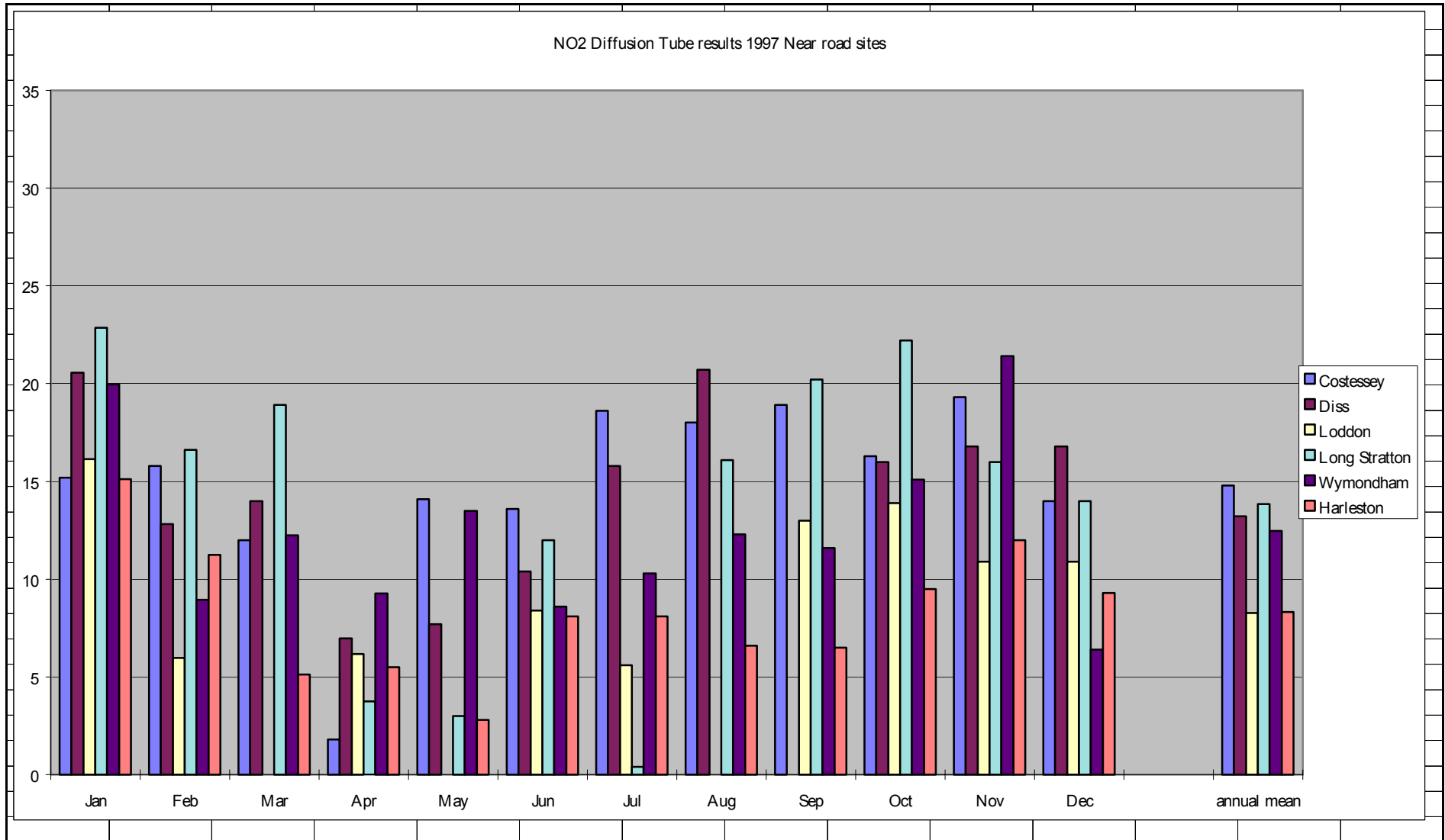
1998 to date, the above plus those listed below.

1 A11 Cringleford, 2 Colney Lane, 3 Cringleford, 4 Colney, 5 Colney, 6 Hingham, 7 Harford Bridges, 8 Poringland, 9 Broome, 10 Forncett.

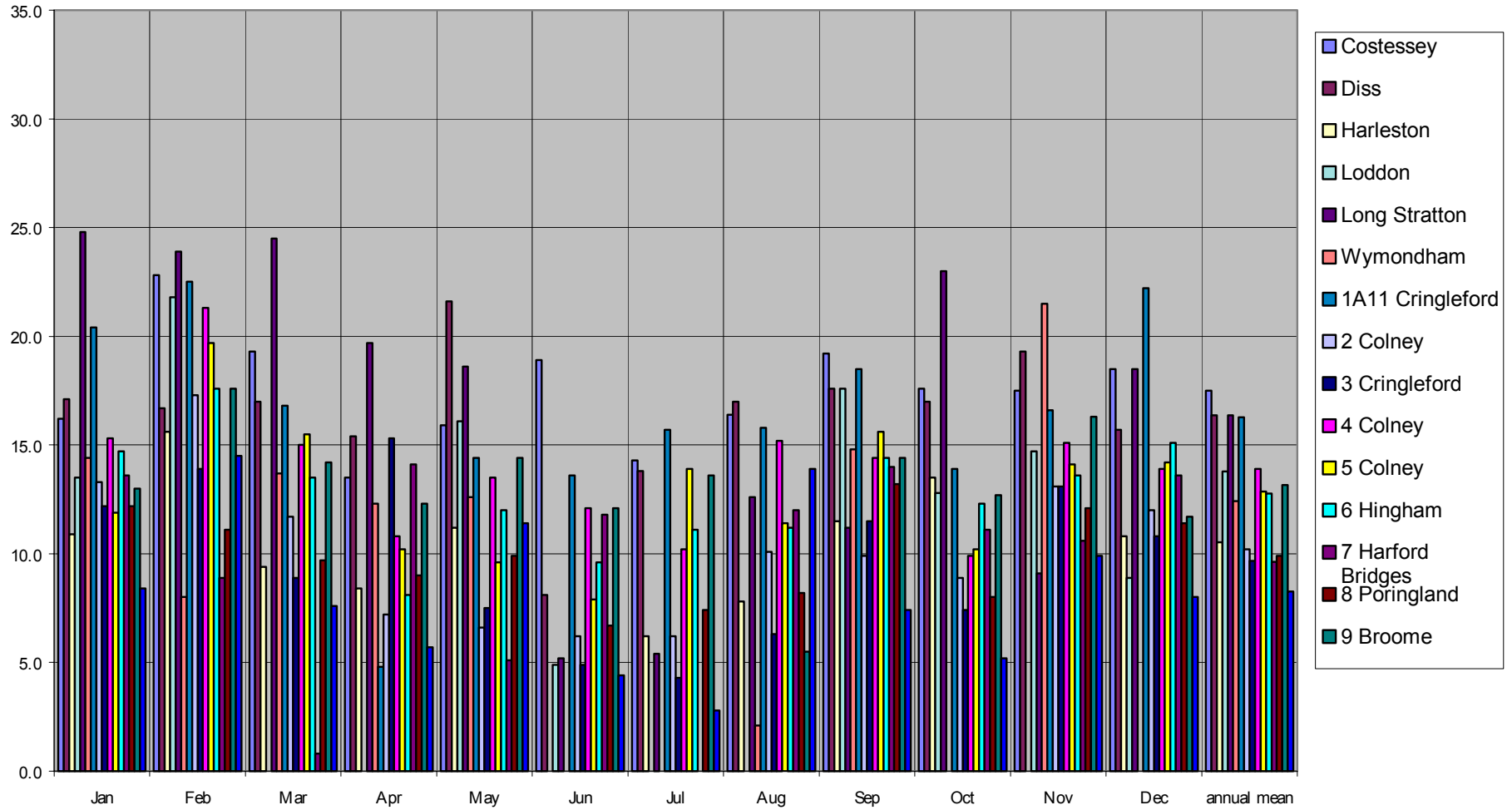
At these locations the single monitoring sites were all near road sites:

MONITORING RESULTS

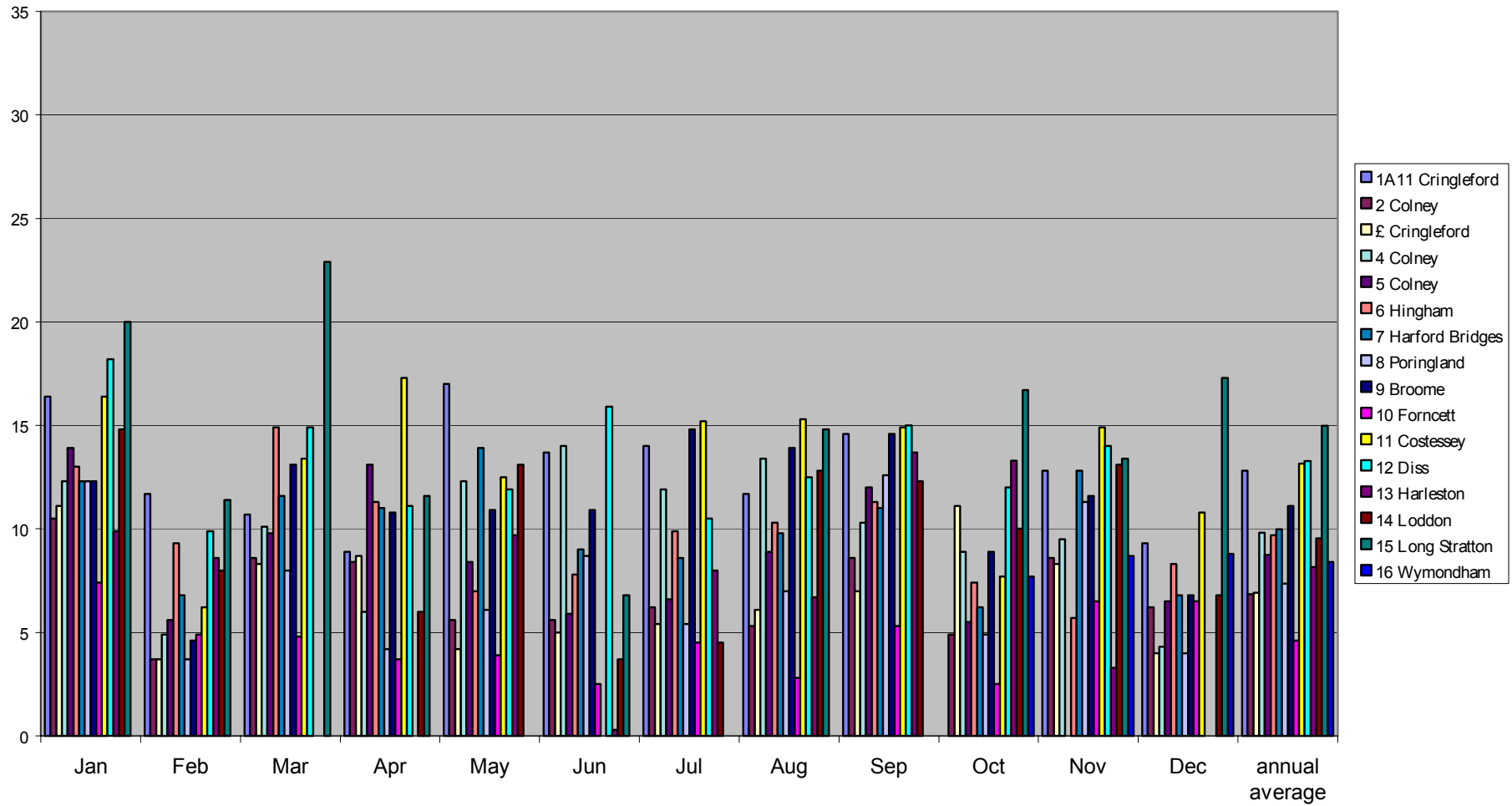
NO2 Diffusion Tube results 1997 Near road sites



NO2 Diffusion tube results 1998 Near road sites



NO2 Diffusion Tube results 1999 Near Road sites



Modelling

Using the Design Manual for Roads and Bridges (DMRB), we are able to estimate the annual mean pollutant level at a particular point.

The model utilises the following input information:

The distance from the receptor to the centre of the road

The distance from the receptor to the kerb of the road (NO₂)

The annual; average daily traffic flow in vehicles per hour (i.e. AADT/24)

The percentage of Heavy Duty Vehicles

The average vehicle speed in Kilometres per hour

The year that is being modelled

To determine whether the air quality objective for NO₂ is likely to be met in terms of the 1 hour mean the suggestion is to ascertain the likely annual mean NO₂ level and using this figure multiply by 6 to give a result for the 1 hour mean.

The data on traffic flows supplied by Norfolk County Council is as follows:

Type	Location	source	1997 AADT	1997 HGV	1997 %HGV	2005H AADT	2005H HGV	2005H %HGV
TN	A11 Wymondham	NCC 12 hr	23038	2168	9%	27185	2493	9%
TN	A140 Swainsthorpe	Linkbase 97	16795	1202	7%	19818	1382	7%
TN	A140 Scole bypass	ATC	12854	1389	11	15168	1597	11%
TN	A140 N of Long Stratton	ATC	17705	1773	10%	20892	2039	10%
TN	A47 Easton	Linkbase 97	19514	1851	9%	23027	2129	9%
TN	A47 Bawburgh	ATC	21007	1823	9%	24788	2097	8%
TN	A47 Trowse	Linkbase 97	25508	1984	8%	30099	2282	8%
PN	A143 Scole Stuston bypass	ATC	8479	1050	12%	10005	1207	12%
PN	A143 Brockdish	Linkbase 96	8981	1112	12%	10598	1279	12%
PN	A143 Earsham	Linkbase 97	6500	884	14%	7670	1017	13%

PN	143 Broome	Linkbase 96	5784	633	11%	6825	728	11%
PN	A143 Geldeston	Linkbase 95	15975	1504	9%	18851	1730	9%
PN	A143 Waterloo	Linkbase 96	4416	403	9%	5211	463	9%
PN	A143 Haddiscoe	Linkbase 97	6736	459	7%	7948	528	7%
PB	A146 Trowse bypass East	ATC	26449	933	4%	31210	1073	3%
PB	A146 Trowse bypass West	ATC	24705	1610	7%	29152	1851	6%
PN	A146 Yelverton	Linkbase 97	12313	680	6%	14529	782	5%
PN	A146 S of Loddon	Linkbase 96	8968	754	8%	10582	867	8%
PN	A146 Thurton	ATC	12643	698	6%	14919	803	5%
PB	A1066 High St Roydon	Linkbase 97	8532	755	9%	10068	868	9%
PB	A1066 Diss	Linkbase 95	15325	1156	8%	18084	1329	7%
BN	B1322 N of Woodton	Linkbase 95	5039	272	5%	5593	288	5%
BN	1077 Diss (centre)	Linkbase 92	9334	300	3%	10361	318	3%

The Guidance produced by the DETR indicates that roads with traffic flows of less than 20000 vehicles per day are unlikely to exceed the UKNAQS standards. Using this data and the DRMB model indicates that none of the roads within South Norfolk will breach the standards in the UKNAQS. The worked assessments are included in Appendix {B}

Particles

The Government has adopted two air quality objectives for fine particles (PM₁₀), which are equivalent to the EU Stage 1 Limit Values. The objectives are 50µg/m³ as the fixed 24-hour mean to be exceeded no more than 35 days per year, and 40µg/m³ as an annual mean, both to be achieved by the end of 2004. The objectives are based on measurements carried out using the European gravimetric transfer reference sampler or equivalent.

The focus of the review and assessment for PM₁₀ must be the following locations:

- background locations
- roadside locations (sites close to the facade of a building)
- other locations where potentially significant groups might be exposed, such as schools or hospitals.

There is a wide range of emission sources which contribute to PM₁₀ concentrations in the UK. These can usefully be divided into 3 main source categories:

- Primary Combustion Particles - particles emitted directly from combustion processes such as road traffic, power generation, industrial combustion processes etc. These particles are generally less than 2.5 µm in diameter and often well below 1µm in diameter;
- Secondary Particles - particles formed in the atmosphere following their release in the gaseous phase. These include sulphates and nitrates, formed from emissions of SO₂ and NO_x; these particles are again generally less than 2.5µm in diameter;
- Coarse or Other Particles - the so-called 'coarse' or 'other' particles component comprises of emissions from a wide range of non-combustion sources. These include resuspended dust from road traffic, construction and mineral extraction processes, wind-blown dusts and soils, and sea salt. These particles are generally greater than 2.5µm in diameter.

The main reason particles were identified as requiring further investigation in South Norfolk was due to the high background levels in the region as a result of material blown in from the near continent. In addition at the time the review was published the UK government was uncertain as to the appropriate standards and objectives within the National Air Quality Strategy.

A significant proportion of the current annual average PM₁₀ is due to the secondary formation of particulate sulphates and nitrates, resulting from the oxidation of sulphur and nitrogen oxides. These are regional scale pollutants and the annual concentrations do not vary greatly over a scale of tens of kilometres. There are also natural or semi-natural sources - the 'coarse' or 'other' particles. The impact of local urban sources is superimposed on this regional background. Such local sources can be responsible for winter episodes of hourly mean concentrations of PM₁₀ above 100 µgm⁻³ associated with poor dispersion. However, it is clear that many of the sources of PM₁₀ are outside the control of individual local authorities and the estimation of future concentrations of PM₁₀ are in part dependent on predictions of the secondary particle component.

The Government has established the Airborne Particles Expert Group (APEG) to advise on sources of PM₁₀ in the UK and current and future ambient concentrations. As part of their deliberations the National Air Quality Strategy objectives were revised in respect of particles during the course of this review. (see Appendix {C})⁷ Thus the objectives outlined in the first stage review differ from those considered here.

⁷ Air Quality (England) Regulations 2000

MONITORING

To date no monitoring of particles has taken place within the district although a continuous particle analyser is to be installed at Long Stratton Library in November 2000.

MODELLING

Road Traffic

The model used in this review is the Design Manual for Roads and Bridges (see Nitrogen Dioxide above.) Because the timescale for compliance differs from that of Nitrogen Dioxide it has been necessary to complete separate runs of the model for particles and nitrogen dioxide.

The results of the model runs are included in Appendix {D}

Other sources of particles which might impact upon the review.

Other sources within South Norfolk

Other methods of Transport

The revised guidance (LAQM.TG4 (00))⁸ states that PM10 emissions are only likely to occur in relation to rail transport where there are large numbers of idling diesel engines. This situation does not occur in South Norfolk.

The guidance also suggests that modern aircraft emit very low levels of particles and studies confirm that airports with less than 5 million passengers per year have a negligible impact of PM10 levels. There are no commercial airports within South Norfolk and is it safe to eliminate air transport as a source of particles within the district.

Domestic sources

In some areas of the UK where there is a significant quantity of domestic solid fuel burnt there is the possibility that exceedences of the objectives may occur. The rural nature of the District means that there is still an amount of solid fuel used. According to the last House Condition Survey carried out within South Norfolk⁹ 12% of households use solid fuel and 6% of this usage is in primary central heating systems plus 6% of households who rely upon heating individual rooms either by means of open fire or closed stoves. Amongst secondary heating systems there is a 49% reliance on solid fuel fires and stoves.

⁸ Part IV The Environment Act 1995. Local Air Quality Management LAQM.TG4(00) May 2000

⁹ South Norfolk Council House Condition Survey 1996

LAQM.TG4 (00) suggests a method of determining whether further assessment is required as a result of the burning of domestic solid fuel. For a small town (around 16m² or less in area) the number of coal burning households density would need to exceed 800 per km². Even for the most densely populated town e.g. Costessey the population density is just under this figure (approximately 791 per km².) Therefore it is concluded that PM10 emissions from domestic coal burning will not result in exceedences of the air quality standard. More detailed explanations and calculation are contained in Appendix {E}

Industrial sources

There are various uncontrolled and fugitive emissions from mineral extraction processes, material stockyards, landfill sites and agricultural activities. In general these activities are carried out a sufficient distance away from the nearest properties so that their impact upon the locations subject to the review would be minimal. Within the local authority there are very few cases of complaint of dust reported.

In the absence of monitored data, the lack of complaint and the comparative isolation of the possible sites it is not concluded that unlikely that the air quality objective will be exceeded as a result of these emissions.

The stage 1 review identified the Part B premises within South Norfolk District Council and in adjoining authorities. In general the authorisations limit the emissions from these premises. In view of these controls and the disparate nature and spread of these activities, it is not felt that they will contribute to any great extent to the general levels of PM10.

Sources outside of the District

As has already been mentioned the major source of PM10 affecting South Norfolk arises from the near continent. Aside from this, emissions from adjoining authorities have a potential to impact upon South Norfolk Council. The emissions have been considered and discussed in the section covering Nitrogen Dioxide and the conclusions are that any emissions from these sources are so small or localised that their impact upon South Norfolk will be minimal. It is considered that these sources will have a minimal impact upon the levels of PM10 within South Norfolk.

CONCLUSION FOR PM10

The Airborne Particles Group (APEG 1999) has assessed in detail the sources of airborne particle concentration in the UK, and their contribution to the current and future particle pollution levels. The analysis suggests that in a year with typical meteorology the policies already in existence are likely to lead to significant reduction in the levels of PM10 by 2004. In some cities and within the vicinity of large industrial uses there are likely to high PM10 levels possibly leading to breaches of the standards laid down in 1997. In years when prolonged periods of air movement from mainland Europe (e.g. weather similar to that in 1996) which occur about one in every 5 to 10

years the analysis suggests that exceedences of 1997 Strategy objectives will be even more widespread.

Maps of predicted PM₁₀ concentrations across the country have been produced for 2004, 2005 and 2009 under different weather conditions. Rural concentrations are highest in the South and East of the UK due to the varying magnitude of the secondary particle contribution.

Recognising these difficulties the Government substantially revised the Air Quality Objective for PM₁₀ in the Air Quality Strategy published in January 2000.

The predictive work in this review indicates that the PM₁₀ concentrations in South Norfolk will be well within the objectives by the date of 31st December 2004. Local primary concentration is expected to be about half of their current value by 2005; secondary particle concentration is expected to reduce to 0.8 of the current concentration and coarse particles is assumed to remain constant.

On current predictions the levels of PM₁₀ from all sources within the district are expected to reduce. Secondary and natural background particles are recognised as being one of the main contributors to PM₁₀ in East Anglia and the South East of England, as concentrations here are known to be some of the highest in the UK. These sources are more dominant in South Norfolk than the local contribution of PM₁₀.

In addition in an as yet unpublished work by Chatterton T. of the University of East Anglia entitled "The relative contribution of local and distant sources of particulates to Eastern England", the conclusion was as follows:

"With coarse and secondary particles comprising 50% or more of PM₁₀ at most of the sites modelled in Norfolk there is possibly little that can be done to specifically target PM₁₀ for reduction at a local level. However, those areas where PM₁₀ is likely to be a problem (except during acute meteorological conditions) are those where there is heavy traffic. It is considered very likely that these areas will also be of concern for nitrogen dioxide and that attempts to meet the 21ppb NO₂ annual average objective by reducing traffic are also likely to reduce PM₁₀ levels as far as locally practicable."

It is not proposed to continue to a Stage 3 review and assessment for the pollutant PM₁₀.

Appendix Objectives for protecting human health for the purposes of Local Air Quality Management

Pollutant	Objective		Date to be achieved by
	<i>Concentration*</i>	<i>Measured as</i>	
Benzene	16.25µg/m ³ (5ppb)	running annual mean	31 December 2003
1,3-butadiene	2.25µg/m ³ (1ppb)	running annual mean	31 December 2003
Carbon monoxide	11.6mg/m ³ (10ppm)	running 8 hour mean	31 December 2003
Lead	0.5µg/m ³	annual mean	31 December 2004
	0.25µg/m ³	annual mean	31 December 2008
Nitrogen dioxide†	200µg/m ³ (105ppb) not to be exceeded more than 18 times a year	1 hour mean	31 December 2005
	40µg/m ³ (21ppb)	annual mean	31 December 2005
Particles (PM ₁₀)	50mg/m ³ not to be exceeded more than 35 times a year	24 hour mean	31 December 2004
	40µg/m ³	annual mean	31 December 2004
Sulphur dioxide	350µg/m ³ (132ppb) not to be exceeded more than 24 times a year	1 hour mean	31 December 2004
	125µg/m ³ (47ppb) not to be exceeded more than 3 times a year	24 hour mean	31 December 2004
	266µg/m ³ (100ppb) not to be exceeded more than 35 times a year	15 minute mean	31 December 2005

†The objectives for nitrogen dioxide are provisional (see paragraphs 194-197 below)

Sulphur Dioxide

The following is an extract from guidance issued by the DETR which is reproduced to assist with the conclusions for Sulphur Dioxide in South Norfolk.

SOURCES

In the first half of the century, emissions of sulphur dioxide were dominated by the combustion of coal, not only in the domestic sector, but also in commercial and industrial premises, and in power stations which were predominantly within towns and cities. Following the smogs of the 1950s and the Clean Air Act of 1956, this pattern changed as cleaner fuels replaced coal in domestic, commercial and industrial sectors, and power generation was concentrated in much larger, more efficient stations in rural areas. As a result, national emissions of sulphur dioxide have decreased by 66% since 1980 and urban smogs like those of the 1950s are now consigned to history.

Standards and Objectives for Sulphur Dioxide

One hour mean of 350 μ g/m³ (132ppb) not to be exceeded more than 24 times per year to be achieved by 31st December 2004

24 hour mean of 125 μ g/m³ (47ppb) not to be exceeded more than 3 times a year, to be achieved by 31st December 2004

15 minute mean of 266 μ g/m³ (100ppb) not to be exceeded more than 35 times a year, to be achieved by 31st December 2005.

The Government has stated that the focus of the review and assessment should be on any non-occupational, near ground level outdoor locations given that exposures over 15 minutes are potentially likely in these locations.

The national inventory of annual sulphur dioxide emissions between 1990 and 1997 is shown in the table below. Emissions today are now dominated by fossil-fuelled power stations, which in 1997 accounted for 62% of the national total. Although emissions of sulphur dioxide in the UK are dominated by a relatively small number of large emitters, there are also significant emissions from the industrial sector, including refineries. In contrast to other pollutants, transport emissions of sulphur dioxide are relatively unimportant nationally, but the contribution of diesel fuel can make a significant contribution to background levels in urban areas.

Source	1990	1991	1992	1993	1994	1995	1996	1997	% of 1997 emissions
Public power	2723	2535	2434	2084	1762	1590	1319	1025	62%
Petroleum refining plants	151	160	178	203	180	175	178	174	10%
Other comb. & trans.	44	40.3	17.2	14	13.8	2.3	11.3	13.9	1%
Residential plant	108	115	103	113	90.7	64.8	68.4	62.9	4%
Comm., public & agri. combustion	89.9	85.3	89.4	95	81.4	61.2	58.6	47.7	3%
Iron & steel combustion	88	86.2	65.9	75.2	68.3	65.5	61.2	61.5	4%
Other comb. in industry	352	369	417	412	343	256	216	178	11%
Processes in industry	44.3	37.9	32.6	30.9	28.5	23.1	23.8	20.7	1%
Offshore oil & gas	15.9	5.8	7.4	5.1	6.2	6.0	6.65	6.34	0%
Road transport: diesel	40.4	40.6	42.3	44.8	43.9	35	25.8	12	1%
petrol	22.5	17.1	19.4	13.9	19.1	15.9	11.5	15.5	1%
all	63	57.7	61.7	58.8	63	50.9	37.4	27.5	2%
Off-road sources	7.28	7.5	7.23	7	6.17	4.54	4.78	4.58	0%
Military	9.24	9.59	9.06	8.03	7.58	7.45	7.44	7.95	0%
Railways	2.52	2.6	2.56	2.4	2.12	1.65	1.58	1.32	0%
Shipping	27.4	29.9	29.2	29.9	29.4	29.4	29.7	27.2	2%
Civil aircraft	0.36	0.47	0.62	0.51	0.66	0.55	0.57	0.74	0%
Non landfill waste treat. & disp.	4.65	4.53	4.24	4.34	3.57	2.03	0.89	1.15	0%
Total	3731	548	3459	3143	2687	2351	2025	1660.	

Technical Annex A183

CURRENT AMBIENT SULPHUR DIOXIDE CONCENTRATIONS

Sulphur dioxide is currently measured at 64 national automatic sites within the National Automatic Urban and Rural Networks. A full list of the sites, a description of the site environment, historical hourly measurements and summary statistics are available on the DETR Web.

1998 was a year characterised by good dispersion of air pollutants. Concentrations of sulphur dioxide during 1998 were therefore generally low when compared to previous years. The most stringent of the Strategy objectives is the 15 minute objective of $266\mu\text{g}/\text{m}^3$ (100ppb), not to be exceeded more than 35 times a year.

During 1998, this objective was only exceeded at 6 of the 62 sites, most of which are located in coal burning areas. The EU Directive limit values were exceeded at fewer sites. The hourly limit value of $350\mu\text{g}/\text{m}^3$ (132ppb), not to be exceeded more than 24 times a year, was not exceeded at any of the national monitoring sites. The daily limit value of $125\mu\text{g}/\text{m}^3$ (47ppb), not to be exceeded more than 3 times a year, was exceeded at the Belfast East and Bury roadside sites. Finally, the annual mean limit value for the protection of ecosystems, applying in locations away from conurbations and motorways, was not exceeded at any rural site during 1998.

HISTORIC TRENDS

An analysis of trends in annual mean and 98th percentile (hourly) sulphur dioxide concentrations has been undertaken using a non-parametric linear regression. The analysis has been applied to those national sites with more than 5 years uninterrupted or near continuous monitoring data, with a minimum of 50% data capture in each year.

Significant downward trends are demonstrated for annual means or 98th percentile

(hourly) concentrations at 19 sites. The analysis shows the dramatic decline in sulphur dioxide concentrations at sites across the UK. Although some of the 95% confidence intervals of the slopes of trends include zero, and should therefore be treated with caution, the majority of the trends show significant downward trends when both statistical tests are applied. The analysis shows statistically significant downward trends at a range of site types including rural and urban background, urban centre and suburban sites. When measurements over the 1990s are considered, the most dramatic decline in peak 98th percentile (hourly) concentrations is seen at Belfast East between 1990 and 1998, with a $26.6\mu\text{g}/\text{m}^3$ (10ppb) annual decline, when averaged over the period.

The largest recent decline in annual mean concentrations has been recorded at the central London site between 1992 and 1998 with an annual decline of $9.8\mu\text{g}/\text{m}^3$ (3.7ppb), when averaged over the period.

It has been noted that exceedences of the 15 minute objective are currently observed downwind of large combustion plant such as power stations. Such plant are currently regulated under BATNEEC (Best Available Techniques Not Entailing Excessive Cost) and the Environmental Protection Act 1990, and will come under the provisions of IPPC. Bearing in mind the envisaged changes in fuel use, it is not expected that there will continue to be exceedences of the Strategy objectives by 2005.

Research carried out for DTI, building on earlier work for DETR, by CERC on the likely impact of small (<20MW) boilers (Adams and Carruthers 1997, Higson and Carruthers 1998), suggested that there may be some configurations of boilers around which exceedences of the 15 minute objectives could occur. This work used a database of small boilers which was incomplete in the sense that location information was not available, so that site specific characteristics such as chimney height and building configurations could not be used in the modelling. Idealised plant configurations therefore had to be assumed. The modelling further implicitly assumed that the boilers were operating at full load, which may be a pessimistic assumption for boilers in this size range. The study used the ADMS modelling system, and concluded that, for the 'worst' combination of chimney height and fuel sulphur coal at 1.6%, typical of UK coal) an area of around 2km^2 would exceed the 15 minute objective. However, because of the limitations in the database, it is not known how many plants in reality have these characteristics. Consequently, it is not known to what extent, if at all, there is a problem. There is no indication from the current monitoring network of widespread exceedences from these sources.

SULPHUR DIOXIDE IN SOUTH NORFOLK

The Stage 1 Review of Air Quality in South Norfolk identified Sulphur Dioxide as requiring further investigation as a result of the emissions from a cold blast cupola sited at Thurton. At the time the stage 1 review was undertaken the information available to the Council was two differing reports from independent consultants on the emissions from the premises. This review will consider the impact of all sources of Sulphur Dioxide within the District.

The current position

An estimate of the background levels of sulphur dioxide in the South Norfolk area has been taken from the figures produced by the national Environmental Technology Centre (NETCEN) a part of AEA Technology plc. The background Sulphur Dioxide concentration in the district is between 3.9 and 9.6 µg/m³ with an average of 4.7µg/m³.

Transport sources are not considered to be major emitters of SO₂ and it is unlikely that they will have significant effect on ambient SO₂ concentration in South Norfolk.¹⁰

In certain areas of the UK domestic burning of coal and oil for heating has been shown to be a significant source of SO₂. South Norfolk has a relatively large percentage of houses that burn coal or oil. The guidance LAQM TG(00) indicates that in areas where domestic emissions are a major source of concern, a low level emissions figure greater than 40 tonnes per year is the critical amount in terms of progression to a Stage 3 assessment.

The 1996 House Condition Survey¹¹ indicated that 28% of households in South Norfolk utilise standard oil boilers and 12% solid fuel as their main source of heating. In addition 49% rely on solid fuel as a secondary heating system.

Industrial Sources

At the time of preparation of the Stage 1 Review and Assessment South Norfolk proceeded to a Stage 2 Assessment for Sulphur Dioxide due to the existence of a cold blast cupola at Thurton in the east of the District. It was thought that no monitoring of emissions had been done in the area when the cupola was operating and that following a planning application for housing in the village in 1988 consultants for the applicant and for the District Council produced different conclusions as to the effect the grounding of the plume from the stack would have on the application site. Although the consultants formed differing views, it transpires that monitoring was carried out by Berridge Environmental Laboratory¹². Three separate monitoring exercises took place in four locations around the cupola. Since that time the cupola has become an authorised process in terms of the Environmental Protection Act 1990 and is subject to conditions relating to emissions. It is therefore considered safe to view the monitoring results taken in 1988 as a conservative estimate for the purposes of this review.

The results indicate that levels when the cupola operates are well below any of the standards in the National Air Quality Strategy.

Appendix <> contains details of the sources of information and calculations used for this purpose.

¹⁰ Part IV The Environment Act 1995. Local Air Quality Management LAQM TG4(00) May 2000

¹¹ South Norfolk Council House Condition Survey 1996

¹² Report No 6817 On atmospheric pollution from Foundry at Thurton 19th August 1988: Berridge Environmental Laboratory, Robjohns Road, Chelmsford, Essex, CM1 3TW

Appendix(Calculation of PM10 from Domestic Solid Fuel Use)

The following outlines the process of calculating the impact of solid fuel use on particle levels and determines whether the 24 hour mean objective is likely to be exceeded.

Screening tool for domestic coal burning

INTRODUCTION

The use of solid fuels for domestic heating has largely been replaced by alternative fuels throughout the United Kingdom. However, there are a few areas where there is still significant solid fuel burning, particularly where alternative fuels are not readily available. The adoption of Smoke Control Areas and the resulting use of solid smokeless fuels (SSF) in most urban areas has reduced the potential for exceedences of the proposed new PM₁₀ objectives. Nonetheless, there remain a few areas where the possibility of exceedence as the result of coal burning remains. This work was intended to help identify potential areas of exceedence.

DISPERSION MODELLING

The dispersion model, ADMS Version 2.2, was used to estimate ground level primary PM₁₀ concentrations in this study. It is an up-to-date model in which the boundary layer structure is characterised by the height of the boundary layer and the Monin-Obukhov length, a length scale dependent on the friction velocity and heat flux at the surface. Concentration distributions are assumed to be Gaussian in stable and neutral conditions, but the vertical distribution is non-Gaussian in convective conditions to take account of the skewed structure of the vertical component of turbulence. It contains a number of complex modules that can allow for the effects of plume rise, complex terrain and buildings. The model is described in a User Manual [CERC, 1995].

The model was used to predict annual average ground level PM₁₀ concentrations resulting from 1 g/s primary emissions from a 1 km square area source. Surface roughness was assumed to be 1 m, typical of urban areas. An emission height of 10 m was used to represent emissions at roof level. Average meteorological data for Wyton was used in the analysis. The model was used to predict ground level concentrations on a 31 x 31, 1 km grid. The ground level concentrations resulting from larger area emissions (more than one 1 km grid square) were calculated by addition. Table 1 shows the calculated maximum ground level concentrations for a 1 g s⁻¹ km⁻² emission for a range of source sizes.

Table 1: Ground level concentrations for a 1 g s⁻¹ km⁻² emission

Source size, km x km	Ground level concentration, µg m ⁻³
1 x 1	9.4
2 x 2	11.0
3 x 3	12.6
4 x 4	13.5
5 x 5	14.3
10 x 10	17.0

Exceedences of the proposed 24-hour mean PM₁₀ objective (as an equivalent annual mean concentration of 28 µgm⁻³) are predicted to occur when there are more than N people per square kilometre in coal burning households, where N is calculated from:

$$N = \frac{(28 - b) 3600 \times 24 \times 365}{c \quad 1000 F U}$$

where b is the annual average background concentration, µg m⁻³;

c is the ground level concentration for unit emission, µg m⁻³, taken from Table 1;

F is the PM₁₀ emission factor for domestic coal burning, 10.4 kg/t (Salway et al, 1996);

U is the per capita coal consumption in coal burning houses, 1.15 t/a (Abbott, 1996)

Figure 1 shows N plotted against background concentration, b, for a range of area sizes.

REVIEW AND ASSESSMENT PROCEDURE

The risk of exceedence of the proposed objectives in coal-burning areas may be estimated as follows.

Determine the area, A, under consideration. Three representative 'area types' have been considered in the assistance, i.e.

- a small village (approx. 1 km² area)
- a small town (approx. 16 km² area)
- a large town (approx. 100 km² area)

Users should select the area most appropriate to their situation. Where there is doubt, the larger area should be chosen e.g. a large village would be represented as a 'small town'.

Determine the population, p, in the most populated square kilometre.

Determine the proportion of land, L, occupied by open space or farmland i.e. excluding gardens and residential roads.

Determine the proportion of households, C, burning coal. Assume 10% of houses burning solid fuel in Smoke Control Areas are burning coal.

Estimate the maximum density of people in households burning coal:

$$D = \frac{p C}{(1 - L)}$$

Determine background concentration for 2004 from the national maps. The scoping assessment will not be affected greatly by the element of double-counting introduced resulting from the inclusion of domestic emissions in the background maps.

Read off the maximum density of people in coal burning households for the appropriate background emission and area size from figure 1. If this maximum density exceeds the value of D given above, then the risk of exceeding the objective as a result of domestic coal burning is small.

Report prepared by the National Environmental Technology Centre, part of AEA Technology, on behalf of the Department of Environment, Transport and the Regions.

Screening for domestic coal use Sulphur Dioxide

A response from the Air Quality modelling Helpline:

“The screening threshold for sulphur dioxide from domestic sources is 300 houses per km². I suggest you do a quick calculation of housing density (should be available from planners or a relevant survey) then take 12% and the 49% - ie 61% as a complete worse case and see whether that figure is over the 300 properties per km² threshold. If not, the impact will be negligible, if it is over the threshold, you may have to look more closely at the usage of the 49% of households who use solid fuels as a secondary source. If it is over the threshold, please get back in touch and we will try and guide further”.

Example of Costessey

Assume a “small town”

Area = 1237 hectares (12.37 Km²) Population = 9850¹³
population per km² = 796

calculations in accordance with TG4(00) may 2000.

Using worst case scenario 61% of households using solid fuel.

Number of people in coal burning households $D=(796*.61)/(1-0.5) = 971$

From table 1 objective likely to be exceeded.

Using the best case scenario 12% of households using solid fuel

Number of people in coal burning households $D=(796*0.12)/(1-0.5) = 191$

From table 1 objective not likely to be exceeded.

¹³ Parish Statistics 1991 - South Norfolk Council handbook

PM10 calculations

In accordance with note from the Review and assessment Helpline organised on behalf of the DETR as follows:

E-mail from University of Western England in response to a query from S Norfolk Council as to the estimation of PM10 levels associated with solid fuel use.

First screening : use 12+49% to give worst case.

If a problem use 12% to give best case.

If best case is not exceeding and worst case is then it will be necessary to estimate effective number of people in coal burning houses as coal burn per annum in tonnes divided by 1.15. See www.aeat.co.uk/netcen/airqual/reports/jpm/jpmtwo1.html

Using the methodology outlined to estimate the number of people per square kilometre in coal burning households (N) as follows:

$$N = \frac{(28 - b) \cdot 3600 \cdot 24 \cdot 365}{c \cdot 1000 \cdot F \cdot U}$$

b is 24µg/m³ (worse case scenario from DETR maps)

c is taken as 16km² from Table 1 above - Ground level concentration is 13.5µg/m³

F=10.4 kg/t} see above

U=1.15 t/a }

N=791

From Table 1 the objective is not likely to be exceeded.

The Calculations and conclusions of monitoring carried out on emissions of Sulphur Dioxide from Thurton Foundry.

Sulphur Dioxide is only produced from the Foundry when the furnace is working and iron being melted down for casting. The hours when the furnace is used is limited within any one day. The furnace is now lit initially with a gas-fired torch. The foundry caters for a high quality market and only about 5-8 tons of iron is used per days casting.

Monitoring 29th July 1988.

The furnace was lit at approximately 9.30am and switched off at 2.15pm giving a total time of 43/4 hours or 285 minutes. The weather conditions were fine and dry with a blustery wind coming from the south-west. The wind direction did not change during the monitoring period.

Monitoring was carried out at 4 points shown on the attached plan.

Sulphur Dioxide was measured by drawing a known volume of air through a dilute solution of hydrogen peroxide and measuring the sulphate produced using the standard colourmetric procedure given in BS1747: Part 7: 1983.

The following levels of sulphur dioxide were measured.

Sample position 1	none detected <the level of detection 3µg/m ³
Sample position 2	4.6µg/m ³
Sample position 3	13.5µg.m ³
Sample position 4	4.0µg/m ³

The second monitoring exercise was carried out on 15th August 1988

Using similar methods the following levels of sulphur dioxide were measured:

sample position 1	13.7µg/m ³
Sample position 2	4.1µg/m ³
Sample position 3	13.2µg/m ³
Sample position 4	Trace, < the level of detection 3µg/m ³

