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Air Quality at Sutton Bridge: 2001 –2002

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Executive Summary

Netcen have measured air pollution levels at Westmere County Primary School, Sutton Bridge on behalf of South Holland District Council, from July 1998. This report summarises the fourth year of data collected, from July 2001 to July 2002. The results of the three previous years are presented in the following reports:
First year of operation: report AEAT/EEQP/00020
Second year of operation: AEAT/ENV/R/0382
Third year of operation: AEAT/ENV/R/0872

The pollutants measured at the site are nitrogen oxides (NO_x), ozone (O_3) and PM_{10} (since 1/10/2000). NO_x is produced in combustion processes and by motor vehicles. O_3 at ground level is produced by chemical reactions between pollutants such as organic compounds. These are often emitted in other parts of the UK or Europe, particularly during hot, sunny weather. The monitoring site also records wind speed and direction.

The data collected from the site have been summarised and compared to current air quality standards set by various bodies, which are described in the text of this report. The data are also compared to those from other local air quality monitoring stations in the east of England.

The NO_2 results show that the Air Quality Standards and Objectives for NO_2 have not been exceeded and levels within Sutton Bridge are low. The highest average concentration of NO_2 when the wind was from the south-east; this may be attributed to the power station, road traffic or other sources around the Sutton Bridge area.

The results show that the following air quality standards have been exceeded:

- O_3 concentrations exceeded the AQS objective daily maximum of running 8-hour means on 35 days during the period; the objective permits only 10 days with 8-hour averages over 50ppb.
- The EC Population Information Threshold for hourly average O_3 concentration was exceeded once (1 hourly average equal to or greater than 90ppb).
- The O_3 concentrations were “high” as defined by DEFRA banding for one hourly average during the period.
- There were 2 daily average PM_{10} gravimetric concentrations above the AQS objective of 50μg m^{-3}; a maximum of 35 such exceedences are permitted each calendar year.

Due to the nature of ground-level ozone formation, sources of ozone and its precursors outside the district may cause the ozone levels to exceed the air quality standards. It is recognised that reduction in ozone concentrations in the UK will require action on a European scale. As a result, the objectives for ozone are not to be included in Local Air Quality Management.

The concentrations of NO_2 and O_3 measured at the Sutton Bridge site were generally similar to those measured at a rural monitoring site in Cambridgeshire. Concentrations were generally much lower than were measured in nearby urban areas, such as Norwich. Average PM_{10} concentrations at Sutton Bridge were similar to those at Norwich.

Contents

1 Introduction

Netcen, part of AEA Technology Environment, has been appointed by South Holland District Council as consultants for the purpose of monitoring air quality at Sutton Bridge. The study of air quality in the town has been necessary as part of the planning consent for the construction and commissioning of a 790MW gas fired power station close to the town. An air quality monitoring site was installed in July 1998. The pollutants measured are oxides of nitrogen (NO_x consisting of nitric oxide, NO and nitrogen dioxide, NO_2), ozone (O_3) and PM_{10} (since 1/10/2000). This report covers the fourth year of operation from 1 July 2001 to 31 June 2002.

Oxides of nitrogen are produced mainly by combustion sources, particularly motor vehicles. NO is not recognised as harmful to health, but it is readily oxidised in the atmosphere to form NO_2. There is evidence that NO_2 in high concentrations causes inflammation of the airways in humans, and may affect lung function.

Ozone is produced by a complex set of chemical reactions in the atmosphere, involving volatile organic species and UV light. The chemical pollutants required for ozone formation may be emitted some distance from the UK, and peak ozone concentrations in the UK are observed during periods where air masses from the continent move over the country. The highest concentrations are frequently observed over the south and south-east of England. The background ozone concentration in unpolluted air is approximately 36ppb.

Most anthropogenic particulate matter in the atmosphere is less than 10 micrometres in diameter (PM_{10}). Sources of PM_{10} include combustion processes such as power stations (fly ash), motor engines (particularly diesel engines) and soot. Particulate matter from these sources typically contains a large proportion of elemental and organic carbon, which is associated with health effects and haze phenomena. PM_{10} is fine enough to penetrate deeply into the human respiratory system before deposition and has a longer residence time than larger particles. This, combined with the presence of large quantities of organic material, may result in significant long term health effects.

2 Monitoring Methods

2.1 EQUIPMENT

A continuous automatic monitoring site has been installed at Westmere County Primary School, Sutton Bridge. A map showing its location is shown separately. The site is fully self-contained, and is equipped with the following:

- Continuous automatic analysers for NO_x and O_3
- PM_{10} equipment – TEOM analyser for continuous measurement of PM_{10} particles.
- Datalogger, modem and telephone line for collection and transmission of data to NETCEN
- Air conditioning to ensure reliable analyser performance
- Compressed gas mixtures of NO and NO_2 at near-ambient concentrations for calibration of the NO_x analyser
- Sensors for wind speed and direction

The principle of operation and expected accuracy of the analysers are given in Table 1.

Table 1: Principle of operation and accuracy of analysers used

Pollutant	Analyser type	Method of operation	Expected accuracy
Ozone	API M400	UV absorption	±11%±2ppb
Oxides of nitrogen	APIM200A	Chemiluminescence	±10%±2.5ppb
PM_{10}	TEOM	Tapered element oscillating microbalance	± 4 μg m^{-3} (precision)

Although the use of TEOMs in the UK is commonplace, there is concern expressed by, amongst others, the Airborne Particles Expert Group (APEG) that this monitoring method does result in an under-read of particle concentrations of between 15 and 30 % at typical ambient concentrations. It is thought this occurs as a result of evaporation of volatile species (eg hydrocarbons) in the heated inlet of the analyser. The air quality objectives referred to in DEFRA's Pollutant Specific Guidance are based on the European reference method, which is a gravimetric method. It is therefore necessary to apply a "correction factor" when comparing TEOM measurements with the objectives. A constant factor of 1.3 is therefore applied to the measurements from this survey when comparing with the objectives. Measurements thus corrected in this report will therefore be referred to as μg m^{-3}, gravimetric.

2.2 OPERATION OF SITE

The routine site operations are carried out by SHDC staff, who have received full training by NETCEN and Enviro Technology Services plc, the suppliers of the monitoring equipment. Data collection, validation and reporting are carried out by NETCEN. NETCEN also supply QA/QC services, consisting of the following:

- Traceable calibrated compressed gas mixtures for the routine calibration of the NO_x analyser
- 6-monthly audits of analyser performance
- Ratified datasets on a six-monthly basis

NETCEN have been awarded UKAS accreditation (calibration laboratory no 0401) for the calibration of compressed gas mixtures and ambient air quality monitoring equipment. The site is operated to the same protocols as the DEFRA automatic urban network, to ensure that the data from the Sutton Bridge site are directly comparable to national network data.

The monitoring equipment is covered by a service contract with the manufacturers UK agent, to ensure reliable operation and prompt repair of faults and breakdowns.

2.3 DATA REPORTING

The data are collected daily by NETCEN, and are inspected for faults or irregularities. The provisional monitoring data are then sent electronically to SHDC on a daily basis. Monthly

reports, including summary statistics are supplied by NETCEN. The final ratified dataset is reported annually.

2.4 DATA CAPTURE

The data capture for the pollutants measured was generally very good, with a data capture of 98% for O_3, 96% for PM10 and 95% for NO_x. The new, solid-state sensors that were installed to improve reliability of the wind speed and direction measurements have resulted in a data capture of better than 99%.

3 Results and Discussion

3.1 PRESENTATION OF DATA

The data from the monitoring survey for the 12 months of operation (July 2001-June 2002) are summarised in tabular form, in Appendix 2. The summary also compares the data with relevant Air Quality Strategy (AQS) and EC Directive standards and guidelines. These are detailed in Appendix 3.

3.2 COMPARISON WITH AIR QUALITY STANDARDS AND OBJECTIVES

Relevant Air Quality Standards and guidelines are given in Appendix 3. These have been subject to recent revision.

3.2.1 Air Quality Standards

NO_2:
The current AQS[1] contains two objectives for NO_2:

- The objective for an hourly mean of 105ppb, to be exceeded not more than 18 times per year, by 31 December 2005. This brings the AQS standard in line with the EC Daughter Directive limit, see below.
- For the annual mean, 21ppb to be achieved by 31 December 2005.
- A new national objective for protection of vegetation, 16ppb (as NO_x) has been adopted for 31 December 2000. This is aimed at the protection of vegetation and ecosystems, and is not to be included in Local Air Quality Management.

The maximum 1 hour mean NO_2 concentration measured in this survey was 46ppb; well within the current and proposed objectives for this parameter. The overall mean for the whole 12-month period was 8ppb; well within the annual mean limit of 21ppb.

O_3:
The current AQS contains one provisional objective for O_3:

- Daily maximum of running 8-hour mean of 50ppb not to be exceeded more than 10 times per year to be achieved by 31 December 2005.

This remains provisional whilst other European countries set their own commitments for the reduction in emissions of O_3 precursors, such as volatile organic compounds (VOCs). This objective is therefore not to be included in Local Air Quality Management.

This value was exceeded on 35 days during the period, with exceedences recorded in July 2001 (10 days), August 2001 (8 days), September 2001 (2 days), March 2002 (1 day), April 2002 (9 days), May 2002 (2 days), June 2002 (3 days). There were a total of 231 occasions on which the running 8-hour running mean exceeded 50ppb.

PM_{10}:
The current AQS contains two objectives for PM_{10}:

- The objective for a 24-hour mean of 50μg m^{-3} gravimetric, not to be exceeded more than 35 times per year, to be achieved by December 2004.
- Annual mean not to exceed 40μg m^{-3} (gravimetric), to be achieved by December 2004

There were 2 days during this period when the daily average PM_{10} gravimetric concentration exceeded 50μg m^{-3} gravimetric. The annual average was 20μg m^{-3} gravimetric, and it is therefore unlikely that the objective for PM_{10} will be breached.

3.2.2 EC Directives

NO_2:

Under EC Directive 96/62, (the "Framework Directive[2]"), provision has been made for re-evaluation of the above NO_2 Directive. New, more stringent limits for this and other pollutants are contained in the first Daughter Directive[3] on oxides of nitrogen, sulphur dioxide, PM_{10}, and lead. This Directive was adopted into UK law via Statutory Instrument 2001 no. 2315 in 1999. The limits for NO_2 are as follows:

- Hourly mean limit 105ppb, to be exceeded not more than 18 times per year, by 1 January 2010.
- Annual mean limit 21ppb, to be achieved by 1 January 2010.
- Annual mean limit of 16ppb (as NO_x) for the protection of vegetation, to be achieved by July 2001.

From the data collected at Sutton Bridge, neither the maximum hourly mean of 46ppb or the annual mean of 8ppb exceeded these limits. The average NO_x concentration was 10ppb, below the EC vegetation limit of 16ppb.

O_3:
The EC has set threshold limits relating to population exposure for O_3 concentrations[4]:

- Population Information Threshold for hourly averages of 90ppb
- Population Warning Value for hourly averages of 180ppb
- Health Protection Threshold for fixed 8-hour means of 55ppb

Under the EC Directive, the DEFRA must inform the public if a network site exceeds 90ppb as an hourly average O_3 concentration, or if it expects a site to exceed 180ppb. This is not applicable to the Sutton Bridge site, but the 90ppb threshold was exceeded on 1 hour during the year.

A new ozone Directive[5] will be brought into UK Law in September 2003. This will set a target of 60ppb as an 8-hour average, not to be exceeded on more than 25 days per calendar year, averaged over 3 years.

PM_{10}:

- 24-hour limit value for protection of human health: 24-hour average of 50μg m^{-3} gravimetric not to be exceeded more than 35 times per calendar year. Annual limit value for protection of human health: annual average of 40μg m^{-3} not to be exceeded.

3.2.3 DEFRA Air Quality Bands

On a day-to-day basis UK air quality data are reported to the public by using a health-effects based system of four bands and a 1-10 index. This provides detail about air pollution level in a simple way, similar to the sun index or pollen index. This is described in Table 2

Table 2: Health Effects Banding System for Air Quality

Banding	Index	Health Descriptor
Low	1	Effects are unlikely to be noticed even by individuals who know they are sensitive to air pollutants
	2	
	3	
Moderate	4	Mild effects, unlikely to require action, may be noticed amongst sensitive individuals.
	5	
	6	
High	7	Significant effects may be noticed by sensitive individuals and action to avoid or reduce these effects may be needed (e.g. reducing exposure by spending less time in polluted areas outdoors). Asthmatics will find that their 'reliever' inhaler is likely to reverse the effects on the lung.
	8	
	9	
Very High	10	The effects on sensitive individuals described for 'High' levels of pollution may worsen.

NO_2 concentrations remained in the DEFRA “low” band throughout the year. O_3 hourly average concentrations were in the “moderate” band for 483 hours and “high” for 1 hour. PM_{10} concentrations were within the DEFRA “moderate” band for 3 hours.

3.3 METEOROLOGICAL MEASUREMENTS

The wind speed and direction roses are given in Appendix 4, together with time series plots for these parameters. The wind direction rose shows the proportion of time in which the wind blows from each of 16 sectors. The wind speed rose shows the average wind speed in each of these sectors. Similarly, the pollution roses show average concentration of each species measured in each of the direction sectors. Data measured during periods of low wind speed ($<0.1 ms^{-1}$) are disregarded in the pollution roses. The power station is situated at a bearing of approximately 155^o from the monitoring site, and the average concentrations of pollutants in the sector 150^o-160^o has been calculated in each case. Note, however, that the town of Sutton Bridge itself may contribute to measured concentrations in this direction, and it is not possible to say with certainty what the likely source of pollution may be.

The wind direction rose shows that the wind was from a south-westerly direction for the majority of the time during the year. North-westerly and south-easterly winds were infrequent during the monitoring period. Wind speeds were more evenly distributed throughout the 16 sectors, northerly and southerly winds being slightly stronger on average. Overall, wind speeds were lower than the previous year.

The maximum average NO concentrations for the year were clearly from the south-east. NO concentrations from the north-east were particularly low. Concentrations from the westerly directions were all fairly uniform. The average concentration in the 150°-160° sector was 4ppb. NO_x showed a similar trend but was more evenly distributed. Again, highest concentrations were from the south-east and the lowest concentrations were from the north-east. The 150°-160° sector average concentration for NO_x was 16ppb. NO is a primary pollutant (i.e., produced directly from pollution sources, such as combustion or road traffic), and thus this can be attributed to a local source.

The NO_2 plot again shows a significant contribution from the south-east (12ppb average in the 150°-160° sector). NO_2 is a secondary pollutant, and may be produced by oxidation of NO in the atmosphere. The higher concentrations of NO_2 from this direction may be due to the conversion of NO from a local source as it moves towards the monitoring site.

Ozone is not emitted directly by sources; ozone is produced by the reaction of various pollutants in the presence of sunlight. Highest levels are always observed in the summer. The background tropospheric O_3 concentration in unpolluted air is approximately 36ppb. The ozone plot shows a reasonably even distribution at approximately 25ppb from all directions except the north-east. The north-east shows higher concentrations of ozone, corresponding to the lower concentrations of NO from this direction. This is understandable, as any ozone mixing with the locally produced NO will gradually react, producing NO_2. The highest concentrations in the north may reflect the lack of depletion of background ozone, as there are no significant sources of ozone sinks in this direction. The highest ozone concentrations recorded (15 August 2001) were measured during a period of generally light winds from the south-east. High ozone levels were also recorded at the DEFRA site at Wicken Fen on this day.

PM_{10} was more evenly distributed than the other measured pollutants. There were very slightly higher concentrations measured from the south-east and the average concentration of PM_{10} in the 150°-160° sector was 18μg m^{-3} TEOM.

4 Comparison with other Monitoring Sites

The data from Sutton Bridge are compared with data from local DEFRA automatic network sites - Wicken Fen (rural site close to Newmarket) and Norwich Centre. The data from these sites are given in Tables 3, 4, 5 and 6 for O_3, NO, NO_2 and PM_{10}.

Table 3: Comparison of Ozone Statistics with DEFRA sites: July 2001-June 2002

O_3	Sutton Bridge (Westmere)	Norwich Centre	Wicken Fen
Max 15-min mean	100ppb	87ppb	85ppb
Max hourly mean	92ppb	81ppb	82ppb
Max 8-hourly mean	77ppb	71ppb	75ppb
Max 24-hourly mean	58ppb	51ppb	50ppb
Mean	27ppb	22ppb	22ppb
Data capture	98%	94%	91%

The measured concentrations from all three sites are generally similar, but the annual average concentration is highest at Sutton Bridge. This may be due to the influence of the background ozone in unpolluted air, which affects Sutton Bridge for much of the year.

Table 4: Comparison of Nitric Oxide Statistics with DEFRA sites: July 2001-June 2002

NO	Sutton Bridge (Westmere)	Norwich	Wicken Fen
Max 15-min mean	230ppb	634ppb	90ppb
Max hourly mean	159ppb	507ppb	80ppb
Max 8-hourly mean	59ppb	263ppb	56ppb
Max 24-hourly mean	46ppb	164ppb	44ppb
Mean	2ppb	9ppb	2ppb
Data capture	98%	95%	88%

Although NO is not regarded as a significant pollutant (it has no recognised adverse affects on human health), it does provide an indication of influence by combustion processes. Urban sites show higher NO concentrations, often due to road traffic. Rural sites show lower levels, as any NO present is oxidised to NO_2 in the atmosphere.

Table 5: Comparison of Nitrogen Dioxide Statistics with DEFRA sites: July 2001-June 2002

NO_2	Sutton Bridge (Westmere)	Norwich	Wicken Fen
Max 15-min mean	52ppb	89ppb	31ppb
Max hourly mean	46ppb	81ppb	30ppb
Max 8-hourly mean	28ppb	49ppb	27ppb
Max 24-hourly mean	27ppb	44ppb	25ppb
Mean	8ppb	14ppb	5ppb
Data capture	95%	96%	88%

The NO_2 concentrations measured at Sutton Bridge are similar to those measured at Wicken Fen. Sutton Bridge is a semi-rural site, and is likely to be influenced by local factors, e.g. traffic. Norwich is an urban site and shows higher levels of NO_2, probably as a result of heavier traffic.

Table 6: Comparison of PM_{10} Statistics with DEFRA sites: July 2001-June 2002

PM_{10} TEOM	Sutton Bridge (Westmere)	Norwich
Max 15-min mean	270μg m^{-3}	275μg m^{-3}
Max hourly mean	198μg m^{-3}	132μg m^{-3}
Max 8-hourly mean	67μg m^{-3}	61μg m^{-3}
Max daily mean	50μg m^{-3}	38μg m^{-3}
Mean	15μg m^{-3}	15μg m^{-3}
Mean (gravimetric)	20μg m^{-3}	20μg m^{-3}
Data capture	96%	96%

There were 2 daily average PM_{10} concentrations above 50μg m^{-3} gravimetric at Sutton Bridge, compared with none at Norwich Centre over the same period. The annual averages at both sites were well below the objective of 40μg m^{-3} gravimetric.

5 Conclusions

1. The maximum hourly mean NO_2 concentration measured at Sutton Bridge during the period 1 July 2001-30 June 2002 was 46ppb. This is well within the AQS limit of 105 ppb and the EC Directive limit (also 105ppb).

2. The annual average NO_2 concentration measured was 8ppb. This is well within the AQS standard of 21ppb, and the EC Daughter Directive (also 21ppb), to be met by 2010.

3. The NO_2 concentrations remained in the DEFRA “low” band throughout the year.

4. O_3 concentrations exceeded the AQS objective daily maximum of running 8-hour means on 35 days during the period; the objective permits only 10 such exceedences.

5. The EC Population Information Threshold for hourly average O_3 concentration was exceeded on one occasion (1 hourly average of 90ppb or above), with the maximum hourly concentration being 92ppb.

6. The O_3 concentrations were “high” as defined by DEFRA band for one hourly average during the period.

7. There were 2 exceedences of the PM_{10} objective for daily average concentrations of 50μg m^{-3} gravimetric; 35 such exceedences are permitted each year.

8. The annual average PM_{10} objective for PM_{10} (40μg m^{-3} gravimetric) was not exceeded.

6 References

1. The Air Quality Strategy.for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482.

2. Council Directive 96/62/EC on Ambient Air Quality Assessment and Management.
3. Council Directive 1999/30/EC relating to limit values for SO_2, NO_2, NO_x, particulate matter and lead in ambient air.
4. Council Directive 92/72/EEC on air pollution by ozone
5. EC Directive 2002/3/EC on ozone in ambient air

Appendices

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Appendix 1
Location of Monitoring Site

Appendix 2
Summary of Data from Sutton Bridge (Westmere School)
Period 01/07/2001 to 30/06/2002

Ozone air pollution was HIGH for 1 hour on 1 day, reaching a maximum hourly mean of 92 ppb on August 15.
NO_2 air pollution was HIGH for 0 hours on 0 days, reaching a maximum hourly mean of 46 ppb on February 15.
PM_{10} air pollution was HIGH for 0 hours on 0 days, reaching a maximum 24-hour mean of 50 $\mu g\ m^{-3}$ on May 10.
NO hourly maximum was 159 ppb on November 19.
NO_x hourly maximum was 183 ppb on November 19.

POLLUTANT	O_3 (ppb)	NO_x (ppb)	NO (ppb)	NO_2 (ppb)	PM_{10} ($\mu g\ m^3$)
	This Period	This Period	This Period	This Period	This Period
Number days in 'VERY HIGH' band	0	n/a	n/a	0	0
Number days in 'HIGH' band	1	n/a	n/a	0	0
Number days in 'MODERATE' band	483	n/a	n/a	0	3
Number days in 'LOW' band	8137	n/a	n/a	8319	8348
Number of exceedences of hourly AQS	n/a	n/a	n/a	0	n/a
Number of exceedences of 8-hr AQS	231	n/a	n/a	n/a	n/a
Number of days with exceedences	35	n/a	n/a	0	2
Number of exceedences of daily AQS	n/a	n/a	n/a	n/a	2
Number of exceedences of annual AQS	n/a	n/a	n/a	0	0
Max 15 min average	100	252	230	52	270
Max 1 hour average	92	183	159	46	198
Max 8 hour average	77	82	59	28	67
Max 24 hr average	58	68	46	27	50
Max daily average	58	59	37	25	50
Average	27	10	2	8	15
Data capture	98%	98%	95%	95%	96%

PM_{10} exceedences of AQS objectives are based on gravimetric equivalent figures. All other PM_{10} figures are based on TEOM data.

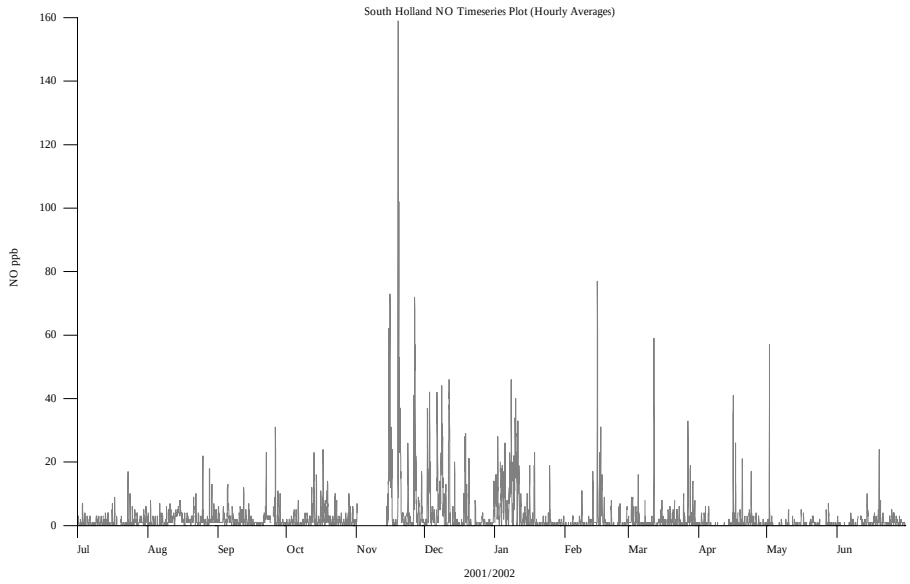


Figure 1 – Timeseries for NO (hourly averages)

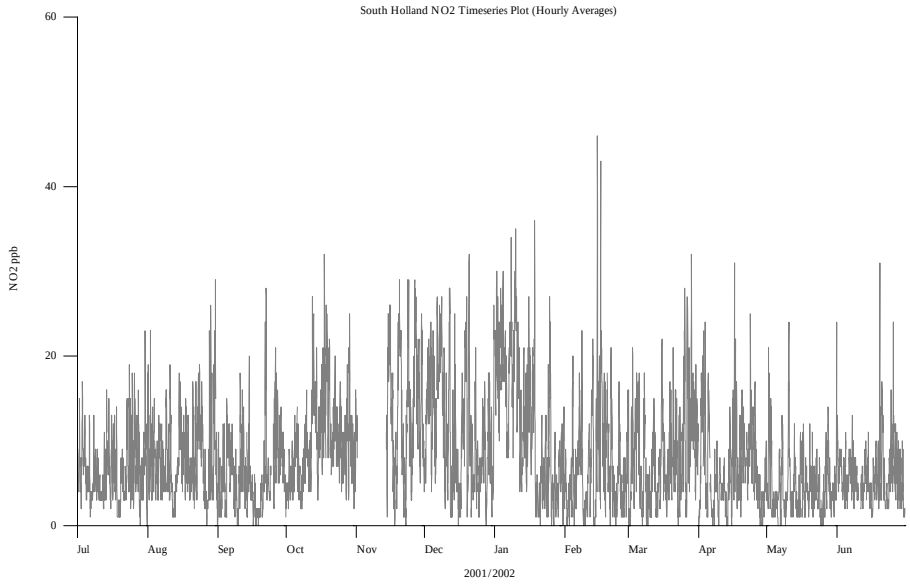


Figure 2 –Timeseries for NO_2 (hourly averages)

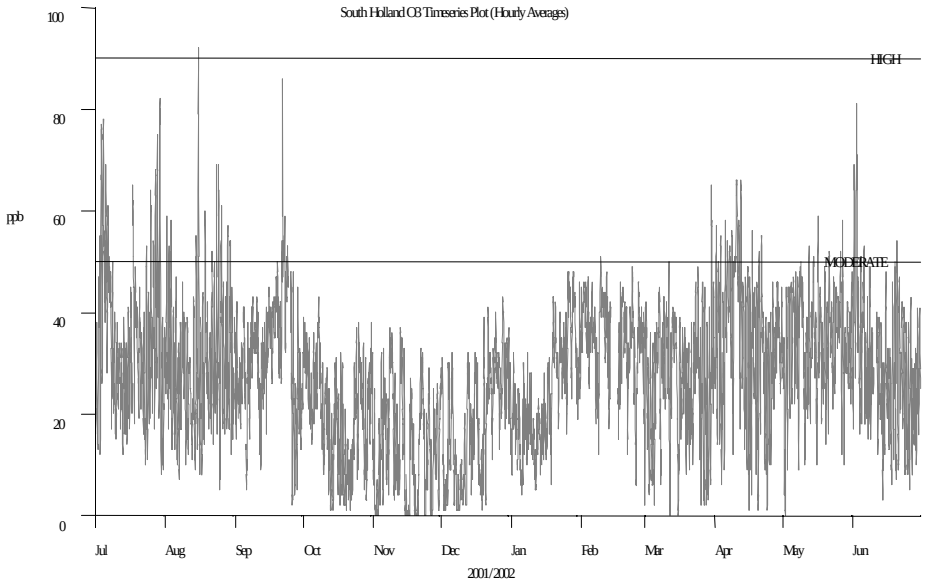


Figure 3 – Timeseries for O_3 (hourly averages)

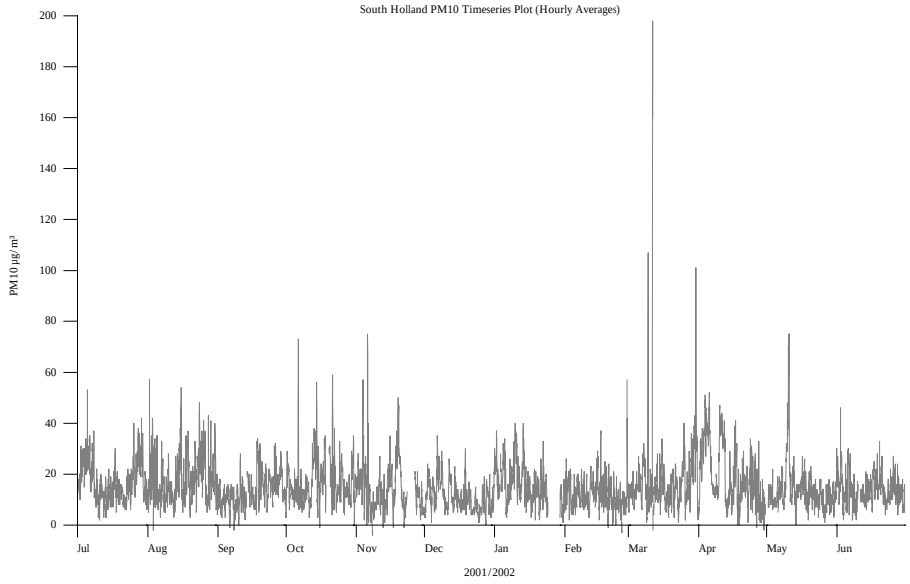


Figure 4 – Timeseries for PM_{10} (hourly averages)

Appendix 3
Relevant Air Quality Standards and Guidelines

Nitrogen Dioxide

Guideline Set By	Description	Criteria Based On	Value / ppb (μgm^{-3})
UK Government - Air Pollution Bandings	LOW Air Pollution		< 150 (287)
	MODERATE Air Pollution	1-hour mean	150 - 299 (287 - 572)
	HIGH Air Pollution		300 - 399 (573 - 763)
	V HIGH Air Pollution		>= 400 (764)
- The Air Quality Strategy(1)	Objective for Dec. 31st 2005	1-hour mean	105 (200) not to be exceeded more than 18 times per calendar year
	Objective for Dec. 31st 2005	Annual mean	21 (40)
European Community(2)	Limit Value	Calendar year of data: 98%ile of hourly means.	104.6 (200)
	Guide Value	98%ile of hourly means.	70.6 (135)
	Guide Value	50%ile of hourly means.	26.2 (50)
Daughter Directive(3)	Limit Value	1 hour mean	104.6 (200) not to be exceeded more than 18 times per calendar year
	Limit Value	Calendar year annual mean	21 (40)
	Limit Value (NO_x)	Calendar year annual mean	16 (30)

(1) The Air Quality Strategy.for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1
(2) Council Directive 85/203/EEC
(3) Council Directive 1999/30/EC
(4) Conversions between μg m^{-3} and ppb given by WHO

Ozone

Guideline Set By	Description	Criteria Based On	Value / ppb (μgm^{-3})
UK Government - Air Pollution Bandings	LOW Air Pollution	Running 8-hour and 1-hour mean	< 50 (100)
	MODERATE Air Pollution	Running 8-hour or 1-hour mean	50 - 89 (100 - 179)
	HIGH Air Pollution	1-hour mean	90 - 179 (180 - 359)
	V HIGH Air Pollution	1-hour mean	>= 180 (360)
- The Air Quality Strategy[1]	Objective for Dec. 31st 2005	Daily maximum running 8-hour mean	50 (100) not to be exceeded more than 10 times per calendar year
European Community[9]	Population Information Threshold	1-hour mean	90 (180)
	Population Warning Value	1-hour mean	180 (360)
	Health Protection Threshold	Fixed 8-hour means (hours 1-8, 9-16, 17-0, 13-20)	55 (110)
	Vegetation Protection Threshold	1-hour mean	100 (200)
	Vegetation Protection Threshold	24 hours (daily mean)	32 (65)
World Health Organisation[4] (Revised Guidelines)	Health Guideline	Running 8-hour mean	60 (120)
United Nations Economic Commission for Europe	Vegetation Guideline	Growing Season[10] mean	25 (50)
	Vegetation Guideline	1-hour mean	75 (150)
	Vegetation Guideline	Running 8-hour mean	30 (60)

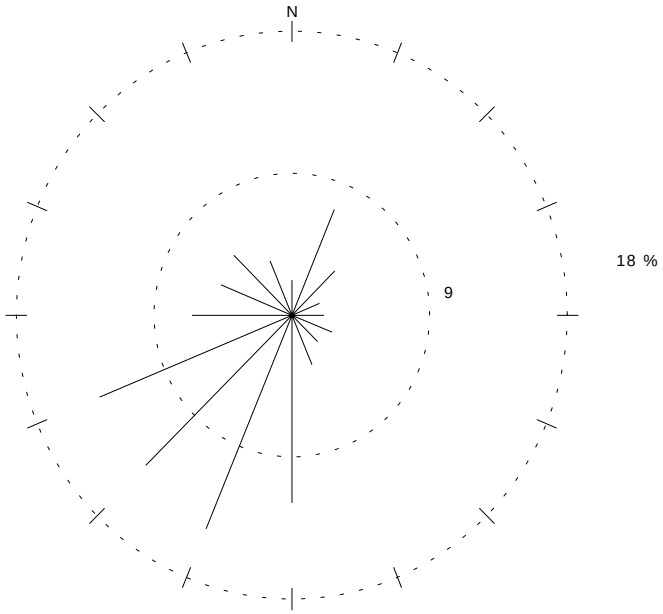
(9) Council Directive 92/72/EEC
(10) Growing season is defined as April to September for WHO guidelines, but is daytime (0900-1500) April to September for UNECE guidelines.

PM_{10} Particulate Matter

Guideline Set By	Description	Criteria Based On	Value / (μgm^{-3})
UK Government - Air Pollution Bandings	LOW Air Pollution	Running 24-hour mean	< 50
	MODERATE Air Pollution		50 – 74
	HIGH Air Pollution		75 – 99
	V HIGH Air Pollution		>= 100
- The Air Quality Strategy(1)	Objective for Dec. 31st 2010	24 hours (daily mean) (Gravimetric data)	50 not to be exceeded more than 7 times per calendar year of 20µg/m3 (11)
	Objective for Dec. 31st 2004	Calendar year annual mean (Gravimetric data)	40
European Community Daughter Directive(3)	Limit Value	24 hours (daily mean) (gravimetric data)	50 not to be exceeded more than 35 times per calendar year
	Limit Value	Calendar year annual mean(gravimetric data)	40

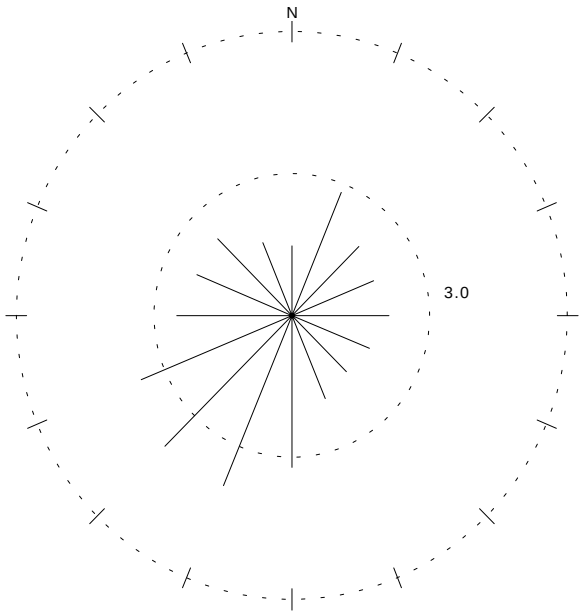
(11) This is an update of the national Air Quality Strategy following public consultation (September 2001)

Appendix 4
Wind Speed, Direction and Pollution Roses at Sutton Bridge (Westmere School)



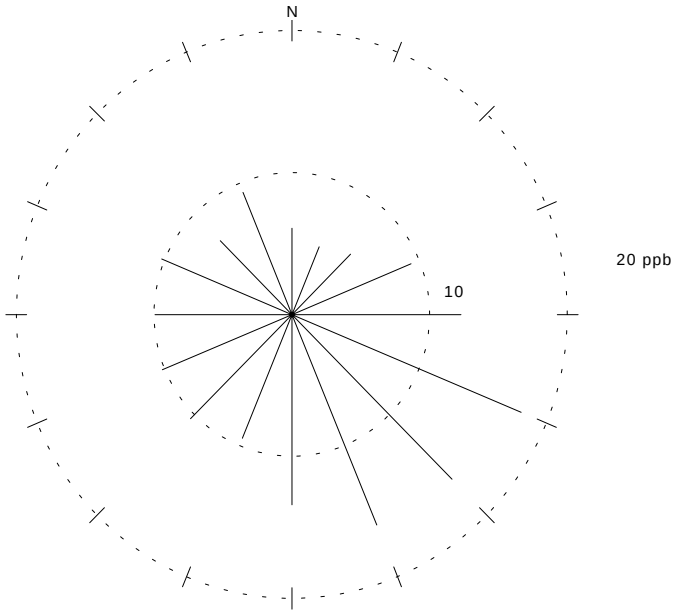
WIND ROSE ANALYSIS

South Holland Wind Direction Rose : 01/07/2001 to 30/06/2002
Frequency of Wind Direction in 150 - 160 degree sector = 1.40 %
Windspeed Threshold set at 0.1 m/s



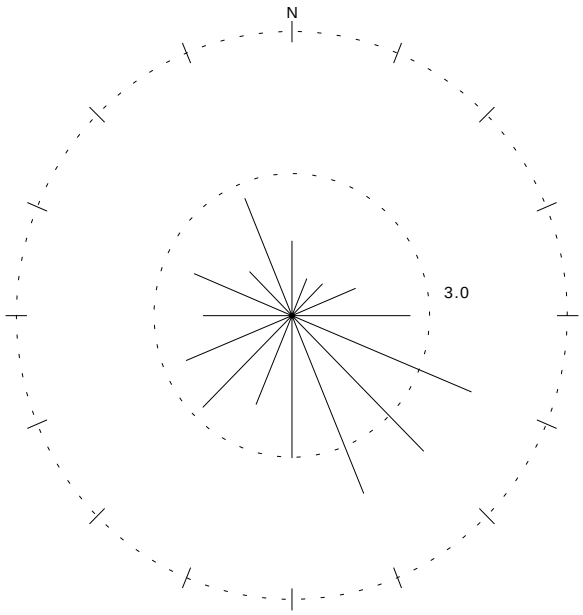
WIND ROSE ANALYSIS

South Holland Wind Speed Rose : 01/07/2001 to 30/06/2002
Average Wind Speed for 150 - 160 degree sector = 1.85 m/sec
Windspeed Threshold set at 0.1 m/s



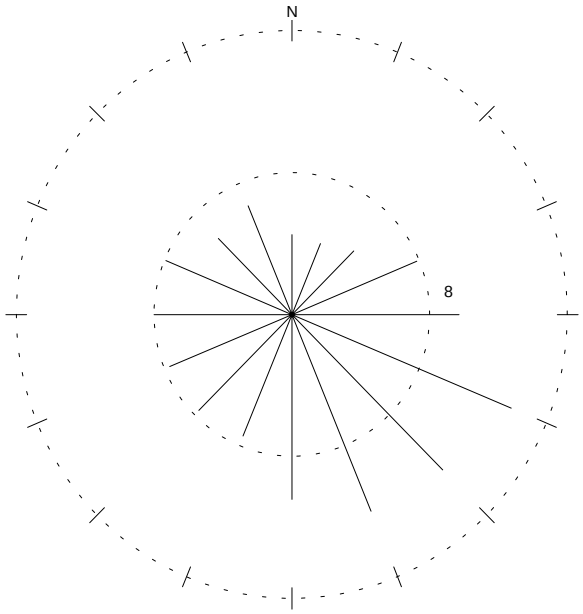
WIND ROSE ANALYSIS

South Holland Nitrogen Oxides Rose : 01/07/2001 to 30/06/2002
Average Nitrogen Oxides for 150 - 160 degree sector = 16.21 ppb
Windspeed Threshold set at 0.1 m/s



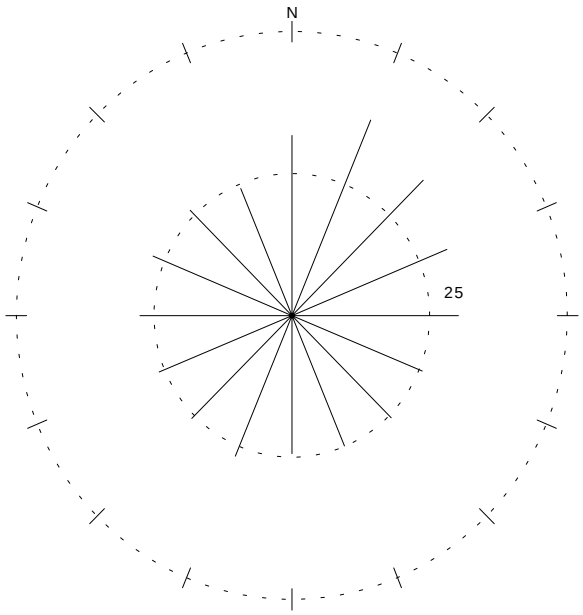
WIND ROSE ANALYSIS

South Holland Nitric Oxide Rose : 01/07/2001 to 30/06/2002
Average Nitric Oxide for 150 - 160 degree sector = 4.16 ppb
Windspeed Threshold set at 0.1 m/s



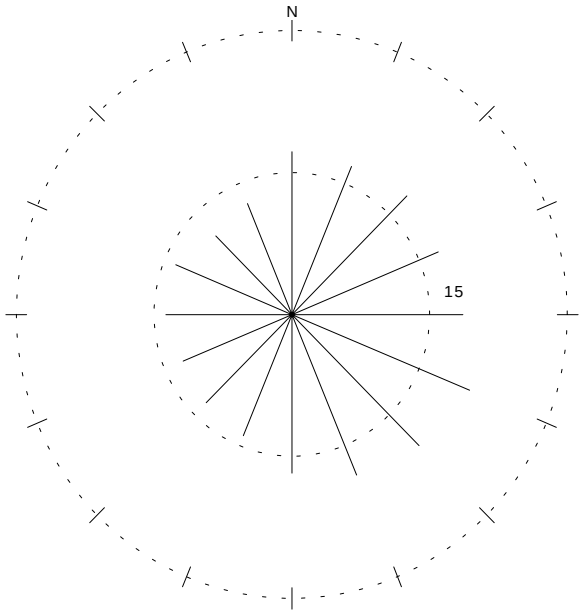
WIND ROSE ANALYSIS

South Holland Nitrogen Dioxide Rose : 01/07/2001 to 30/06/2002
Average Nitrogen Dioxide for 150 - 160 degree sector = 12.05 ppb
Windspeed Threshold set at 0.1 m/s



WIND ROSE ANALYSIS

South Holland Ozone Rose : 01/07/2001 to 30/06/2002
Average Ozone for 150 - 160 degree sector = 25.58 ppb
Windspeed Threshold set at 0.1 m/s



WIND ROSE ANALYSIS

South Holland PM10 Particulate Matter Rose : 01/07/2001 to 30/06/2002
Average PM10 Particulate Matter for 150 - 160 degree sector = 18.10 µg m-3 (20'C 1013mb)
Windspeed Threshold set at 0.1 m/s