NORWICH
City Council

ENVIRONMENT ACT 1995 PART IV

LOCAL AIR QUALITY MANAGEMENT
Review and Assessment of Air Quality-Stages 2 & 3

City of Norwich

Consultation Document

November 2001

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CONTENTS

FOREWORD

THE REVIEW OF THE LOCAL AIR QUALITY WITHIN THE CITY OF NORWICH

Environmental concern is now increasingly focusing on the quality of the atmosphere. Improvements in knowledge, the awareness and links with the effects of air pollution not only on human health but also its degradation of both natural and man-made environments has led to demands that enough is enough. There is a universal understanding that all Countries must take action if the air is to be protected. Everybody has the right to expect good air quality. It is a key issue of sustainability for the future and our children.

The Government has implemented the United Kingdom National Air Quality Strategy and this imposes duties upon Local Authorities to investigate the quality of air in their areas and where necessary take relevant action.

This document is the Council's Review and Assessment of the City's air quality under Stages 2 and 3 of the above strategy.

Cllr Andrew Pearmain
Environment Portfolio Holder
Norwich City Council
November 2001

Environment Act 1995 Part IV: Local Air Quality Management City of Norwich: Review and Assessment of Air Quality Stages 2 & 3.

Executive Summary

- Section 80 Environment Act 1995 requires the Secretary of State to publish a National Air Quality Strategy.
- The strategy was launched in 1997 and air quality standards were prescribed for seven pollutants, which the Government considers to be of concern to human health.
- The air quality of the City was reviewed and assessed in three stages; Stage 1: an initial desk top study to identify which pollutant require further investigation;
  Stage 2: includes estimation, modelling or measurement of pollutants and, where this indicates national objectives will not be achieved;
  Stage 3: using advanced modelling techniques and emission inventories.
- Where, following the above review and assessment of air quality, it is concluded that local air quality will not meet national targets, an Air Quality Management Area(s) will be declared and Norwich City Council will produce strategies that will ultimately deliver the standard.
- The Stage 1 review and assessment concluded that three pollutants required further investigation in order to ascertain whether the 2005 objectives would be achieved. These are: Nitrogen dioxide (NO_x), Sulphur dioxide (SO_2) and Particulate matter (PM_{10}).
- The Stage 2 review and assessment for Sulphur dioxide (SO_2) and Particulate matter (PM_{10}) concluded that Air Quality Standard for 2005 would be achieved
- Nitrogen dioxide (NO_2) was taken straight to a Stage 3 review and assessment as Stage 1 clearly indicated it was unlikely to achieve the set Air Quality standard in 2005.
- The Stage 3 review and assessment for Nitrogen dioxide (NO_2) concludes that the Air Quality standard is unlikely to be achieved in certain areas of the city by 2005.
- Norwich City Council proposes to declare 3 Air Quality Management Areas. The Air Quality Management Areas are defined in Figure 1
- Within 4 months of this report the council will make the AQMA order.
- Within 12 months of this report the council will carryout and consult on a Stage 4 review and assessment, and simultaneously produce and consult on an Action Plan.
- Within 18 months of this report the Action Plan will be in place.

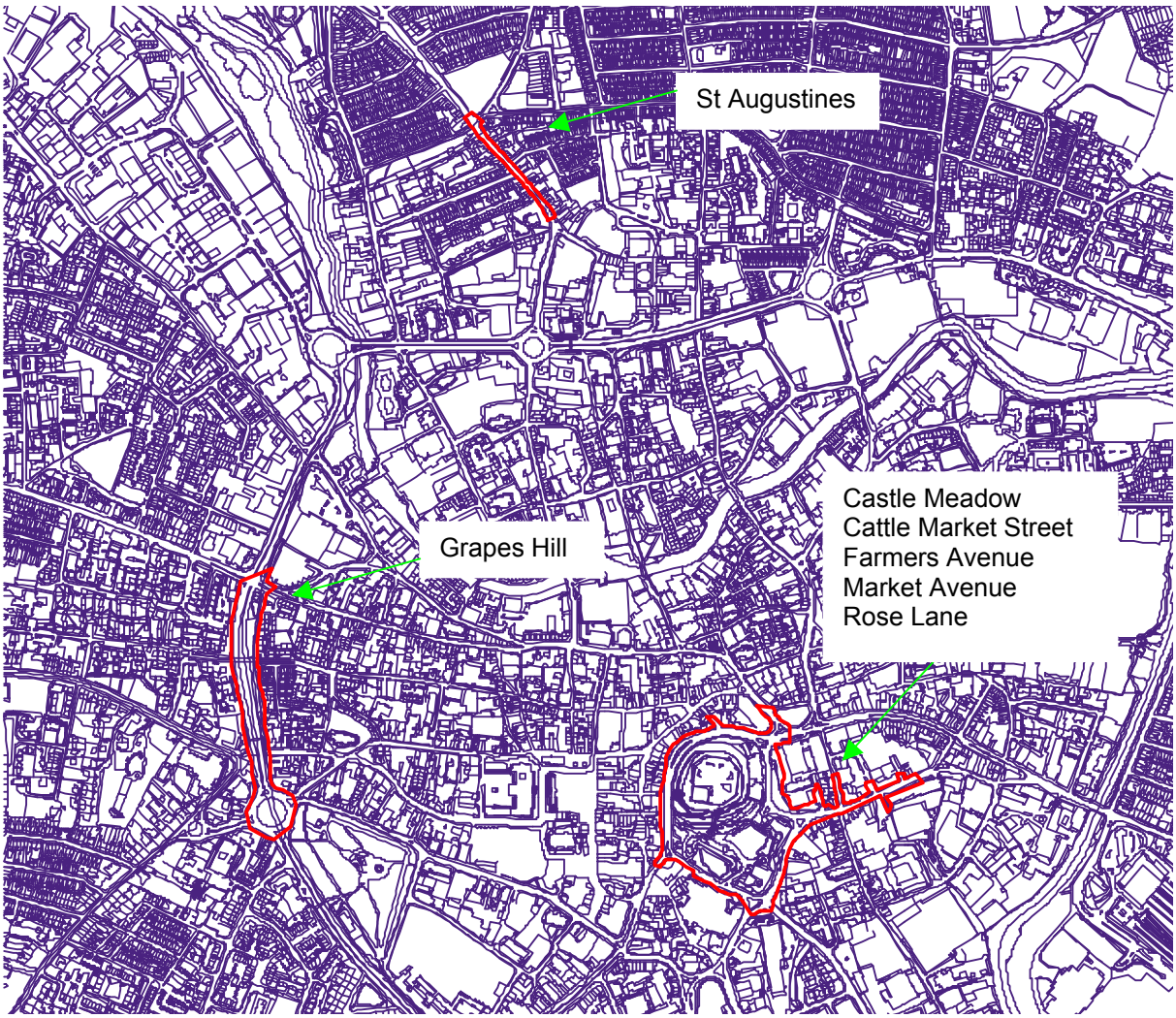

St Augustines
Grapes Hill
Castle Meadow
Cattle Market Street
Farmers Avenue
Market Avenue
Rose Lane

Figure 6.4

1.0 INTRODUCTION

1.1 The quality of the air we breathe is a matter of local, national and international concern. Norwich City Council launched its Environmental Protection Strategy and Policy Statement in 1992; amongst other things, the objective for pollution control being "to protect the human environment from the harmful effects of pollution". The Council has since developed the "Norwich 21 "Process (its corporate name for Agenda 21) within which air quality plays its part towards achieving sustainability for Norwich.

1.2 With the introduction of Part IV of the Environment Act 1995, a national framework was put into place to address air quality. The two main requirements being:

- The production of a National Air Quality Strategy (NAQS), which sets out air quality standards, for the seven principal pollutants (Table 1), and the time scale for their achievement and;
- A review by Local Authorities of their own air quality to assess whether the above national standards are being achieved or will be achieved by 2005.

1.3 The review and assessment process is undertaken in three stages:

- Stage 1: this is the initial "desk top" study, and where pollutants are identified as requiring further investigation, they are considered under:
- Stage 2: which includes estimation, modelling or measurement of pollutants. Where this stage predicts that a pollutant will not meet the national standard it is then considered under:
- Stage 3: using advanced modelling techniques and emission inventories.

1.4 The first stage review and assessment of the air quality in the City of Norwich was completed and published in June 1999, and it should be considered in conjunction with this document as it provides considerable background information not reproduced in this review and assessment.[1]

1.5 A consultation exercise was undertaken following publication of the stage 1 review and assessment. Where it was felt appropriate, the comments of the consultees are addressed in the body of the report.

1.6 The first stage review and assessment concluded that of the seven pollutants specified for considered by the Council, three required further investigation.

[1] Copies of the Stage 1 Review and Assessment can be obtained from Environmental Health Services Norwich City Council Elliot House 130 Ber Street Norwich NR1 3AG.

1.7 Sulphur dioxide (SO_2) and Particulate matter (PM_{10}) required further investigation under Stage 2. However in relation to Nitrogen dioxide (NO_2), the data used in the Stage 1 indicated that this pollutant would require detailed modelling under Stage 3 to determine if the national standard will be achieved. In view of this, and in accordance with Government guidance (LAQM.G1(97)) it was decided to proceed directly to a Stage 3 review and assessment for Nitrogen dioxide (NO_2).

1.8 In January 2000, a revised version of the Air Quality Strategy for England, Scotland, Wales and Northern Ireland was published. The revision changed the National Air Quality Objectives by changing pollutant concentrations, their compliance dates and introducing new objectives.

1.9 The revised changes and objectives were consolidated within legislation, (the Air Quality (England) Regulations 2000), and these are detailed in Table 1.1

1.10 The conclusions drawn in the stage 1 review and assessment have been re-examined against the revised Air Quality Strategy and the conclusion to move to a further review and assessment for Nitrogen dioxide, Sulphur dioxide and Particulate matter has been reconfirmed.

1.11 This document is therefore the Council's stage 2 review and assessment for Sulphur dioxide and Particulate matter and the stage 3 review and assessment for Nitrogen dioxide.

Air Quality Standards and Objectives

Substance	Original Air Quality Objective to be achieved by 31st December 2005	Revised Air Quality Objective
Benzene	5ppb or less, when expressed as a running annual mean	**running annual mean** of 16.25 µg/m^3 (5ppb) to be achieved by 31 December 2003
1,3- Butadiene	1ppb or less, when expressed as a running annual mean	**running annual mean** of 2.25 µg/m^3 (1ppb) to be achieved by 31 December 2003
Carbon monoxide	10ppm or less, when expressed as a running 8 hour mean	**running 8 hour mean** 11.6 µg/m^3 (10ppm) to be achieved by 31 December 2003
Lead	0.5 micrograms per cubic metre or less per calendar year	**annual mean** 0.5 µg/m^3 to be achieved by 31 December 2004 **annual mean** 0.25 µg/m^3 to be achieved by 31 December 2008
Nitrogen dioxide	150ppb or less, when expressed as an hourly mean, and 21ppb or less when expressed as an annual mean	**one hour mean** of 200µg/m^3 (105ppb) not exceeded more than 18 times per year to be achieved by 31 December 2005 annual mean of 40µg/m^3 (21ppb) to be achieved by 31 December 2005
PM_{10}	50 micrograms per cubic metre or less, when expressed as the 99th percentile of daily maximum running 24 hour means	**24 hour mean** of 50 µg/m^3 not exceeded more than 35 times per year **annual mean** of 40 µg/m^3 to be achieved by 31 December 2004
Sulphur dioxide	100ppb or less, when expressed as a 15 minute mean, 47ppb when expressed as a 24 hour mean and 132ppb when expressed as a 1 hour mean	**one hour mean** of 350µg/m^3 (132ppb) not to be exceeded mire than 24 times a year to be achieved by 31 December 2004 **24 hour mean** of 125 µg/m^3 (47ppb) not to be exceeded more than 3 times a year to be achieved by 31 December 2004 **15 minute mean** of 266 µg/m^3 (100ppb) not to be exceeded more than 35 times a year to be achieved by 31 December 2005

ppb= parts per billion

2.0 SOURCES OF AIR POLLUTION AFFECTING NORWICH CITY

2.1 INTRODUCTION

2.1.1 Air quality in Norwich is influenced by the emissions of pollutants within the city boundary as well as those entering from the surrounding area. The total emissions of pollutants to atmosphere, which are detailed in local emissions inventories, are therefore important.

2.1.2 The weather and other atmospheric conditions also influence local air quality. When certain weather conditions prevail, air pollution may be carried considerable distances and therefore have no impact locally. Conversely, other weather conditions may result in pollution being deposited into the area.

2.1.3 At certain times of the year, mainly winter temperature inversions will occur and these cause the pollution to be held in the area, allowing their concentrations to increase.

2.1.4 In the summertime we experience the haze known as *summertime smog.* This is where atmospheric conditions, particularly sunlight and humidity affect air pollution by influencing chemical reactions between pollutants. This is commonly noticeable when Nitrogen dioxide and volatile organic compounds emitted from vehicle engines react in heat and sunlight to form Ozone. Large areas may be affected by Ozone as a result of this reaction.

2.2 TRANSPORTATION SOURCES

2.2.1 The City is served by the following main roads:-

A47 eastwards to Gt Yarmouth
A47 westwards to Kings Lynn
A140 northwards to North Norfolk
A140 southwards to Ipswich
A11 south westwards to Thetford
A146 south eastwards to Lowestoft
A1067 north westwards to Fakenham
A1151 north eastwards to the Norfolk Broads

2.2.2 In recent decades the volume and variety of road transport on such roads has grown dramatically. Vehicle exhaust emissions have grown to match or indeed exceed other sources of the most important pollutants

and today are the dominant source of pollution within most urban areas

2.2.3 All Government forecasts show that car use is likely to increase for the foreseeable future. The Department of Transport Environment and the Regions has produced local traffic forecasts based on assumptions used in the national forecasts which are in turn based on factors such as car ownership and population forecasts. The following table gives predicted local traffic increases forecast for 1996 - 2006 based on the two alternative scenarios of low and high growth.

Location	Low Growth	High Growth
National (G.B.)	8.4%	22.5%
Norfolk	7.3%	22.2%
Norwich	7.0%	24.3%
Breckland	8.7%	24.8%
Broadland	9.6%	23.8%
Great Yarmouth	4.6%	17.8%
King's Lynn and West Norfolk	7.5%	21.6%
North Norfolk	8.3%	23.0%
South Norfolk	4.9%	18.5%

2.2.4 These figures represent an overview and individual areas within each Local Authority area may be higher or lower than the forecast. The most recent information for Norwich is detailed in Appendix 1 (source Norfolk County Council Highways)

2.2.5 With the rise in traffic it might be expected that emissions will generally increase. However, Central Government action in promoting better design by, for example, the use of catalytic converters will, it is believed, see a short-term general reduction in emissions to 2005. However, as the 21st century progresses, these emissions will start to rise again due to the sheer weight of numbers of vehicles forecasted to be on the roads (assuming current day technology and fuels).

2.2.6 It must be stressed that the City's roads do not generally suffer from continuous high levels of traffic or congestion although at times during the day, particularly rush hour, several roads can become slow moving.

2.2.6 The National Air Quality Strategy document has provided information, which suggests that emissions from aircraft associated with ground movement, take off, and landing cycles contribute little to overall pollution levels. For this reason it was concluded in the Part 1 Review and Assessment of Air Quality that the contribution of emissions from aircraft using Norwich Airport do not require further consideration.

2.2.7 The railway system uses locomotives with electric and diesel engines. Whilst emissions from the locomotives with diesel engines can be an important source of pollution, the use of diesel locomotives is steadily decreasing and are used here predominantly for local services which leads the Council to conclude that the contribution of emissions from this source requires no further consideration.

2.2.8 Emissions from the engines of cruisers on the river Wensum are not thought to contribute detrimentally to the general ambient air quality of the City due to their low numbers and limited periods of use and therefore these sources have not been considered further.

2.3 INDUSTRIAL SOURCES

2.3.1 Within the City, industry is sited mainly on the Industrial and Trading Estates, which are at the following locations:

Bowthorpe Employment Area
City Trading Estate
Fifers Lane
Hellesdon Park Industrial Estate
Norwich Airport Industrial Estate
Riverside Redevelopment Area
Salhouse Road
Sweet Briar Industrial Estate
Vulcan Road
Whiffler Road
White Lodge Trading Estate

2.3.2 The Pollution Prevention and Control Act 1999 received Royal Assent on 27th July 1999 and allows regulations to be made that implement the 1996 EU Directive on Integrated Pollution Prevention and Control (IPPC). The Act provides for the repeal of Part I of the Environmental Protection Act 1990, and introduces new controls over certain "prescribed processes".

2.3.3 Under the former regime the processes considered the most polluting were regulated by way of prior authorisation. There was a dual system of enforcement with the processes designated as "Part A" being regulated by the Environment Agency and those "Part B" by the Local Authority. The "Part A" processes discharge pollutants to more than one medium, i.e. air, land and water courses, and the "Part B" ones to atmosphere alone

2.3.4 The new regime has retained the dual system of enforcement with those processes now designated as A1 being regulated by the Environment Agency and those designated as A2 by the Local Authority. A2 activities include most of those previously authorised as Part B processes. In future all processes will operate under an IPPC Permit.

2.3.5 The Act provides for transitional arrangements, with existing installations or those already holding an authorisation under the Part I of the Environmental Protection Act 1990 to be phased into the new regime between 2000 and 2007, depending upon their sector. However, new installations (i.e. those brought into operation after 31st October 1999) have to apply for an IPPC Permit straight away. Appendix 2 contains updated details of the process originally designated as Part A and Part B.

2.4 TRANSBOUNDARY SOURCES

2.4.1 The transboundary nature of air pollutants has meant that the Reviews have had to consider sources from outside the City boundary, and in this respect each of the abutting local authorities have been contacted. Updated lists of the processes originally designated Part A and Part B held by Breckland, Broadland and South Norfolk Councils are detailed in Appendix 3.

2.4.2 The relationship between transboundary and local air pollution is difficult to specify. However, there is significant evidence to show the transboundary movement of small particles (PM_{10}) from Europe and it is believed that elevated levels in the UK are often due to European sources. This is considered in more detail under the review of PM_{10}.

2.5 FUTURE DEVELOPMENTS

2.5.1 The review and assessments of local air quality will predict whether the air quality standards specified for the

seven principal pollutants are likely to be achieved in 2005.

2.5.2 As part of the reviews, the local authority has to consider future developments both local and transboundary, which may lead to increased pollution levels. In relation to the pollutant reviewed in this document, the following have been considered:

a) Improvements to the trunk road system.

b) Increased use of rail freight and passenger services.

c) Industrial developments.

3.0 MONITORING AND MODELLING METHODOLOGY

3.1 It is important when comparing the monitoring results from different sites and by the use of different methods that we know how well each individual piece of equipment operates including the accuracy of each method and the estimated analytical uncertainty.

3.2 The two parameters that are considered in relation to the above are as follows:

- Accuracy – how close the measurement is to the true value of the parameter being measured
- Estimated uncertainty – the extent to which multiple measurements of the same parameter repeat

3.3 The monitoring for the stage 2&3 review and assessment was undertaken using a combination of the following monitoring techniques:

- Diffusion tubes – Nitrogen dioxide
- Semi-automatic analyser – Sulphur dioxide
- Continuous automatic analyser – Nitrogen dioxide, Sulphur dioxide and Fine Particulates (PM_{10})
- Appendix 4 contains further details of the monitoring methodology.

3.4 The modelling for the stage 2&3 review and assessment was carried out using:

- *The Design Manual for Roads and Bridges* and;
- *ADMS-Urban*
- Appendix 5 contains details of the modelling techniques and their validation and accuracy.

4.0 SECOND STAGE REVIEW AND ASSESSMENT OF FINE PARTICLES OR PM_{10}

4.1 INTRODUCTION

4.1.1 PM_{10} is defined as the total mass (per unit volume of air) or particles of medium aerodynamic diameter less than 10 μm (one micron equals 1/1,000,000 metre). These particles have the greatest likelihood of reaching the lung. It is for this reason that they are of concern.

4.1.2 Unlike the individual gaseous pollutants, which are single, well defined substances, particulate matter in the atmosphere is composed of a wide range of materials arising from a variety of sources. The concentration of fine particles ($PM_{10)}$ can broadly be split into three categories:

- Primary particles – those derived from combustion sources e.g. road traffic bonfires
- Secondary particles – produced through the chemical reaction of primary emissions e.g. SO_2 & NO_2 to create sulphates and nitrates.
- Coarse particles – tend to be local naturally occurring sources e.g. wind blown dust

4.1.3 Primary and secondary particles have a potential to travel thousands of kilometres before being removed and therefore sources of pollution from elsewhere e.g. continental Europe can provide a significant contribution to PM_{10} concentrations locally.

4.1.4 Examples of man-made primary sources are: carbon particles from incomplete combustion; ash; recondensed metallic vapours; and so called secondary particles or aerosols, formed by chemical reactions in the atmosphere. In addition to being emitted directly from combustion sources, man-made particles can arise from: mining; quarrying and construction operations; brake and tyre wear in motor vehicles; and from road dust lifted by moving traffic or strong winds. Natural sources of particles include wind blown dust from agricultural activity and importantly for coastal authorities sea salt, and biological particles such as pollens and fungal spores.

4.1.5 The dominant source of primary PM_{10} is from vehicles and in particular diesel vehicle emissions. However, added to these primary sources are secondary particles formed by the chemical reaction of gases within the atmosphere. Unlike primary particles they are less easy to ascribe to their original sources. They comprise mainly ammonium sulphate and

nitrate, originating from oxidation of sulphur and nitrogen oxides to acids which are then neutralised by atmospheric ammonia derived from agricultural sources. These chemical processes are slow and their persistence in the atmosphere prolonged. They are therefore distributed more evenly throughout urban and rural areas and are important in the transboundary effects of this pollutant. Several episodes of poor air quality have been attributed to the importation of PM_{10} from the continent. Table 4.1 shows the primary man made emission sources of PM_{10} in the UK from 1995-1997

Table 4.1: Annual Emissions of PM_{10} in the UK in 1995-1997.

Source	**Emissions 1995 kilotonnes***	**Emissions 1996 kilotonnes***	**Emissions 1997 kilotonnes***	**Percentage of 1997 Total ****
Public power	37	34	23	12
Residential Plant	28	30	28	15
Commercial/public/agric Combustion	6	6	6	3
Refineries (Petroleum)	4	4	4	2
Iron and Steel (Combustion)	1	1	1	0
Other Industrial Combustion	23	21	19	10
Construction	4	4	4	2
Industrial Processes	21	21	21	11
Quarrying	24	22	22	12
Road Transport				
Diesel	41	41	33	18
Petrol	12	11	10	5
Tyre and Brakes wear	4	5	5	3
Off Road Sources	2	2	2	1
Military	0	0	0	0
Railways	1	1	1	0
Shipping	1	1	1	1
Civil aircraft	0	0	0	0
Other Combustion and Transport	3	4	4	2
Non Landfill Waste Treatment and Disposal	2	2	1	1
Non Livestock Agriculture	0	0	0	0
TOTAL	**215**	**207**	**184**	

- Figures rounded to nearest kilotonne
- ** Figures rounded to nearest 1%

Source: The United Kingdom National Air Quality Strategy 2000

4.2 STANDARD AND OBJECTIVE FOR PM_{10}

4.2.1 The original air quality objective to be achieved by 31st December 2005 was 50 μg/m^3 or less, when expressed as the 99th percentile of daily maximum running 24 hour means (i.e. on all but four days per year assuming perfect operation of monitoring equipment with 100% data capture).

4.2.2 The Government has now adopted the following air quality objective for PM_{10}:

> *50 μg/m^3 or less when expressed as a 24 hour mean not to be exceeded more than 35 times per year (to be achieved by 331st December 2004) and;*
>
> *40μg/m3 or less when expressed as an annual mean (to be achieved by 31st December 2004.*

4.2.3 The focus of our review and assessment for PM_{10} is non-occupational, near ground level outdoor locations with elevated PM_{10} concentrations in areas where a person might reasonably be expected to be exposed over a 24 hour period (e.g. in the vicinity of housing, schools or hospitals etc)

4.3 CURRENT POSITION

4.3.1 The 24-hour mean provisional objective on which the original first stage review and assessment was carried out based on the best available knowledge at the time. The new objectives are based on gravimetric measurements, which tend to be used as the reference standard in Europe. In the UK, PM_{10} have historically been measured by the Tapered Element Oscillating Microbalance (TEOM) sampler,which tends to under-read particulates. A correction factor of TEOM x 1.3 = Gravimetric is used.

4.3.2 The work carried out by NETCEN (as recommended by LAQM.TG4 00) has shown estimated annual mean background UK concentrations of PM_{10} to be 25.5 $\mu g/m^3$, (comprised of 10.2 $\mu g/m^3$ primary particles, 9.4 $\mu g/m^3$ secondary particles and 5.0 $\mu g/m^3$ coarse particles). The estimated mean background concentration of total PM10 across the City is between 25.1 – 27.5 $\mu g/m^3$.[2]

4.3.3 Since the original review and assessment was completed in 1999, there has been much research into the origin, transportation and health effects of PM_{10}.

4.3.4 The City Council in partnership with the Norfolk Air Quality Steering Group comprising representatives of the Norfolk District Councils, Norfolk County Council, the University of East Anglia and the Environment Agency, has jointly funded a research project utilising the Meteorological Office's NAME dispersion model.

4.3.5 The research project[3] was completed in December 2000 and the summary of the review and assessment of PM_{10} for Norwich is detailed in 4.4.

4.3.6 In addition to the above, the opportunity has been taken to review the original areas of assessment for PM_{10} carried out under the Stage 1 Review and Assessment. These are detailed in sections 4.5. to 4.10.

[2] Maps of Air Pollution in the UK: *http://www.aeat.co.uk/netcen/airqual/laqm/index.html*

[3] *The Relative Contribution of Local and Distant Sources of Particulates to Eastern England* Chatterton T.: School of Environmental Science University of East Anglia, December 2000 (Copies of the document can be obtained from Environmental Health Services Norwich City Council Elliot House 130 Ber Street Norwich NR1 3AG.)

4.4 SUMMARY OF REVIEW AND ASSESSMENT OF PM10

4.4.1 Under the original objective for PM_{10}, we would have automatically had to move to a Stage 3 Review and Assessment for particulates as the monitoring data for Norwich Centre monitoring site, beginning in July 1997 showed 63 exceedences of the 24-hour running mean in the first 5 months.

4.4.2 However following this there have only been two subsequent exceedences of the 24-hour running mean Standard, both on the 22/03/2000.

4.4.3 The change of the objective to a daily mean rather than a running mean has reduced the exceedences to 4, although if the data is converted to $\mu g/m^3$ [gravimetric] as required in the new Pollutant Specific Guidance[3], there are 22 exceedences during the 32 months for which ratified data is available.

4.4.4 Table 4.2 shows all measured exceedences of the 24-hour Daily Mean for particulates in Norwich since monitoring began. Gravimetric levels were calculated using the DETR recommended correction factor of 1.3, and out of the 22 exceedences using gravimetric levels, only 4 also exceed the limit using the TEOM levels (notably on consecutive days from 30/10/97 – 02/11/97 during the "*Guy Fawkes*" season

[3] DETR – LAQM.TG4(00

Table 4.2: 24hr Daily Mean PM_{10} for Norwich Centre > 50µg/m^3 [gravimetric]

Date	24hrDm[T]	24hrDM[G]
09/08/97	46.21	60.07
12/08/97	43.71	56.82
21/08/97	40.58	52.76
29/09/97	38.88	50.54
29/10/97	41.38	53.79
30/10/97	**66.92**	86.99
31/10/97	**57.54**	74.80
01/11/97	**55.38**	71.99
02/11/97	**51.14**	60.94
26/11/97	38.71	50.32
28/01/98	43.92	57.09
16/03/98	43.63	56.71
29/03/98	40.46	52.60
13/05/98	43.08	56.01
17/11/98	40.65	50.65
17/03/99	40.04	52.05
01/04/99	39.67	51.57
02/08/99	39.42	51.24
02/09/99	41.29	53.68
06/09/99	40.96	53.25
11/09/99	49.50	64.35
22/03/00	45.67	59.37

4.5 PM_{10} - ROAD TRANSPORT

4.5.1 The biggest single source of PM_{10}, identified at the Stage 1 Review and Assessment was road transport, and this situation has not changed (Table 4.1 The Annual Emissions of PM_{10}).

4.5.2 Additionally, guidance from the government suggests that roads with an annual average daily traffic flow (AADF) in excess of 25,000 vehicles emit significant quantities of PM_{10} and warrant further attention. Appendix 1 shows the roads with a projected AADF in excess of 25,000.

4.5.3 There was no local monitoring of PM_{10} for the Stage 1 Review and Assessment, and in the light of the revised LAQM guidance and the conclusions in 4.3 it is not proposed to carryout monitoring or further investigation of PM_{10} for this review and assessment as it is highly unlikely that the standard will be exceeded.

4.6 PM_{10} – OTHER TRANSPORTATION SOURCES

4.6.1 The revised LAQM guidance from the Government does not raise any new issues concerning emissions from aircraft, rail or river traffic sources within the City, and these will not be considered further at this time.

4.7 PM_{10} – INDUSTRIAL SOURCES

Part A Processes

4.7.1 There are no Part A Processes within the City which emit PM_{10}.

Part B Processes

4.7.2 There are 44 Part B Processes within the City and these are detailed in Appendix 2. Whilst many of the processes have the ability to release dust, including PM10, none are considered to be significant emitters and therefore these sources will not be considered further.

4.8 PM10 – TRANSBOUNDARY INDUSTRIAL SOURCES

4.8.1 There are three local authorities adjoining the City, these being Breckland, Broadland and South Norfolk Councils.

4.8.2 There are 2 Part A Processes and 68 Part B Processes in Breckland district, 1 Part A Process and 34 Part B Processes in Broadland district and 0 Part A Processes

and 60 Part B Processes in South Norfolk district. These are detailed in Appendix 3.

4.8.3 Enquiries with these authorities have confirmed that there are no new industrial sources planned to be in operation by 2004, and as the Stage 1 Review and Assessment did not consider that these sources would significantly contribute to PM_{10} levels in the City they will not be considered further at this stage.

4.8.4 The Stage 1 Review and Assessment highlighted PM_{10} originating from continental Europe as being a significant contributor to background levels in this region, and to investigate this further the Council jointly funded the research project detailed in 4.2.7.

4.8.5 The conclusions to this research project (4.3) indicate that no further consideration of this source is necessary at this stage.

4.8 PM_{10} – NATURAL SOURCES

4.9.1 These include course particles such as windblown agricultural dusts, pollens and soils from open spaces, roads and the surrounding agricultural areas. In certain areas sea salt can made up a significant proportion of PM_{10}, although the distance of the coast from the City makes it unlikely that this source would contribute significantly to the air quality. By their very nature these particles are not readily controllable and the level of their contribution in future years is likely to remain constant.

4.10 PM_{10} – OTHER SOURCES

4.10.1 The Stage 1 Review and Assessment highlighted domestic heating as providing a significant proportion of PM_{10} material, although with gas replacing solid fuel and fuel oil it was felt that this contribution would reduce. This situation does not appear to have changed and therefore further consideration of this source is not felt necessary at this stage.

4.11 CONCLUSIONS FOR PM_{10}

4.11.1 The information presented in this section shows that it is not expected that the air quality objectives for PM_{10} will be exceeded within the City.

4.11.2 In view of the above it is not proposed to take PM_{10} to a Stage 3 Review and Assessment.

5.0 SECOND STAGE REVIEW AND ASSESSMENT OF SULPHUR DIOXIDE SO_2

5.1 INTRODUCTION

5.1.1 At normal temperature and pressure Sulphur Dioxide (SO_2) is a gas. In the presence of water the gas dissolves to produce an acidic solution, this solution naturally oxidises to form sulphuric acid. Volcanic activity and marine organisms generate natural releases of SO_2. Within the UK the principal source of SO_2 is the combustion of fossil fuels which naturally contain sulphur, such as coal and heavy oils.

5.1.2 When SO_2 is inhaled into the human body it dissolves on moist surfaces to form an acidic solution. This acts as an irritant as its presence stimulates nerves in the lining of noise, throat and airways of the lungs, and exposure to high concentrations of the gas may result in breathing difficulties. Studies have shown that asthmatics and those suffering from chronic lung disease may be particularly susceptible to its affects. SO_2 can also have an adverse affect on vegetation.

5.1.3 In the nineteenth century and early part of the twentieth century dense fogs occurred in the industrial cities. These weather conditions were named “smogs”. They were caused by the combination of sooty particles and SO_2 produced by coal burning in domestic and industrial buildings which could not disperse and dilute due to weather inversions. It was noted that numbers of people with chest illnesses increased and excess deaths occurred during these episodes, particularly among those already affected by lung disease and also in the elderly population.

5.1.4 The linkage of pollution from coal burning and ill health led to the creation of the Clean Air Act of 1956. Subsequently the use of coal as a domestic and industrial fuel within industrial areas has declined. This movement lead to the siting of coal and oil burning power stations in rural areas away from heavily populated cities.

5.1.5 Table 5.1 shows the principal man-made sources of SO2 in the UK from 1995-1997.

Table 5.1: Annual Emissions of SO_2 in the UK 1995-1997

Source	Emissions 1995 kilotonnes *	Emissions 1996 kilotonnes *	Emissions 1997 kilotonnes *	Percentage of 1997 Total **
Public Power	1590	1319	1025	62
Residential Plant	65	68	63	15
Commercial/public/agric. Combustion	61	59	48	3
Refineries (Petroleum)	175	178	174	10
Iron and Steel (Combustion)	66	61	62	4
Other Industrial Combustion	256	216	178	11
Off Shore Oil and Gas	6	7	6	0
Industrial Processes	23	24	21	1
Road Transport				
Diesel	35	26	12	1
Petrol	16	12	16	1
Off Road Sources	5	5	5	0
Military	7	7	8	0
Railways	2	2	1	0
Shipping	29	30	27	2
Civil aircraft	1	1	1	0
Other Combustion and Transport	12	11	14	1
Non Landfill Waste Treatment and Disposal	2	1	1	0
Total	**2351**	**2026**	**1662**	

* Figures rounded to nearest kilotonne

** Figures rounded to nearest 1%

Source: The United Kingdom National Air Quality Strategy 2000

5.2 STANDARD AND OBJECTIVE FOR SO_2

5.2.1 The original air quality objective to be achieved by 31st December 2005 was 100ppb or less, when expressed as a 15 minute mean, 47 ppb when expresses as a 24 hour mean and 132 ppb when expressed as a 1 hour mean.

5.2.2 The Government has now adopted the following air quality objective for SO_2 :

> *15-minute mean of 266μg/m^3 (100ppb) as an air quality standard for sulphur dioxide (SO_2), with an objective for the standard not to be exceeded more than 35 times per year (this approximates to the 99.9th percentile) by the end of 2005;*
>
> *1 hour mean objective of 350μg/m^3 (132ppb) to be exceeded no more than 24 times per year (approximates to the 99.7th percentile);*
>
> *24 hour mean objective of 125 μg/m^3 (47ppb) to be exceeded no more than 3 times per year (approximates to 99th percentile)*
>
> *The 1 hour and 24 hour objectives to be achieved by the end of 2004.*

5.2.3 The focus of our review and assessment for SO_2 is non-occupational, near ground level outdoor locations given that exposures over 15 minutes are potentially likely in these locations.

5.3 CURRENT POSITION

5.3.1 The Stage 2 Review and Assessment for SO_2 was considered necessary as doubts were raised under Stage 1 as to whether the objective would be achieved in relation to the emissions from Part A and B Processes, the data from the current monitoring system and the solid fuel/fuel oil combustion systems exceeding 5MW.

5.3.2 The Stage 1 Review and Assessment used this data and confirmed that the annual average levels of SO2 in Norwich for the years 1995, 1996 and 1997 were 11ppb, 10ppb and 13ppb respectively. However, the levels at the Guildhall site exceeded the set standard on several occasions, with levels of over 60ppb being recorded between June and October 1997.

5.3.3 Norwich City Council is continuing to monitor SO_2 on a daily basis using semi-automatic analysers (SO_2 bubblers) at urban background locations, and this methodology can be used to collect daily average sulphur dioxide data.

The annual 99.9th percentile of 15-minute averages and the annual maximum daily average can be correlated and related by a mathematical function[1]. This function can be used to estimate the 99.9th percentile of 15-minute averages from daily measurements.

However, there is uncertainty in the relationship and to take account of this it can be assumed that the risk of exceeding the air quality objective is negligible if the maximum daily mean concentration is less than 48 ppb.

5.3.4 The background concentration of SO_2 in the City is estimated to be between 8.1-10ppb[2]

5.3.5 The results for the monitoring of SO_2 in the City for 1999-2000 and 2000-2001 are detailed in Appendix 5.

5.3.6 In addition to the above monitoring, the opportunity has been taken to review the original areas of assessment for SO_2 carried out under the Stage 1 Review and Assessments. These are detailed in sections 5.5 to 5.8.

[1] LAQM.TG4(98), p39.

[2] Figures produced by the National Environmental Technology Centre (NETCEN), part of AEA Technology plc

5.4 SUMMARY OF REVIEW AND ASSESSMENT OF SO_2

5.4.1 The monitoring sites for Sulphur dioxide (SO_2) are sited at Churchill Road, Guildhall, Hardy Road, Rouen Road and Tuckswood and the results for the monitoring periods 1999 to 2000 and 2000 to 2001 are given in Appendix 6.

5.4.2 During the monitoring period 30th March 1999 to January 2000, all the sites except the Guildhall returned results that were within the air quality standard of 47ppb (24-hour mean). The Guildhall site regularly gave results, which exceeded the standard, with a maximum level of 951ppb being measured.

5.4.3 The levels of SO_2 measured at the Guildhall site gave serious cause for concern as not only were they in excess of 20 times the air quality standard, but they did not reflect the levels being measured at other sites which had a similar surrounding environment.

5.4.4 The high levels measured at the Guildhall were discussed with AEA Technology plc, who ratify the SO_2 data from the Churchill Road site for the UK network.

5.4.5 On their recommendation we systematically renewed the monitoring equipment. This took place over a 3 month period beginning December 1999.

5.4.6 Over this period the SO_2 levels measured at the Guildhall have gradually dropped until the levels were comparable to the other sites.

5.4.7 These levels have been maintained during the monitoring period April 2000 to March 2001 and the expectation is that the daily 24-hour mean and consequently the other standards will not be exceeded in the future.

5.5 SO_2 – ROAD TRANSPORT

5.5.1 Road transport is a relatively small source of SO_2, with diesel engines generation higher levels than petrol.

5.5.2 National research has shown an increase in SO_2 levels above the background level at road side locations, but not to the extent where exceedances are likely to be recorded in the absence of other local sources.

5.5.3 Local monitoring has initially shown elevated levels at the Guildhall (see 5.4) although traffic is now not considered a major emitter of SO2 and it is unlikely that it will have any significant effect on ambient SO2 concentrations, especially on short-term peak concentrations. The advice in LAQM.TG4 (00) supports this view.[4]

5.6 SO2 – OTHER TRANSPORTATION SOURCES

5.6.1 The other transportation sources within the city and in the surrounding areas are not considered of a sufficient quantity to result in a failure to achieve the air quality standard.

5.7 SO2 – INDUSTRIAL SOURCES

5.7.1 The Part A and Part B processes within the city and in the areas covered by Breckland, Broadland and South Norfolk Councils have been reviewed with regard to their ability to contribute to the SO_2 levels in the city.

5.7.2 The only Part A process which has the potential to emit significant quantities of SO_2 is British Sugar at Cantley, within Broadland Councils area.

5.7.3 The only Part B process which has the potential to emit significant quantities of SO_2 is in Redland Aggregates at Trowse.

5.7.4 However, the contribution that these sources would add to the existing measured SO_2 levels in the air is unlikely to result in a failure to achieve the air quality standard.

5.8 SO2 – OTHER SOURCES

5.8.1 Heavy fuel oil boilers with a thermal power rating greater than 5MW may produce significant quantities of sulphur dioxide. In the Part 1 Review and Assessment of SO_2, 4 sites were identified with boilers of this size or greater

[4] LAQM.TG4 (00) Part IV The Environment Act 1995 Local Air Quality Management*: Review and Assessment Pollutant Specific Guidance*

and these were University of East Anglia (2 x 7 MW), Colmans (2 x 13.8 MW) and Norwich Corrugated Board (1 x 5.6MW & 1 x 7 MW)

5.8.2 These boilers run on a dual-fuel system where by gas power is the norm, except in extreme weather conditions when the Gas companies interrupt the gas supply.

5.8.3 The contribution of SO_2 emissions from domestic heating systems is still considered to be low with the trend continuing to move towards the replacement of solid fuels and oil heating to gas.

5.8.4 Therefore, the contribution that these sources would add to the existing measured SO_2 levels in the air is unlikely to result in a failure to achieve the air quality standard.

5.9 CONCLUSIONS FOR SO2

5.9.1 The information presented in this section shows that it is not expected that the air quality objectives for Sulphur dioxide (SO_2) will be exceeded.

5.9.2 In view of the above it is not proposed to take Sulphur dioxide (SO_2) to a Stage 3 Review and Assessment.

6.0 THIRD STAGE REVIEW AND ASSESSMENT OF NITROGEN DIOXIDE NO_2

6.1 INTRODUCTION

6.1.1 Nitrogen dioxide (NO_2) and Nitric oxide (NO) are both oxides of nitrogen and together they are referred to as NO_x. All combustion processes produce some NO_x, but only NO_2 is associated with adverse effects on human health.

6.1.2 Nitrogen dioxide is a reddish brown gas produced by the oxidation of nitric oxide in the atmosphere particularly by ozone. Elevated levels of NO_x occur in urban environments under stable meteorological conditions when the air mass is unable to disperse.

6.1.3 In the presence of sunlight it reacts with hydrocarbons to produce photochemical pollutants such as ozone. In addition, NO_x have a lifetime of approximately one-day with respect to conversion to nitric acid. This in turn is removed from the atmosphere by direct deposition, possibly via rain, thereby contributing to acid deposition.

6.1.1 Table 6.1 shows the principal man-made sources of oxides of nitrogen in the UK from 1995 to 1997.

Table 6.1: Annual Emissions of NO_X in the UK 1995-1997

Source	Emissions 1995 kilotonnes *	Emissions 1996 kilotonnes *	Emissions 1997 kilotonnes *	Percentage of 1997 Total **
Public Power	493	448	370	20
Residential Plant	66	75	69	4
Commercial/public/agric. Combustion	37	39	36	2
Refineries (Petroleum)	48	49	48	3
Iron and Steel (Combustion)	24	24	25	1
Other Industrial Combustion	155	154	145	8
Off Shore Oil and Gas	1	1	1	0
Industrial Processes	5	5	5	0
Road Transport				
Diesel	448	425	398	22
Petrol	557	534	485	26
Off Road Sources	72	77	74	4
Military	37	35	35	2
Railways	14	15	14	1
Shipping	64	69	66	4
Civil aircraft	10	11	11	1
Other Combustion and Transport	53	51	50	3
Non Landfill Waste Treatment and Disposal	8	6	4	0
Total	**2092**	**2018**	**1836**	

* Figures rounded to nearest kilotonne

** Figures rounded to nearest 1%

Source: The United Kingdom National Air Quality Strategy 2000

6.2 STANDARD AND OBJECTIVE FOR NITROGEN DIOXIDE

6.2.1 The original air quality objective to be achieved by 31st December 2005 was 150ppb or less, when expressed as an hourly mean, and 21ppb or less when expressed as an annual mean.

6.2.2 The Government has now adopted the following air quality objective for Nitrogen dioxide (NO_2):

> *One hour mean of 200µg/m^3 (105ppb) not exceeded more than 18 times per year to be achieved by 31 December 2005*
>
> *Annual mean of 40µg/m^3 (21ppb) to be achieved by 31 December 2004*

6.2.3 The focus of our review and assessment for Nitrogen Dioxide (NO_2) is non-occupational, near ground level outdoor locations given that exposures over 15 minutes are potentially likely in these locations.

6.3 CURRENT POSITION

6.3.1 The first stage review and assessment concluded that Nitrogen dioxide (NO_2) required further investigation.

6.3.2 However in relation to Nitrogen dioxide (NO_2), the data used in the Stage 1 indicated that this pollutant would require detailed modelling under Stage 3 to determine if the national standard will be achieved.

6.3.3 In view of this, and in accordance with Government guidance[5] it was decided to proceed directly to a Stage 3 review and assessment for Nitrogen dioxide (NO_2).

6.3.4 The Stage 3 Review and Assessment NO_2 requires a detailed and robust assessment of the potential impacts, and the council will need to define both the magnitude and geographical extent of exceedences of the objective at this stage. It will also need to have confidence that its decision whether to designate an AQMA or not is soundly based.[6]

6.3.5 The report that forms the basis for the Stage 3 Review and Assessment was compiled for the council as part of a Natural Environment Research Council funded CASE (Co-operative Awards in Sciences of the Environment) studentship. The work was carried out as a partnership between Norwich City Council and the School of Environmental Sciences at the University of East Anglia.[7]

[5] DETR Part IV The Environment Act 1995 Local Air Quality Management LAQM.G1 (00) – *Framework for Review and Assessment of Air Quality.*

[6] DETR Part IV The Environment Act 1995 Local Air Quality Management LAQM.TG4 (00) – *Review and Assessment-Pollutant Specific Guidance.*

[7] CHATTERTON T.: *Modelling Nitrogen Dioxide in Norwich with Respect to the Annual Air Quality Objective* School of Environmental Sciences University of East Anglia 2001.

6.4 SUMMARY OF REVIEW AND ASSESSMENT OF NO_2.

6.4.1 The detailed modelling carried out assesses the likelihood of the annual average Air Quality Objective for Nitrogen Dioxide being met within the council's area.

6.4.2 The modelling work has been undertaken using ADMS-Urban using a variety of input data. These consisted of:

- traffic flows for major roads in the Norwich area, based on a combination of automatic and manual traffic counts and modelled flows from the County Council's SATURN traffic model;
- meteorological data for 1996 from the Norwich Weather Centre; and,
- estimates of background levels of NO_2 for 1996 and 2005 from work done at the National Environmental Technology Centre (NETCEN).

6.4.3 As Norwich has no significant industrial sources of NO_2 as judged by the DETR Technical Guidance notes[8] the modelling technique used consisted of calculating pollution from road sources and adding to this estimated background levels.

6.4.4 Validation of the model was undertaken by comparing model results with data from diffusion tubes at ten sites across Norwich in a variety of background and roadside locations.

6.4.5 The two scenarios modelled are based on future traffic growth predictions of 7% and 24%. These two factors have been applied to all modelled roads, although it is acknowledged that traffic growth is unlikely to be uniform on all roads.

6.4.6 The City Centre Transport Plan will make changes to the road network and it is currently anticipated traffic flows will decrease within the city centre and relocate these journeys in to the ring roads. These effects of these changes will need to be reviewed as will the major redevelopment of Riverside, Chapelfield and the hospital site.

6.4.7 This technique produced results which, when validated against monitoring data, have shown an accuracy well within the *"factor of two"* often cited as acceptable.

[8] DETR Part IV The Environment Act 1995 Local Air Quality Management LAQM.TG4 (00) – *Review and Assessment-Pollutant Specific Guidance.*

6.4.8 The modelling work carried out indicate that on the basis of the predicted emissions reductions and traffic growth there are areas of Norwich which will not meet the Air Quality Objective for Nitrogen Dioxide.

6.4.9 The modelled roads which have potential areas of exceedance are detailed in Table 6.1

Table 6.1: Modelled Roads with Potential Areas of Exceedance

Predominant Sources of Pollution within Potential Areas of Exceedance	Other Modelled Roads within Potential Areas of Exceedance
Agricultural Hall Plain	Bank Plain
Aylsham Road	Barrett Road
Barn Road	Ber Street
Barrack Street	Bowthorpe Road
Bishops Bridge Road	Bull Close Road
Boundary Road	Carrow Road
Bracondale	City Road
Castle Meadow	Convent Road
Cattlemarket Street	Cromer Road
Chapelfield Road	Daniels Road
Colman Road	Drayton Road
Dereham Road	Earlham Road
Duke Street	Gurney Road
Farmers Avenue	Hall Road
Golden Ball Street	Harvey Lane
Grapes Hill	Heartsease Lane
Guardian Road	Heigham Road
Ipswich Road	Heigham Street
King Street	Kett's Hill
Lakenham Road	Magdelen Road
Martineau Lane	Magdelen Street
Mile Cross Road	Mousehold Lane
Mile End Road	Nelson Street
Newmarket Road	Old Palace Road
Queens Road	Plumstead Road East
Red Lion Street	Riverside
St Augustines Street	Rouen Road
St Crispins Road	Silver Road
St Stephens Road	Sprowston Road
St Stephens Street	St Williams Way
Trowse Bypass	Sweetbriar Road
Westwick Street	Unthank Road
	Waterloo Road
	Westlegate
	Waterworks Road

6.4.10 These roads have been divided into two groups, those that appear to be the major source of pollution within the areas of exceedance and those that merely traverse the area.

6.4.11 The areas shown as areas of potential on the maps in Figure 6.1 are larger than expected. This is due to buildings not being included in the model runs which results in a tendency for the model to over predict at sites that are screened from the nearest predominant road source.[9]

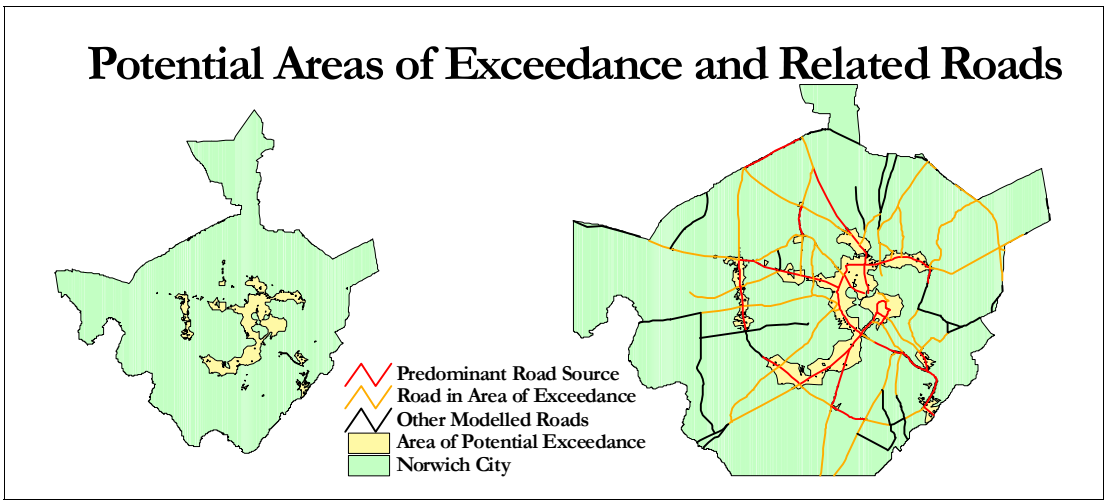


Figure 6.1

6.4.12 The accuracy of the contour lines produced by the modelling requires consideration. By calculating the Standard Deviation for the Model (in this case SDM = 3.02) a series of six contoured regions are produced which equate to the contour plus and minus 1 and 2 standard deviations. This produces the following contour lines based on the air quality standard of 21ppb i.e. 27.0, 24.0, **21.0**, 18.0, and 15.0 ppb.

6.4.13 These regions vary from where the AQ objective is "almost certain" to be achieved to that where the AQ objective is "almost certain" to be exceeded, with the greatest uncertainty being in the regions immediately either side of the 21ppb line.

6.4.14 Any Air Quality Management Area would therefore be based on the worst scenario modelled (2005 High) and the contour which reflects the most certainty of exceedance within it.

[9] CHATTERTON T.: *Modelling Nitrogen Dioxide in Norwich with Respect to the Annual Air Quality Objective: Section 3.5* -School of Environmental Sciences University of East Anglia 2001.

6.4.15 The uncertainty contours for the 2005 predictions, for both the high and low traffic flow scenarios are shown in Figure 6.2, and the close up of the city centre contouring in Figure 6.3

6.5 CONCLUSIONS FOR NO_2

6.5.1 The modelled results show that there are areas of Norwich almost certain to exceed the Air Quality Standard for Nitrogen dioxide in 2005 based on the current information available.

6.5.2 The council therefore proposes to declare 3 Air Quality Management Areas (AQMA) within the city and these are detailed in Figures 6.4, 6.5 and 6.6.

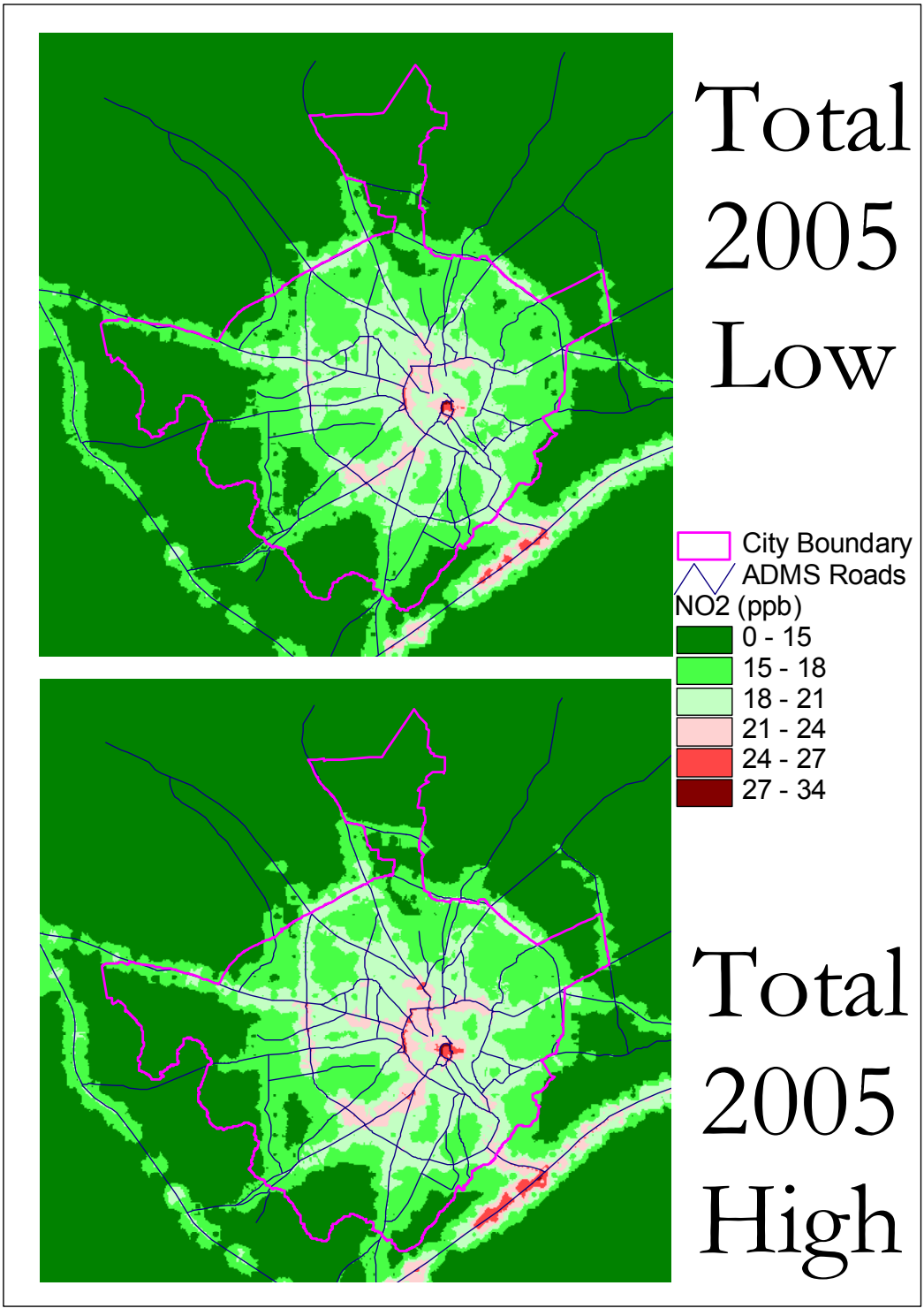


FIGURE 6.2: Uncertainty Contours for 2005 Predictions (1996 Weather Data)

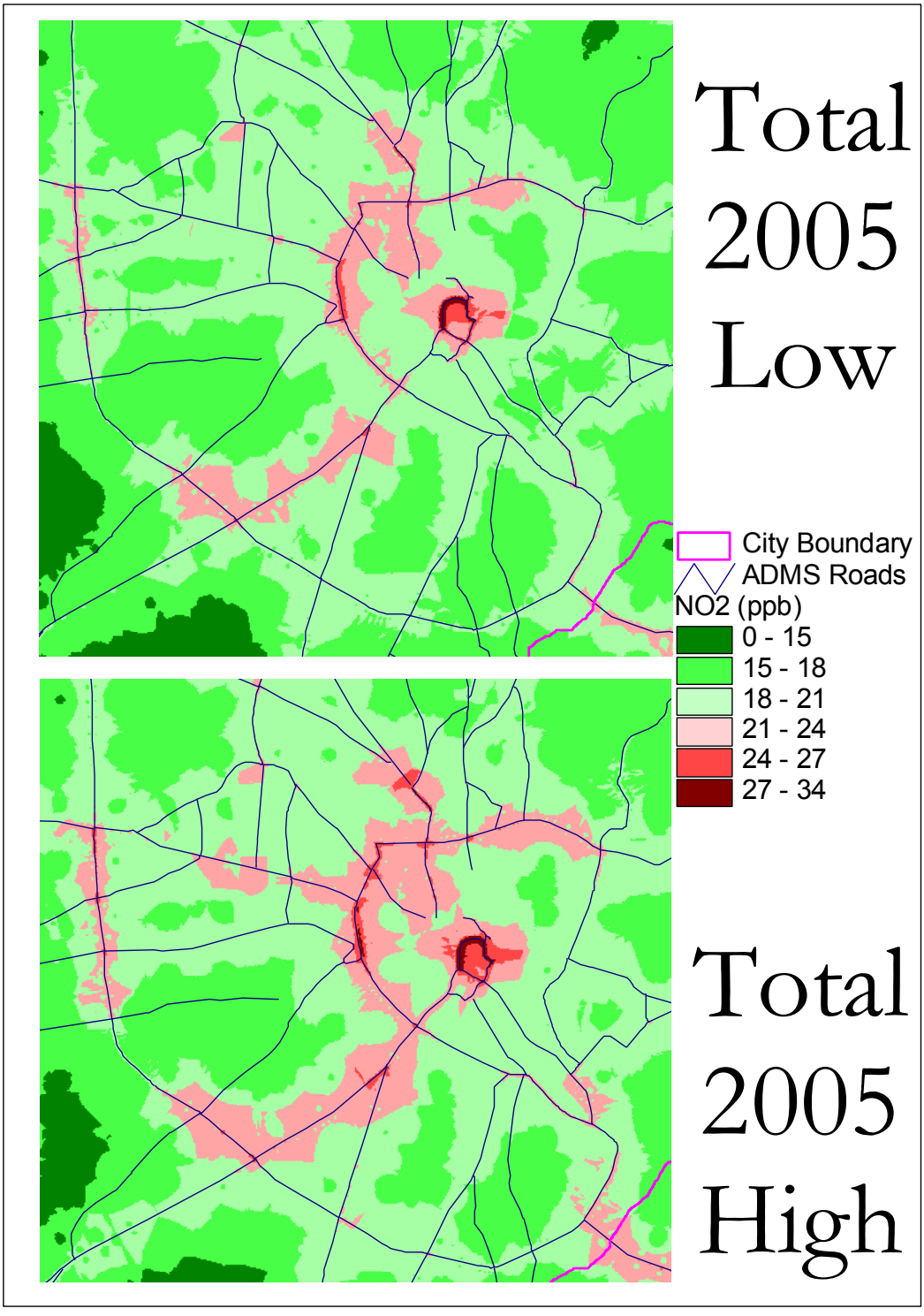
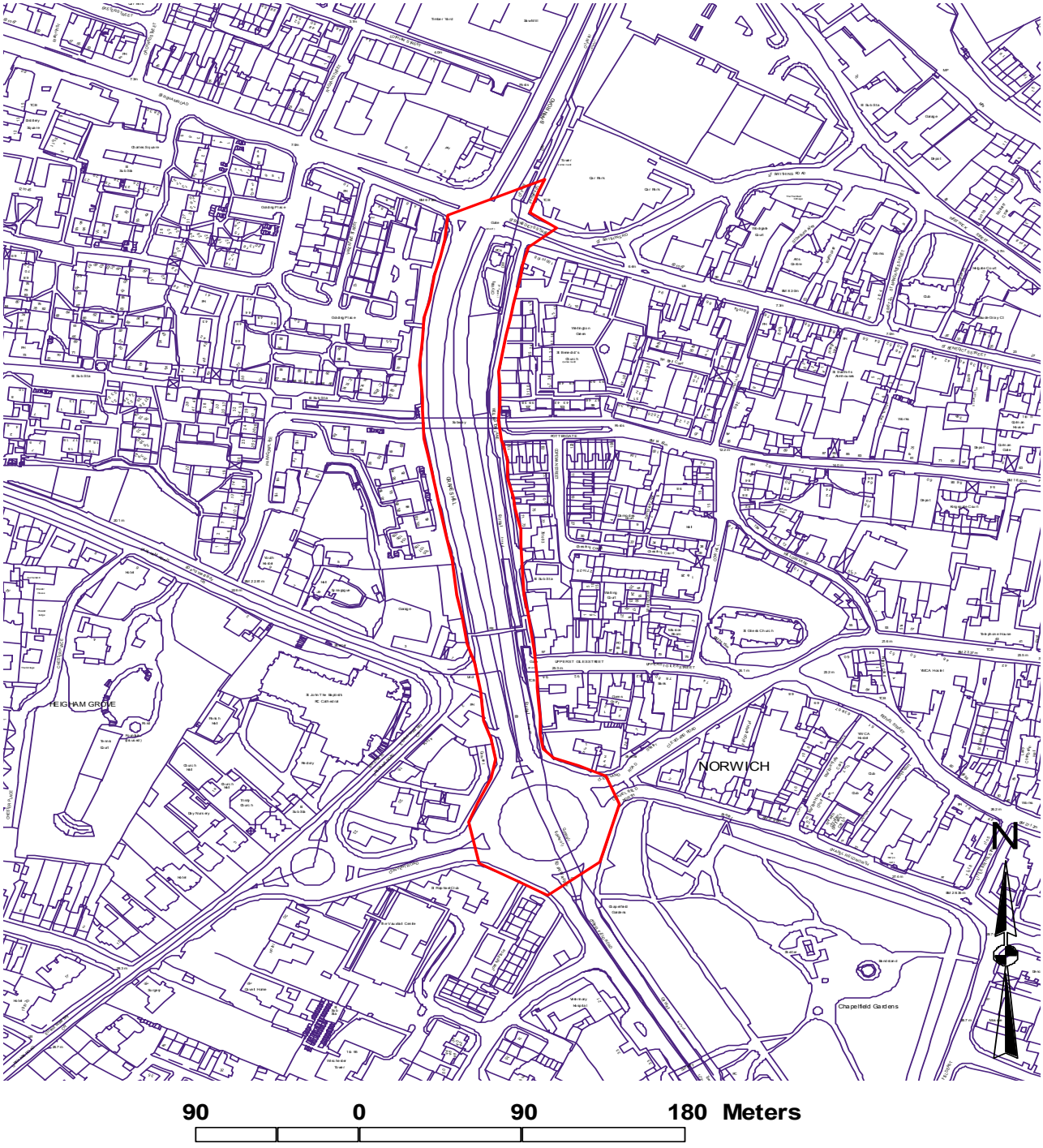
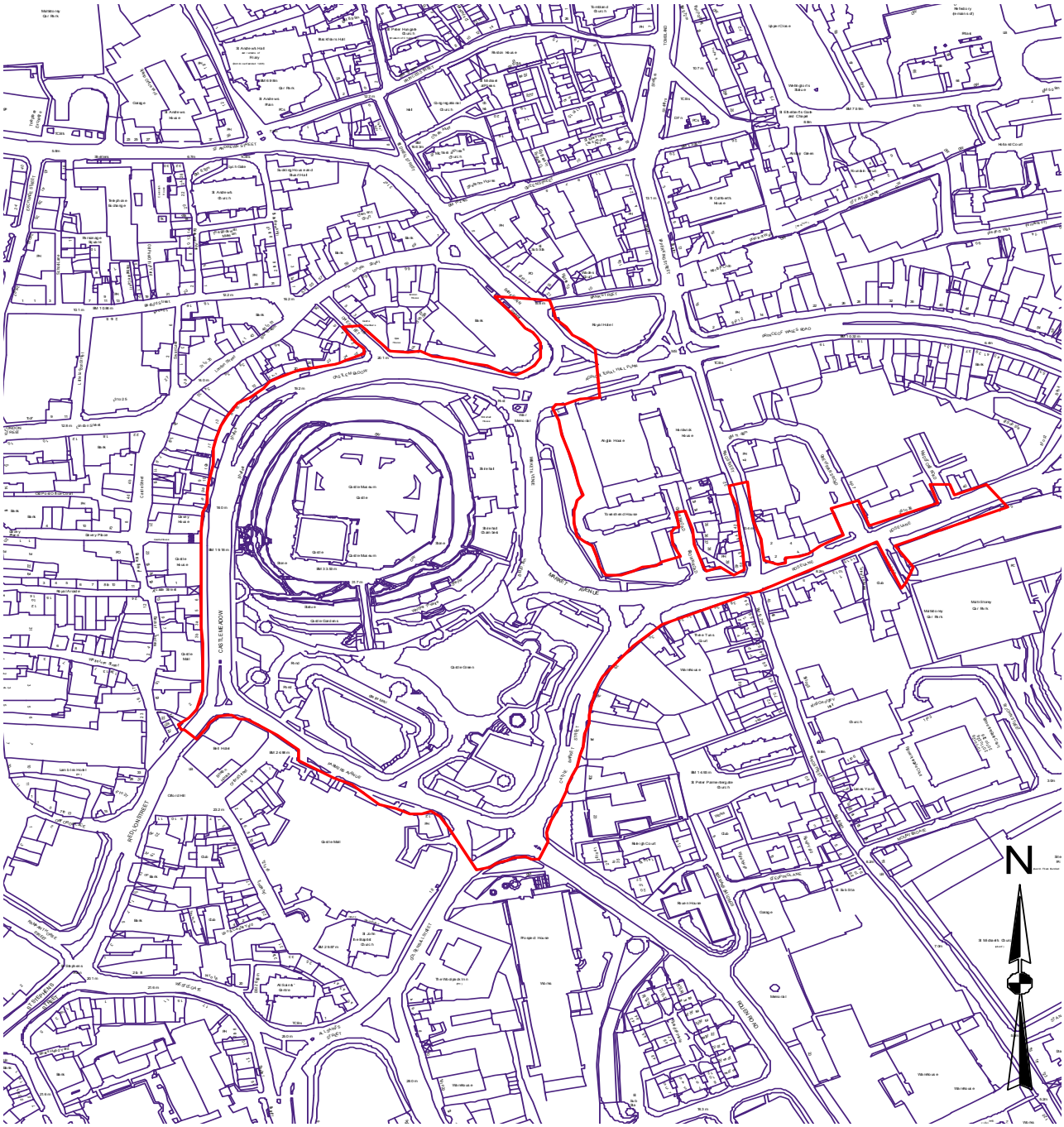


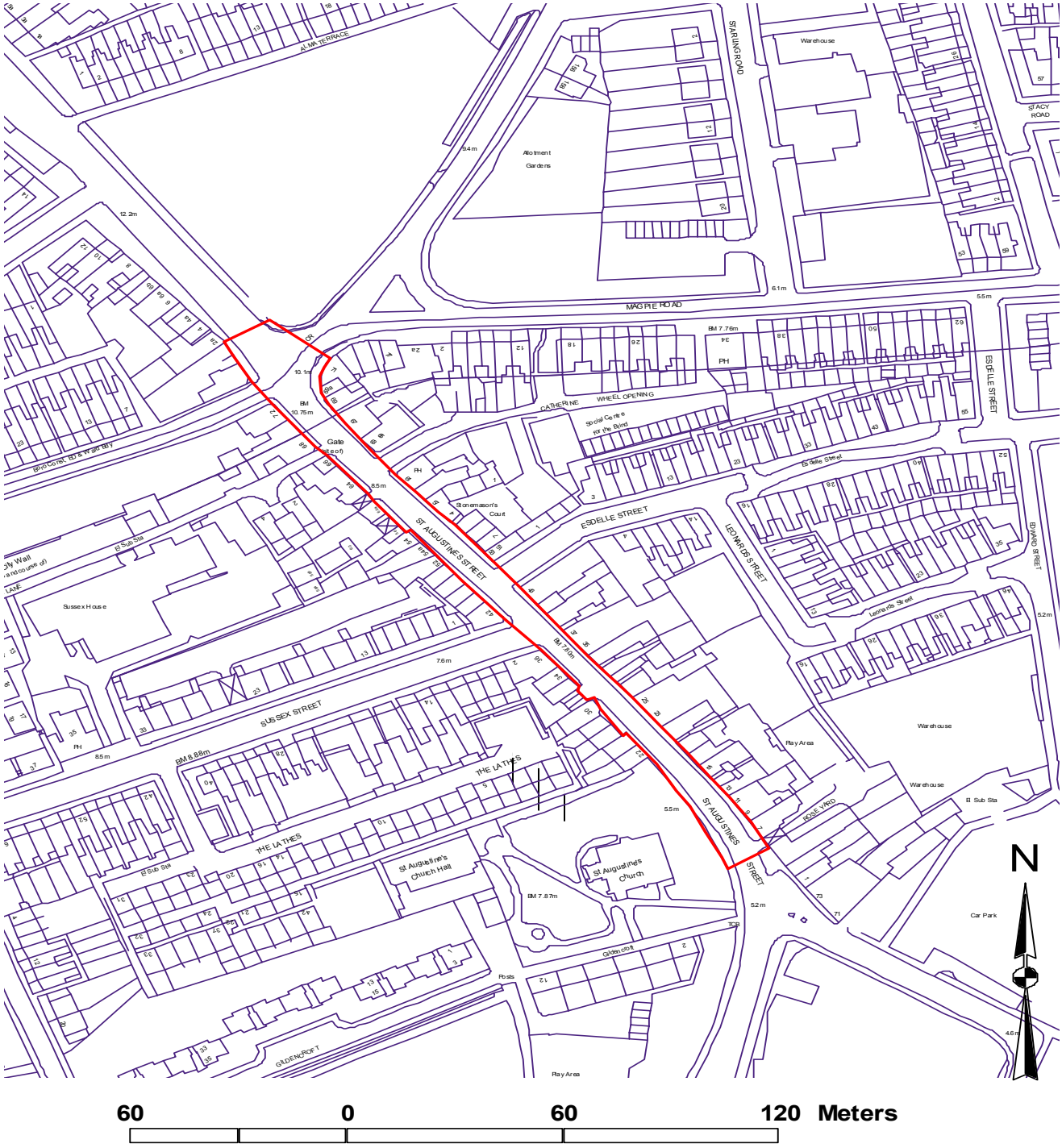
FIGURE 6.3: Close up of City Centre contouring



*Air Quality Management Area No 1:*Grapes Hill
Figure 6.4



*Air Quality Management Area No 2:*Castle Meadow, Cattle Market Street, Farmers Avenue, Market Avenue and Rose Lane.
Figure 6.5



*Air Quality Management Area No 3:*St Augustines
Figure 6.6
Figure 6.5

DECLARING Air Quality Management Areas (AQMA's) TURNING REVIEWS INTO ACTION

7.1 Where the council have identified areas of non-compliance with the National Air Quality Standards they must designate these areas as AQMA's, and the order declaring the areas is to be completed within 4 months of the completion of the Stage 3 review and assessment.

7.2 There making of the order is not prescribed by Statutory Instrument. However national guidance[10] advises that the order must designate the area (a map is recommended), the order must be dated, officially sealed and ratified by full Council.

7.3 Within 12 months of the completion of the Stage 3 review and assessment the council will have completed and consulted on a further assessment of air quality which considers the current and future quality of the air in the AQMA (Stage 4 review and assessment)

7.4 In parallel with the Stage 4 review and assessment, the council will prepare a written Action Plan in pursuit of the air quality objectives.

7.5 The council will consult on the draft Action Plan within 12 months, and have it in place within 18 months, of the completion of the Stage 3 review and assessment.

7.6 The Action Plan will show our commitment to:

- taking air quality into account in other policy areas e.g. planning, transport;
- to partnership working e.g. HA, EA, other LA's;
- the consideration of policy options such as traffic management schemes, and emissions testing powers;
- greening local authority fleet and activities
- future monitoring and information dissemination.
- Clear and firm timetables for implementing various measures;
-