Report

Air Quality Review and Assessment Stage 3 – Domestic Fuel Combustion

A report for Carrickfergus Borough Council

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Executive Summary

The UK Government published its strategic policy framework for air quality management in 1995 establishing national strategies and policies on air quality. The NI Environment Order came into operation in January 2003 and implements both the European Air Framework Directive 96/62EC and the UK Air Quality Strategy. The Air Quality Strategy provides a framework for air quality control through air quality management and air quality objectives.

Under the Air Quality Strategy all Local Authorities are thus required to undertake an air quality review. In areas where air quality objectives are not anticipated to be met by the specified date, Local Authorities are required to establish Air Quality Management Areas to improve air quality.

Local Air Quality Management Policy Guidance (LAQM.PGNI (03)) is designed to help relevant authorities with their Local Air Quality Management (LAQM) duties under Part III of the Environment (NI) Order 2002. The Environment (NI) Order 2002 provides the framework for LAQM across Northern Ireland. The Air Quality Objectives set out in the Air Quality Regulations (NI) 2003 provide the statutory basis for the system of LAQM.

The first step in the process of LAQM is to undertake a review of current and potential future air pollution. Carrickfergus Borough Council have completed a Stage 1 review and assessment which concluded that a Stage 2 was required for the pollutants nitrogen dioxide, sulphur dioxide and particulate matter.

The Carrickfergus Stage 1 review and assessment also identified the need to further assess domestic combustion as a source of pollution. This report forms the Stage 2 + 3 Air Quality Review for domestic combustion by Carrickfergus Borough Council. This report investigates current and potential future PM_{10} and SO_2 levels through an examination of the domestic combustion sources, emissions modelling exercises and by reference to monitored air quality data. As part of this report, detailed modelling of domestic fuel combustion using ADMS version 3.1 has been undertaken within two $1km^2$ grids in Carrickfergus, identified in the Stage 1 as requiring further assessment.

The conclusions of the report are:

Particulate Matter (PM_{10})

The modelling shows that an exceedence of the PM_{10} objective is possible under certain meteorological conditions conducive to poor dispersion. Therefore on the basis that an exceedence is likely under specific meteorological conditions an Air Quality Management Area (AMQA) should be declared and a further assessment undertaken. Continuous monitoring already in place should continue, applying suitable QC procedures. This data should be revisited and considered again in the action planning and further assessment phase.

Sulphur dioxide (SO_2)

The detailed modelling has shown that SO_2 emissions arising from domestic fuel combustion in Carrickfergus Borough Council are not predicted to cause an exceedence of the air quality objectives within Carrickfergus and Greenisland.

Maps reproduced within this document

Acronyms and definitions

ADMS	an atmospheric dispersion model
AQDD	Air Quality Daughter Directives
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
AURN	Automatic Urban and Rural Network
defra	Department for the Environment, Food and Rural Affairs
DETR	Department of the Environment, Transport and the Regions (now defra)
DoE NI	Department of Environment Northern Ireland
EA	Environment Agency
EPA	Environmental Protection Act
EPAQS	Expert Panel on Air Quality Standards
GIS	Geographical Information System
NAEI	National Atmospheric Emission Inventory
NAQS	National Air Quality Strategy (now called the Air Quality Strategy)
ppb	parts per billion
r	the correlation coefficient
$\mu g\ m^{-3}$	micrograms per cubic meter

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1 Introduction

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1.1 PURPOSE OF THE STUDY

netcen was commissioned to complete a stage 2 and 3 assessment of domestic fuel combustion for Carrickfergus Borough Council.

The assessment:

- Investigates present and potential future air quality in the Carrickfergus Borough Council area
- Identifies any actions that are likely to be required by Carrickfergus Borough Council under the Environment (NI) Order 2002.

1.2 GENERAL APPROACH TAKEN

The approach taken in this study was to:

- Collect fuel use survey data for the grids identified as requiring future assessment (carried out by Carrickfergus Borough Council);
- Compile emission inventory for each area;
- Use monitoring data to assess the ambient concentrations produced by domestic fuel combustion and to verify the output of modelling studies;
- Model the concentrations of PM_{10} and SO_2 in each selected grid square including local background concentration using ADMS 3.1;
- Present the concentrations as contour plots, directly comparable to the relevant objectives, overlaid onto a map of local housing;
- Comment on the uncertainty in the predicted concentrations.

1.3 VERSION OF THE LAQM TECHNICAL GUIDANCE USED IN THIS ASSESSMENT

In preparing this report the latest version of the Government Guidance has been used LAQM.TG(03) in conjunction with the previous 'Pollutant Specific Guidance' (2000).

1.4 NUMBERING OF FIGURES AND TABLES

The numbering scheme is not sequential, the figures and tables are numbered according to the chapter and section that they relate to.

1.5 UNITS OF CONCENTRATION

The units throughout this report are presented in $\mu g\ m^{-3}$ and the PM_{10} levels are gravimetric equivalent (which is consistent with the presentation of the AQS objectives), unless otherwise noted.

1.6 STRUCTURE OF THE REPORT

This document is the completion of the stage 2 and 3 review and assessment for domestic fuel combustion for Carrickfergus Borough Council. This chapter, Chapter 1 has summarised the need for the work and the approach to completing the study.

Chapter 2 of the report describes the most recent developments in the UK's Air Quality Strategy (AQS).

Chapter 3 contains details of the information used to conduct this review and assessment for Carrickfergus Borough Council.

Chapter 4 describes the results of the assessment and discusses whether PM_{10} and SO_2 objectives will be exceeded in Carrickfergus Borough Council in 2004/5. The results of the analysis are displayed as contour plots.

Chapter 5 summarises and concludes the finding of this report.

Chapter 6 makes recommendations.

2 The Updated Air Quality Strategy

2.1 THE NEED FOR AN AIR QUALITY STRATEGY

After agreement, in June 1998 at the European Union Environment Council, of a Common Position on the First Air Quality Daughter Directive (AQDD), the UK government published its proposals for review of the National Air Quality Strategy (in 1999). Subsequent to this review, the Air Quality Strategy for England, Scotland, Wales and Northern Ireland was published in January 2000.

The Environment Order (NI) 2002 came into operation in January 2003 and implements both the European Air Framework Directive 96/62/EC, Daughter Directives and the UK Air Quality Strategy.

The Environment Order (NI) 2002 provides the framework for LAs to review air quality in Northern Ireland and for implementation of any AQMAs. It is issued by the Department of the Environment in Northern Ireland under Article 16 of the Environment (NI) Order 2002. Under the Order, District councils and other relevant authorities are required to have regard to published guidance when carrying out any of their duties under, or by virtue of, Part III of the order. The published guidance is outlined in Table 2.1 below.

Table 2.1 Environment Order (NI) 2002 Key Guidance:

▪ The statutory background and the legislative framework within which relevant authorities have to work
▪ The new principles behind reviews and assessments of air quality up to 2010 and the recommended steps that relevant authorities should take
▪ The timetable for reviews and assessments up to 2010
▪ How district councils should handle the designation of AQMAs
▪ How relevant authorities should handle the drawing up and implementation of action plans
▪ Recommendations and suggestions on taking forward the development of local and regional air quality strategies
▪ Suggestions of how relevant authorities should consult and liase with others
▪ Local transport measures which Roads Service might wish to consider
▪ The general principles behind air quality and land use planning; and
▪ How enforcing authorities should use powers of entry under Article 19 of the Order

2.2 OVERVIEW OF THE PRINCIPLES AND MAIN ELEMENTS OF THE AIR QUALITY STRATEGY

The main elements of the AQS can be summarised as follows:

- The use of a health effects based approach using air quality standards and objectives.
- The use of policies by which the objectives can be achieved and which include the input of important actors such as industry, transportation bodies and local authorities.
- The predetermination of timescales with target dates of 2003, 2004, 2005, 2008 and 2010 for the achievement of objectives and a commitment to review the Strategy every three years.

The UK Government intention is that the AQS provides a framework for the improvement of air quality that is both clear and workable. In order to achieve this, the Strategy is based on several principles which include:

- the provision of a statement of the Government's general aims regarding air quality;
- clear and measurable targets;
- a balance between local and national action and
- a transparent and flexible framework.

Co-operation and participation by different economic and governmental sectors is encouraged within the context of existing and potential future international policy commitments.

2.2.1 Air Quality Strategy

At the centre of the AQS is the use of air quality standards to enable air quality to be measured and assessed. These also provide the means by which objectives and timescales for the achievement of objectives can be set. Most of the proposed standards have been based on the available information concerning the health effects resulting from different ambient concentrations of selected pollutants and are the consensus view of medical experts on the Expert Panel on Air Quality Standards (EPAQS). These standards and associated specific objectives to be achieved between 2003 and 2010 are shown in Table 2.2. The table shows the standards in $\mu g\ m^{-3}$ with the number of exceedences that are permitted (where applicable).

Table 2.2. Objectives included in the Air Quality Regulations (NI) 2003 for the purpose of Local Air Quality Management.

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene	16.25 μgm^{-3} 3.25 μgm^{-3}	Running annual mean Running annual mean	31.12.2003 31.12.2010
1,3 Butadiene	2.25 μgm^{-3}	Running annual mean	31.12.2003
Carbon Monoxide	10.0 mgm^{-3}	Maximum daily running 8-hour mean	31.12.2003
Lead	0.5 μgm^{-3} 0.25 μgm^{-3}	Annual mean Annual mean	31.12.2004 31.12.2008
Nitrogen Dioxide[1]	200 μgm^{-3} not to be exceeded more than 18 times a year 40 μgm^{-3}	1 hour mean annual mean	31.12.2005 31.12.2005
Particles (PM_{10})[2] **Gravimetric**[3]	50 μgm^{-3} not to be exceeded more than 35 times a year 40 μgm^{-3}	24 hour mean annual mean	31.12.2004 31.12.2004
Sulphur Dioxide	350 μgm^{-3} not to be exceeded more than 24 times per year 125 μgm^{-3} not to be exceeded more than 3 times per year 266 μgm^{-3} not to be exceeded more than 35 times per year	1 hour mean 24 hour mean 15 minute mean	31.12.2004 31.12.2004 31.12.2005

Notes
1. The objectives for nitrogen dioxide are provisional.
2. Likely to be new particles objective for 2010, not in regulation at present, expected after the review of the EU's first Air Quality Daughter Directive (2005)
3. Measured using the European Gravimetric reference standard or equivalent.

2.2.2 Relationship between the UK Air Quality Standards and EU air quality Limit Values

As a member state of the EU, the UK must comply with European Union Directives.

There are four EU ambient air quality directives that the UK has transposed into UK law. These are:

- **96/62/EC** Council Directive of 27 September 1996 on ambient air quality assessment and management. (the Ambient Air Framework Directive)

- **1999/30/EC** Council Directive of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide, oxides of nitrogen, particulate matter and lead in ambient air. (the First Daughter Directive)

- **2000/69/EC** Directive of the European Parliament and the Council of 16 Nov 2000 relating to limit values for benzene and carbon monoxide in ambient air. (the Second Daughter Directive)

- **2002/03/EC** Directive of the European Parliament and the Council of 12 Feb 2002 relating to ozone in ambient air. (the third Daughter Directive)

The first, second and third daughter directives contain air quality Limit Values for the pollutants that are listed in the framework directive. The United Kingdom (i.e. Great Britain and Northern Ireland) must comply with these Limit Values. The UK Air Quality Strategy must comply with the limit values set out in the EU Air Quality Daughter Directives, but the UK Air Quality Strategy also includes stricter objectives for some pollutants, for example, sulphur dioxide.

The UK Government is ultimately responsibility for achieving the EU limit values. However, it is important that Local Air Quality Management is used as a tool to ensure that the necessary action is taken at local level to work towards achieving the EU limit values by the dates specified in the relevant EU Directives.

2.2.3 Policies in place to allow these objectives to be achieved

The policy framework to allow these objectives to be achieved is one that that takes a Local Air Quality Management approach. This is superimposed upon existing national and international regulations in order to effectively tackle local air quality issues as well as issues relating to wider spatial scales. National and EC policies which already exist provide a good basis for progress towards the air quality objectives set for 2003 to 2010. For example, the Environmental Protection Act 1990 allows for the monitoring and control of emissions from industrial processes and various EC Directives have ensured that road transport emission and fuel standards are in place. These policies are being developed to include more stringent controls. Developments in the UK include the announcement by the Environment Agency in January 2000 on controls on emissions of SO_2 from coal and oil fired power stations. This system of controls means that by the end of 2005 coal and oil fired power station emissions will result in ambient concentrations that meet the air quality standards set out in the AQS.

Northern Ireland now has in place the Air Quality Limit Value regulation (NI) 2002, the Air Quality (Amended) Limit Value Regulations (NI) 2002 and the Air Quality (Ozone) Regulations (NI) 2003. The Government has recognised the problems associated with achieving the standard for ozone, a secondary pollutant and transboundary in nature and it is recognised that local authorities themselves can exert little influence on concentrations when they are the result of regional primary emission patterns. For this reason Ozone is specifically excluded from the LAQM regime.

Local air quality management provides a strategic role for local authorities in response to particular air quality problems experienced at a local level. This builds upon current air quality control responsibilities and places an emphasis on bringing together issues relating to transport, waste, energy and planning in an integrated way. This integrated approach involves a number of different aspects. It includes the development of an appropriate local framework that allows air quality issues to be considered alongside other issues relating to polluting activity. It should also enable co-operation with and participation by the general public in addition to other transport, industrial and governmental authorities.

The Government has prepared guidance to help local authorities to use the most appropriate tools and methods for conducting a review and assessment of air quality in their Borough. This is part of a package of guidance being prepared to assist with the practicalities of implementing the AQS. Other guidance covers air quality and land use planning, air quality and traffic management and the development of local air quality action plans and strategies.

2.2.4 Timescales to achieve the objectives

Objectives are to be met within the timescales shown in Table 2.2. Note: the objectives for NO_2 remain provisional.

2.3 AIR QUALITY REVIEWS

A range of Technical Guidance has been issued to enable air quality to be monitored, modelled, reviewed and assessed in an appropriate and consistent fashion. This includes the Technical Guidance LAQM.TG(03), and the previous version LAQM.TG4(00) May 2000, on 'Review and Assessment: Pollutant Specific Guidance'. This review and assessment has considered the procedures set out in the guidance.

The primary objective of undertaking a review of air quality is to identify any areas that are unlikely to meet air quality objectives and ensure that air quality is considered in local authority decision making processes. The complexity and detail required in a review depends on the risk of failing to achieve air quality objectives.

At present Councils in Northern Ireland are engaged in the 3 staged approach to review and assessment as set out in the original technical guidance. The Stages are briefly described in Table 2.3. The latest technical guidance LAQM.TG(03) is based on a revised '2 step' approach. The revised steps are briefly described in Table 2.4. In this process a Stage 1 equates to an 'updating and Screening assessment, and a stage 2 and 3 equates to a 'detailed assessment'.

The department recommends that councils where feasible should use the latest technical guidance LAQM.TG(03) to complete their first rounds of review and assessment. Where councils have commenced using the old technical guidance (LAQM. TG (00)) they may continue using the old guidance. However the methodology should be cross-referenced with the new guidance.

As Carrickfergus had already embarked on the stage 3 review and assessment the domestic fuel grids assessed are 1x1km grids, as defined in (LAQM. TG4 (00)). Other than this however, the latest technical guidance LAQM.TG (03) has been used as the guidance document for the domestic fuel combustion modelling methodology. In practice, the high resolution modelling and the method of source definition used in this report means that defining a 1x1km area makes no difference to the output when compared with a smaller total area. This is because the source is modelled the same irrespective of whether a smaller total area were modelled, for example; 500m x 500m.

In the previous stages of review and assessment areas of potential exceedence of the air quality objectives for SO_2 and PM_{10} were identified following LAQM.TG4 (00). The latest guidance, LAQM.TG (03) requires the assessment to be carried out in greater detail by considering 500x500m areas. The detailed modelling carried out in this Stage 3 uses the 1x1km areas, but this takes account of all areas of significant domestic solid fuel burning. In practice, the high resolution modelling and the method of source definition used in this report means that defining a 1x1km area makes no difference to the output when compared with a smaller total area. This is because treatment of the sources with the present model is at a resolution of 10 – 20m, hence the model output for a given location is the same whether the area modelled is a 1x1km area or a 0.5x0.5km area or less.

Table 2.3 Brief details of Stages in the Air Quality Review and Assessment process (LAQM.TG4(00))

Stage	Objective	Approach	Outcome
First Stage Review and Assessment	• Identify all significant pollutant sources within or outside of the authority's area.	• Compile and collate a list of potentially significant pollution sources using the assessment criteria described in the Pollutant Specific Guidance	
	• Identify those pollutants where there is a **risk** of exceeding the air quality objectives, and for which further investigation is needed.	• Identify sources requiring further investigation.	• Decision about whether a Stage 2 Review and Assessment is needed for one or more pollutants. If not, no further review and assessment is necessary.
Second Stage Review and Assessment	• Further screening of significant sources to determine whether there is a significant risk of the air quality objectives being exceeded.	• Use of screening models or monitoring methods to assess whether there is a risk of exceeding the air quality objectives.	
	• Identify those pollutants where there is a **risk** of exceeding the objectives, and for which further investigation is needed.	• The assessment need only consider those locations where the highest likely concentrations are expected, and where public exposure is relevant.	• Decision about whether a Stage 3 Review and Assessment is needed for one or more pollutants. If, as a result of estimations of ground level concentrations at suitable receptors, a local authority judges that there is no significant risk of not achieving an air quality objective, it can be confident that an Air Quality Management Area (AQMA) will not be required. • However, if there is doubt that an air quality objective will be achieved a third stage review should be conducted.

Table 2.3 (contd.) Brief details of Stages in the first Review and Assessment process

Stage	Objective	Approach	Outcome
Third Stage Review and Assessment	• Accurate and detailed assessment of both current and future air quality. Assess the **likelihood** of the air quality objectives being exceeded.	• Use of validated modelling and quality-assured monitoring methods to determine current and future pollutant concentrations.	
	• Identify the geographical boundary of any exceedences, and description of those areas, if any, proposed to be designated as an AQMA.	• The assessment will need to consider all locations where public exposure is relevant. For each pollutant of concern, it may be necessary to construct a detailed emissions inventory and model the extent, location and frequency of potential air quality exceedences.	• Determine the location of any necessary Air Quality Management Areas (AQMAs). Once an AQMA has been identified, there are further sets of requirements to be considered. • A further assessment of air quality in the AQMA is required within 12 months which will enable the degree to which air quality objectives will not be met and the sources of pollution that contribute to this to be determined. A local authority must also prepare a written action plan for achievement of the air quality objective. Both air quality reviews and action plans are to be made publicly available.

Table 2.4 Brief details of Steps in the revised Air Quality Review and Assessment process (LAQM.TG(03))

Level of Assessment	Objective	Approach
Updating and Screening Assessment (USA)	• To identify those matters that have changed since the last review and assessment, which might lead to a risk of an air quality objective being exceeded.	• Use a checklist to identify significant changes that require further consideration. • Where such changes are identified, then apply simple screening tools to decide whether there is sufficient risk of an exceedence of an objective to justify a detailed assessment.
Detailed Assessment	• To provide an accurate assessment of the likelihood of an air quality objective being exceeded at locations with relevant exposure. This should be sufficiently detailed to allow the designation or amendment of any necessary AQMAs.	• Use quality-assured monitoring and validated modelling methods to determine current and future pollutant concentrations in areas where there is a significant risk of exceeding an air quality objective.

2.4 LOCATIONS THAT THE REVIEW AND ASSESSMENT MUST CONCENTRATE ON

For the purpose of review and assessment, the authority should focus their work on locations where members of the public are likely to be exposed over the averaging period of the objective. Table 2.5 summarises the locations where the objectives should and should not apply.

Table 2.5 Typical locations where the objectives should and should not apply

Averaging Period	Pollutants	Objectives *should* apply at …	Objectives should *not* generally apply at …
Annual mean	• 1,3 Butadiene • Benzene • Lead • Nitrogen dioxide • Particulate Matter (PM_{10})	• All background locations where members of the public might be regularly exposed.	• Building facades of offices or other places of work where members of the public do not have regular access.
		• Building facades of residential properties, schools, hospitals, libraries etc.	• Gardens of residential properties.
			• Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term
24 hour mean and 8-hour mean	• Carbon monoxide • Particulate Matter (PM_{10}) • Sulphur dioxide	• All locations where the annual mean objective would apply.	• Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.
		• Gardens of residential properties.	

Table 2.5 (contd.) Typical locations where the objectives should and should not apply

Averaging Period	Pollutants	Objectives should apply at …	Objectives should generally not apply at …
1 hour mean	• Nitrogen dioxide • Sulphur dioxide	• All locations where the annual mean and 24 and 8-hour mean objectives apply.	• Kerbside sites where the public would not be expected to have regular access.
		• Kerbside sites (e.g. pavements of busy shopping streets).	
		• Those parts of car parks and railway stations etc. which are not fully enclosed.	
		• Any outdoor locations to which the public might reasonably expected to have access.	
15 minute mean	• Sulphur dioxide	• All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	

It is unnecessary to consider exceedences of the objectives at any location where public exposure over the relevant averaging period would be unrealistic, and the locations should represent non-occupational exposure.

AQS Key Points

- The Environment (Northern Ireland) Order 2002 has implemented an Air Quality Strategy for the control of air quality.

- A central element in the Strategy is the use of air quality standards and associated objectives based on human health effects that have been included in the Air Quality Regulations.

- The Strategy uses a local air quality management approach in addition to existing national and international legislation. It promotes an integrated approach to air quality control by the various actors and agencies involved.

- Air quality objectives, with the exception of ozone, are to be achieved by specified dates up to the end of 2010.

- A number of air quality reviews are required in order to assess compliance with air quality objectives. The number of reviews necessary depends on the likelihood of achieving the objectives

3 Information and tools used to support this assessment

This chapter presents the information and tools used to support this review and assessment.

3.1 INFORMATION PROVIDED BY CARRICKFERGUS BC

The following information from Carrickfergus Borough Council was used to complete this Review and Assessment:

- Local air quality monitoring data
- Domestic Fuel Combustion Survey
- Local Fuel Data
- Information on Kilroot Power Station.

3.2 LOCAL AIR QUALITY MONITORING DATA

3.2.1 Extent of data available

Carrickfergus Borough Council has carried out monitoring of SO_2 and PM_{10} since July 2002 with continuous monitors in Carrickfergus Town (341130, 387999). The instrumentation employed uses UV fluorescence for the measurement of SO_2 and the TEOM technique for PM_{10}, these methods are appropriate for Detailed Assessment under LAQM (LAQM TG(03)). All TEOM data are quoted as gravimetric equivalent in accordance with the guidance. Appendix 1 provides more details about this local air quality monitoring programme.

netcen has not undertaken any scaling or ratification of the dataset provided by Carrickfergus BC. However, netcen has undertaken a review of the data comparing the trends of the pollutants to other nearby National Network monitoring stations. The Carrickfergus dataset follows the same temporal variation as seen at the AURN station at Belfast Centre, providing a degree of confidence in the dataset.

3.3 MAPS

Carrickfergus Borough Council provided maps of the grids to be modelled.

3.4 MET DATA USED IN THE DISPERSION MODELLING

Hourly sequential data was obtained for 2002 and 2003 for the Aldergrove site for input into the ADMS dispersion model. 2002 data was used for the modelling and a combination between 2002 and 2003 was used to bias correct the modelling work as this covers the same period of monitoring data available for PM_{10} and SO_2 (July 2002 – June 2003).

3.5 OVERVIEW OF THE MODELLING APPROACH

The dispersion model ADMS 3.1 has been used to predict the PM_{10} and SO_2 levels in Carrickfergus BC. ADMS is a PC-based model that includes an up-to-date representation of the atmospheric processes that contribute to pollutant dispersion and has been deemed suitable for use in the review and assessment process.

The emissions arising from each survey area have been modelled as volume sources 10m high with each emission point set at 5m high. Emissions have been weighted with both seasonal and diurnal emission patterns. The seasonal pattern was calculated on a degree day basis to weight emissions to the colder periods of the year following the BREDEM model (BREDEM, BRE, 1985). Temperature data for each hour was taken from the 2002 Aldergrove meteorological data.

The modelled concentrations have then been added to estimated background concentrations (taken from the netcen NAEI web site www.naei.org.uk).

3.5.1 Model bias

The monitoring site at Carrickfergus Town (Rosebrook Avenue) has been used as a reference site to bias correct the model results. The monitoring data was reviewed by **netcen** as explained in section 3.2.1.

The purpose of this adjustment was to ensure that the modelled concentrations equalled the measured values at the monitoring locations. The same modelling methodology has been used at other Local Authorities to maintain consistency in the modelling approach and thus minimise the uncertainty of applying a generic bias correction.

More details of the bias correction are given in Appendix 3

3.5.2 Model uncertainties

The calculations have not taken account of:

- Uncertainties in the fuel use survey;
- Uncertainties in how the burning of domestic fuel might change in future years;
- Uncertainty resulting from year to year variations in atmospheric conditions;
- Uncertainty in emission factors
- Uncertainty in monitoring data

The above uncertainties are dealt with as fully as possible but it is important to remember that the modelling depends highly on the accuracy of the fuel use survey, which is a sample survey. It is assumed that the fuel use survey is representative and will remain representative of the fuel use at the time of the objectives. As we are assuming the fuel use profile will remain the same there is no need to correct the fuel use survey to the year of the objective. Predicted future background concentrations have been applied.

The dispersion modelling is based upon the meteorology and emissions for 2002, clearly meteorological conditions will vary from year to year but overall would be expected to be broadly representative of local conditions for the year of the objectives.

The monitoring data was provided by Carrickfergus Borough Council for July 03 to June 04.

Emissions Factors are average emission factors and do not take into account , for example natural variation in coal and its sulphur content variability.

4 Review and assessment of PM_{10} and SO_2 from Domestic Fuel combustion

4.1 INTRODUCTION

4.1.1 PM_{10}

Airborne particulate matter varies widely in its physical and chemical composition, source and particle size. Particles are often classed as either primary (those emitted directly into the atmosphere) or secondary (those formed or modified in the atmosphere from condensation and growth). PM_{10} particles (the fraction of particles in air size <10 µm aerodynamic equivalent diameter) can potentially pose significant health risks as they are small enough to penetrate deep into the lungs. Larger particles are not readily inhaled.

A major source of fine primary particles is combustion processes, in particular diesel combustion, where transport of hot exhaust vapour into a cooler tailpipe or stack can lead to spontaneous nucleation of "carbon" particles before emission. Secondary particles are typically formed when low volatility products are generated in the atmosphere, for example the oxidation of sulphur dioxide to sulphuric acid. The atmospheric lifetime of particulate matter is strongly related to particle size, but may be as long as 10 days for particles of about 1 µm in diameter.

Concern about the potential health impacts of PM_{10} has increased very rapidly over recent years. Increasingly, attention has been turning towards monitoring the smaller particle fraction, $PM_{2.5}$, and even smaller size fractions or total particle numbers.

Objectives for particulate matter

The Air Quality Strategy objectives to be achieved by 31st December 2004 are:

- An annual average concentration of 40 µg m^{-3} (gravimetric);
- A maximum 24-hourly mean concentration of 50 µg m^{-3} (gravimetric) not to be exceeded more than 35 times a year.

The National Perspective

National UK emissions of primary PM_{10} have been estimated as totalling 182,000 tonnes in 2001. Of this total, around 18% was derived from road transport sources, 11% from power stations and 21% from combustion in commercial and residential. It should be noted that, in general, the emissions estimates for PM_{10} are less accurate than those for the other pollutants with prescribed objectives, especially for sources other than road transport.

The Government established the Airborne Particles Expert Group (APEG) to advise on sources of PM_{10} in the UK and current and future ambient concentrations. Their conclusions were published in January 1999 (APEG, 1999)[5]. APEG concluded that a significant proportion of the current annual average PM_{10} 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 such as wind-blown dust and sea salt particles. The impact of local urban sources is superimposed on this regional background. Such local sources are generally responsible for winter episodes of hourly mean concentrations of PM_{10} above 100 µg m^{-3} associated with poor dispersion. However, it is clear that many of the sources of PM_{10} are outside the control of individual local authorities and the estimation of future concentrations of PM_{10} are in part dependent on predictions of the secondary particle component.

4.1.2 SO_2

Sulphur dioxide is a corrosive acid gas which combines with water vapour in the atmosphere to produce acid rain. Both wet and dry deposition have been implicated in the damage and destruction of vegetation and in the degradation of soils, building materials and watercourses. SO_2 in ambient air is also associated with asthma and chronic bronchitis.

The principal source of this gas is power stations burning fossil fuels which contain sulphur. Episodes of high concentrations of SO_2 now only tend to occur in cities in which coal is still widely used for domestic heating, in areas affected by heavy industry and in footprints of power stations. As some power stations are now located away from urban areas, SO_2 emissions may affect air quality in both rural and urban areas. Since the decline in domestic coal burning in cities and in power stations overall, SO_2 emissions have diminished steadily and, in most European countries, they are no longer considered to pose a significant threat to health.

Objectives for sulphur dioxide
the Air Quality Strategy Objectives to be achieved are:

- 266 $\mu g\ m^{-3}$ as a 15 minute mean (maximum of 35 exceedences a year or equivalent to the 99.9th percentile) to be achieved by the 31st December 2005
- 350 $\mu g\ m^{-3}$ as a 1 hour mean (maximum of 24 exceedences a year or equivalent to the 99.7th percentile) to be achieved by the 31st December 2004
- 125 $\mu g\ m^{-3}$ as a 24 hour mean (maximum of 3 exceedences a year or equivalent to the 99th percentile) to be achieved by the 31st December 2004

The 15 minute mean objective is the most stringent; the other two objectives are unlikely to be exceeded if this objective is not exceeded.

The National Perspective
Sulphur dioxide is emitted in the combustion of coal and oil. Emissions today are dominated by fossil fuelled power stations. Combustion in energy production accounted for 73% of the national total emission. Emissions from road transport are a very small fraction of the national total: less than 1% and combustion in Commercial, institutional and residential combustion accounted for 18% of the national total.

Exceedences of the 15-minute air quality standard currently occur near industrial processes for which the stack heights were designed to meet previous air quality standards and downwind of large combustion plant such as power stations. Exceedences are also possible in areas where significant quantities of coal are used for space heating. These large combustion plants are currently regulated under BATNEEC and the EPA 1990, and will come under the provisions of the IPPC. The government considers that bearing in mind the envisaged change in fuel use, it does not expect exceedences of the 15-minute objective by 2005 from these sources.

4.2 DOMESTIC FUEL COMBUSTION: STAGE ONE CONCLUSIONS

Solid fuel burning for domestic heating is still relatively common in parts of Northern Ireland. Where solid fuel burning is predominant it may have the potential to cause exceedences of the objectives. According to PSG (LAQM TG (00)), ' the risk of exceedence within an area can be considered significant where the density of coal burning (or solid smokeless fuel burning) houses exceeds 300 properties per 1km^2. In such cases PSG recommends an authority proceed to a second or third stage review and assessment.

In the first stage of Review and Assessment, Carrickfergus Borough Council identified two areas as having a high proportion of solid fuel use, one situated in Carrickfergus town and the other in Greenisland. These two areas were identified for further assessment.

4.3 CARRICKFERGUS BOROUGH COUNCIL FUEL USE SURVEY

Carrickfergus Borough Council undertook a fuel use survey between mid February and the end of March 2002. A total of 700 households (25% of the properties) were surveyed between the two specific one kilometre squares of interest. The findings are summarised below.

4.3.1 Carrickfergus: Northern Grid

There were a total of 1931 houses within the 1km^2 grid in Carrickfergus Town. Nearly 50% of the houses use oil as their main fuel followed by coal users with 25% (see table 4.1).

Table 4.1 Fuels for heating purposes

	Number Properties	*% of Properties*
Oil	942	49
Coal/Solid Fuel	487	25
Electricity	215	11
Gas	287	15
Total	1931	100

Figure 4.1 shows the location of surveyed dwellings and their main fuel type. Figure 4.2 shows the location of Kilroot Power Station. Its characteristics are as follow for 2002:

- Grid reference: (343896, 388585)
- SO_2 emissions: 5.48e+2 and PM_{10} emissions: 0
- Height: 200 m
- Diameter: 5.5 m
- Exit temperature: 120 degrees C
- Exit Velocity: 17.64 m/s.

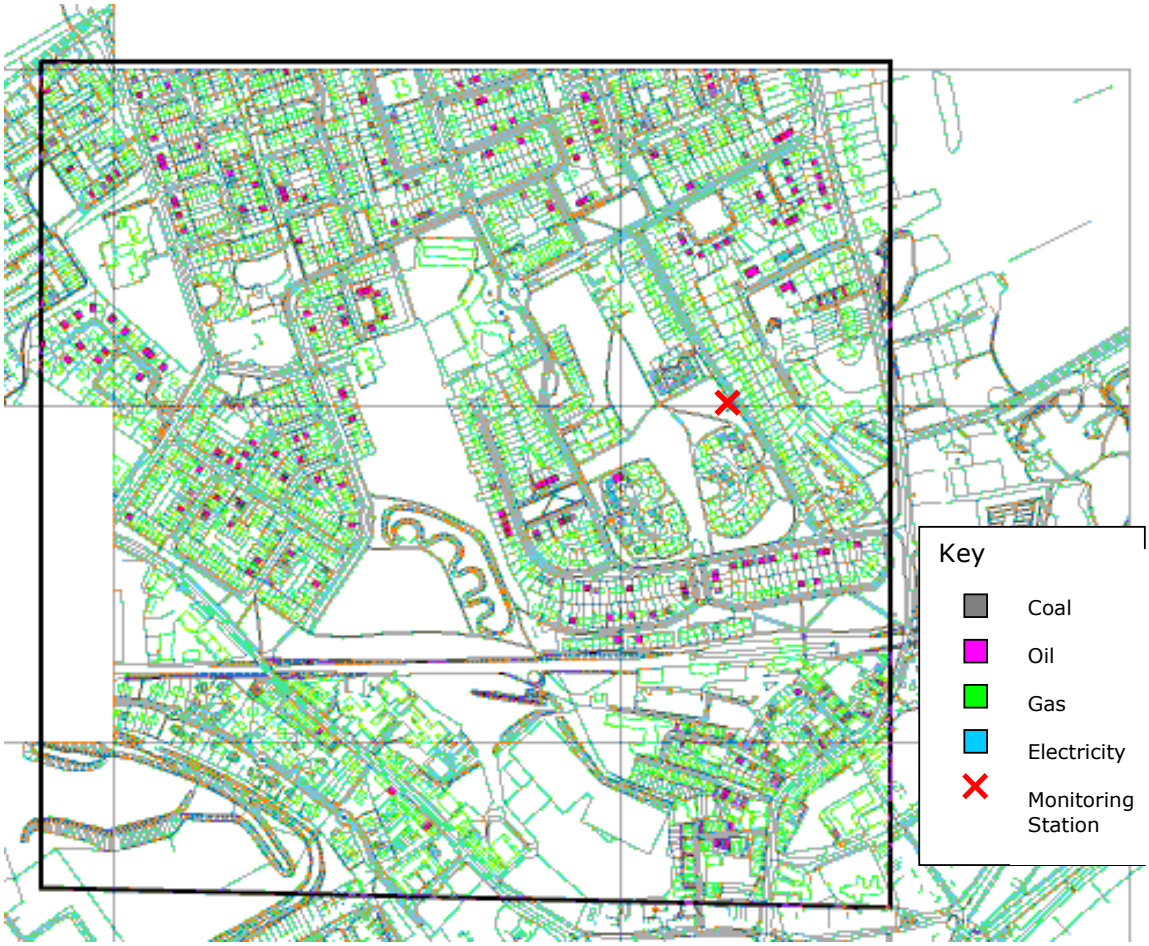


Figure 4.1 Fuel Use Survey for Northern Grid: Carrickfergus

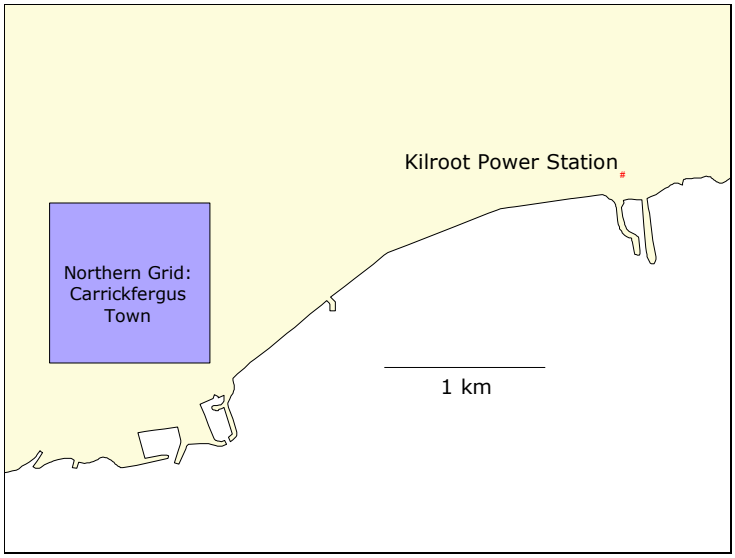


Figure 4.2 Location of Kilroot Power Station

4.3.2 Greenisland: Southern Grid

There were a total of 1191 houses within the 1km^2 of the Southern Grid: Greenisland. The fuel breakdown is similar to the northern grid with 25% of the surveyed houses using coal and 53% using oil (see table 4.2)

Table 4.2 Fuels for heating purposes

	Number Properties	*% of Properties*
Oil	582	53
Coal/Solid Fuel	268	25
Electricity	167	15
Gas	74	7
Total	1091	100

Figure 4.3 shows the location of surveyed dwellings and their main fuel type.

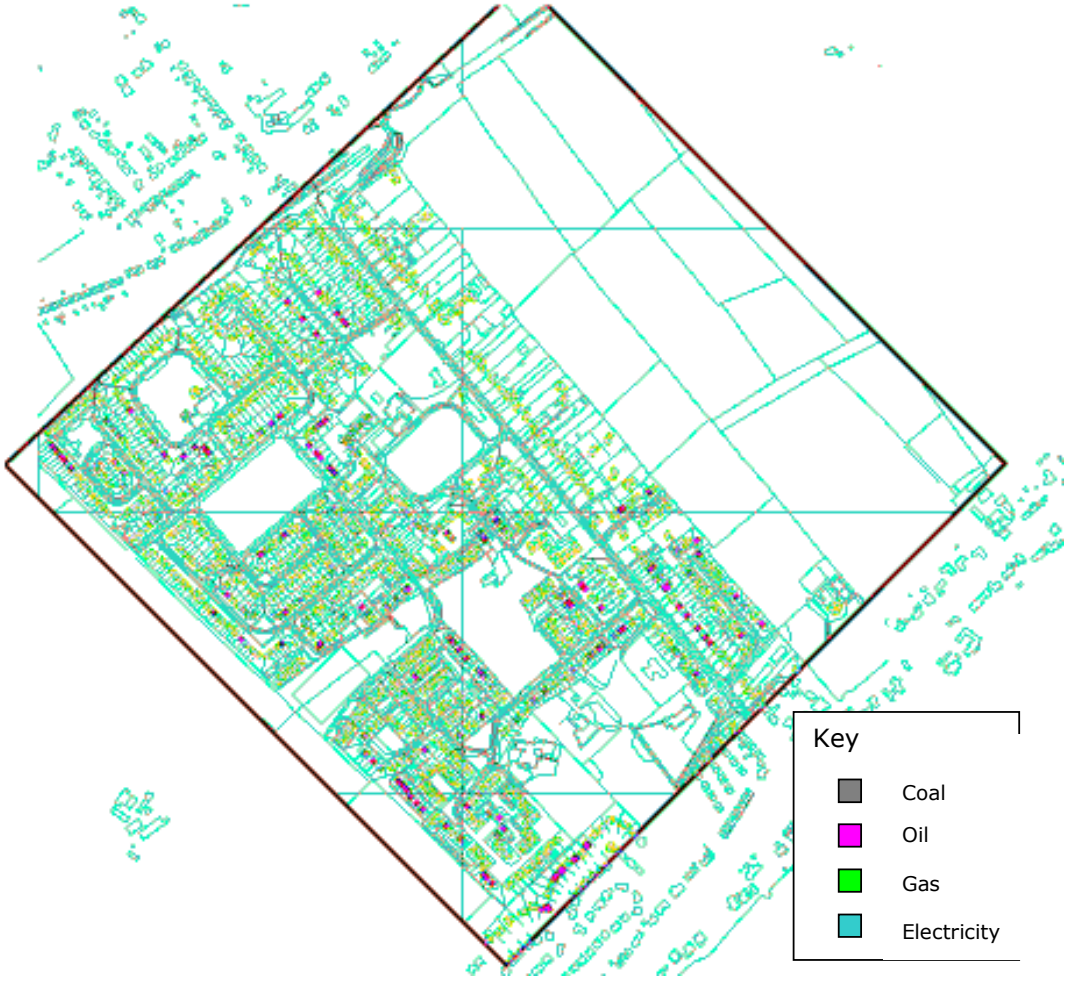


Figure 4.3 Fuel Use Survey for Southern Grid: Greenisland

4.4 DOMESTIC SOURCES STAGE TWO REVIEW AND ASSESSMENT

As stated in the guidance, the Second Stage Review and Assessment should focus upon a review of monitoring data within the local area. Based upon that, if local concentrations exceed the air quality objectives (or in the absence of monitoring data) then a third stage review and assessment should be carried out.

The monitoring data is not a complete data set and not directly comparable to the objectives. Because there is not enough monitoring information to determine any likely exceedence of the SO_2 and PM_{10} objectives it has been decided by Carrickfergus Borough Council to proceed to a Stage 3 Review and assessment for domestic combustion sources based on more detailed modelling.

4.5 DOMESTIC SOURCES STAGE THREE REVIEW AND ASSESSMENT

The fuel use survey undertaken by Carrickfergus Borough Council has been used in combination with the Air Dispersion Model ADMS 3.1 to determine whether domestic fuel combustion is likely to cause exceedences of the objectives. The 15 minute mean SO_2 objective of 266μgm^{-3} is the most stringent of the three SO_2 objectives. The 24 hours mean PM_{10} objective is the most stringent of the PM_{10} objectives. Therefore the ADMS modelling was carried out relevant to these objectives. If these objectives can be met the other objectives will also be met.

The emission rate for up to 5 areas within the two 1km^2 grids were calculated based on the number of properties within each area and the fuel use. The emission rate was calculated in grams/$metre^3$/second. This enabled them to be entered directly into the ADMS model as a volume source.

4.5.1 Emissions rates

Table 4.4 Emission rates resulting from domestic fuel combustion (Northern: Carrickfergus)

	Number of houses	*Area (m^2)*	*g SO_2 per year*	*g PM_{10} per year*
Volume 1	260	61937	3,189,528	2,550,992
Volume 2	510	231731	3,104,212	2,378,765
Volume 3	141	265214	6,281,067	4,919,713
Volume 4	252	53109	3,892,866	3,186,563
Volume 5	43	58012	530,622	433,729
Total	1206	-	16,998,295	13,469,762

Table 4.5 Emission rates resulting from domestic fuel combustion (Southern: Greenisland)

	Number of houses	*Area (m^2)*	*g SO_2 per year*	*g PM_{10} per year*
Volume 1	348	137190	2,116,707	1,620,479
Volume 2	250	108723	1,818,907	1,443,223
Volume 3	128	78777	507,742	348,965
Volume 4	92	54867	1,236,936	997,969
Volume 5	273	93589	3,160,208	2,580,633
Total	1091	-	8,840,500	6,991,269

The assumptions in the modelling exercise are:

- Chimney height 5m.
- Temperature 15 °C.
- Varying emission rates for discrete areas based on the number of properties.
- Surface Roughness 0.5m
- Time varying Emission factors adjusted to reflect temperature in Met data.
- The fuel use survey is representative of the grid population.
- Meteorological data from Aldergrove 2002.
- Concentrations calculated to a resolution of 20m.
- Monitoring data is correct

The background concentrations were added to the modelled concentrations. The background concentrations were estimated for each grid from the netcen background concentration maps. The values estimated were:

	Carrickfergus	**Greenisland**
PM_{10} 2004	19 μgm^{-3}	18.6μgm^{-3}
SO_2 2001	10 μgm^{-3}	6.5 μgm^{-3}

To make the SO_2 background relevant to the 15 minute mean, PSG (LAQM TG (00)) recommends that the background for 2005 is doubled. Therefore the background contribution that has been added on to the 15 minute mean SO_2 concentrations is 20 μgm^{-3} for Carrickfergus and 13 μgm^{-3} for Greenisland. On the other hand, conversion of the background PM_{10} contribution to the daily mean is given as the annual mean background times 1.68. Therefore, the background contribution of PM_{10} was of 38 μgm^{-3} for Carrickfergus and 37.2 μgm^{-3} for Greenisland.

Appendix 2 includes the wind rose produced by ADMS from the met data supplied to the model.

4.6 MODEL RESULTS

The model results are presented here.

Figure 4.4 Carrickfergus Town – 2004 PM_{10} 24h mean corrected modelled results

Figure 4.5. Carrickfergus Town – 2005 SO_2 15 minute mean corrected modelled results

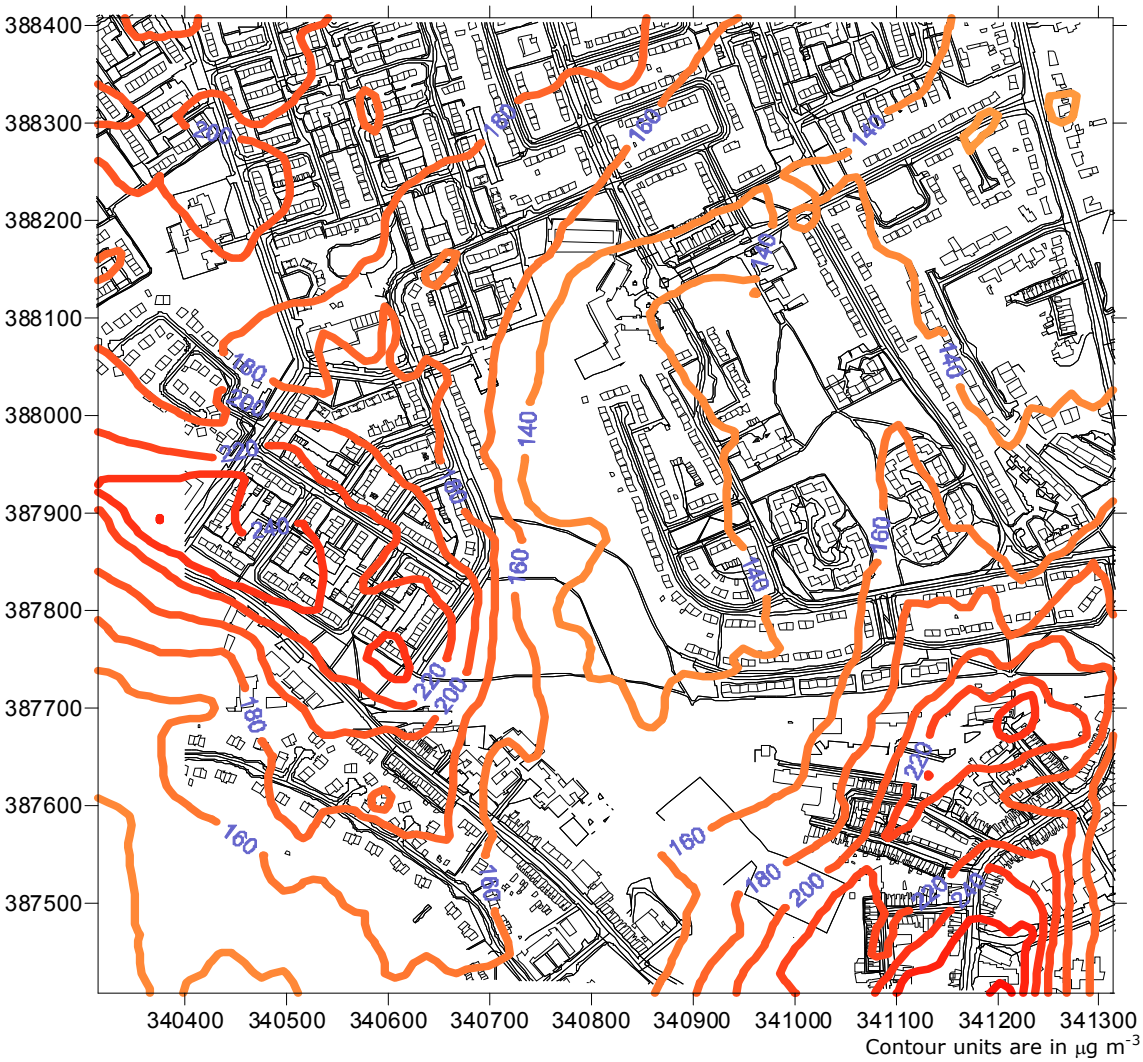
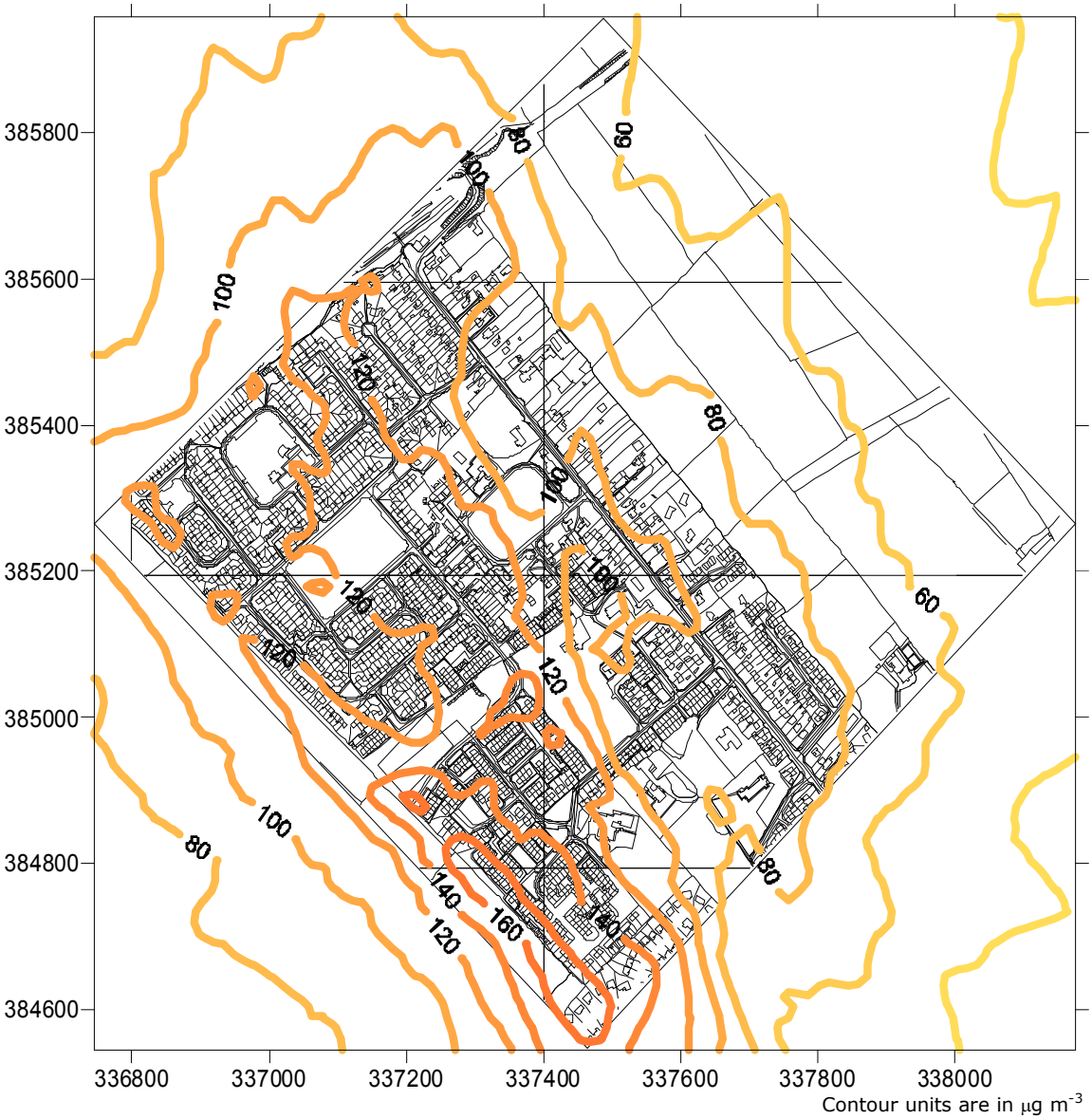


Figure 4.6. Greenisland grid - PM_{10} 24h mean corrected for model bias using the model bias factor from the northern grid (the bias factor was determined using monitoring data from Rosebrook Avenue Station).

Figure 4.7. Greenisland grid – SO_2 15 minute mean corrected for model bias using the model bias factor from the northern grid (the bias factor was determined using monitoring data from Rosebrook Avenue Station).



4.7 DISCUSSION

4.7.1 PM_{10}

It can be seen from figures 4.4 and 4.6 that the concentration contours show areas of higher and lower PM_{10} concentrations and these are well correlated to the areas of higher density housing.

The areas have been modelled so that the contours can be directly compared with the PM_{10} 24 hour mean objective; 50μgm^{-3} with 35 exceedences. Simply this means that when looking at the plots, if there are any contours at a location showing concentration over 50μgm^{-3}, then there is predicted to be an exceedence of the objective.
There are two locations in each modelled area showing concentrations higher than 50 μgm^{-3} indicating exceedence of the PM_{10} daily average objective. From figure 4.4 it can be seen that the daily average objective will be exceeded through out the Carrickfergus town grid. From the fuel use survey it appears that the main factors causing elevated concentrations appear to be a combination of high density housing and a high percentage of coal burning properties in Carrickfergus Town and Greenisland areas.

4.7.2 SO_2

It can be seen from figures 4.5 and 4.7 that the concentration contours show areas of higher and lower SO_2 concentrations which are well correlated to the areas of higher density housing; in some cases a slight offset is evident which is most likely due to prevailing meteorological conditions. The contours differ from those in the PM_{10} plots due to the differing averaging period of the objective.

The areas have been modelled so that the contours can be directly compared with the SO_2 15 minute objective; 266μgm^{-3}. Simply this means that when looking at the plots, if there are any contours shows a location with concentration over 266μgm^{-3} there is predicted to be an exceedence of the objective.
The plots show that there are no predicted exceedences of the SO_2 objective in either of the two grids.

5 Conclusions

5.1 PARTICULATE MATTER (PM_{10})

The detailed modelling has shown that PM_{10} emissions arising from domestic fuel combustion in Carrickfergus Borough Council **are likely to cause an exceedence** of the air quality objective within Carrickfergus Town and Greenisland under meteorological conditions conducive to poor dispersion.

5.2 SULPHUR DIOXIDE (SO_2)

The detailed modelling has shown that SO_2 emissions arising from domestic fuel combustion in Carrickfergus Borough Council are **not predicted to cause an exceedence** of the air quality objectives within Carrickfergus and Greenisland.

6 Recommendations

The modelling shows that an exceedence of the PM_{10} objective is possible under certain meteorological conditions conducive to poor dispersion. Since model verification further monitoring data has been made available. A review of this most recent data reveals 3 exceedences across the winter 2003/2004 period. It should be noted that the monitoring station, whilst in a domestic coal burning area, is not in the area of predicted highest concentration by the model. Therefore on the basis that an exceedence is likely under specific meteorological conditions an Air Quality Management Area (AMQA) should be declared and a further assessment undertaken. Continuous monitoring already in place should continue, applying suitable QC procedures. This data should be revisited and considered again in the action planning and further assessment phase.
The reduction in concentration required to meet the Air quality Objective for PM10 is a reduction of approximately 25 $\mu g\ m^{-3}$ in Carrickfergus town and 5 $\mu g\ m^{-3}$ in Greenisland.

Domestic fuel combustion is believed to be the only significant source in the localised area. A contribution from a power station in the region has been incorporated into the model but the contribution to local concentrations is small. Therefore for source apportionment it is reasonable to conclude that domestic fuel combustion is the major cause of the predicted PM_{10} exceedence, composing the background contribution and the domestic fuel combustion contribution.

In the next stage under the action planning and further assessment phase further modelling of possible fuel use change scenarios would provide information on the quantity of emissions reduction that the scenarios could deliver. From this the subsequent change in concentrations could be modelled within the exceedence area. This further modelling would therefore provide the information required to inform what options are available to reduce concentrations for the action planning phase and how effective they would be for working towards the objective.

Further details on AQMA designation is given in the 'Northern Ireland Local Air Quality Management Policy Guidance' document (LAQM.PGNI(03) Table 3). It also sets out how to proceed from here and under what timescales.

This report should now be submitted to defra for review. Consultation on the stage 2 and stage 3 reports should be undertaken with the general public and the relevant authorities by March 2004. Designation of an AQMA should be completed by April 2004.
When an AQMA has been declared, the next action is to submit a draft action plan to other relevant authorities by July 2004. The consultation on draft action plans is to be completed by March 2005 and then submitted by April 2005. Also in April 2005 a progress report should be completed. (LAQM.PGNI(03)Table 3)

References

CRE, 1997. PM10 emission factors for domestic solid fuels. Report prepared for Belfast City Council. Report number: 7323-3. July 1997.

Defra (2003). Part IV of the Environment Act 1995. Local Air Quality Management. Technical Guidance LAQM. TG(03).

DETR (2000) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Department of the Environment, Transport and the Regions. Cm 4548, SE 2000/3, NIA 7.

NAEI (2002). UK Emissions of Air Pollutants 1970 - 2000. Goodwin, Salway, Dore, Murrells, Passant, King, Coleman, Hobson, Pye, Watterson, Haigh & Conolly. November 2002. Report produced by Netcen for Defra, National Assembly of Wales, the Scottish Executive and the Department of the Environment, Northern Ireland.

Carrickfergus BC, Carrickfergus BC Fuel Use Survey 2001/2002

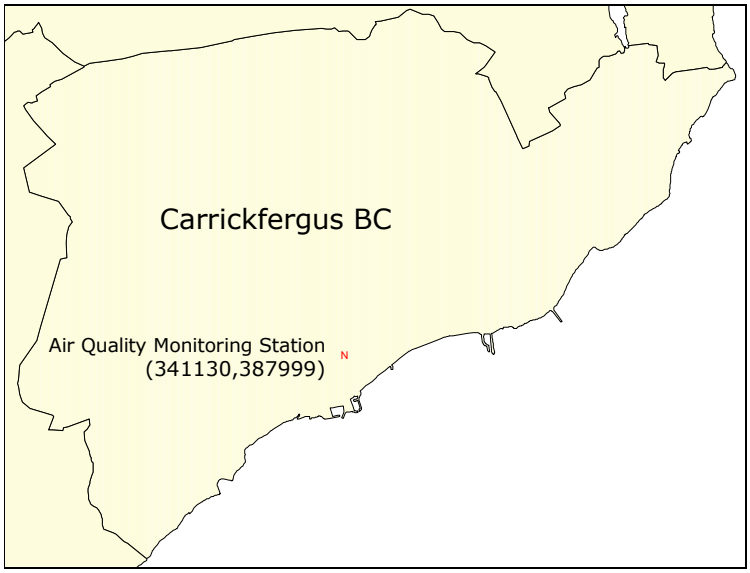
Appendices

CONTENTS

Appendix 1
Automatic Monitoring Station Data

CARRICKFERGUS AMBIENT AIR MONITORING PROGRAMME

Carrickfergus Borough Council has undertaken automatic ambient air monitoring of SO_2 and PM_{10} since July 2002. The instrumentation employed uses UV fluorescence for the measurement of SO_2 and the TEOM technique for PM_{10}, these methods are appropriate for Detailed Assessment under LAQM (LAQM TG(03)). The monitoring station is located in Carrickfergus Town in Rosebrook Avenue. The exact location of the monitoring station is provided below. The station is located in the Carrickfergus Town Centre grid which has been modelled for domestic fuel combustion. It is therefore in a relevant location.



Location of Automatic Monitoring Station in Carrickfergus

The data presented here has been provided to **netcen** by Carrickfergus Borough Council as finalised data. Thus no further data scaling or ratification of the data has been undertaken. However, a qualitative review of the data has been completed comparing the trends of the pollutants to nearby AURN monitoring stations. As can be seen in Figures 1 & 2 below, the Carrickfergus dataset broadly follows the same temporal variation as seen at the AURN station at Belfast Centre for PM_{10} and Belfast Centre and Belfast East for SO_2. This provides a degree of confidence in the dataset.

The data supplied by Carrickfergus Borough Council, and used in the verification process of the modelling, was uploaded to the **netcen** database and analysis of the data provided the following data summaries. Table 1 provides descriptive statistics of the Carrickfergus data, whilst Table 2 provides comparison against the Air Quality Objective values set down in the Air Quality Regulations (Northern Ireland) 2003.

Table 1 Air Quality Summary Statistics, Carrickfergus 01 July 2002 to 30 June 2003

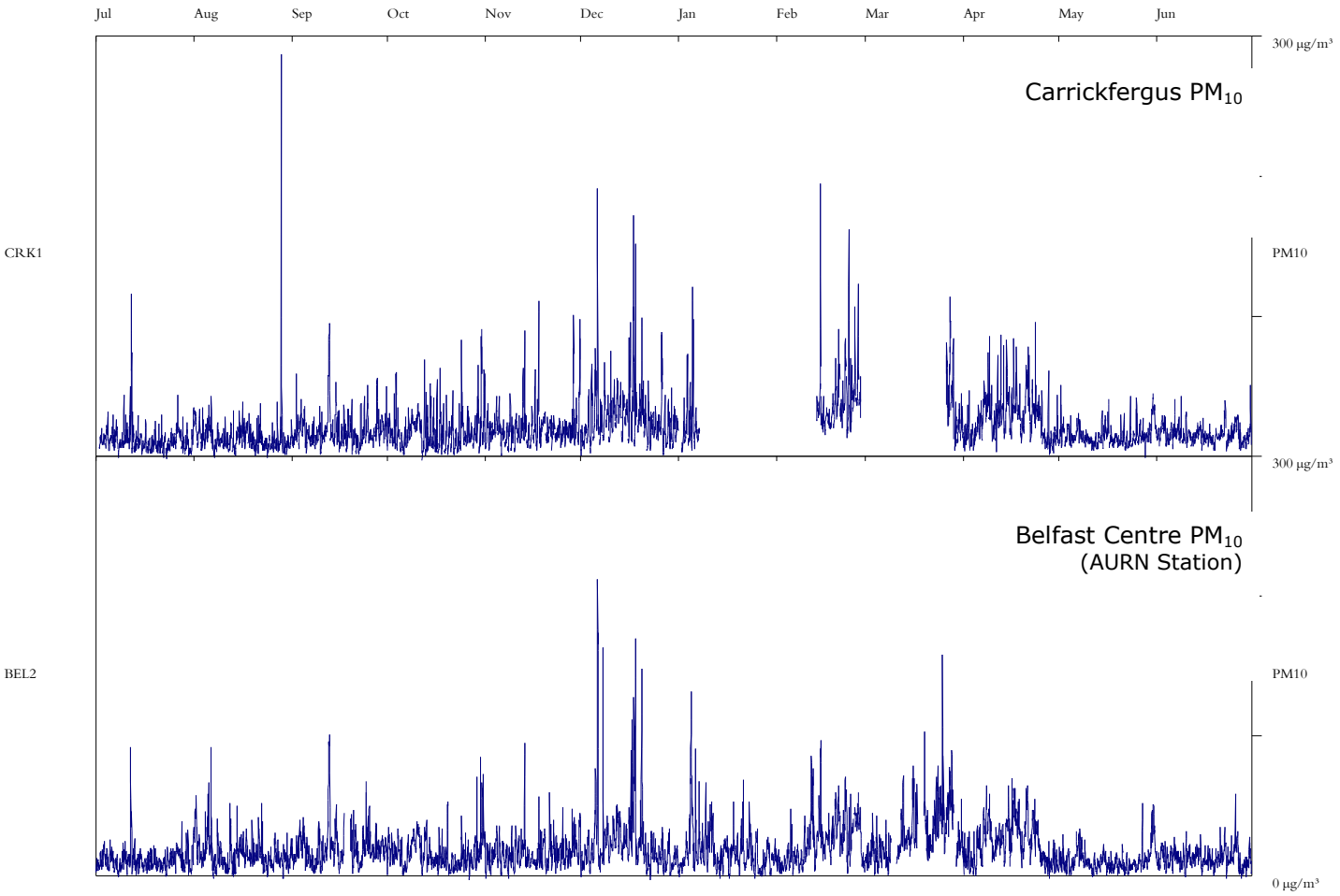
POLLUTANT	SO_2	PM_{10}	GR_{10}
Maximum 15-minute mean	237 µg m^{-3}	574 µg m^{-3}	746 µg m^{-3}
Maximum hourly mean	186 µg m^{-3}	287 µg m^{-3}	373 µg m^{-3}
Maximum running 24-hour mean	57 µg m^{-3}	59 µg m^{-3}	77µg m^{-3}
Maximum daily mean	52 µg m^{-3}	56 µg m^{-3}	72 µg m^{-3}
Average	9 µg m^{-3}	20 µg m^{-3}	25 µg m^{-3}
Data capture	88.6 %	78.2 %	78.2 %

Table 2: Air Quality Exceedence Statistics, Carrickfergus 01 July 2002 to 30 June 2003

Pollutant	Air Quality Regulations (Northern Ireland) 2003	Exceedences	Days
Sulphur Dioxide	15-minute mean >266 µg m^{-3}	0	0
Sulphur Dioxide	Hourly mean > 350 µg m^{-3}	0	0
Sulphur Dioxide	Daily mean > 125 µg m^{-3}	0	0
PM_{10} Particulate Matter (Grav)	Daily mean > 50 µg m^{-3}	17	17
PM_{10} Particulate Matter (Grav)	Annual mean > 40 µg m^{-3}	0	-

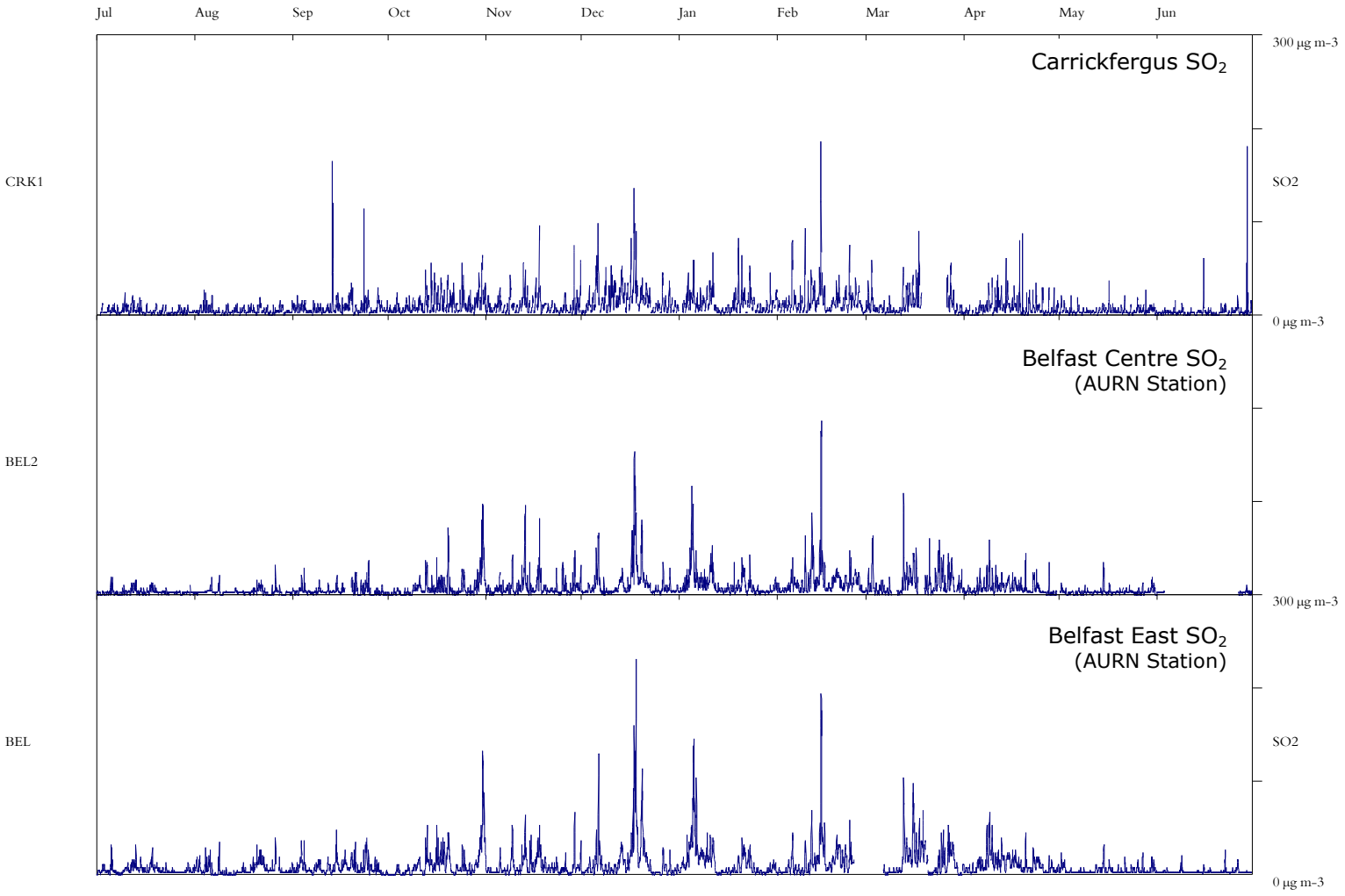
Note: A factor of 1.3 has been used to correct TEOM PM_{10} to gravimetric equivalent PM_{10} (GR_{10} in Table 1)

Figure 1: PM_{10} Hourly Mean Data for 1 July 2002 to 30 June 2003



PM10 Particulate Matter July 2002 to June 2003

Figure 2: SO2 Hourly Mean Data for 1 July 2002 to 30 June 2003



Sulphur Dioxide July 2002 to June 2003

netcen

Appendix 2
Aldergrove Met Station Data

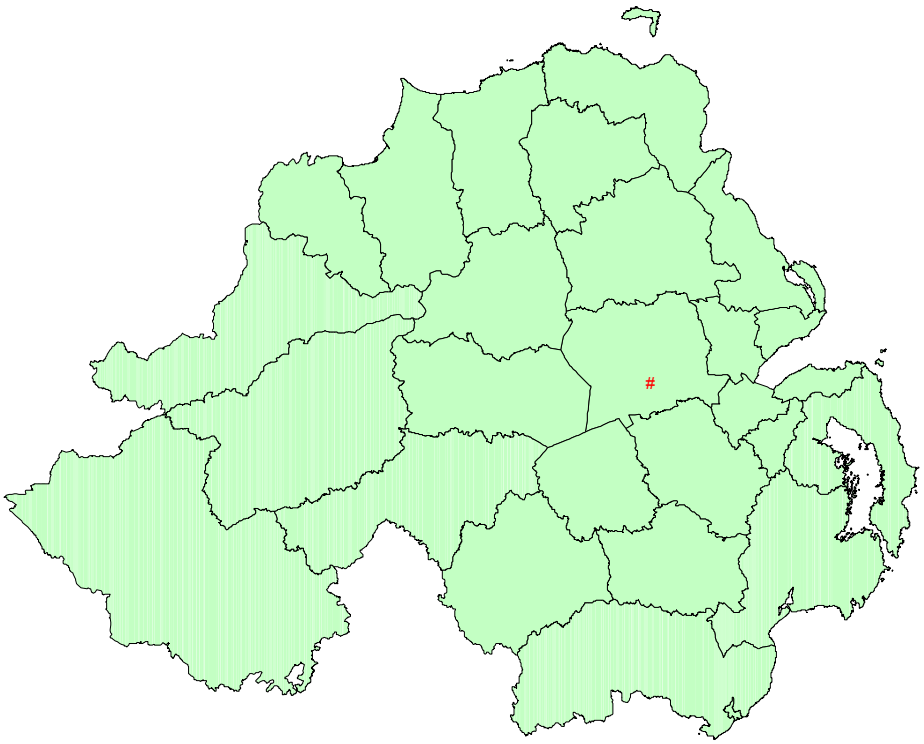
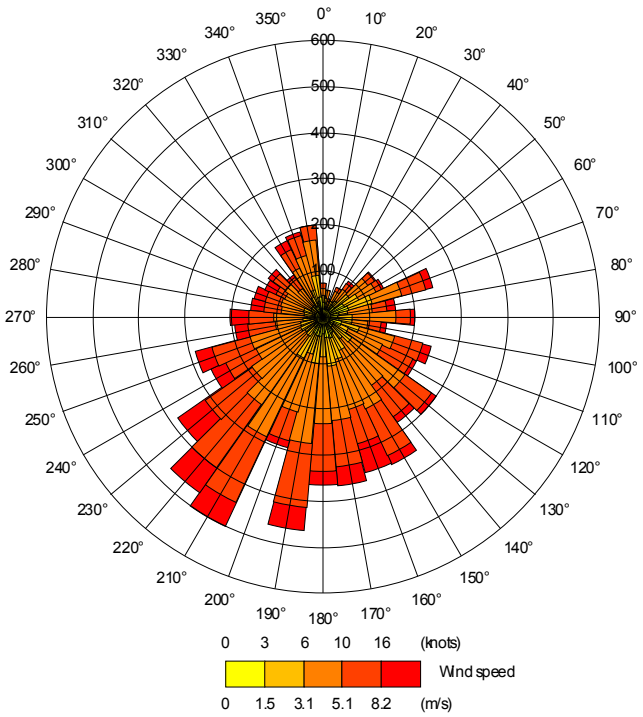


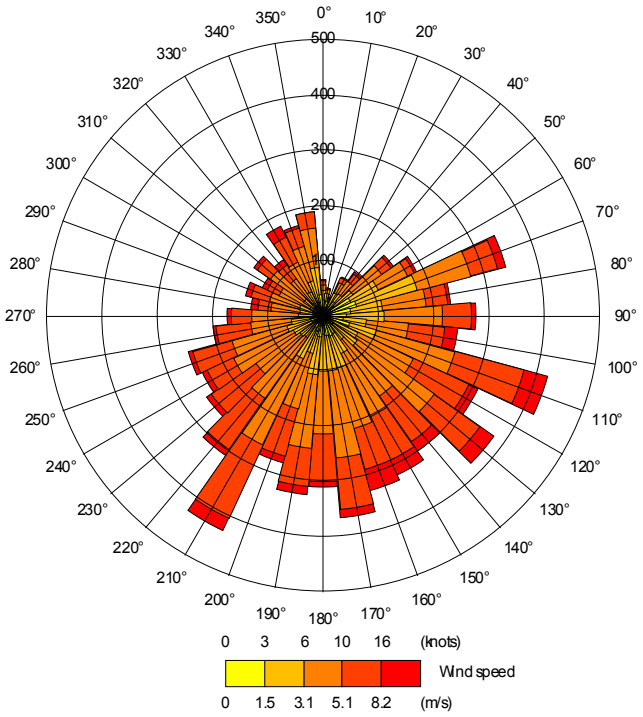
Figure A2- Location of Aldergrove Station

Table A2 - Characteristics of Aldergrove Station

Description – Aldergrove International airport.	
DCNN	9142
Eastings	314700
Northings	379800
Latitude Deg Min	54 39 N
Longtitude Deg Min	06 13 W
Station height AMSL (m)	68
Effective height of anemograph (m)	10



Wind rose for the Aldergrove 2002 met data



Wind rose for the Aldergrove July 2002 – June 2003 met data

Appendix 3
Model Bias correction

Carrickfergus BC Bias Correction and Modelling

Bias correction

PM_{10} and SO_2 ambient concentrations were modelled using met data from Aldergrove between July 2002 and June 2003 (This is the same period from which monitoring data for PM_{10} and SO_2 was available from the monitoring station). This model run included both time varying emissions from domestic fuel burning and the constant emissions from Kilroot Power Station.

The modelled 90%ile of 24h mean for PM_{10} and 99.9%ile of 15 minute mean for SO_2 were then compared to the monitoring results for the same period. Following the formulas below, a bias correction factor was worked for PM_{10} and SO_2:

$$PM_{10\ monitoring\ data} = (background_{PM10} \times 1.68) + (Modelled\ result \times f_{PM10}) \quad [90.41\%\ 24h\ mean]$$

$$SO_{2\ monitoring\ data} = (background_{SO2} \times 2) + (Modelled\ result \times f_{SO2}) \quad [99.9\%\ 15\text{-}min\ mean]$$

Table 3.1 Summary of model bias correction

	Monitoring data (Carrickfergus station)	**Background** (from NAEI)	**Modelled** (ADMS 3.1)	**Bias correction** (factor)
PM_{10} gravimetric	46.8 μg m^{-3}	19 μg m^{-3}	7.0 μg m^{-3}	**2.13**
SO_2	133 μg m^{-3}	10 μg m^{-3}	100.5 μg m^{-3}	**1.12**

Met data variations

Having worked out a bias correction factor for the model run, modelling was carried out again using 1999 and 2002 met data, separately. The results obtained for these two years were very similar. The most recent met data was to be used (2003 was not complete at the time of modelling). As can be seen in figure 1, 1999 and 2002 met data have similar windrose with a predominant southwesterly wind[1].

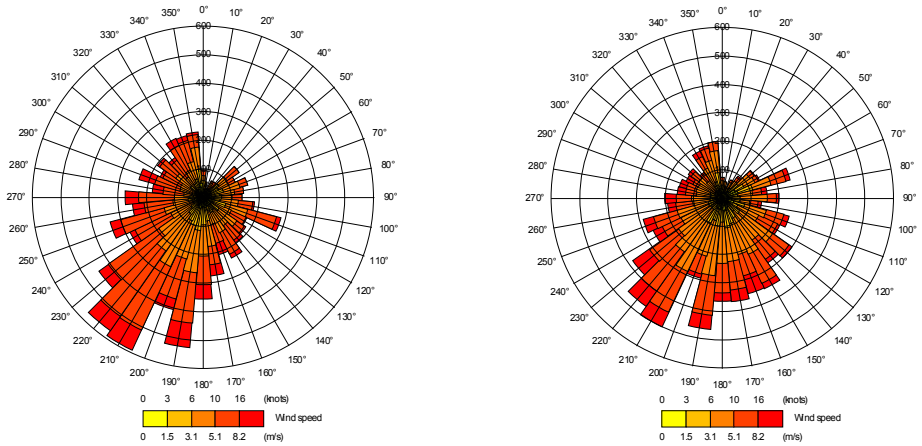


Fig 1. Wind rose for the Aldergrove 1999 (left) and 2002 (right) met data

[1] **Note that there are other factors affecting pollutants dispersions. Wind directions is only an example to show that met data used is different.**

In order to carry out the modelling assessment, met data for the complete year 2002 was used. However, the bias correction used to correct the model results were from the met data 2002-2003 as this was the only period with monitoring data available. This explains the difference between modelled results presented in the report (Year 2002) and monitoring data measured in Rosebrook Avenue Station since July 2002. On this basis had there been monitoring for the whole of 2002 more PM_{10} exceedences may have been recorded.

As figure 2 shows, the wind patterns between 2002 and 2002/2003 are not similar. Both Southeasterly and Southwesterly winds dominated in 2002/2003 compared to Southwesterly winds in 2002.

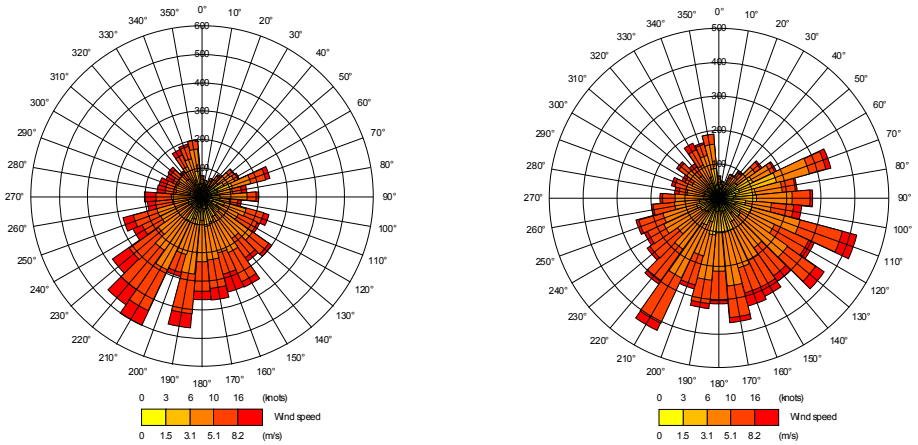
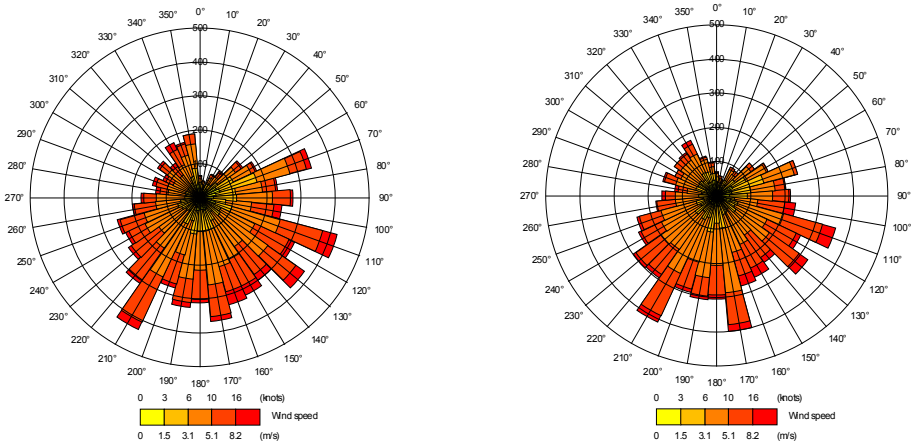


Fig 2. Wind rose for 2002 met data (left) and july 2002 – June 2003 met data (right)

Figure 3 shows that 2002/2003 windroses are similar to 2003 met data alone.



Wind rose for July 2002 – June 2003 met data (left) and 2003 met data (right)

Monitoring period used for Bias correction

The data set used for model verification runs 01/07/2002 through 30/06/2003. This was the monitoring data provided by Carrickfergus BC. In reviewing the data (Appendix 1), it was noted that the period of interest (Winter 2002/2003) coincided with periods of elevated PM_{10} across the whole of the UK. These periods are well documented (see

http://www.airquality.co.uk/archive/reports/list.php - forecasting reports) and were driven by transboundary PM_{10}.

These national PM episodes were considered with respect to the model verification process. It is recognised that the inclusion of many transboundary episodes within a dataset will result in a conservative model bias correction factor. On review, a decision was made to use all available data within the monitoring period for the following reasons:

- The national transboundary episodes were recorded during the winter 2002/2003 period, the same period of interest with respect to domestic fuel combustion. Simply removing the transboundary episodes may remove significant domestic contributions.
- On the basis of the information available, we consider there is no robust method of source apportionment to enable the domestic contribution to be isolated, LAQM.TG (04) does not provide guidance on this.
- Many of national episodes are not present in the Carrickfergus monitoring data set with gaps coinciding with known transboundary episodes.

Location of monitoring station

Apart from the influence of met data to the modelling results, it should also be highlighted that monitoring results from Rosebrook Avenue might not represent the areas with highest pollution. House density nearby is less compared to two areas where possible exceedences have been modelled.