# Air Quality Review and Assessment Stage 3 – Domestic Fuel Combustion

A report for Ballymena 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 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.

This report on domestic fuel combustion forms part of the stage 3 air quality review for Ballymena Borough Council. Only $PM_{10}$ and sulphur dioxide are considered in this report. This is because $PM_{10}$ and sulphur dioxide are the only pollutants of concern when considering domestic fuel combustion. This report investigates $PM_{10}$ and sulphur dioxide levels through an examination of the location and size of domestic combustion sources, emissions modelling exercises and by reference to monitored air quality data.

As part of this report, detailed modelling using ADMS version 3.1 has been undertaken for six one kilometre square grids identified in the Stage 2 assessment. These are:

- Cullybackey (1)
- Ahoghill (2)
- Dunclug (3)
- Ballymena Town Centre (4)
- Ballykeel (5)
- Ballee (6)

The model results have been bias corrected using data from Rosebrook Avenue in Carrickfergus Borough Council, as at the time of modelling, Ballymena BC did not have a complete dataset suitable for bias correcting the ADMS modelling. This modelling study will provide indicative results and will alert Ballymena Borough Council if concentrations in the borough are likely to exceed the objectives and therefore whether any actions should be undertaken.

The conclusions of the report are:

### Particulate Matter ($PM_{10}$)

The modelling shows that an exceedence of the daily mean $PM_{10}$ objective is likely within Dunclug and Ballykeel under certain meteorological conditions conducive to poor dispersion. 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.

Monitoring should now been undertaken for a location relevant to domestic fuel combustion in the modelled area. Then in the action planning and further assessment phase this modelling should be revisited and considered again using a suitable period of local monitoring data (for model verification). Consideration could also be given to improving the reliability and coverage of the fuel use survey during further assessment.

### Sulphur dioxide ($SO_2$)

Emissions arising from domestic fuel combustion in Ballymena Borough Council are not predicted to cause an exceedence of the $SO_2$ air quality objectives. However the monitor currently within the modelled area should be relocated to a more relevant location within the grid, in terms of highest predicted concentrations and relevant receptors. This would enable a greater degree of confidence when this data is subsequently used for model verification.

**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 |
| $\mu g\ m^{-3}$ | micrograms per cubic meter |

# Contents



## Appendices

# 1 Introduction

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.

## 1.1 PURPOSE OF THE STUDY

**netcen** was commissioned to complete stage 3 assessment of domestic fuel combustion for Ballymena Borough Council.

The assessment:

- Investigates present and potential future air quality in the Ballymena Borough Council area
- Identifies any actions that are likely to be required by Ballymena 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 Ballymena Borough Council);
- Compile emission inventory for each area;
- Use the monitoring data to assess the ambient concentrations produced by domestic fuel combustion and to validate the output of modelling studies;
- Model the concentrations of $PM_{10}$ and $SO_2$ in each of selected grid squares including local background concentration using ADMS 3.1;
- Present the concentrations as contour plots of concentrations, 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 Ballymena 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 Ballymena Borough Council.

Chapter 4 describes the results of the assessment and discusses whether $PM_{10}$ and $SO_2$ objectives will be exceeded in Ballymena 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 $\mu gm^{-3}$<br>3.25 $\mu gm^{-3}$ | Running annual mean<br>Running annual mean | 31.12.2003<br>31.12.2010 |
| **1,3 Butadiene** | 2.25 $\mu gm^{-3}$ | Running annual mean | 31.12.2003 |
| **Carbon Monoxide** | 10.0 $mgm^{-3}$ | Maximum daily running 8-hour mean | 31.12.2003 |
| **Lead** | 0.5 $\mu gm^{-3}$<br>0.25 $\mu gm^{-3}$ | Annual mean<br>Annual mean | 31.12.2004<br>31.12.2008 |
| **Nitrogen Dioxide**[1] | 200 $\mu gm^{-3}$ not to be exceeded more than 18 times a year<br>40 $\mu gm^{-3}$ | 1 hour mean<br>annual mean | 31.12.2005<br>31.12.2005 |
| **Particles ($PM_{10}$)**[2]<br>**Gravimetric**[3] | 50 $\mu gm^{-3}$ not to be exceeded more than 35 times a year<br>40 $\mu gm^{-3}$ | 24 hour mean<br>annual mean | 31.12.2004<br>31.12.2004 |
| **Sulphur Dioxide** | 350 $\mu gm^{-3}$ not to be exceeded more than 24 times per year<br>125 $\mu gm^{-3}$ not to be exceeded more than 3 times per year<br>266 $\mu gm^{-3}$ not to be exceeded more than 35 times per year | 1 hour mean<br>24 hour mean<br>15 minute mean | 31.12.2004<br>31.12.2004<br>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 responsible 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 objectives 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 a 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.

Ballymena have screened to determine the necessity for a stage 3 review and assessment on the basis of the number of domestic fuel burning properties within 1x1km grids, as defined in (LAQM. TG4 (00)). As required by the Northern Ireland Policy guidance the latest technical guidance LAQM.TG (03) methodology should be used for domestic fuel combustion modelling where possible. In practice, the high resolution modelling and the method of source definition used in this report means that defining 1km areas 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.<br><br>• 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.<br>• 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.<br>• 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<br>• Benzene<br>• Lead<br>• Nitrogen dioxide<br>• 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<br>• Particulate Matter ($PM_{10}$)<br>• 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<br>• 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 BALLYMENA BC

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

- Local air quality monitoring data
- Domestic Fuel Combustion Survey
- Local Fuel Data

## 3.2 LOCAL AIR QUALITY MONITORING DATA

### 3.2.1 Extent of data available

Ballymena have undertaken continuous $SO_2$ monitoring at a location within one of the grid areas to be modelled. However, at the time of modelling, Ballymena Borough Council did not have a complete dataset suitable for bias correcting the ADMS modelling. Nearby, 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

Ballymena 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 Ballymena 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 99.9$^{th}$ percentile) to be achieved by the 31$^{st}$ December 2005
- 350 $\mu g\ m^{-3}$ as a 1 hour mean (maximum of 24 exceedences a year or equivalent to the 99.7$^{th}$ percentile) to be achieved by the 31$^{st}$ December 2004
- 125 $\mu g\ m^{-3}$ as a 24 hour mean (maximum of 3 exceedences a year or equivalent to the 99$^{th}$ percentile) to be achieved by the 31$^{st}$ 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, Ballymena Borough Council identified six areas as having a high proportion of solid fuel use, and therefore requiring further assessment.

# 4.3 BALLYMENA BOROUGH COUNCIL FUEL USE SURVEY

Ballymena Borough Council undertook fuel use survey in October 2003. A random sample of 30% of houses within each square, with the exception of Cullybackey where 50% survey was conducted from this square. The findings are summarised below.

### 4.3.1 Cullybackey: Grid 1

There are a total of 846 houses within the 1km$^2$ grid in Cullybackey. Nearly 86% of the houses use oil as their main fuel followed by coal users with 13% (see table 4.1).

Table 4.1 Fuels for heating purposes

| | Number Properties | % of Properties |
|---|---|---|
| Oil | 728 | 86 |
| Coal/Solid Fuel | 110 | 13 |
| Electricity | 8 | 1 |
| Gas | 0 | 0 |
| Total | 846 | 100 |

### 4.3.2 Ahoghill: Grid 2

There are a total of 859 houses within the 1km$^2$ in Ahoghill. Nearly 72% of the houses use oil as their main fuel followed by coal users with 26% (see table 4.2)

Table 4.2 Fuels for heating purposes

| | Number Properties | % of Properties |
|---|---|---|
| Oil | 619 | 72 |
| Coal/Solid Fuel | 223 | 26 |
| Electricity | 17 | 2 |
| Gas | 0 | 0 |
| Total | 859 | 100 |

### 4.3.3 Dunclug: Grid 3

There are a total of 1173 houses within the 1km$^2$ in Dunclug. Nearly 63% of the houses use oil as their main fuel followed by coal users with 31%. Only 6% use electricity (see table 4.3)

Table 4.3 Fuels for heating purposes

| | Number Properties | % of Properties |
|---|---|---|
| Oil | 739 | 63 |
| Coal/Solid Fuel | 364 | 31 |
| Electricity | 70 | 6 |
| Gas | 0 | 0 |
| Total | 1173 | 100 |

### 4.3.4 Ballymena Town Centre: Grid 4

There are a total of 892 houses within the 1km$^2$ in the Town Centre. Nearly 76% of the houses use oil as their main fuel followed by coal users with 13%. Only 11% use electricity (see table 4.4)

Table 4.4 Fuels for heating purposes

| | Number Properties | % of Properties |
|---|---|---|
| Oil | 678 | 76 |
| Coal/Solid Fuel | 116 | 13 |
| Electricity | 98 | 11 |
| Gas | 0 | 0 |
| Total | 892 | 100 |

### 4.3.5 Ballykeel: Grid 5

There are a total of 961 houses within the 1km$^2$ in Ballykeel. Nearly 51% of the houses use oil as their main fuel followed by coal users with 35%. Only 14% use electricity (see table 4.5)

Table 4.5 Fuels for heating purposes

| | Number Properties | % of Properties |
|---|---|---|
| Oil | 490 | 51 |
| Coal/Solid Fuel | 336 | 35 |
| Electricity | 135 | 14 |
| Gas | 0 | 0 |
| Total | 961 | 100 |

### 4.3.6 Ballee: Grid 6

There are a total of 1177 houses within the 1km$^2$ in Ballee. Nearly 75% of the houses use oil as their main fuel followed by electricity users with 15%. Only 10% use electricity (see table 4.6)

Table 4.6 Fuels for heating purposes

| | Number Properties | % of Properties |
|---|---|---|
| Oil | 883 | 75 |
| Coal/Solid Fuel | 118 | 10 |
| Electricity | 176 | 15 |
| Gas | 0 | 0 |
| Total | 1177 | 100 |

## 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 Ballymena 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 Ballymena 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 266$\mu gm^{-3}$ is the most stringent of the three $SO_2$ objectives. The daily mean $PM_{10}$ objective is the most stringent of the 50$\mu gm^{-3}$ $PM_{10}$ objectives. Therefore the ADMS modelling was carried out relevant to these objectives because if these objectives can be met the other objectives will also be met.

The emission rate for up to 5 areas within the six 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 4.7 Emission rates resulting from domestic fuel combustion (Cullybackey)

| | Number of houses | Area ($m^2$) | g $SO_2$ per year | g $PM_{10}$ per year |
|---|---|---|---|---|
| **Volume 1** | 62 | 66443 | 373,154 | 271,469 |
| **Volume 2** | 378 | 133080 | 2,275,033 | 1,655,085 |
| **Volume 3** | 92 | 59965 | 553,712 | 402,825 |
| **Volume 4** | 174 | 73014 | 1,047,238 | 761,865 |
| **Volume 5** | 140 | 89413 | 842,605 | 612,994 |
| **Total** | 846 | - | 5,091,741 | 3,704,238 |

Table 4.8 Emission rates resulting from domestic fuel combustion (Ahoghill)

| | Number of houses | Area ($m^2$) | g $SO_2$ per year | g $PM_{10}$ per year |
|---|---|---|---|---|
| **Volume 1** | 194.0 | 119519 | 2,158,713 | 1,338,822 |
| **Volume 2** | 322 | 142076 | 3,583,018 | 2,222,169 |
| **Volume 3** | 173 | 78470 | 1,925,038 | 1,193,898 |
| **Volume 4** | 144 | 99233 | 1,602,344 | 993,765 |
| **Volume 5** | 26 | 15220 | 289,312 | 179,430 |
| **Total** | 859 | - | 9,558,424 | 5,928,085 |

Table 4.9 Emission rates resulting from domestic fuel combustion (Dunclug)

| | Number of houses | Area ($m^2$) | g $SO_2$ per year | g $PM_{10}$ per year |
|---|---|---|---|---|
| **Volume 1** | 200 | 92536 | 1,706,750 | 1,704,822 |
| **Volume 2** | 268 | 49788 | 2,287,046 | 2,284,462 |
| **Volume 3** | 128 | 78837 | 1,092,320 | 1,091,086 |
| **Volume 4** | 449 | 153848 | 3,831,655 | 3,827,326 |
| **Volume 5** | 128 | 66866 | 1,092,320 | 1,091,086 |
| **Total** | 1,173 | - | 10,010,092 | 9,998,783 |

Table 4.10 Emission rates resulting from domestic fuel combustion (Town Centre)

| | Number of houses | Area ($m^2$) | g $SO_2$ per year | g $PM_{10}$ per year |
|---|---|---|---|---|
| **Volume 1** | 164 | 78670 | 720,367 | 520,132 |
| **Volume 2** | 310 | 248256 | 1,361,670 | 983,177 |
| **Volume 3** | 132 | 69202 | 579,808 | 418,643 |
| **Volume 4** | 250 | 102014 | 1,098,121 | 792,885 |
| **Volume 5** | 36 | 38443 | 158,129 | 114,175 |
| **Total** | 892 | - | 3,918,095 | 2,829,012 |

Table 4.11 Emission rates resulting from domestic fuel combustion (Ballykeel)

| | Number of houses | Area ($m^2$) | g $SO_2$ per year | g $PM_{10}$ per year |
|---|---|---|---|---|
| **Volume 1** | 168 | 84948 | 2,222,667 | 1,797,200 |
| **Volume 2** | 313 | 99126 | 4,141,040 | 3,348,354 |
| **Volume 3** | 76 | 50425 | 1,005,492 | 813,019 |
| **Volume 4** | 318 | 105811 | 4,207,191 | 3,401,842 |
| **Volume 5** | 86 | 36514 | 1,137,794 | 919,995 |
| **Total** | 961 | - | 12,714,183 | 10,280,410 |

Table 4.12 Emission rates resulting from domestic fuel combustion (Ballee)

| | Number of houses | Area ($m^2$) | g $SO_2$ per year | g $PM_{10}$ per year |
|---|---|---|---|---|
| **Volume 1** | 505 | 285919 | 1,879,139 | 1,181,980 |
| **Volume 2** | 160 | 56636 | 595,371 | 374,489 |
| **Volume 3** | 175 | 56067 | 651,187 | 409,597 |
| **Volume 4** | 174 | 85906 | 647,466 | 407,256 |
| **Volume 5** | 163 | 57595 | 606,534 | 381,510 |
| **Total** | 1,177 | - | 4,379,697 | 2,754,833 |

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.

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

Table 4.13

| | Cullybackey | Ahoghill | Dunclug | Town Centre | Ballykeel | Ballee |
|---|---|---|---|---|---|---|
| **$PM_{10}$ 2004** | 14.4 $\mu gm^{-3}$ | 15 $\mu gm^{-3}$ | 17.6 $\mu gm^{-3}$ | 18.2 $\mu gm^{-3}$ | 18.6$\mu gm^{-3}$ | 17$\mu gm^{-3}$ |
| **$SO_2$ 2001** | 3.5 $\mu gm^{-3}$ | 1.5 $\mu gm^{-3}$ | 6 $\mu gm^{-3}$ | 8 $\mu gm^{-3}$ | 9 $\mu gm^{-3}$ | 8 $\mu gm^{-3}$ |

To make the $SO_2$ background relevant to the 15 minute mean, PSG (LAQM TG (00)) recommends that the background for 2005 is doubled. 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.

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. Table 4.14 summarises the exceedence results shown in figures 4.1 to 4.12 for $PM_{10}$ and $SO_2$. Exceedence of the $PM_{10}$ 24 hour mean 50$\mu gm^{-3}$ objective is indicated for Dunclug and Ballykeel. There were no exceedences of the $SO_2$ 15 minutes mean.

Table 4.14 Summary model results

| | *$PM_{10}$ 24h mean exceedence* | *$SO_2$ 15 minutes mean exceedence* |
|---|---|---|
| **Cullybackey** | **No** (fig 4.1) | **No** (fig 4.2) |
| **Ahoghill** | **No** (fig 4.3) | **No** (fig 4.4) |
| **Dunclug** | **Yes** (fig 4.5) | **No** (fig 4.6) |
| **Town Centre** | **No** (fig 4.7) | **No** (fig 4.8) |
| **Ballykeel** | **Yes** (fig 4.9) | **No** (fig 4.10) |
| **Ballee** | **No** (fig 4.11) | **No** (fig 4.12) |

**Figure 4.1 Cullybackey** – 2004 $PM_{10}$ 24h mean corrected modelled results (the bias factor was determined using monitoring data from Carrickfergus BC).

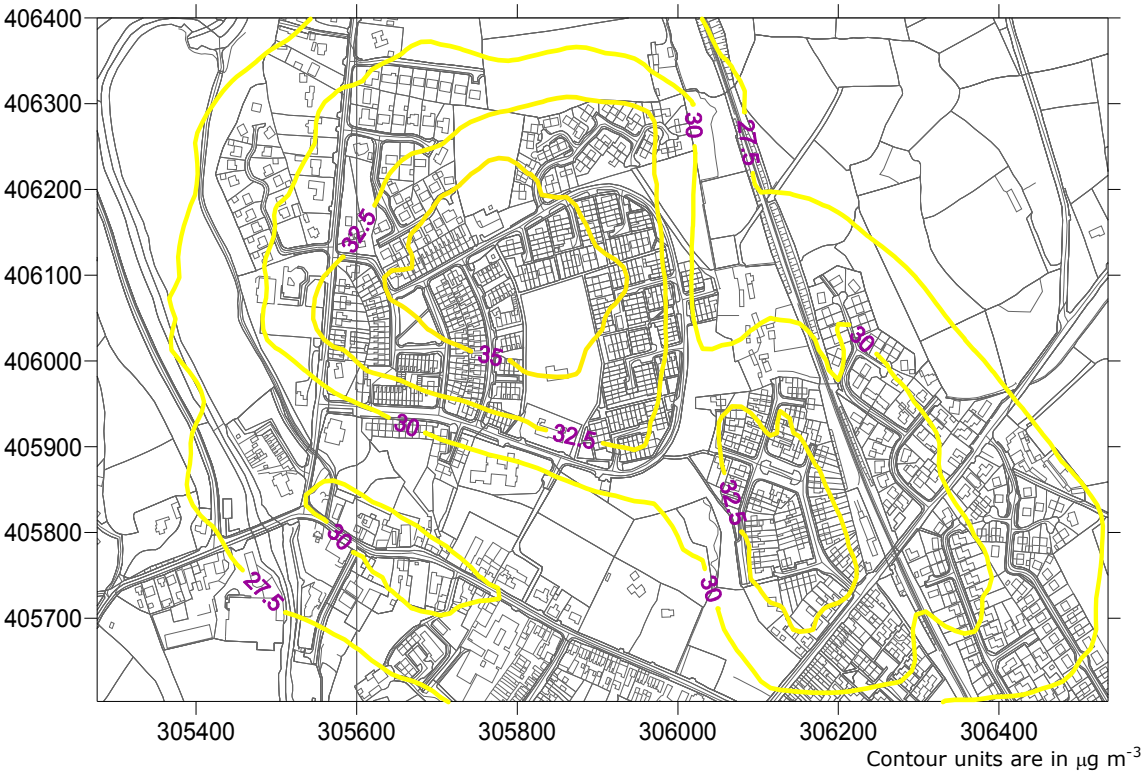



**Figure 4.2 Cullybackey** – 2005 $SO_2$ 15 minute mean corrected modelled results (the bias factor was determined using monitoring data from Carrickfergus BC).

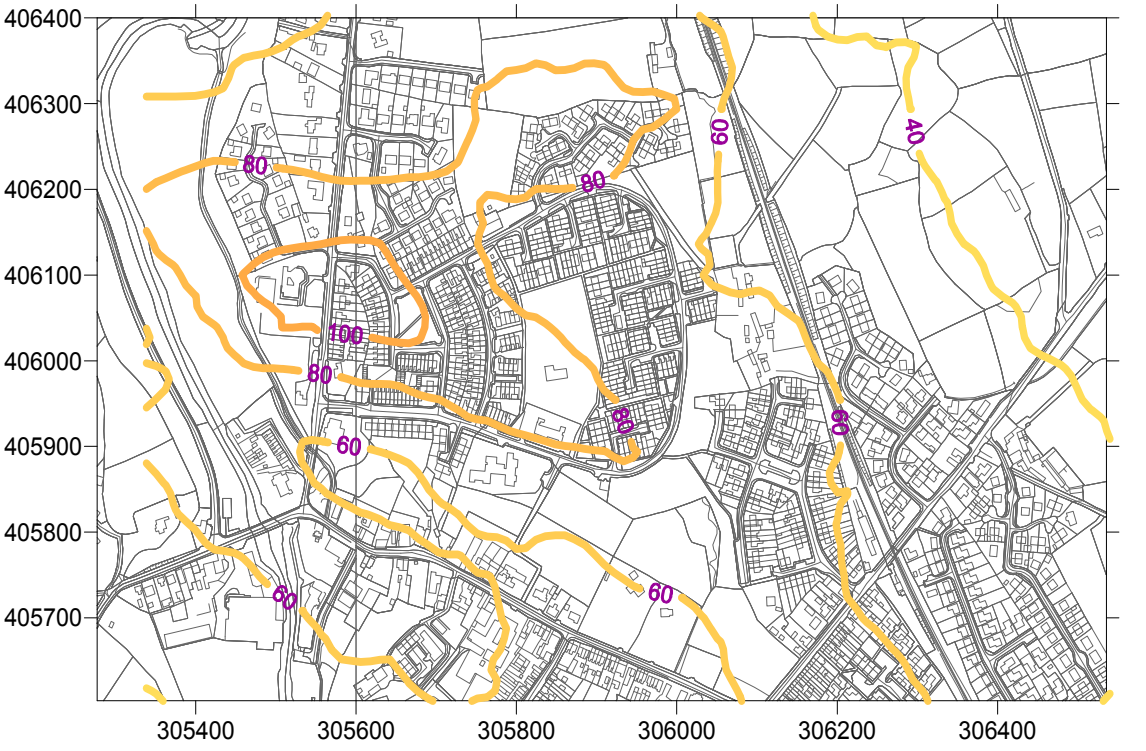


**Figure 4.3 Ahoghill** – 2004 $PM_{10}$ 24h mean corrected modelled results (the bias factor was determined using monitoring data from Carrickfergus BC).

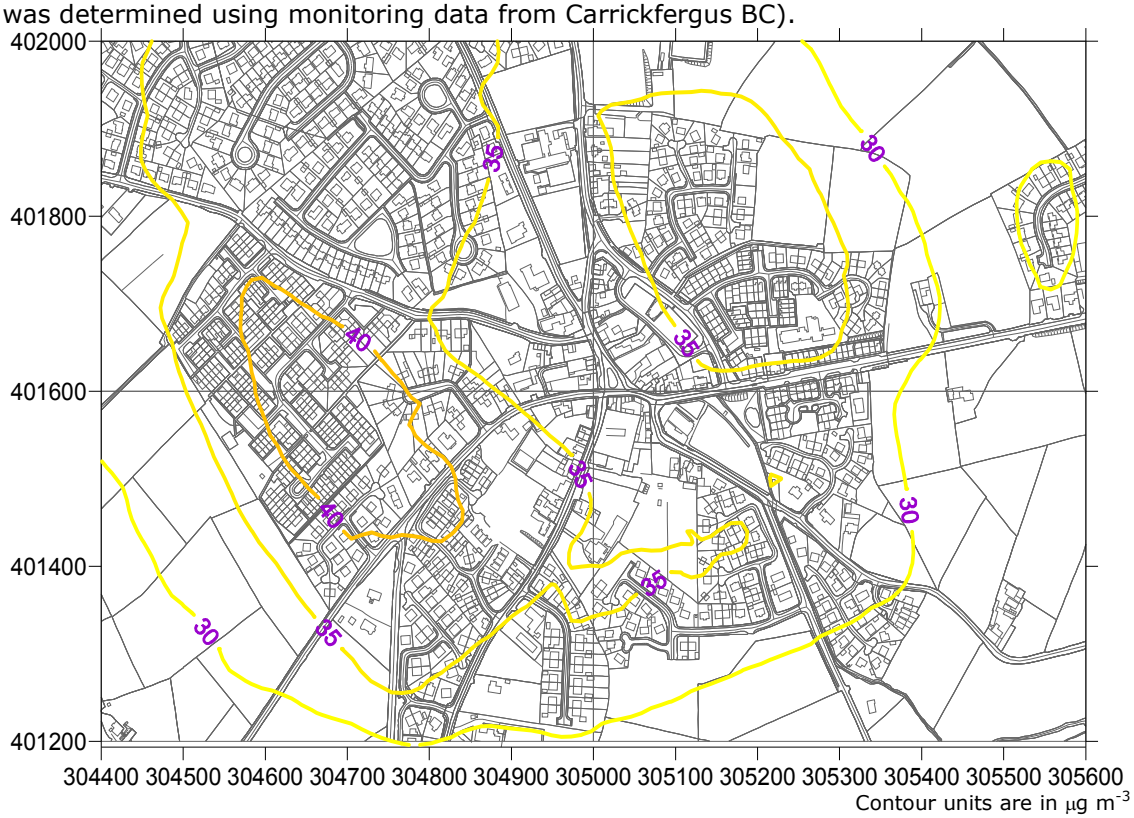



**Figure 4.4 Ahoghill** – 2005 $SO_2$ 15 minute mean corrected modelled results (the bias factor was determined using monitoring data from Carrickfergus BC).

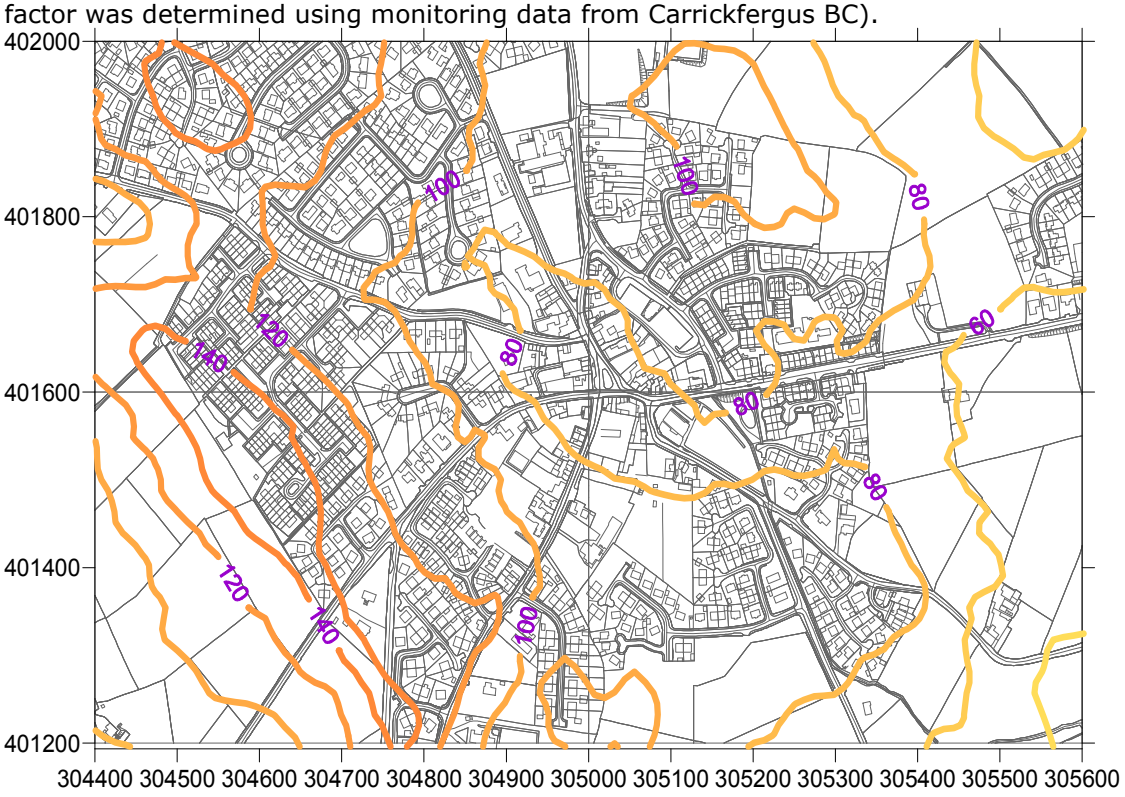


**Figure 4.5 Dunclug** – 2004 $PM_{10}$ 24h mean corrected modelled results (the bias factor was determined using monitoring data from Carrickfergus BC).

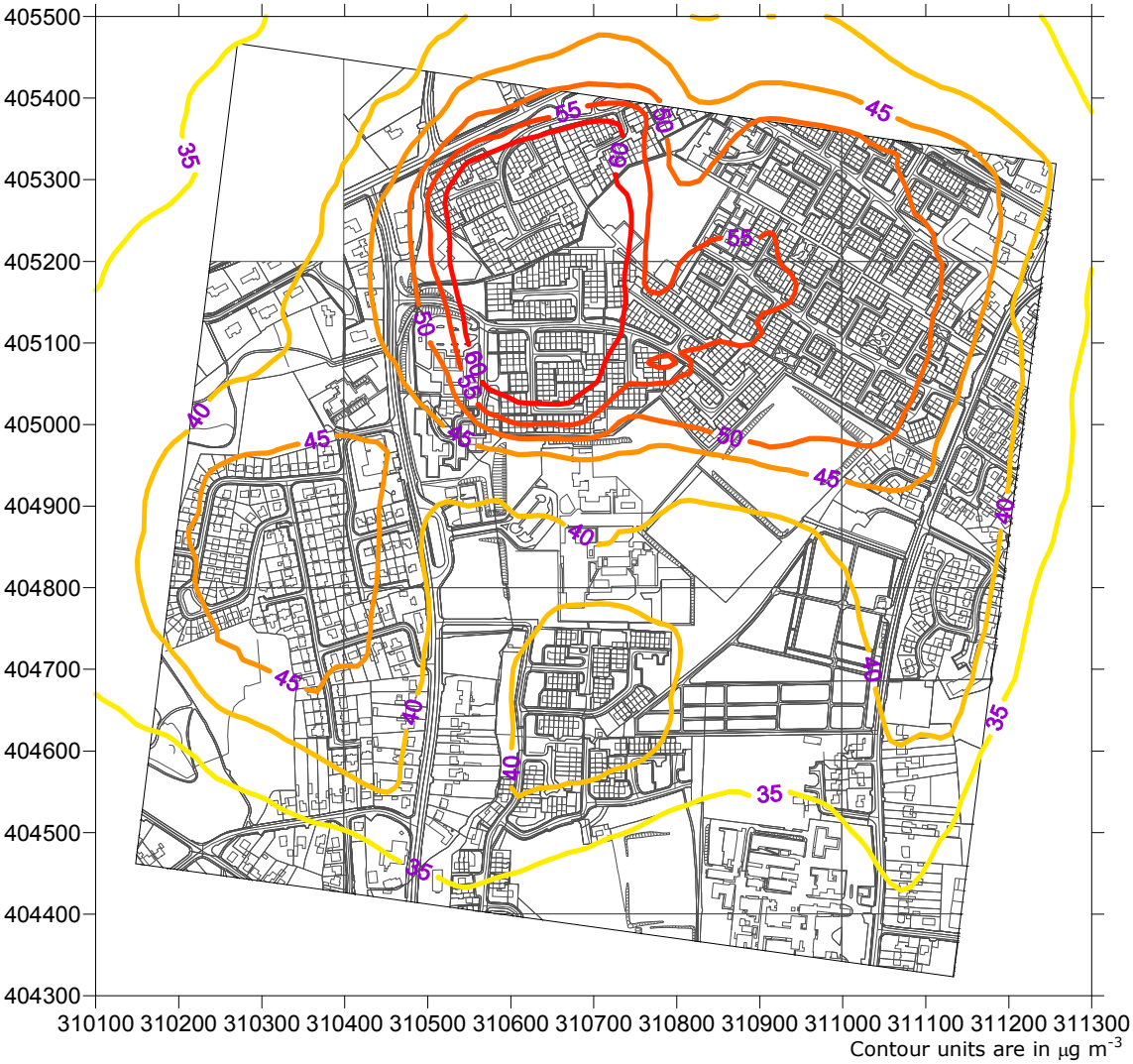
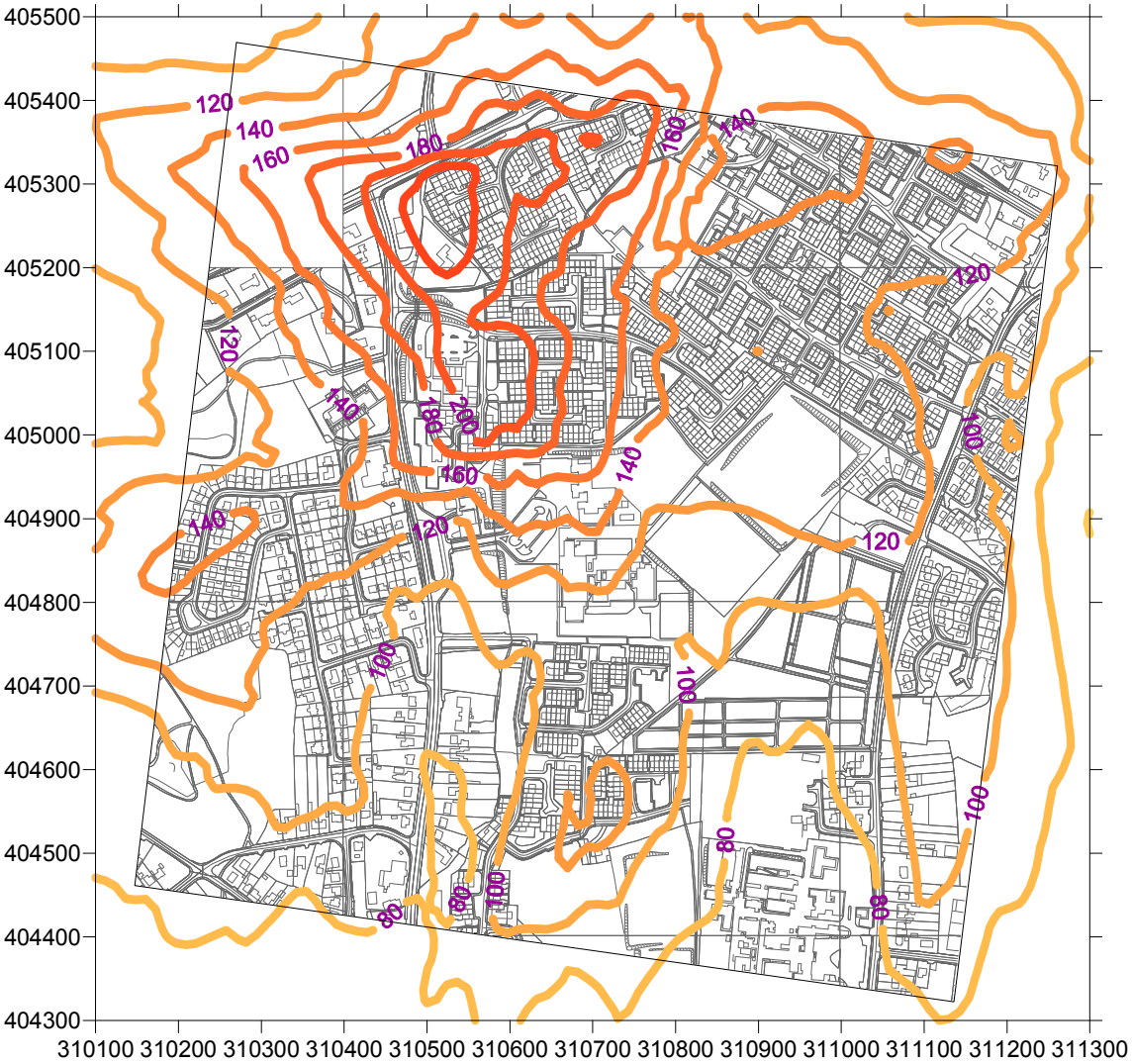


**Figure 4.6 Dunclug** – 2005 $SO_2$ 15 minute mean corrected modelled results (the bias factor was determined using monitoring data from Carrickfergus BC).




Contour units are in μg $m^{-3}$

**Figure 4.7 Town Centre** – 2004 $PM_{10}$ 24h mean corrected modelled results (the bias factor was determined using monitoring data from Carrickfergus BC).

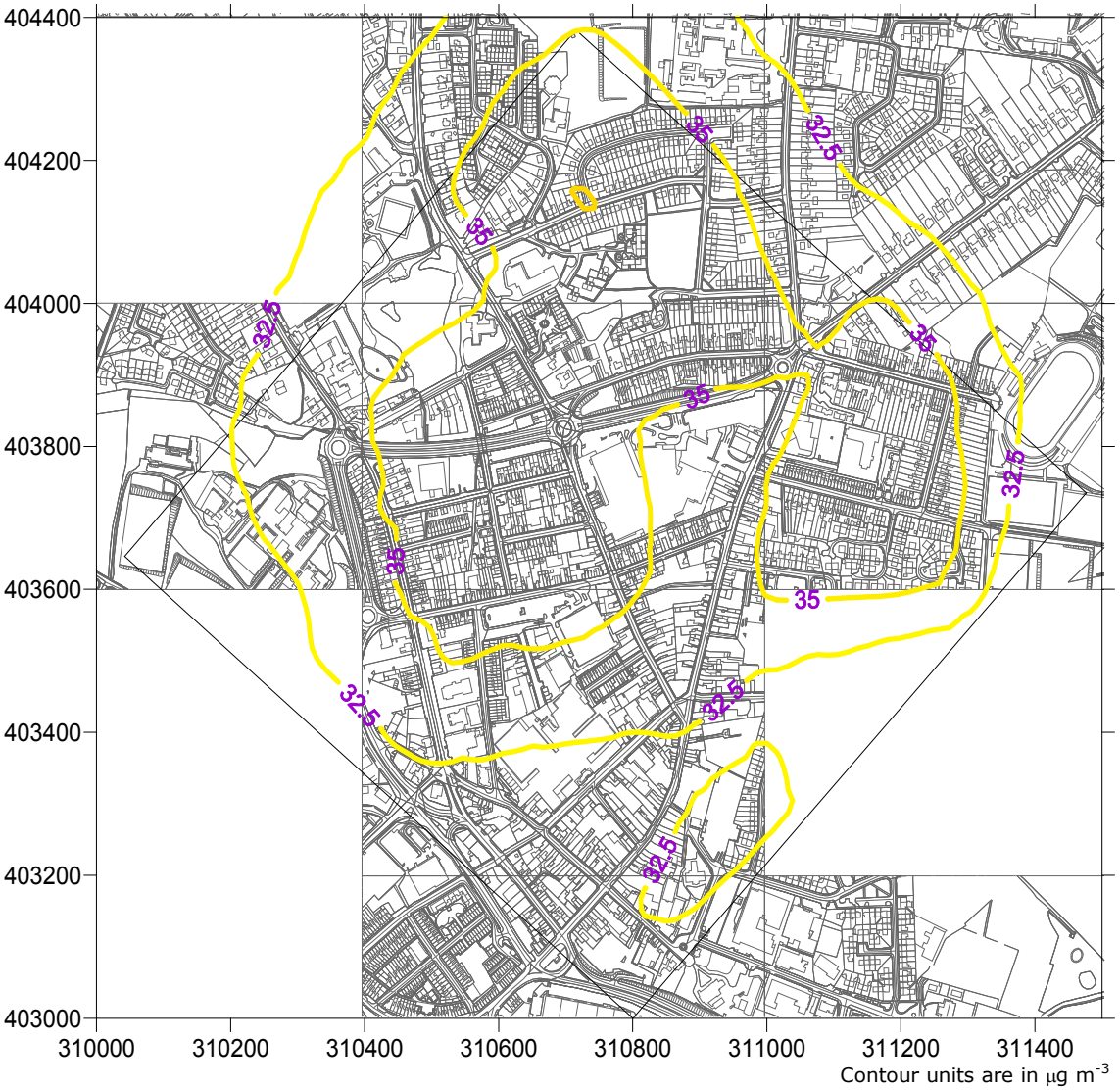
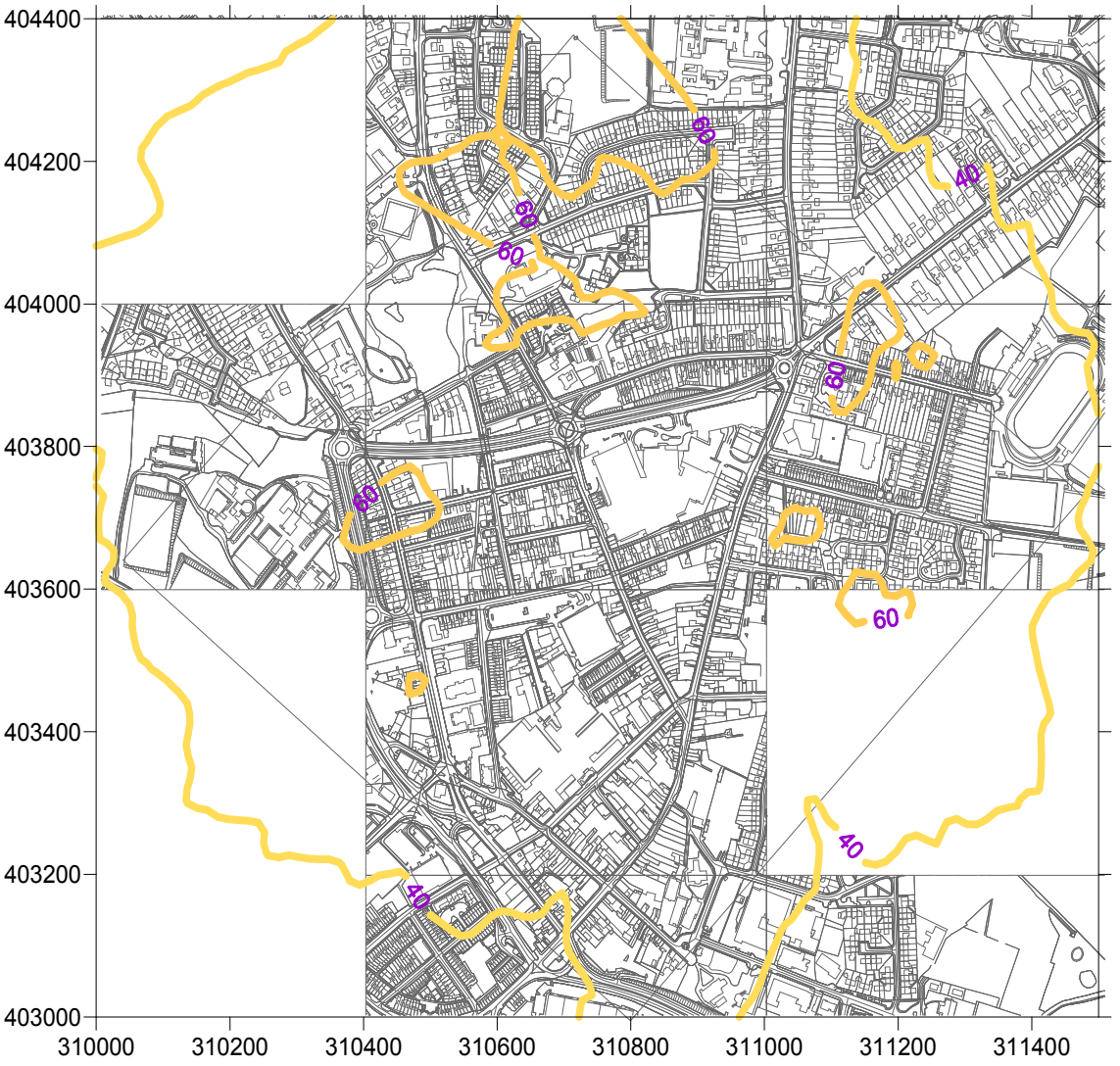


**Figure 4.8 Town Centre** – 2005 $SO_2$ 15 minute mean corrected modelled results (the bias factor was determined using monitoring data from Carrickfergus BC).




Contour units are in μg $m^{-3}$

**Figure 4.9 Ballykeel** – 2004 $PM_{10}$ 24h mean corrected modelled results (the bias factor was determined using monitoring data from Carrickfergus BC).

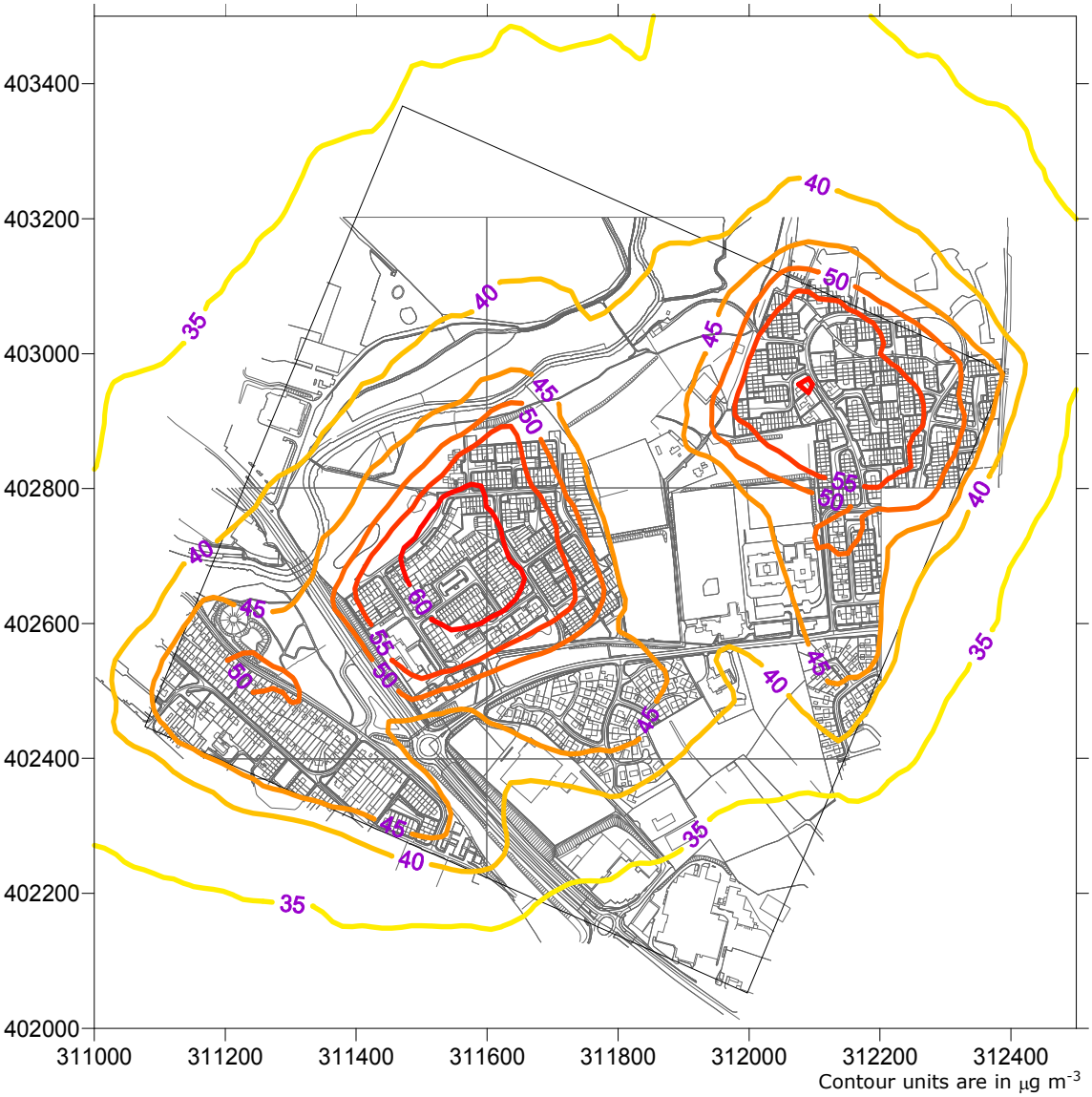


**Figure 4.10 Ballykeel** – 2005 $SO_2$ 15 minute mean corrected modelled results (the bias factor was determined using monitoring data from Carrickfergus BC).

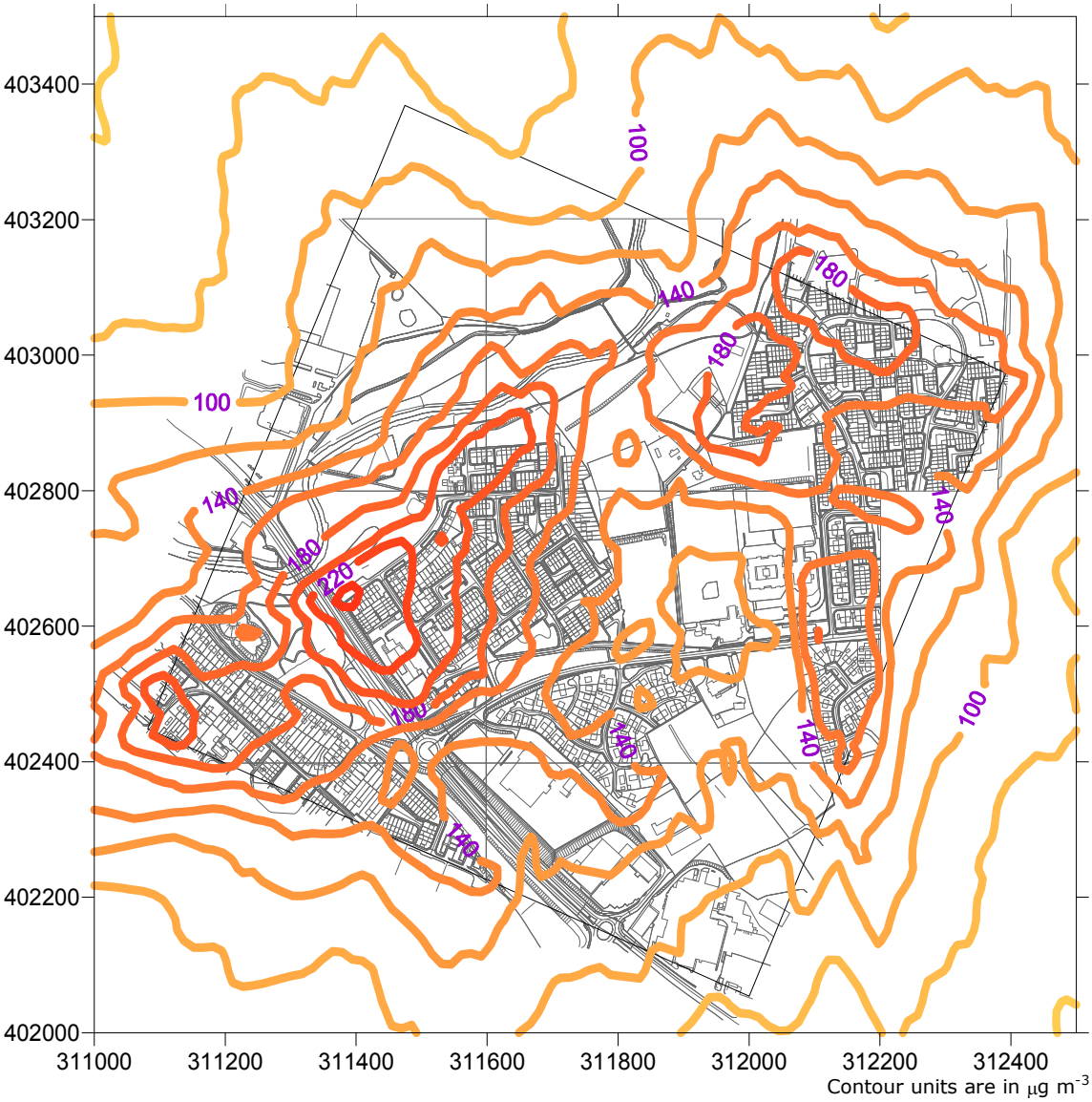
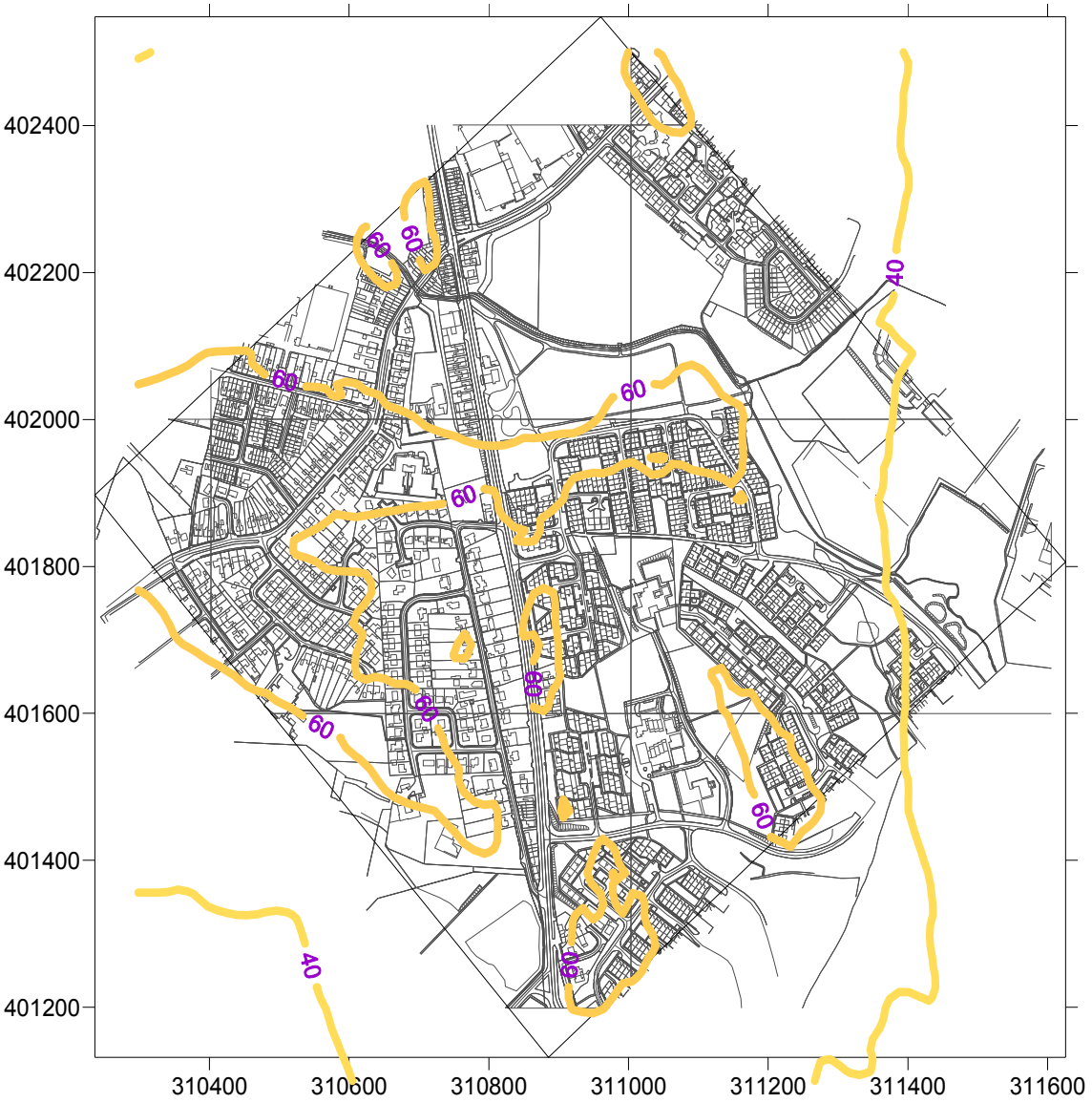


**Figure 4.11 Ballee** – 2004 $PM_{10}$ 24h mean corrected modelled results (the bias factor was determined using monitoring data from Carrickfergus BC).

**Figure 4.12 Ballee** – 2005 $SO_2$ 15 minute mean corrected modelled results (the bias factor was determined using monitoring data from Carrickfergus BC).




Contour units are in μg $m^{-3}$

# 4.7 DISCUSSION

## 4.7.1 $PM_{10}$

The areas have been modelled so that the contours can be directly compared with the $PM_{10}$ daily mean objective; 50$\mu gm^{-3}$ with 35 exceedences. Simply this means that when looking at the plots, if there are any contours at a location showing concentration over 50$\mu gm^{-3}$, then there is predicted to be an exceedence of the objective.

It can be seen from figures 4.5 and 4.7 that the daily mean objective will be exceeded in Dunclug and Ballykeel. The exceedences correlated to the areas of higher density housing and high percentage coal burning areas. There is one area in Dunclug and two in Ballykeel showing concentrations higher than 50$\mu gm^{-3}$ indicating exceedence of the $PM_{10}$ daily average objective.

Figures 4.1, 4.3, 4.7 and 4.11, show that there are no predicted exceedences in Cullybackey, Ahoghill, Ballymena Town Centre and Ballee.

## 4.7.2 $SO_2$

The areas have been modelled so that the contours can be directly compared with the $SO_2$ 15 minute objective; 266$\mu gm^{-3}$. Simply this means that when looking at the plots, if there are any contours shows a location with concentration over 266$\mu gm^{-3}$ 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 any of the six grids (see figure 4.2, 4.4, 4.6, 4.8, 4.10 and 4.12).

# 5 Conclusions

## 5.1 PARTICULATE MATTER ($PM_{10}$)

The detailed modelling has shown that $PM_{10}$ emissions arising from domestic fuel combustion in Ballymena Borough Council are likely to cause an exceedence of the air quality objective within Dunclug and Ballykeel 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 Ballymena Borough Council are not predicted to cause an exceedence of the air quality objective within any of the six grids.

# 6 Recommendations

The modelling shows that an exceedence of the daily $PM_{10}$ objective is possible under certain meteorological conditions conducive to poor dispersion. 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.

Domestic fuel combustion is believed to be the only significant source in the localised area and is the only source modelled. Therefore for source apportionment it is reasonable to conclude that domestic fuel combustion is the cause of the exceedence, composing the background contribution and the domestic fuel combustion contribution.

The reduction in concentration required to meet the Air Quality Objective for $PM_{10}$ is a reduction of approximately $10\mu g\ m^{-3}$ in Dunclug and Ballykeel.

Since modelling, $SO_2$ monitoring has been undertaken for a location relevant to domestic fuel combustion in the modelled area. However this location is relevant but not ideally located within the areas of predicted highest concentrations, and not at an ideal location from the point of view of relevant receptors. Therefore it is recommended that the monitor be relocated within the grid area.

As explained in LAQM TG (03), monitoring campaigns are expected to give a more accurate indication of $PM_{10}$ concentrations than modelling studies. As there is currently no $PM_{10}$ monitoring with which to verify the model it is recommended that alongside a relocated $SO_2$ monitor a $PM_{10}$ monitor is also installed. The monitoring location should be suitable according to the criteria stipulated in paragraph 8.24 of the technical guidance.

This modelling should be revisited and considered again, in the action planning and further assessment phase, using any newly available monitoring data suitable for model verification. The model bias adjustment can then be recalculated using the local monitoring data. As detailed in paragraph 7.41 of LAQM TG (03), it is essential to carry out model verification using monitoring data, and while this has been done in this study, it would be preferable to use a local monitoring study for model verification. Consideration could also be given to improving the reliability and coverage of the fuel use survey during the further assessment.

Following localised model verification, should an exceedence still be predicted, further modelling of possible fuel use change scenarios should be carried out. Scenario modelling would provide information on the quantity of emissions reduction that different 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.

# References

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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.

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Ballymena BC, Ballymena BC Fuel Use Survey 2001/2003

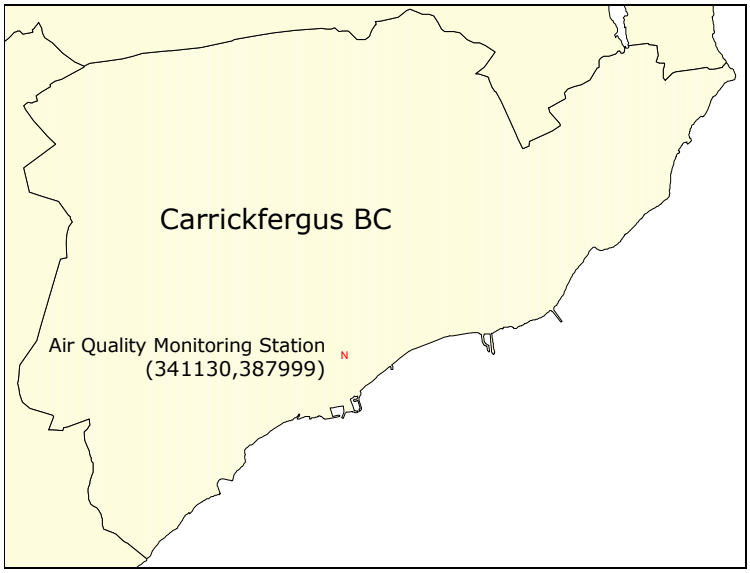
# Appendices

## 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**

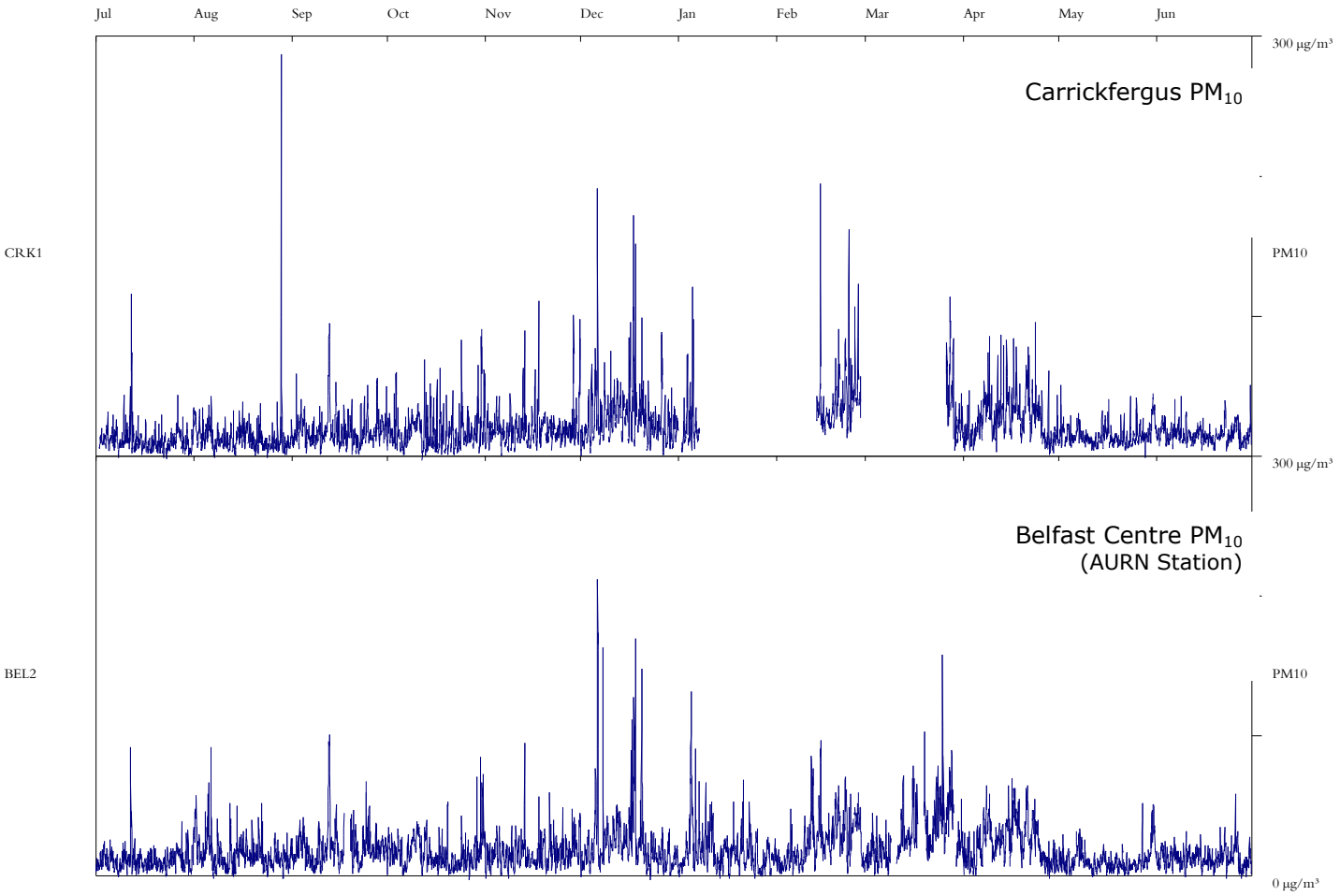
| POLLUTANT | $SO_2$ | $PM_{10}$ | $GR_{10}$ |
|---|---|---|---|
| Maximum 15-minute mean | 237 µg $m^{-3}$ | 574 µg $m^{-3}$ | 746 µg $m^{-3}$ |
| Maximum hourly mean | 186 µg $m^{-3}$ | 287 µg $m^{-3}$ | 373 µg $m^{-3}$ |
| Maximum running 24-hour mean | 57 µg $m^{-3}$ | 59 µg $m^{-3}$ | 77µg $m^{-3}$ |
| 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 | - |

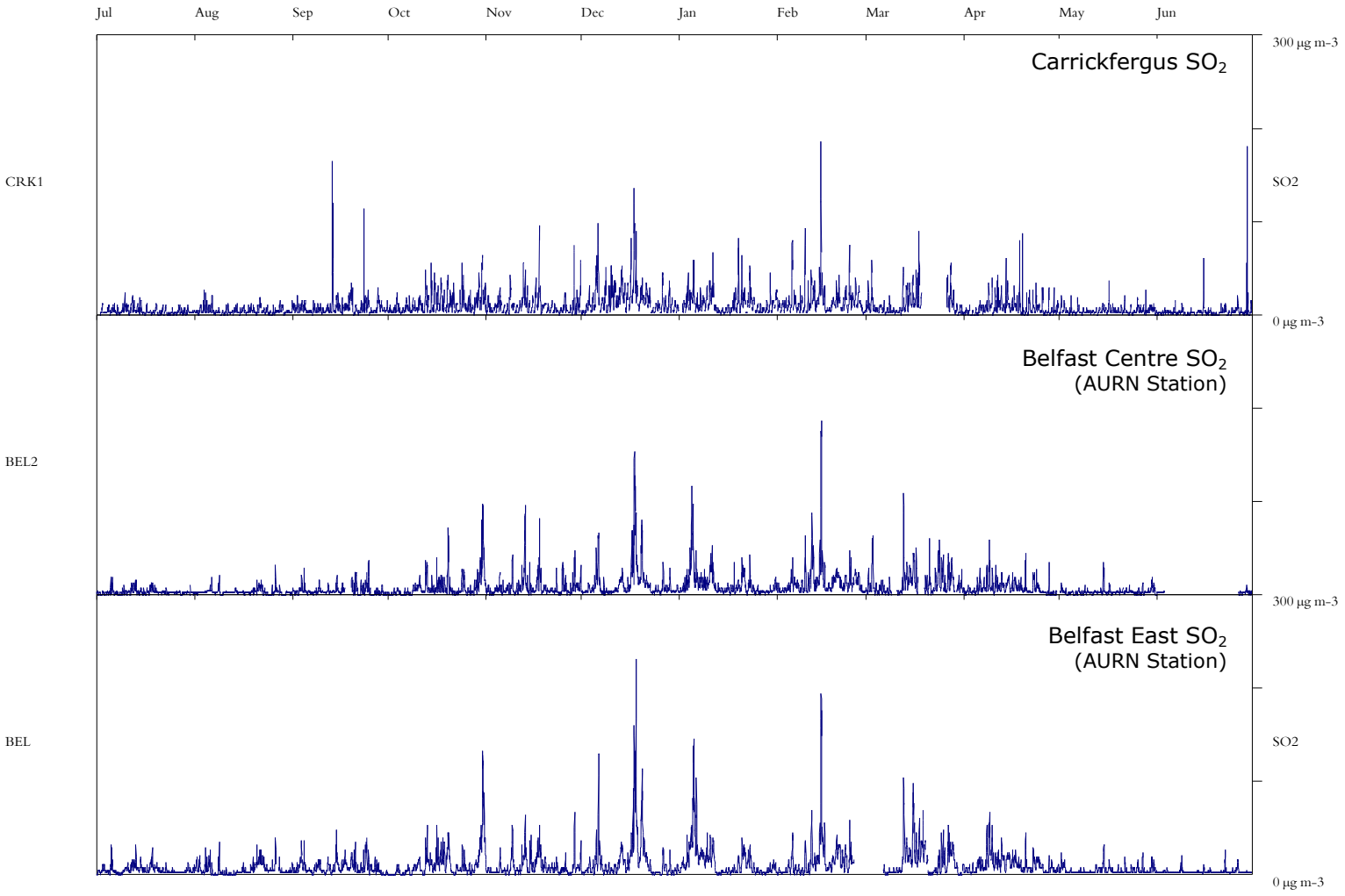
Note: A factor of 1.3 has been used to correct TEOM $PM_{10}$ to gravimetric equivalent $PM_{10}$ ($GR_{10}$ in Table 1)

## 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

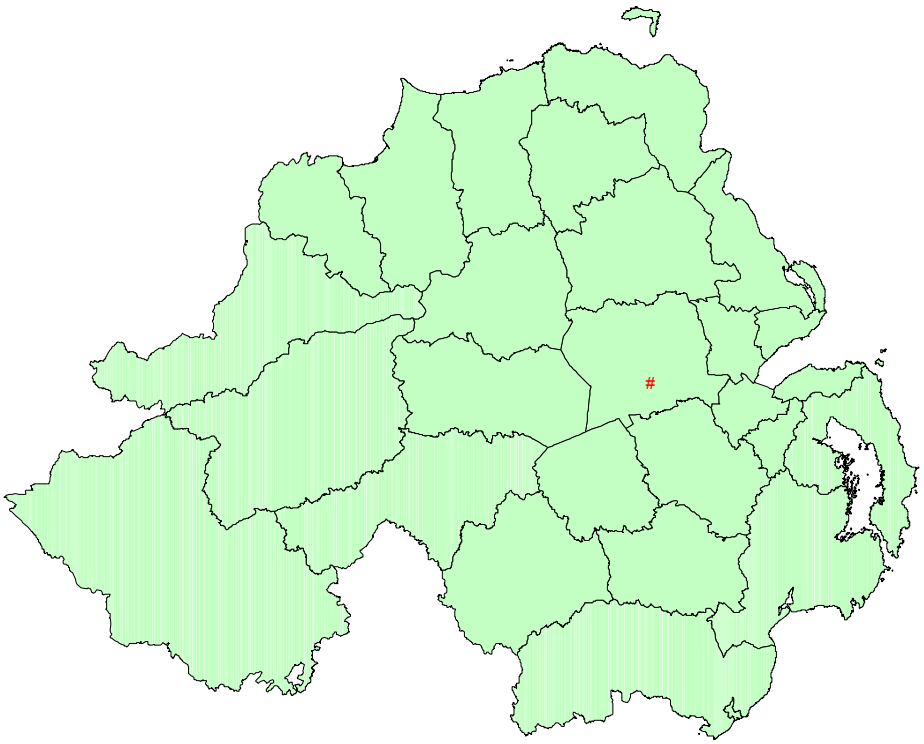
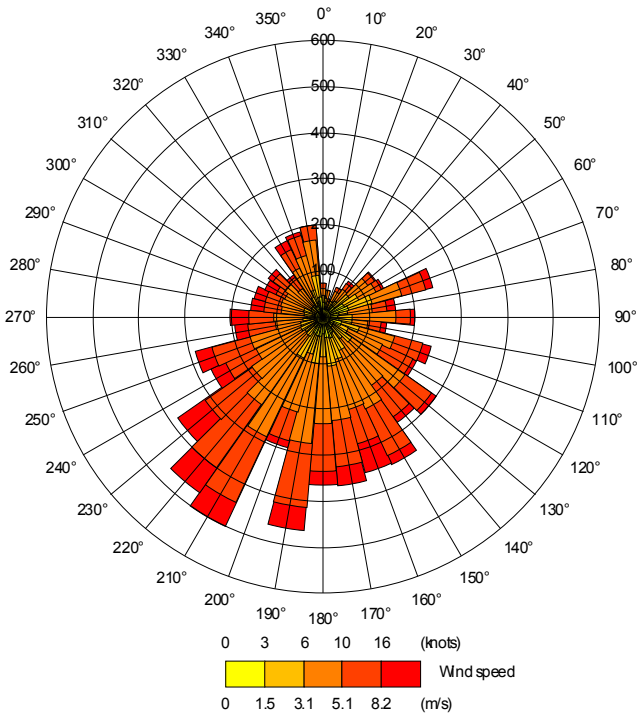


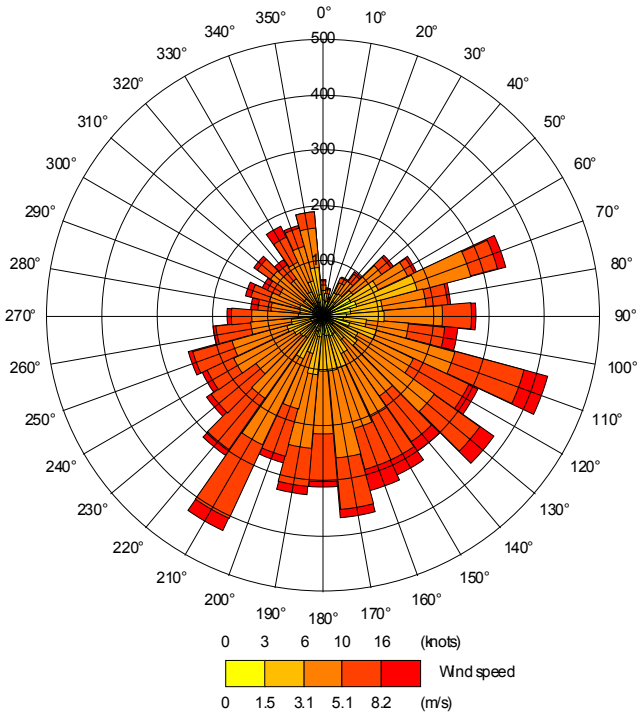

**Figure A2- Location of Aldergrove Station**

**Table A2 - Characteristics of Aldergrove Station**

| **Description – Aldergrove International airport.** | |
|---|---|
| **DCNN** | 9142 |
| **Eastings** | 314700 |
| **Northings** | 379800 |
| **Latitude Deg Min** | 54 39 N |
| **Longitude 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].

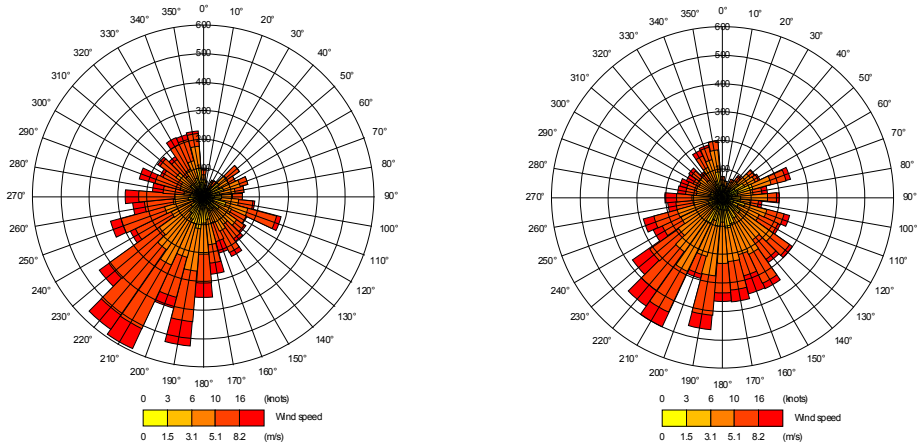



**Fig 1. Wind rose for the Aldergrove 1999 (left) and 2002 (right) met data**

[1] **Note that there are other factors affecting pollutant 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.

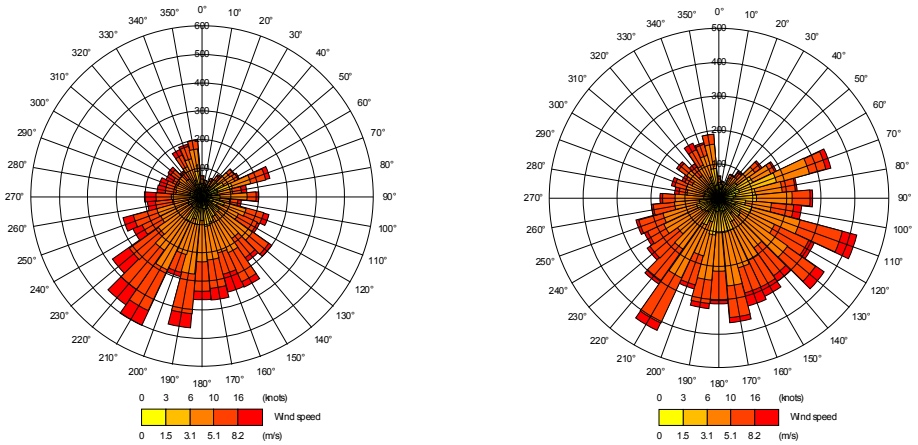
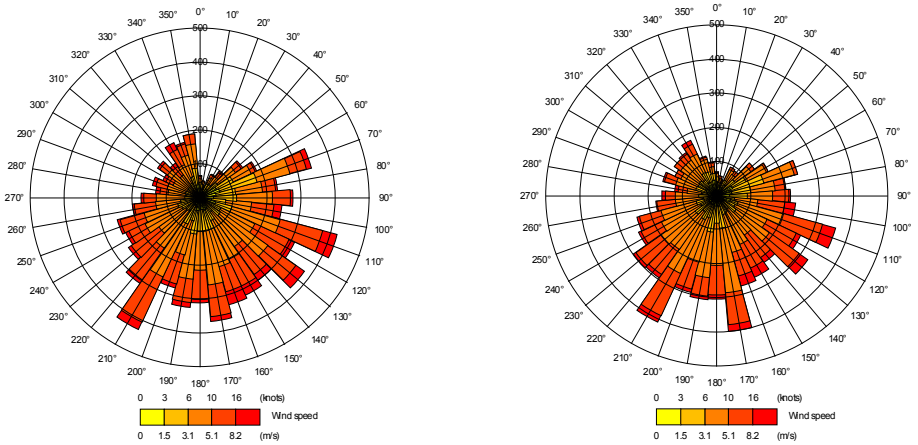



**Fig 2. Wind rose for 2002 met data (left) and july 2002 – June 2003 met data (right)**

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

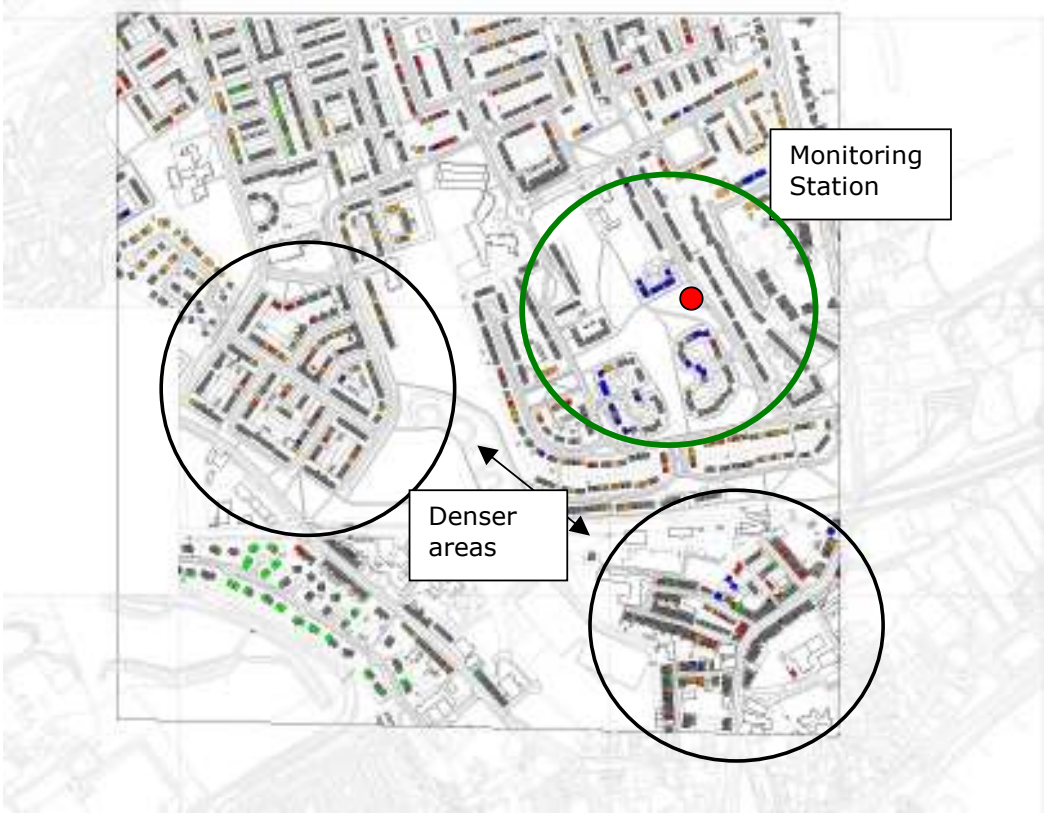
http://www.airquality.co.uk/archive/reports/list.php - forecasting reports) and were driven by transboundary $PM_{10}$.

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.




**2003 met data**