



## Air Quality Monitoring in Northern Ireland 2003



# Air Quality Monitoring in Northern Ireland, 2003

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A report produced for the Department of the  
Environment in Northern Ireland in partnership with  
the Chief Environmental Health Officers Group.

March 2005

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| <b>Title</b>                                       | Air Quality Monitoring in Northern Ireland, 2003   |
| <b>Customer</b>                                    | Department of the Environment in Northern Ireland  |
| <b>Customer reference</b>                          |  |
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| <b>File reference</b>                              | ED48289001/001   |
| <b>Report number</b>                               | AEAT/ENV/R/1868<br>ISBN 1-905127-13-8  |
| <b>Report status</b>                               | Issue 1  |

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**“Our aim is to protect and conserve the natural and built environment and to promote its appreciation for the benefit of present and future generations.”**

## ***Foreword***

*Air quality has been steadily improving in Northern Ireland in recent years. However, given both our improved understanding of the air pollution problem and our lifestyles, we need to be vigilant if this positive trend is to continue.*

*Since the publication of the first Air Quality Monitoring Report in 2002, a lot of progress has been made. The legal framework is now firmly established; and funding has been provided to enable District Councils to carry out their local air quality management responsibilities. The first round of review and assessment of local air quality is almost complete. Areas at risk of exceeding air quality objectives have been identified and declared as Air Quality Management Areas. Where such areas have been declared, Councils and Relevant Authorities are beginning to draw up local action plans aimed at delivering air quality improvements.*

*Government is reviewing the Air Quality Strategy. A revised strategy will be published later this year.*

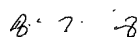
*The European Commission is reviewing air quality policy as part of the Clean Air for Europe (CAFÉ) programme. It is expected that the CAFÉ thematic strategy will be published by mid-2005; it will set out the Commission's policy framework for the period up to 2020.*

*This report draws on all the results of air quality monitoring in Northern Ireland and provides a comprehensive view of air quality in 2003. It has been drawn up by the Environment and Heritage Service and The Chief Environmental Health Officers Group.*

*We commend this Report to you and would welcome any comments you may have.*



*Richard Rogers  
Chief Executive Environment and Heritage Service*



*John Michael  
Chairman of the Chief Environmental Health Officers Group*

# Executive Summary

This report presents a summary of air quality monitoring in Northern Ireland over the calendar year 2003. It is intended to bring together in one report, results from all the District Councils and Government air quality monitoring sites in Northern Ireland over this period, both as part of larger monitoring networks and for other purposes. The report aims to provide information on the main pollutants of concern, details of the air quality monitoring undertaken in 2003, a summary of results for each pollutant, and an update on local air quality management.

Following the previous year's substantial increase in the number of monitoring sites in Northern Ireland, some further sites were commissioned during 2003. These were mostly intended to target areas where high pollutant concentrations were expected, and one new site, Dale's Corner in Londonderry, has highlighted a potential exceedence of an Air Quality Strategy (AQS) objective.

The AQS objectives for carbon monoxide, benzene and 1,3 butadiene have been met, by the due date of 31<sup>st</sup> December 2003, at each of the sites where they were monitored.

Carbon monoxide was monitored using automatic techniques at two sites (Belfast and Londonderry). Both met the EC 2<sup>nd</sup> Daughter Directive limit value and UK AQS objective for this pollutant in 2003.

Benzene was monitored at two sites, Belfast Centre and Belfast Roadside, using pumped tube samplers. Monitoring of 1,3-butadiene (using passive diffusion tubes) began at both sites in May 2003. Levels of both pollutants are within AQS objectives.

On the basis of results from 2003 and previous years, it is unlikely that Northern Ireland will have difficulty in meeting air quality objectives for sulphur dioxide or metallic elements. However, monitoring results indicate that the following pollutants may present a problem in meeting air quality objectives, in some parts of Northern Ireland: nitrogen dioxide, particulate matter as PM<sub>10</sub>, ozone, and polycyclic aromatic hydrocarbons.

2003 was an unusual year in terms of weather conditions and air pollution episodes (although it was not considered to be exceptional). Factors including a very hot, sunny summer, long-range transport of Saharan dust particles, and long-range transport of ozone and its precursors from mainland Europe, resulted in several episodes of poor air quality (particularly in the summer), with many sites recording high levels of oxides of nitrogen, PM<sub>10</sub>, and ozone.

Nitrogen dioxide was monitored using the automatic chemiluminescent technique at 14 sites. Results from some sites showed potential exceedences of AQS objectives. Belfast Westlink exceeded the 1<sup>st</sup> Daughter Directive limit and AQS objective of 200  $\mu\text{g m}^{-3}$  for the hourly mean more than the permitted 18 times during 2003. In addition, four sites exceeded the EC 1<sup>st</sup> Daughter Directive limit value and AQS objective for the annual mean nitrogen dioxide (40  $\mu\text{g m}^{-3}$ ). These were all roadside sites, near busy major roads: Belfast Westlink, Belfast Newtownards Road, Londonderry Dale's Corner, and Newry Trevor Hill. The Dale's Corner site began operation in November 2003, and data capture was just 11%. Further monitoring is therefore needed in order to accurately assess the annual mean, but 2004 data appear to confirm that this site may have difficulty meeting the annual mean NO<sub>2</sub> objective in 2005.

It is predicted that these four sites (and possibly other similar locations) may not meet the AQS objective for the annual mean by 2005. One (Belfast Westlink) may not meet the EC Daughter Directive limit value in 2010. However, these predictions may be pessimistic given that mean NO<sub>2</sub> levels were somewhat higher in 2003 than in previous recent years. Several sites showed higher concentrations of NO<sub>2</sub> in 2003 than in 2002, reflecting the generally higher levels of this pollutant measured throughout the UK.

Nitrogen dioxide was also monitored on a monthly basis using passive diffusion tube samplers at 260 sites in 2003. The EC 1<sup>st</sup> Daughter Directive limit value and AQS objective for the annual

mean ( $40 \mu\text{g m}^{-3}$ ) was exceeded at eighteen roadside diffusion tube sites in 2003. These sites were situated beside busy roads in both major urban centres and smaller towns. On the basis of the 2003 results, it is predicted that 13 of these sites may not meet the AQS objective for the annual mean by the required date of 2005. Two (in central Belfast) are predicted not to meet the EC Daughter Directive limit value in 2010.

Sulphur dioxide ( $\text{SO}_2$ ) was monitored using automatic techniques at 17 sites, of which three were new for 2003. All automatic sites met the 1<sup>st</sup> Daughter Directive limit values and AQS objectives. In particular, Belfast East met the AQS objectives for both the 15-minute mean and the 24-hour mean in 2003, only the second year in which it has done so. Where data were available for comparison, annual mean  $\text{SO}_2$  concentrations for 2003 were similar to those measured in 2002 or slightly higher.

The number of sites monitoring suspended particulate matter as  $\text{PM}_{10}$  increased from 18 to 23 during 2003. All sites except one (Newry, Trevor Hill) met the AQS objective of  $40 \mu\text{g m}^{-3}$  for the annual mean  $\text{PM}_{10}$ , as gravimetric equivalent. Four sites exceeded the AQS objective of  $50 \mu\text{g m}^{-3}$  (gravimetric equivalent) for the 24-hour mean on more than the permitted 35 occasions. These were Armagh Lonsdale Road, Belfast Westlink, Newry Trevor Hill and Strabane Springfield Park. The first three of these are close to busy or congested roads, the fourth is on a housing estate where solid fuel use is prevalent, and dispersion can be poor.

Ozone was monitored at four sites: three using automatic techniques (Belfast, Londonderry and the rural Lough Navar) and one using diffusion tubes (in Fermanagh). Londonderry exceeded the target value of the AQS objective on more than the permitted ten days. This is the third time in four years that the Londonderry site has exceeded this objective. However, ozone is a transboundary pollutant and not easy to control by local action.

Polycyclic aromatic hydrocarbons were monitored at two sites: Lisburn Dunmurry and Belfast Clara Street. The 2003 annual mean benzo(a)pyrene (B(a)P) concentration at Belfast Clara Street was considerably lower than the previous year's value. The Belfast site met the new AQS objective of  $0.25 \text{ ngm}^{-3}$ . However, B(a)P concentrations at Lisburn Dunmurry remained considerably higher than those measured at most urban sites in the network, and above the AQS objective (which is to be met by 2010). The major source of PAH around Lisburn is the widespread use of domestic solid fuels.

Twenty-five District Councils in Northern Ireland have now completed the first round of review and assessments of local air quality. Nine Councils have identified areas that are likely to exceed Air Quality Objectives of which six have now declared those areas as Air Quality Management Areas. A further two councils, Ards and Derry, have indicated their intention to declare. These areas have been designated officially by means of an "order". Armagh have submitted further information and have indicated that they will not be declaring an AQMA. At the time of writing, Newry and Mourne City Council had still to complete their first round assessment of local air quality.

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# 1 Introduction

## 1.1 BACKGROUND

This report on air quality monitoring in Northern Ireland has been produced for the Department of the Environment, by **netcen** (an operating division of AEA Technology Environment). It contains information on monitoring carried out in Northern Ireland on behalf of Government and by District Councils during 2003. There are now a considerable number of air quality monitoring sites established across Northern Ireland, a significant number of which are incorporated into large-scale national networks such as the Automatic Urban and Rural Network, and Non-Automatic Networks. Data from these sites are reported together with data from the considerable number of other monitoring sites operated by Northern Ireland's District Councils.

Much of Northern Ireland is rural, and in such areas air quality is usually good. However, urban localities experience generally higher levels of pollution. Historically, there has been limited availability of natural gas in Northern Ireland; as a result, domestic use of coal, solid fuels and oil has remained relatively widespread. Therefore, levels of pollutants associated with domestic solid fuel burning, such as particulate matter (smoke and PM<sub>10</sub>) and sulphur dioxide (SO<sub>2</sub>), can be particularly high in parts of Northern Ireland. Oxides of nitrogen (NO and NO<sub>2</sub>) are also pollutants of concern in some urban areas; the dominant source of these pollutants is likely to be motor vehicles. In rural areas, ozone episodes can be a problem (particularly during hot weather). Now that the majority of District Councils have completed their first round of Review and Assessment reports, the pollutants of concern in each District have been highlighted, and Air Quality Management Areas declared where necessary.

## 1.2 OBJECTIVES

Air quality monitoring in Northern Ireland is carried out by various District Councils and other bodies. Techniques used range from simple passive samplers to sophisticated automatic analysers. Some monitoring sites are part of larger networks; others are not. This report aims to bring together all air quality monitoring data obtained for Northern Ireland in 2003. It is intended to assist District Councils in their ongoing Review and Assessments of local air quality by:

- providing information on the main pollutants of concern,
- setting out details of the air quality monitoring undertaken in 2003, including details of new monitoring sites which began operation during this year,
- comparing the monitoring data obtained by the District Councils with applicable limit values and objectives, and
- presenting a brief summary of trends, based on historical data from the long-running monitoring sites.

It is not intended that this report will make specific comment or recommendations on air quality monitoring in Northern Ireland. The need for additional monitoring within individual District Council areas should be identified as part of the ongoing Review and Assessment process (referred to later). This report is intended to be primarily an update on developments in the field of air quality and a summary of air quality data across Northern Ireland for 2003.

## 2 Air Quality Developments

### 2.1 THE EUROPEAN UNION

The European Council Directive 96/62/EC on Ambient Air Quality Assessment and Management, (The Framework Directive), establishes a framework under which the EU will agree air quality limit values for specified pollutants in a series of 'Daughter Directives'. The structures established under the UK Air Quality Strategy and supporting legislation will provide principal means of implementing the UK's commitments under this Directive. So far, three Daughter Directives have been agreed:

The First Daughter Directive (1999/30/EEC), sets limit values for sulphur dioxide (SO<sub>2</sub>), oxides of nitrogen, particulate matter as PM<sub>10</sub>, and lead. It came into force on 19 July 1999 and was transposed into legislation by The Air Quality Limit Values Regulations (Northern Ireland) 2002.

The Second Daughter Directive (2000/69/EC) sets limit values for carbon monoxide (CO) and benzene. It came into force on 13 December 2000 and was transposed by The Air Quality Limit Values (Amendment) Regulations (Northern Ireland) 2002.

The Third Daughter Directive (or EC Ozone Directive, 2002/3/EC) sets target values for protection of human health and vegetation. It came into force on 12 February 2002. This Directive was transposed into legislation by The Air Quality (Ozone) Regulations (Northern Ireland) 2003

The Fourth Daughter Directive (2004/107/EC) covers the remaining pollutants listed in the Framework Directive. These pollutants are polycyclic aromatic hydrocarbons and the metallic elements cadmium, arsenic, nickel and mercury. Two years after publication the directive will be transposed into regulations. It is expected that work on regulations will begin during 2005.

#### 2.1.1 Clean Air for Europe (CAFÉ)

The European Commission is reviewing air quality policy as part of the Clean Air for Europe (CAFE) programme which is one of the thematic strategies under the European Union's 6<sup>th</sup> Environmental Action programme. It is expected that the CAFE thematic strategy will be published by mid 2005. The aim of the strategy is to establish a framework for European policy on air quality up to 2020.

### 2.2 THE AIR QUALITY STRATEGY

The first Air Quality Strategy (AQS) was published in 1997, setting out policies for the management of ambient air quality and thus fulfilling the requirement of the Environment Act 1995 for a national air quality strategy. Pollutants originally covered by the strategy were: benzene, 1,3-butadiene, carbon monoxide, lead, oxides of nitrogen, particulate matter (as PM<sub>10</sub>) and sulphur dioxide. The strategy sets out a strategic framework within which air quality policies will be taken forward in the short to medium term, and sets objectives to be met by 2005 for the air pollutants covered. The strategy was subsequently reviewed, and a revised Air Quality Strategy for England, Scotland, Wales and Northern Ireland was published in January 2000.

In February 2003, Defra and the Devolved Administrations published an addendum to the Air Quality Strategy. The addendum brings into line objectives for carbon monoxide and benzene with the limits set by the 2<sup>nd</sup> Daughter Directive. In addition, further provisional PM<sub>10</sub> objectives have been set for 2010 and for the first time, a provisional objective for polycyclic aromatic hydrocarbons (PAHs) has been added.

Following consultation on a PAH objective for Northern Ireland the Department of Environment in Northern Ireland issued a corrigendum to the Air Quality Strategy in 2003. The corrigendum sets a provisional air quality objective of 0.25ng m<sup>-3</sup> for Northern Ireland to be achieved by 2010.

Defra and the Devolved Administrations are currently reviewing the Air Quality Strategy. The focus of this review will be more on process and polices that work toward delivering air quality objectives. The review will also consider links to climate change and the concept of “gap closure”. It is expected that a draft revised strategy will be published for consultation during the summer of 2005.

## 2.3 LOCAL AIR QUALITY MANAGEMENT REVIEW AND ASSESSMENT

Under the Environment (Northern Ireland) Order 2002, District Councils in Northern Ireland are required to carry out a Review and Assessment of their local air quality. The process is set out in the Department of the Environment’s Local Air Quality Management Policy Guidance LAQM PGNI(03).

Twenty-five District Councils in Northern Ireland have now completed the first round of review and assessments of local air quality. Table 2.1 below provides a summary of the first round of review and assessment.

**Table 2.1 Summary of 1<sup>st</sup> Round of Review and Assessment**

| <b>Council</b>                      | <b>Pollutants Identified at 1<sup>st</sup> Stage requiring Stage 2 assessment</b> | <b>Pollutants Identified at 2nd Stage requiring Stage 3 assessment</b> | <b>Pollutants Identified at 3rd Stage at risk of exceeding Air Quality Objectives</b> | <b>AQMA Declared</b> |
|-------------------------------------|---|--|---|----------------------|
| <b>Antrim</b>                       | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | NO <sub>2</sub> ,SO <sub>2</sub>                                       | SO <sub>2</sub>   | Yes                  |
| <b>Ards</b>                         | PM <sub>10</sub> ,SO <sub>2</sub> , NO <sub>2</sub><br>CO                         | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                     | PM <sub>10</sub>  | No                   |
| <b>Armagh</b>                       | CO, Benzene<br>PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                 | PM <sub>10</sub> ,SO <sub>2</sub>                                      | PM <sub>10</sub>  | No                   |
| <b>Ballymena</b>                    | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                     | PM <sub>10</sub>  | Yes                  |
| <b>Ballymoney</b>                   | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub> ,SO <sub>2</sub>                                      | None  | No                   |
| <b>Banbridge</b>                    | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub>   | None  | No                   |
| <b>Belfast</b>                      | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub><br>CO, Lead                    | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                     | PM <sub>10</sub> ,NO <sub>2</sub>   | Yes                  |
| <b>Carrickfergus</b>                | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub> ,SO <sub>2</sub>                                      | PM <sub>10</sub>  | Yes                  |
| <b>Castlereagh</b>                  | PM <sub>10</sub> ,NO <sub>2</sub> ,SO <sub>2</sub><br>CO                          | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                     | None  | No                   |
| <b>Coleraine</b>                    | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub> ,SO <sub>2</sub>                                      | None  | No                   |
| <b>Cookstown</b>                    | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub> ,SO <sub>2</sub>                                      | None  | No                   |
| <b>Craigavon</b>                    | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | NO <sub>2</sub>  | None  | No                   |
| <b>Derry City</b>                   | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                     | NO <sub>2</sub>   | No                   |
| <b>Down</b>                         | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                |  | None  | No                   |
| <b>Dungannon &amp; South Tyrone</b> | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | NO <sub>2</sub>  | None  | No                   |
| <b>Fermanagh</b>                    | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub>   | None  | No                   |
| <b>Larne</b>                        | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                     | None  | No                   |
| <b>Limavady</b>                     | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub>   | None  | No                   |
| <b>Lisburn</b>                      | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                     | None  | No                   |
| <b>Magherafelt</b>                  | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                     | None  | No                   |
| <b>Moyle</b>                        | PM <sub>10</sub> ,SO <sub>2</sub>   | PM <sub>10</sub> ,SO <sub>2</sub>                                      | None  | No                   |
| <b>Newry</b>                        | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                     | Not Completed   | No                   |
| <b>Newtown-abbey</b>                | PM <sub>10</sub> ,SO <sub>2</sub> ,NO,<br>CO, Lead                                | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                     | PM <sub>10</sub>  | Yes                  |
| <b>North Down</b>                   | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                     | None  | No                   |
| <b>Omagh</b>                        | PM <sub>10</sub> ,SO <sub>2</sub> ,NO <sub>2</sub>                                | PM <sub>10</sub> ,SO <sub>2</sub>                                      | None  | No                   |
| <b>Strabane</b>                     | PM <sub>10</sub> ,SO <sub>2</sub>   | PM <sub>10</sub>   | PM <sub>10</sub>  | Yes                  |

Nine Councils have identified areas that are likely to exceed Air Quality Objectives of which six have now declared those areas as Air Quality Management Areas (AQMA). A further two councils,

Ards and Derry, have indicated their intention to declare. These areas have been, or will be designated officially by means of an "order". Table 2.2 provides summary information in relation to AQMA's. Armagh have submitted further information and indicated that they will not be declaring an AQMA. Newry have still to complete their first round assessment of local air quality.

**Table 2.2 District Council AQMAs**

| <b>Council</b>       | <b>Pollutant</b>                   | <b>Source</b> | <b>Date Declared</b> | <b>Number of Air Quality Management Areas</b> |
|----------------------|------------------------------------|---------------|----------------------|---|
| <b>Antrim</b>        | SO <sub>2</sub>                    | Domestic      | 31/10/04             | 1   |
| <b>Ards</b>          | PM <sub>10</sub>                   | Domestic      |                      | 1 (proposed)                                  |
| <b>Ballymena</b>     | PM <sub>10</sub>                   | Domestic      | 1/11/04              | 2   |
| <b>Belfast</b>       | NO <sub>2</sub> & PM <sub>10</sub> | Roads         | 31/8/04              | 4   |
| <b>Carrickfergus</b> | PM <sub>10</sub>                   | Domestic      | 7/9/04               | 2   |
| <b>Derry</b>         | NO <sub>2</sub>                    | Roads         |                      | 1 (proposed)                                  |
| <b>Newtownabbey</b>  | PM <sub>10</sub>                   | Domestic      | 26/10/04             | 1   |
| <b>Strabane</b>      | PM <sub>10</sub>                   | Domestic      | 30/6/04              | 3   |

### **2.3.1 Air Quality Management Action Plans**

District Councils are required under the Environment (NI) Order 2002 to prepare written action plans in pursuit of the achievement of air quality objectives in AQMA's. There is also however a responsibility on other relevant authorities to identify actions in pursuit of the achievement of air quality objectives so far as is compatible with their powers and functions. Relevant authorities include; DRD, DOE, DHSSPS, DETI, NIHE, the Northern Ireland Authority for Energy Regulation and District Councils.

### **2.3.2 Local Air Quality Management Progress Reports**

Statutory local air quality management progress report guidance LAQM PRG NI(04) was issued to all District Councils in Northern Ireland in November 2004. Progress reports are intended to check if there have been any changes in respect to all seven pollutants since the last round of the review and assessment process. District Councils will be expected to report any provisional monitoring data over the previous calendar year. The timetable set out in LAQM PRG NI (04) requires District Councils to submit progress reports to the Department by April 2005.

### **2.3.3 The Second Round of Review and Assessment**

The Department's policy guidance LAQM PGNI (03) sets out a revised two-stage process that follows the first round of review and assessment.

**Updating and Screening Assessment (USA)** for identifying those aspects that have changed since the first round of reviews and assessments, including lessons learnt from the first round that may require further assessment. The updating and screening assessment should include an explanation of the conclusion reached as to whether the District Council should proceed to a detailed assessment or not.

**Detailed Assessment (DA)** of those pollutants and specific locations that have been identified as requiring further work – i.e. where an exceedence of an air quality objective is likely, and members of the public are likely to be exposed over the averaging period of the relevant air quality objective.

The timetable for the second round of review and assessment is set out in the Department's policy guidance LAQM PGNI(03). Updating and screening reports are required to be submitted to the Department by April 2006.

## 2.4 MONITORING

Following the substantial increase, during 2002, in the number of monitoring sites, seven additional new automatic monitoring sites came into operation during 2003. These sites have been set up as a consequence of the Environment and Heritage Service Local Air Quality Grant Scheme. The grant scheme provided approximately £2.5M over 2001–2004 to support District Councils in their review and assessment of local air quality. The number of NO<sub>2</sub> diffusion tube sites remained roughly the same. During 2003, many District Councils in Northern Ireland continued to make a valuable contribution to national networks including the Automatic Urban and Rural Network (AURN), the Nitrogen Dioxide Network and Smoke and Sulphur Dioxide Network. Information on these monitoring networks can be found on the Air Quality Archive, at [www.airquality.co.uk](http://www.airquality.co.uk).

### **No monitoring of metallic air pollutants was undertaken in Northern Ireland during 2003.**

The most recent study in the region (reported in the 2000-2001 report in this series) involved the monitoring of five metals; lead (Pb), cadmium (Cd), arsenic (As), nickel (Ni), and mercury (Hg), at three sites over a 12-month period, December 1999 to November 2000. This monitoring was carried out by Casella Stanger on behalf of the Department of Environment, Transport and the Regions (now Defra), as part of a study investigating ambient concentrations of these metals around industrial emission sources. The three sites were all located near to power stations or large industrial plant. The study concluded that, even in industrial locations, ambient concentrations of these metallic pollutants were unlikely to constitute a problem.

## 2.5 QUALITY ASSURANCE AND QUALITY CONTROL

In the tables of site details in the subsequent sections of the report, sites belonging to the AURN and the Calibration Club will be indicated. (QA/QC procedures for Calibration Club sites are the same as for AURN sites, except that data ratification is carried out on a 6-monthly basis rather than 3-monthly).

Not all sites whose data are reported here belong to a larger network or to the Calibration Club, but it is assumed that in all cases the QA/QC specifications of the Local Air Quality Management Technical Guidance (LAQM TG(03)<sup>1</sup>) will have been followed.

### 3 Carbon Monoxide

Carbon monoxide (CO) is a pollutant gas generated by combustion sources. The dominant source is road transport, although domestic and other combustion processes contribute. At very high concentrations (such as may occur inside a building with a faulty heating appliance), it can be a dangerous asphyxiant. Whilst outdoor concentrations do not generally reach dangerous levels, they may still have adverse health effects for vulnerable people. As CO is a component of vehicle emissions, the highest outdoor concentrations occur near busy roads.

In this report, concentrations of carbon monoxide are expressed as milligrammes (i.e.  $10^{-3}$  grammes) per cubic metre ( $\text{mgm}^{-3}$ ). To convert to parts per million, if necessary, the following relationship should be used:

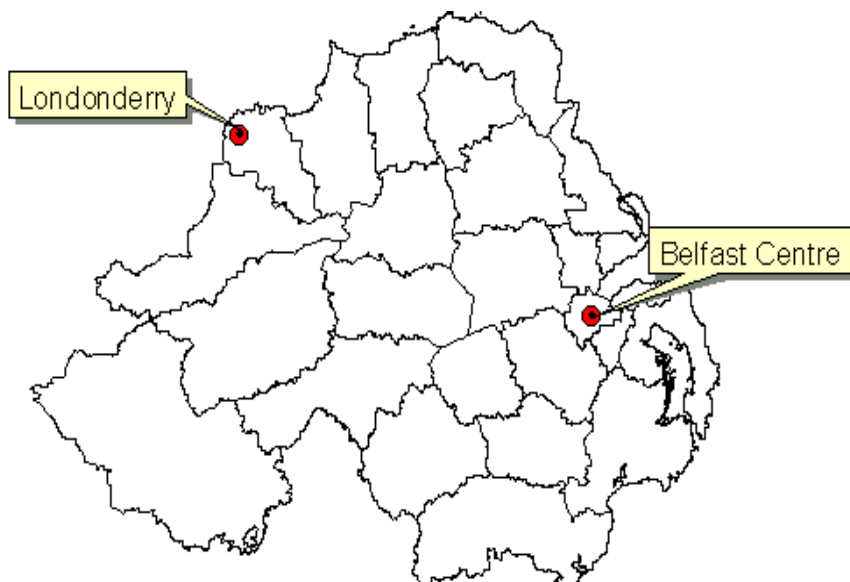
1 ppm =  $1.16 \text{ mgm}^{-3}$  for carbon monoxide at 293K (20°C) and 1013mb.

#### 3.1 MONITORING OF CARBON MONOXIDE

CO is monitored at two sites in Northern Ireland. They are part of the Automatic Urban and Rural Network (AURN) and use the Non-Dispersive Infra Red (NDIR) continuous monitoring technique. The sites are listed in Table 3.1, and their locations are shown in Figure 3.1.

**Table 3.1 CO Monitoring Sites**

| Site                      | Grid Reference | Classification   | Network |
|---------------------------|----------------|------------------|---------|
| Belfast Centre            | J 339 744      | Urban Centre     | AURN    |
| Londonderry (Brooke Park) | C 429 172      | Urban Background | AURN    |



**Figure 3.1 CO Monitoring Sites in Northern Ireland, 2003**

Figure 3.2 shows the Belfast Centre automatic monitoring site at Lombard Street, a typical example of an automatic AURN site used to monitor CO and other pollutants.



**Figure 3.2 Belfast Centre AURN Monitoring Site**

## 3.2 LIMIT VALUES AND OBJECTIVES FOR CARBON MONOXIDE

The World Health Organisation has established non-mandatory air quality guidelines for carbon monoxide. Within the European Community, CO is covered by EC Directive 2000/69/EC (the 2<sup>nd</sup> Daughter Directive). In the UK, the Air Quality Strategy contains an objective for CO, to be met by 31<sup>st</sup> December 2003. (The term "maximum daily 8-hour running mean" just means that the 8-hour period can be any 8 hours during the day – the start and end times are not specified. It is identical to "maximum running 8-hour mean".)

**Table 3.2 Limit Values and Objectives for Carbon Monoxide**

| Averaging period   | EC Limit or AQS Objective         | No. of Permitted exceedences | To be achieved by              |
|--|-----------------------------------|------------------------------|--------------------------------|
| <b>WHO (non-mandatory)</b>   |                                   |                              |                                |
| 15-minute  | 100 mgm <sup>-3</sup>             | -                            | -                              |
| 30-minute  | 60 mgm <sup>-3</sup>              | -                            | -                              |
| 1-hour   | 30 mgm <sup>-3</sup>              | -                            | -                              |
| 8-hour   | 10 mgm <sup>-3</sup>              | -                            | -                              |
| <b>EC 2<sup>nd</sup> Daughter Directive (2000/69/EC)</b>               |                                   |                              |                                |
| Max. Daily 8-hour mean   | 10 mgm <sup>-3</sup><br>(8.6 ppm) | -                            | 1 <sup>st</sup> January 2005   |
| <b>Air Quality Strategy (as currently adopted in Northern Ireland)</b> |                                   |                              |                                |
| Max running 8-hour mean  | 10 mgm <sup>-3</sup><br>(8.6 ppm) | -                            | 31 <sup>st</sup> December 2003 |



### 3.3 CARBON MONOXIDE RESULTS

The results from the CO measuring sites are shown in Table 3.3 below. Annual data capture is shown as a percentage. (The historic dataset is shown in Appendix 2).

**Table 3.3 Results from Automatic CO Monitoring Sites, 2003**

| Calendar Year  | Data Capture % | Annual Mean $\text{mg m}^{-3}$ | Max running 8-Hour Mean $\text{mg m}^{-3}$ | Number of Exceedences of EC Limit Value | Number of Exceedences of AQS Objective |
|----------------|----------------|--------------------------------|--|---|--|
| Belfast Centre | 79             | 0.2                            | 2.7  | 0                                       | 0                                      |
| Londonderry    | 98             | 0.2                            | 1.7  | 0                                       | 0                                      |

Both sites currently meet the EC 2<sup>nd</sup> Daughter Directive limit value, and have achieved the Air Quality Strategy objective for this pollutant, with maximum daily running 8-hour mean below  $10 \text{ mgm}^{-3}$  since 1996. It should be noted that the sites have achieved the AQS objective by the due date of 31<sup>st</sup> December 2003.

### 3.4 CARBON MONOXIDE TRENDS

Figure 3.3 illustrates the falling trend in maximum 8-hour running mean CO concentration for the two sites. Peak CO concentrations at both sites have decreased since the mid 1990s, despite a slight increase in 2001.

Trends are often shown more clearly by statistics based on longer periods, such as the annual mean. Figure 3.4 shows how the annual mean CO concentrations at the same sites have decreased since the early and mid 1990s. Both sites recorded a decrease between 2001 and 2002, after several years when annual mean CO concentrations had remained static. Based on a regression analysis (Theil's non-parametric regression analysis), there is a significant downward trend in the annual mean carbon monoxide concentration at both sites.

Emission inventory data for the UK (although not for Northern Ireland alone) are available from the National Atmospheric Emissions Inventory (NAEI), on the World Wide Web at [www.naei.org.uk](http://www.naei.org.uk). Total UK emissions of carbon monoxide have reduced by 63% between 1990 and 2002, and the downward emission trend shows no sign of flattening off in recent years. An emission inventory study of Greater Belfast<sup>2</sup>, based on 1997 data, calculated that around 23% of Belfast's CO emissions arise from domestic combustion; a much larger proportion than in other UK cities (for example around 10% in Swansea and Port Talbot<sup>3</sup>, and less than 2% in Merseyside, Bristol and Southampton<sup>3</sup>) However, Belfast's total CO emissions are still dominated by road traffic (75%), and total UK emissions from domestic combustion are decreasing.

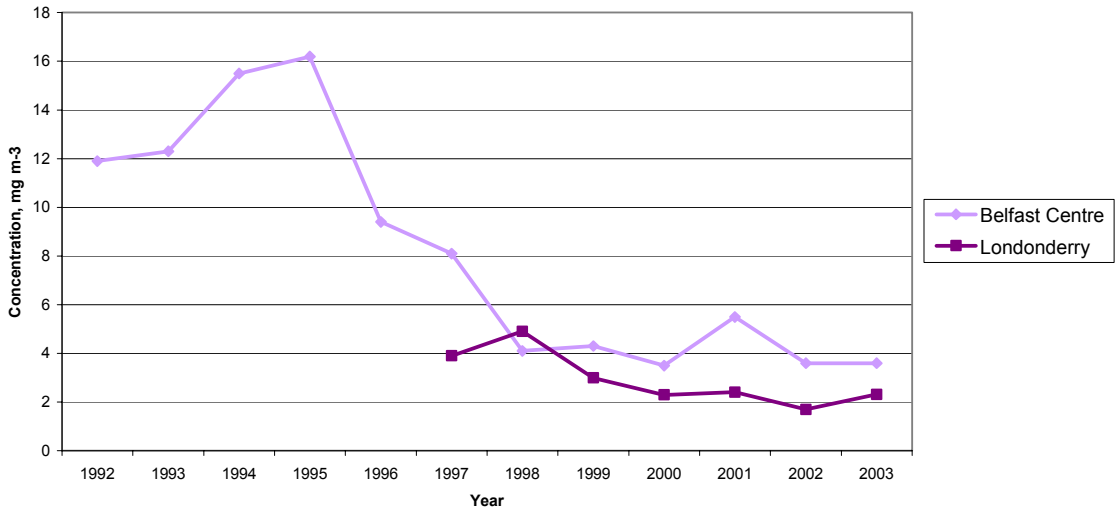


Figure 3.3 Maximum Running 8-hour Mean CO Concentration

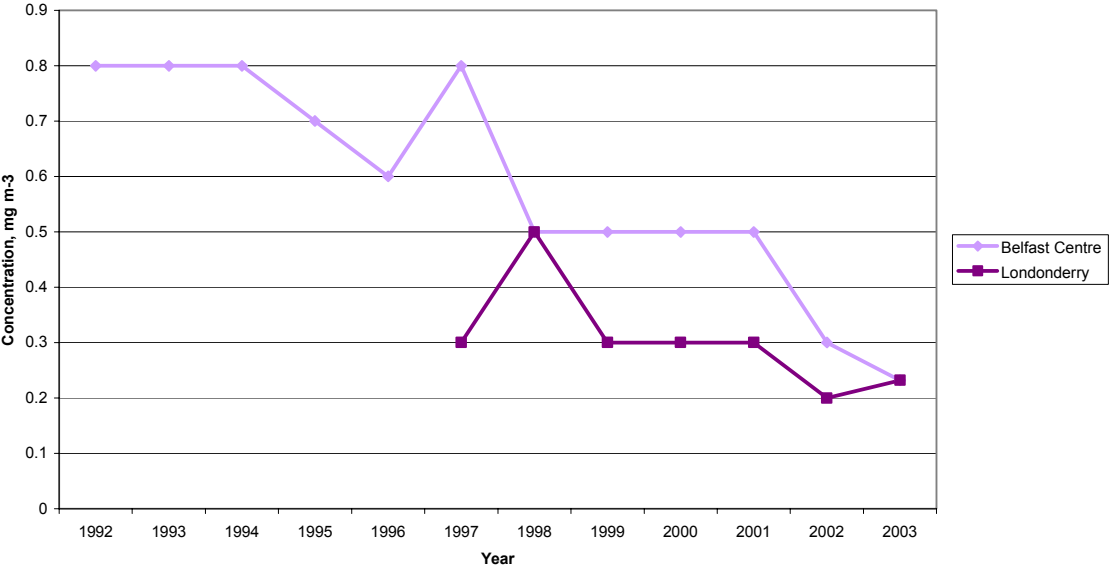


Figure 3.4 Annual Mean CO Concentrations

## 4 Nitrogen Dioxide

Combustion processes (including vehicle engines) emit a mixture of nitrogen dioxide (NO<sub>2</sub>) and nitric oxide (NO). This mixture of oxides of nitrogen is collectively termed NO<sub>x</sub>. NO is subsequently oxidised to NO<sub>2</sub> in the atmosphere. NO<sub>2</sub> is an irritant to the respiratory system, and can affect human health. Ambient concentrations of NO<sub>2</sub> are likely to be highest in the most built-up areas, especially where traffic is congested, or buildings either side of the street create a “canyon” effect, impeding the dispersion of vehicle emissions.

In this report, concentrations of nitrogen dioxide are expressed as microgrammes (i.e. 10<sup>-6</sup> grammes) per cubic metre (µg m<sup>-3</sup>). To convert to parts per billion (ppb) if necessary, the following relationship should be used:

1 ppb = 1.91 µg m<sup>-3</sup> for nitrogen dioxide at 293K (20°C) and 1013mb.

### 4.1 MONITORING OF NITROGEN DIOXIDE

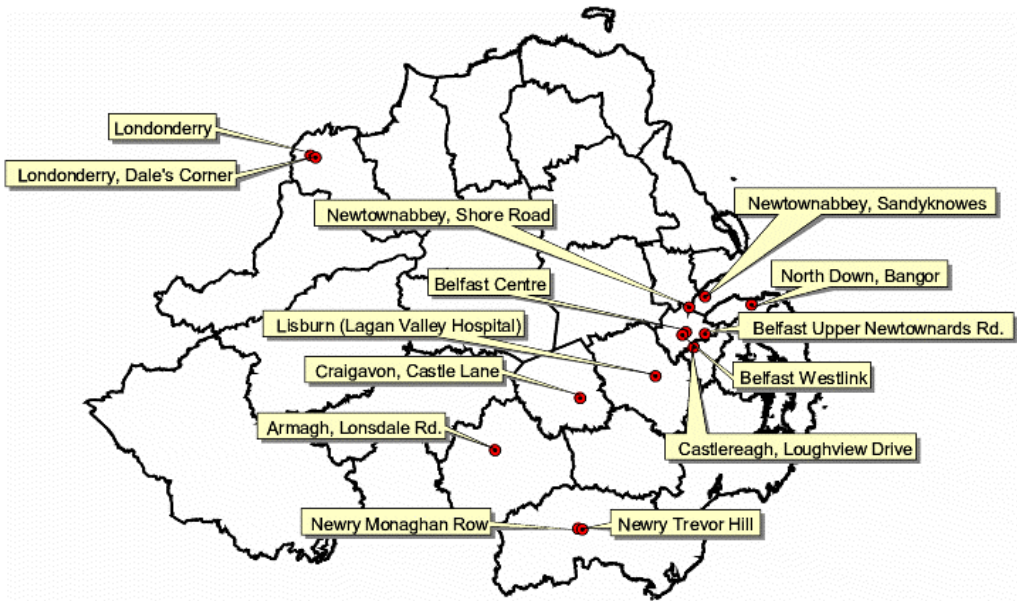
Monitoring of NO<sub>2</sub> is carried out by two methods; automatic NO<sub>x</sub> analysers and NO<sub>2</sub> diffusion tubes. Automatic analysers are based on the chemiluminescent method, and provide continuous monitoring of NO, NO<sub>2</sub> and total NO<sub>x</sub>. The results can be directly compared with air quality objectives based on short-term measurements such as the hourly mean. This technique is the reference method for the EC 1<sup>st</sup> Daughter Directive. However, this automatic equipment is expensive and is commonly supplemented by a low-cost indicative method, diffusion tubes. These are passive samplers, which work by absorbing the pollutant direct from the surrounding air and need no power supply. Tubes are exposed for periods of typically 2-5 weeks, providing an average result for the exposure period. Although diffusion tube data cannot be compared directly with air quality limit values based on short-term averages, the low cost of diffusion tubes means they can be used to give wide spatial coverage, and are useful for screening studies, identifying areas with high mean concentrations of NO<sub>2</sub>, which can then be targeted for monitoring using more sophisticated techniques.

Four new automatic NO<sub>2</sub> monitoring sites started operation in Northern Ireland during 2003, taking the total number to fourteen. These are at Newtownabbey (Shore Road), Newtownabbey (Sandyknowes), Londonderry (Dale’s Corner) and Holywood, North Down. These new sites, like those set up in 2002, are mostly located at roadside locations, where levels of NO<sub>2</sub> are expected to be high. The sites are listed in Table 4.1, and their locations are shown in Figure 4.1. All of these sites use the chemiluminescent method

**Table 4.1 Automatic NO<sub>2</sub> Monitoring Sites**

| Site                            | Grid Ref. | Classification   | Network             |
|---------------------------------|-----------|------------------|---------------------|
| Belfast Centre, Lombard Street  | J 339 744 | Urban Centre     | AURN                |
| Armagh, Lonsdale Road           | H 876 458 | Roadside         | Armagh              |
| Belfast Westlink                | J 330 737 | Roadside         | Belfast             |
| Belfast, Upper Newtownards Rd.  | J 385 739 | Roadside         | Belfast             |
| Castlereagh, Loughview Drive    | J 357 707 | Roadside         | Castlereagh         |
| Craigavon, Castle Lane          | J 082 584 | Roadside         | Craigavon           |
| Holywood                        | J 396 792 | Roadside         | North Down          |
| Lisburn (Lagan Valley Hospital) | J 265 637 | Roadside         | Lisburn             |
| Londonderry, Brooke Park        | C 429 172 | Urban Background | AURN                |
| Londonderry, Dale’s Corner      | C 441 167 | Roadside         | Derry               |
| Newry, Monaghan Row             | J 078 268 | Urban Background | Newry & Mourne (CC) |
| Newry, Trevor Hill              | J 088 266 | Roadside         | Newry & Mourne (CC) |
| Newtownabbey, Sandyknowes       | J 385 830 | Roadside         | Newtownabbey        |
| Newtownabbey, Shore Road        | J 347 804 | Roadside         | Newtownabbey        |

CC = Calibration Club sites.



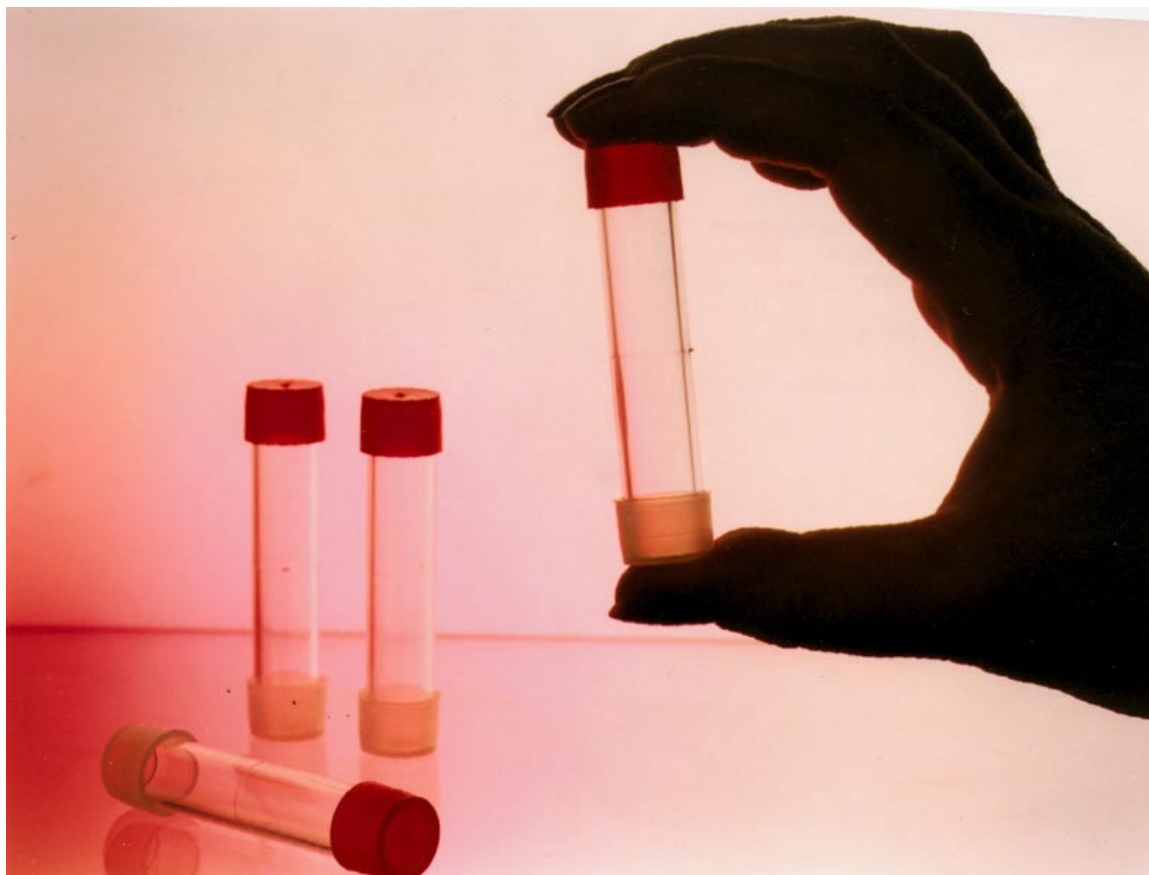
**Figure 4.1 Automatic NO<sub>2</sub> Monitoring Sites 2003**

One of the automatic NO<sub>2</sub> monitoring sites which began operation in 2003 was the roadside site at Shore Road, Newtownabbey: this new site is shown in Figure 4.2.



**Figure 4.2 New Automatic Monitoring site for NO<sub>x</sub>, Shore Road, Newtownabbey**

As mentioned above, many District Councils in Northern Ireland also carry out indicative monitoring of NO<sub>2</sub> using diffusion tubes, as pictured in Figure 4.3.



**Figure 4.3 NO<sub>2</sub> Diffusion Tubes**

District Councils usually operate several sites. Some District Councils participate in the national Nitrogen Dioxide Network, and submit monthly measurements from typically four locations within their area: two Roadside and two Urban Background. The total number of sites operated by each District Council, and the number belonging to the Nitrogen Dioxide Network, are listed in Table 4.2. The total number of NO<sub>2</sub> diffusion tube sites in 2003 was 260 (just three more than the previous year). As there are so many, full site details are provided in Appendix 1, Table A1.1.

**Table 4.2 Diffusion Tube NO<sub>2</sub> Monitoring Sites 2003**

| <b>District Council</b> | <b>Number of sites</b> | <b>Number belonging to NO<sub>2</sub> Network (as of 2003)</b> |
|-------------------------|------------------------|--|
| Antrim                  | 17                     | 0  |
| Ards                    | 4                      | 4  |
| Armagh                  | 8                      | 4  |
| Ballymena               | 13                     | 4  |
| Ballymoney              | 10                     | 4  |
| Banbridge               | 4                      | 4  |
| Belfast                 | 17                     | 4  |
| Carrickfergus           | 11                     | 3  |
| Castlereagh             | 5                      | 3  |
| Coleraine               | 9                      | 0  |
| Cookstown               | 5                      | 0  |
| Craigavon               | 8                      | 4  |
| Down                    | 8                      | 4  |
| Dungannon               | 5                      | 4  |
| Fermanagh               | 6                      | 0  |
| Larne                   | 8                      | 0  |
| Limavady                | 8                      | 0  |
| Lisburn                 | 8                      | 4  |
| Londonderry             | 18                     | 5  |
| Magherafelt             | 7                      | 0  |
| Moyle                   | 8                      | 0  |
| Newry & Mourne          | 8                      | 4  |
| Newtownabbey            | 41                     | 3  |
| North Down              | 8                      | 4  |
| Omagh                   | 11                     | 3  |
| Strabane                | 5                      | 0  |
| <i>TOTAL</i>            | <i>260</i>             | <i>65</i>  |

NO<sub>2</sub> diffusion tube monitoring sites in Northern Ireland are categorised as follows:

- **(A) Roadside;** 1-5m from the kerb of a busy road.
- **(B) Intermediate;** 20-30m from the same or equivalent busy road. (This site type is now less widely used than in earlier years).
- **(C) Urban Background;** >50m from any busy road and typically in a residential area.
- **(D) Rural Background;** sites > 50m from any busy road, in a rural area.
- **(E) Other;** usually monitoring sites related to a specific industrial source.

Locations of the NO<sub>2</sub> diffusion tube monitoring sites in the Roadside category are shown in Figure 4.4, and NO<sub>2</sub> diffusion tube monitoring sites in other categories are shown in Figure 4.5. These figures show the locations of sites operating in 2003.

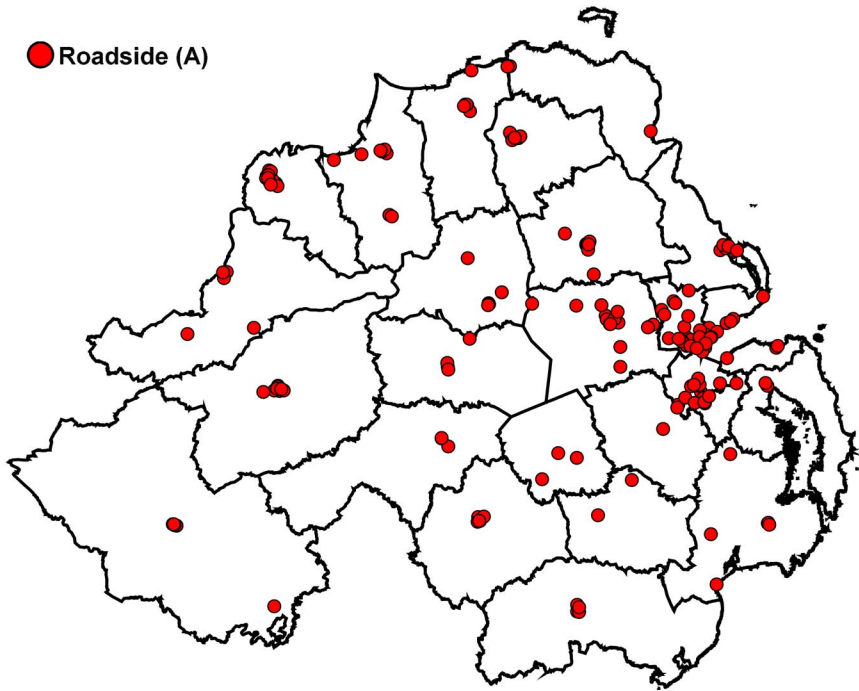


Figure 4.4 NO<sub>2</sub> Diffusion Tube Monitoring Sites 2003: Roadside

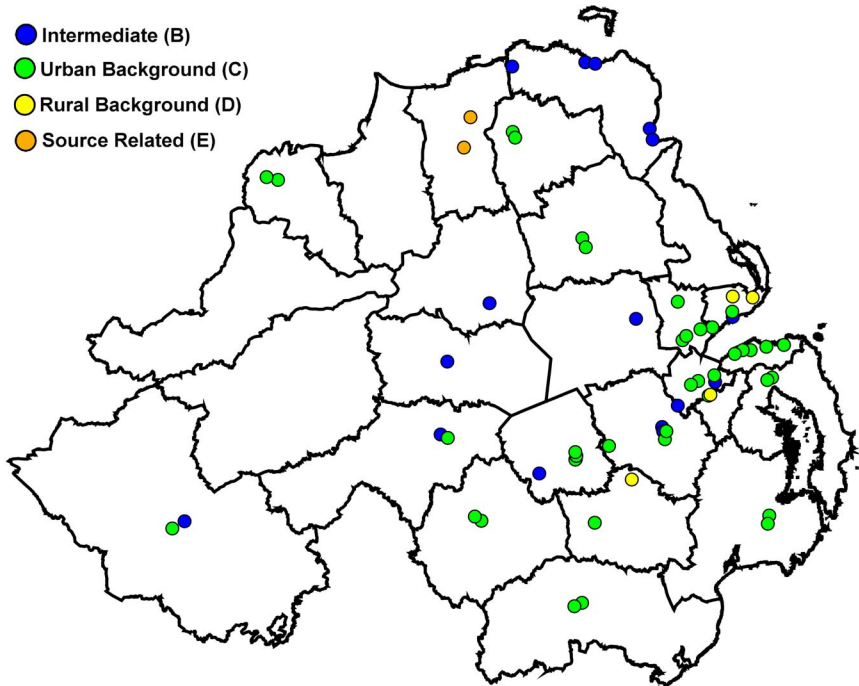


Figure 4.5 NO<sub>2</sub> Diffusion Tube Monitoring Sites 2003: Non-Roadside Categories

## 4.2 LIMIT VALUES AND OBJECTIVES FOR NITROGEN DIOXIDE

The World Health Organisation has set non-mandatory guide values for NO<sub>2</sub>. Within Europe, NO<sub>2</sub> is covered by the 1<sup>st</sup> Daughter Directive, 1999/30/EC. In the UK, the Air Quality Strategy sets objectives for this pollutant, for protection of human health and ecosystems. Limit values and objectives for NO<sub>2</sub> are shown in Table 4.3.

**Table 4.3 Limit Values and Objectives for Nitrogen Dioxide**

| Averaging period   | EC Limit or AQS Objective            | No. of Permitted exceedences | To be achieved by              |
|--|--------------------------------------|------------------------------|--------------------------------|
| <b>WHO (non-mandatory)</b>                               |                                      |                              |                                |
| 1 hour   | 200 $\mu\text{g m}^{-3}$             | -                            | -                              |
| Annual Mean  | 40 $\mu\text{g m}^{-3}$              | -                            | -                              |
| <b>EC 1<sup>st</sup> Daughter Directive (1999/30/EC)</b> |                                      |                              |                                |
| 1 hour   | 200 $\mu\text{g m}^{-3}$             | 18 per year                  | 1 <sup>st</sup> January 2010   |
| Annual Mean  | 40 $\mu\text{g m}^{-3}$              | -                            | 1 <sup>st</sup> January 2010   |
| Annual Mean, for protection of vegetation                | 30 $\mu\text{g m}^{-3}$<br>Total NOx | -                            | 19 <sup>th</sup> July 2001     |
| <b>Air Quality Strategy</b>                              |                                      |                              |                                |
| 1 hour   | 200 $\mu\text{g m}^{-3}$             | 18 per year                  | 31 <sup>st</sup> December 2005 |
| Annual Mean  | 40 $\mu\text{g m}^{-3}$              | -                            | 31 <sup>st</sup> December 2005 |
| Annual Mean, for protection of vegetation                | 30 $\mu\text{g m}^{-3}$<br>Total NOx | -                            | 31 <sup>st</sup> December 2000 |

## 4.3 AUTOMATIC NITROGEN DIOXIDE RESULTS

Table 4.4 below shows NO<sub>2</sub> results from the automatic monitoring sites in Northern Ireland. To keep the table to a manageable size, only 2003 data are tabulated here: statistics for previous years are provided in Appendix 2. Table 4.4 shows the relevant parameters for comparison with the Air Quality Strategy objectives:

- (i) percentage data capture for the year
- (ii) maximum one-hour mean
- (iii) the 19<sup>th</sup> highest one-hour mean during the year (18 exceedences are permitted, so if the 19<sup>th</sup> highest 1-hour mean is 200  $\mu\text{g m}^{-3}$  or less, the site meets the AQS 1-hour objective for NO<sub>2</sub>. Where the data capture is less than 90%, the 99.8<sup>th</sup> percentile of hourly means is shown instead, as specified by the Technical Guidance LAQM.TG(03)<sup>1</sup>.
- (iv) The number of hourly means greater than the hourly EC limit value and AQS objective, i.e. 200  $\mu\text{g m}^{-3}$
- (v) The annual mean, for which the EC limit value and AQS objective is 40  $\mu\text{g m}^{-3}$ .

Seven of the 14 sites achieved at least 90% data capture for 2003. Of those which did not, four were new sites, commissioned part way through the year. Data capture at Craigavon and Londonderry Dale's Corner was less than 20%: annual statistics from these sites may therefore not be representative and should be treated with caution.

Two sites, Armagh Lonsdale Road and Belfast Westlink, recorded one or more maximum hourly mean NO<sub>2</sub> concentrations greater than the 1<sup>st</sup> Daughter Directive limit and AQS objective of 200  $\mu\text{g m}^{-3}$  for the hourly mean. However, only Belfast Westlink exceeded this objective more than the permitted 18 times during 2003, with a total of 27 exceedences.

Where data capture is less than 90%, it is not valid to simply count the total number of exceedences of the 1-hour objective. Instead, according to the Technical Guidance<sup>1</sup> the 99.8<sup>th</sup> percentile of 1-hour means should be compared with the 1-hour NO<sub>2</sub> objective itself (200  $\mu\text{g m}^{-3}$ ). On this basis, the seven sites with less than 90% data capture all appeared to meet the AQS objective for 1-hour mean NO<sub>2</sub>.



Comparison with the hourly mean objective is illustrated in Figure 4.6 and 4.7. Figure 4.6 shows hourly mean data, compared with the AQS 1-hour objective of  $200 \mu\text{g m}^{-3}$ . The graph shows the maximum 1-hour mean and 19<sup>th</sup> highest (or 99.8<sup>th</sup> percentile where data capture is less than 90%) as bars, with the AQS objective of  $200 \mu\text{g m}^{-3}$  as horizontal line. A maximum of 18 exceedences of this objective are permitted in any one calendar year, so if the 19<sup>th</sup> highest 1-hour mean is greater than this value, the site has not met the objective in 2003. Figure 4.7 shows the actual number of 1-hour means which were greater than  $200 \mu\text{g m}^{-3}$ , compared with the maximum permitted total (18 per calendar year) as a horizontal line.

**Table 4.4 NO<sub>2</sub> Results from Automatic Monitoring Sites, 2003**

| Site                                    | 2003 Data Capture % | Highest 1-Hour Mean $\mu\text{g m}^{-3}$ | 19 <sup>th</sup> Highest 1-hour mean (or 99.8 <sup>th</sup> percentile of hourly means if DC < 90%) | No. of 1-hour means > $200 \mu\text{g m}^{-3}$ | Annual Mean $\mu\text{g m}^{-3}$ | Annual Mean > $40 \mu\text{g m}^{-3}$ ? |
|---|---------------------|--|---|--|----------------------------------|---|
| Armagh, Lonsdale Road                   | 98                  | 374                                      | 172   | 11   | 34                               | No                                      |
| Belfast Centre, Lombard Street          | 95                  | 170                                      | 109   | 0  | 32                               | No                                      |
| Belfast - Newtownards Road              | 96                  | 179                                      | 148   | 0  | <b>45</b>                        | <b>Yes</b>                              |
| Belfast - Westlink                      | 94                  | 258                                      | <b>210</b>  | <b>27</b>                                      | <b>53</b>                        | <b>Yes</b>                              |
| Castlereagh, Loughview Drive            | 63                  | 149                                      | 117   | 0  | 34                               | No                                      |
| Craigavon, Castle Lane                  | 18 *                | 94                                       | 75  | 0  | 22                               | No                                      |
| Holywood <sup>3</sup>                   | 70                  | 111                                      | 96  | 0  | 25                               | No                                      |
| Lisburn, Lagan Valley Hospital          | 78                  | 172                                      | 121   | 0  | 28                               | No                                      |
| Londonderry, Brooke Park                | 95                  | 96                                       | 73  | 0  | 17                               | No                                      |
| Londonderry, Dale's Corner <sup>1</sup> | 11 *                | 166                                      | 155   | 0  | <b>48</b>                        | <b>Yes</b>                              |
| Newry, Monaghan Row                     | 97                  | 98                                       | 84  | 0  | 20                               | No                                      |
| Newry, Trevor Hill                      | 91                  | 189                                      | 153   | 0  | <b>50</b>                        | <b>Yes</b>                              |
| Newtownabbey, Sandyknowes <sup>2</sup>  | 68                  | 164                                      | 119   | 0  | 30                               | No                                      |
| Newtownabbey, Shore Road <sup>2</sup>   | 70                  | 132                                      | 120   | 0  | 29                               | No                                      |

Footnotes:

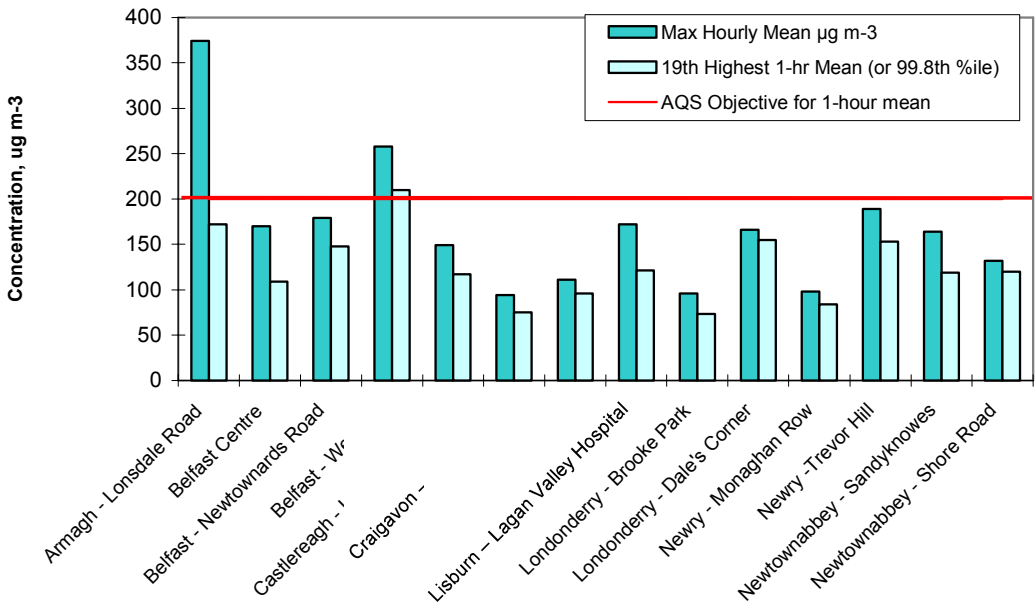
1 - New site, in operation from Nov 2003

2 - New site in operation from Apr 2003

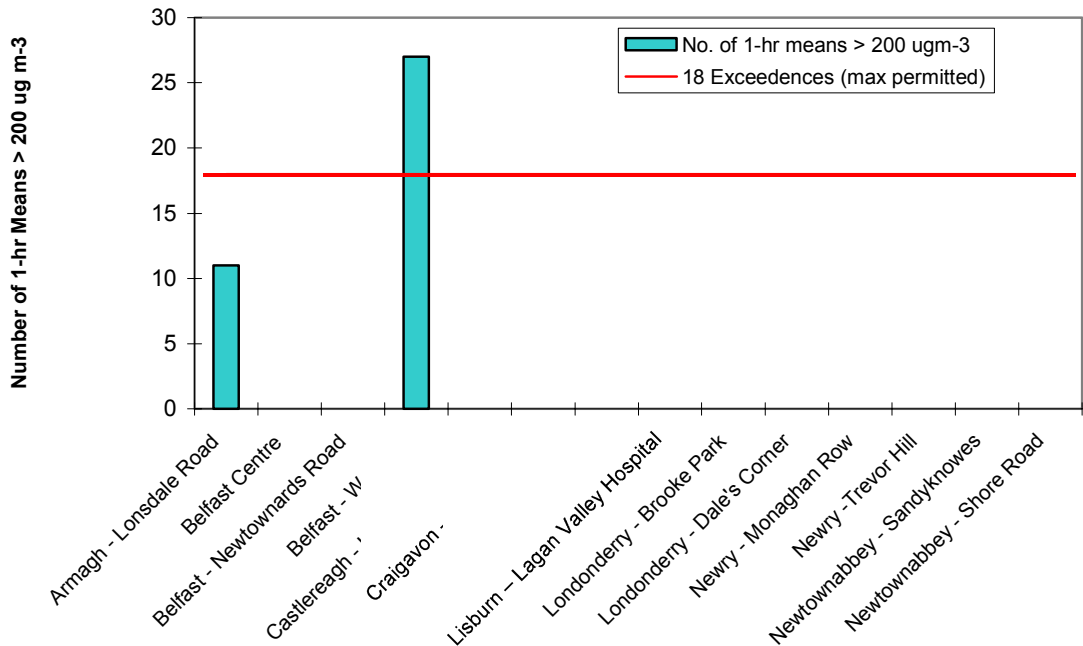
3 - New site in operation from Apr 2003

\* - Very low data capture: annual statistics may not be representative.

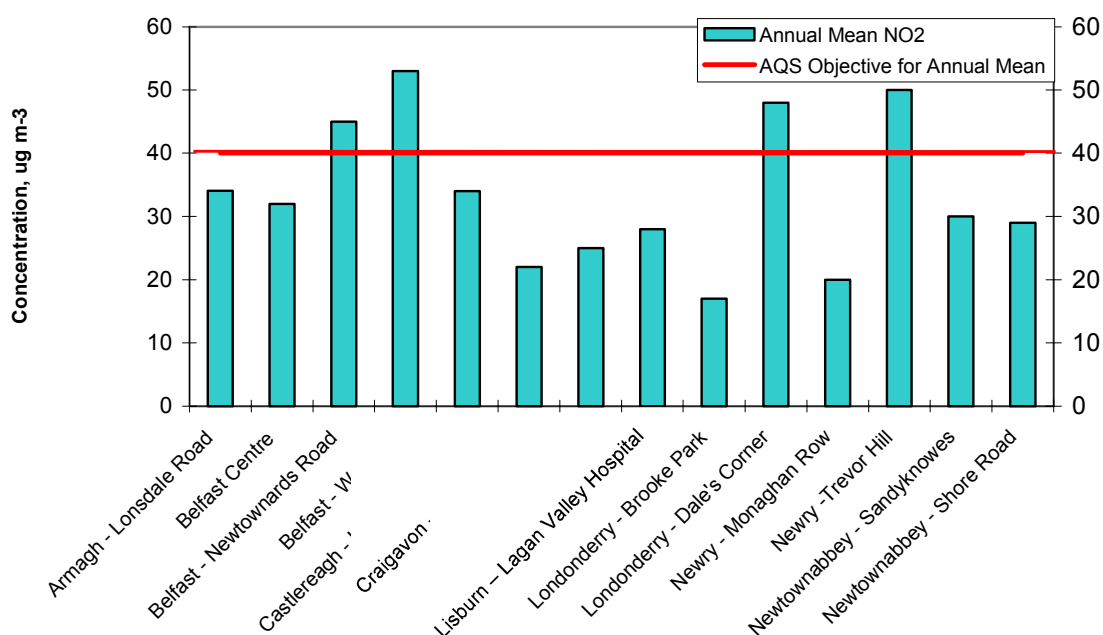
Four sites measured 2003 annual mean NO<sub>2</sub> concentrations greater than the AQS objective of  $40 \mu\text{g m}^{-3}$  (to be met by 2005). These were all roadside sites; Belfast Westlink, Belfast Newtownards Road, Londonderry Dale's Corner and Newry Trevor Hill. Londonderry Dale's Corner is a new site, which started up in November 2003 and has only 11% data capture for the year – insufficient for a reliable annual mean. However, 2004 data from this site confirm that it may have difficulty in meeting the annual mean objective for NO<sub>2</sub>. Figure 4.8 shows the annual mean NO<sub>2</sub> concentration at each site, compared with the AQS objective of  $40 \mu\text{g m}^{-3}$  for this parameter.



**Figure 4.6 Comparison of 1-hour Mean NO<sub>2</sub> Concentrations (2003) with AQS 1-hour mean Objective.** Figure 4.6 shows the maximum hourly mean and the 19<sup>th</sup> highest hourly mean (or the 99.8<sup>th</sup> percentile of hourly means in cases where data capture was less than 90%). If the latter (shown by the lighter coloured bar) is greater than 200µg m<sup>-3</sup>, the site has exceeded the objective, on more than the 18 permitted occasions. This was the case for just one site – Belfast Westlink.



**Fig. 4.7 Number of Exceedences of AQS Objective for 1-hour mean NO<sub>2</sub> Concentration.** Figure 4.7 shows the actual number of exceedences of the AQS objective at each site during 2003. A maximum of 18 exceedences is permitted: one site (Belfast Westlink) had more than this.



**Figure 4.8 Comparison of Annual Mean NO<sub>2</sub> from Automatic Sites 2003 with AQS Objective.**

Figure 4.8 shows that four sites exceeded the annual mean objective of  $40 \mu\text{g m}^{-3}$  during 2003.

The Technical Guidance LAQM.TG(03) provides a method for estimating annual mean NO<sub>2</sub> concentrations for future years at roadside sites (Box 6.6 of LAQM.TG(03)). Using this approach, it is predicted that any roadside site with a 2003 annual mean NO<sub>2</sub> concentration greater than  $42.2 \mu\text{g m}^{-3}$  is likely to exceed the AQS objective of  $40 \mu\text{g m}^{-3}$  in 2005. This is the case for Belfast Westlink, Belfast Newtownards Road, and Newry Trevor Hill. Using the same method, any roadside site with a 2003 annual mean NO<sub>2</sub> concentration greater than  $51.2 \mu\text{g m}^{-3}$  is likely to have an annual mean NO<sub>2</sub> concentration greater than  $40 \mu\text{g m}^{-3}$  in 2010. This is predicted to be the case for just one site - Belfast Westlink. However, it should be noted that levels of NO<sub>2</sub> measured in 2003 were particularly high at many sites, due to meteorological and other factors.

The EC and AQS vegetation protection limit of  $30 \mu\text{g m}^{-3}$  total NO<sub>x</sub> is not applicable to any of the above sites, as they are all in built up areas.

## 4.4 DIFFUSION TUBE NITROGEN DIOXIDE RESULTS

### 4.4.1 Analysis of Bias-Adjusted Data

Diffusion tubes frequently exhibit bias (over- or under-read) relative to the chemiluminescence analyser (which has been defined as the reference technique for NO<sub>2</sub>), and when using diffusion tubes in Local Air Quality Review and Assessment, the Technical Guidance LAQM.TG(03) states that it is necessary to correct for any such bias. This is usually done by co-locating diffusion tubes alongside an automatic NO<sub>2</sub> monitoring site for a minimum period of nine months: by comparing diffusion tube and automatic measurements of NO<sub>2</sub> from the site, it is possible to establish a "bias adjustment factor" (BAF), as set out in Box 6.4 of the Guidance. This is then applied to the annual mean diffusion tube measurements from the other sites in the survey. (It should be noted that diffusion tube bias can vary from site to site and month to month, so bias adjustment can only be approximate).

The Local Authorities who supplied the diffusion tube data presented in this report were asked also to identify the laboratory used for supply and analysis of their diffusion tubes, and also to supply a bias adjustment factor, if possible. This has allowed us, for the first time in this series of reports, to carry out an analysis of bias-adjusted NO<sub>2</sub> diffusion tube data. If no bias adjustment factor was

available, we have used either a combined bias adjustment factor (BAF) for the specified laboratory, from the Review and Assessment Website at <http://www.uwe.ac.uk/agm/review/diffusiontube240904.xls> or, failing this, the factor reported by another Local Authority using the tubes from the same laboratory. Table 4.5 shows the average concentrations as measured by diffusion tubes, for each site type.

**Table 4.5 Average NO<sub>2</sub> Concentrations in Northern Ireland Measured by Diffusion Tubes**

| Site Type                 | Number of sites with valid annual mean, 2003: | Average NO <sub>2</sub> , 2003<br>µg m <sup>-3</sup><br>Not Adjusted for Bias | Average NO <sub>2</sub> , 2003<br>µg m <sup>-3</sup><br>Bias Adjusted |
|---------------------------|---|---|---|
| A (Roadside)              | 192   | 25  | 26  |
| B (Intermediate)          | 16  | 16  | 16  |
| C (Urban Background)      | 40  | 18  | 18  |
| D (Rural Background)      | 3   | 10  | 10  |
| E (Other: Source-related) | 2   | 7   | 7   |

The application of the various laboratories' bias adjustment factors has scaled up some site's results, while scaling down others. The overall effect of this on the average of all Northern Ireland sites' results has been small.

Bias-adjusted annual mean NO<sub>2</sub> concentrations for 2003 have been compared with the AQS objective of 40 µg m<sup>-3</sup>. During 2003, 18 sites had annual mean NO<sub>2</sub> concentrations greater than the EC Directive limit and AQS objective of 40 µg m<sup>-3</sup>. All but one were Roadside (type A), and are shown in Table 4.6.

**Table 4.6 Diffusion Tubes Sites with Annual Mean NO<sub>2</sub> Concentrations greater than 40 µg m<sup>-3</sup> (after application of Bias Adjustment Factors)**

| Site                               | Type | Average NO <sub>2</sub> , 2003<br>µg m <sup>-3</sup><br>Not Adjusted for Bias | Average NO <sub>2</sub> , 2003<br>µg m <sup>-3</sup><br>Bias Adjusted |
|------------------------------------|------|---|---|
| Belfast, Great George's Street     | A    | 47  | 55  |
| Belfast, Westlink                  | A    | 45  | 52.7  |
| Dungannon, Church St,              | A    | 43.7  | 43.7  |
| Londonderry, Brooke Park           | C    | 42.8  | 40.3  |
| Londonderry, 3 Creggan Road,       | A    | 42.8  | 40.3  |
| Newry, Kilmorey Street             | A    | 42.8  | 44.3  |
| Cookstown, James St,               | A    | 42  | 44.1  |
| Newry, 20a Water Street            | A    | 41.6  | 43.1  |
| Cookstown, Church Street           | A    | 41  | 43.1  |
| Belfast City Hall, Donegall Square | A    | 41  | 48  |
| Limavady, Irish Green St.          | A    | 40.9  | 40.9  |
| Belfast, Saintfield Road           | A    | 38  | 44.5  |
| Belfast, Milner Street             | A    | 38  | 44.5  |
| Belfast, Cromac Street (A),        | A    | 38  | 44.5  |
| Belfast, Black's Road              | A    | 38  | 44.5  |
| Belfast, 301 Ormeau Road           | A    | 37  | 43.3  |
| Belfast, Stockman's Lane           | A    | 35  | 41  |
| Belfast, Cromac Street (B)         | A    | 35  | 41  |

As observed previously, exceedences of the annual mean limit for NO<sub>2</sub> appear to occur not only in large urban centres, but also at roadside locations in smaller towns and cities with frequent heavy or waiting traffic, or street "canyon" effects.

Using the approach set out in (Box 6.6) of LAQM.TG(03) annual mean NO<sub>2</sub> concentrations for 2005 and 2010 can be estimated using current results. In the case of roadside sites, the 2005 annual mean is predicted to exceed 40 µg m<sup>-3</sup> if the 2003 annual mean is greater than 42.2 µg m<sup>-3</sup>. This is the case for 13 of the above sites. Similarly, the 2010 annual mean is predicted to exceed 40 µg m<sup>-3</sup> if the 2003 annual mean is greater than 51.2 µg m<sup>-3</sup>. Just two sites fall into this category – Westlink and Great Georges Street, both in Belfast. However, these predictions can only be approximate, as diffusion tubes are only considered an indicative technique.

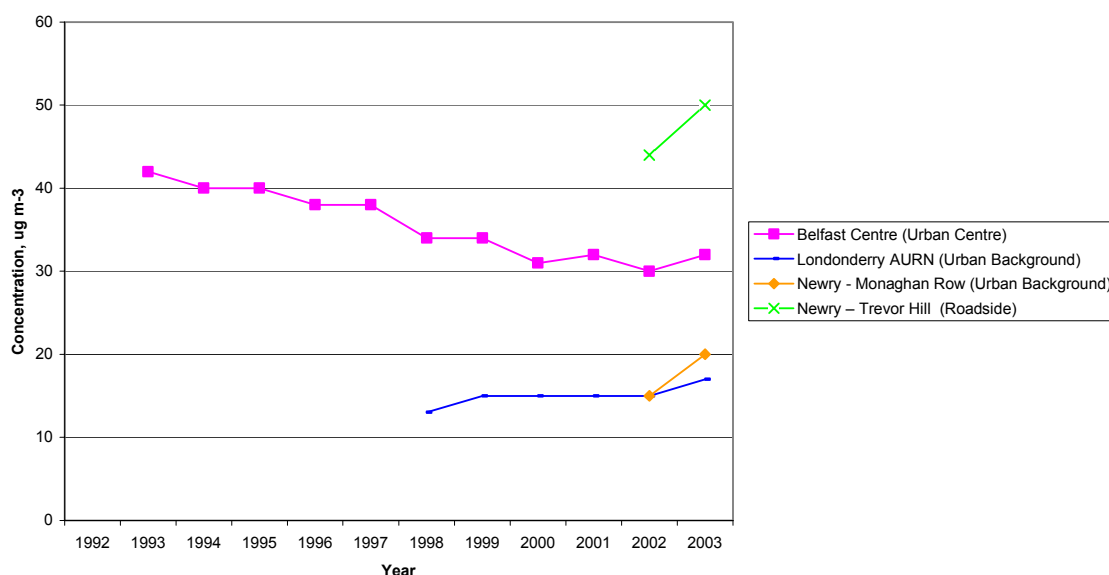
## 4.5 NITROGEN DIOXIDE TRENDS

Emission inventory data from the National Atmospheric Emissions Inventory at [www.naei.org.uk](http://www.naei.org.uk) show that total estimated UK emissions of NO<sub>x</sub> have decreased by 43% between 1989 and 2000. This is attributed to a substantial decrease in emissions from road vehicles and from power stations. These figures relate to the whole UK, but as vehicle emissions account for 60% of Greater Belfast’s total NO<sub>x</sub> emissions<sup>2</sup>, a downward trend in ambient NO<sub>2</sub> in Northern Ireland would also be expected. Indeed the previous reports in this series have identified a significant downward trend in ambient concentrations of NO<sub>2</sub> at Belfast Centre.

### 4.5.1 Trends at Automatic Nitrogen Dioxide Sites

Figure 4.8 shows how annual mean NO<sub>2</sub> concentrations have changed at the automatic sites in Northern Ireland. Annual means are shown only where there is at least 75% data capture for the year, and sites are only included where there are two or more years for which this is the case. Only four sites meet these criteria, and of these, only two have been in operation for at least five years (the minimum considered necessary to assess trends) Belfast Centre and Londonderry AURN sites. Regression analysis (Theil’s non-parametric analysis) shows a significant downward trend (at the 95% confidence level) in annual mean NO<sub>2</sub> concentration at Belfast Centre, but not at Londonderry.

Annual mean NO<sub>2</sub> concentrations at all four sites in Figure 4.8 showed an increase in 2003 compared to 2002. This reflects the increase in mean NO<sub>2</sub> concentration observed throughout the UK during 2003, by both automatic and non-automatic monitoring networks.



**Figure 4.8 Annual Mean NO<sub>2</sub> Concentrations at Automatic Monitoring Sites (data capture at least 75%)**

#### 4.5.2 Trends at Diffusion Tube Nitrogen Dioxide Sites

Around 25% of the NO<sub>2</sub> diffusion tube sites operated by District Councils in Northern Ireland are also part of the NO<sub>2</sub> Network. (The proportion was higher in previous years, but has been reduced by the large number of new sites which began operation in 2002, most of which were set up for local monitoring purposes and are not part of the Network). One of the objectives of this Network is to investigate long-term trends in concentrations of this pollutant.

Table 4.8 shows annual mean NO<sub>2</sub> concentrations for Northern Ireland, based on data from the NO<sub>2</sub> Network. These statistics are based upon the Network sites only, for two reasons: firstly, very few of the non-Network sites have long-term datasets available, and secondly, the Network sites as a group are intended to be representative of Northern Ireland. By contrast many non-Network sites are located where NO<sub>2</sub> is known or suspected to be high.

**The data in Table 4.8 are not bias-adjusted.** In previous years, reliable bias adjustment has not been possible as there has been insufficient information: therefore, in order to compare like with like, uncorrected 2003 data are used in this investigation of trends.

**Table 4.8 Average NO<sub>2</sub> Concentrations, NO<sub>2</sub> Network Diffusion Tube Sites in Northern Ireland (NOT bias-adjusted)**

| Year | Average Roadside<br>$\mu\text{g m}^{-3}$ | Average<br>Intermediate $\mu\text{g m}^{-3}$ | Average Urban<br>Background $\mu\text{g m}^{-3}$ |
|------|--|--|--|
| 1993 | 38                                       | 24   | 19   |
| 1994 | 40                                       | 25   | 19   |
| 1995 | 42                                       | 24   | 18   |
| 1996 | 40                                       | 21   | 18   |
| 1997 | 36                                       | 20   | 16   |
| 1998 | 36                                       | 20   | 13   |
| 1999 | 33                                       | 21   | 14   |
| 2000 | 29                                       | 19   | 13   |
| 2001 | 27                                       | -  | 14   |
| 2002 | 27                                       | -  | 14   |
| 2003 | 27 <sup>1</sup>                          | -  | 14 <sup>2</sup>                                  |

Footnotes:

1 - the unadjusted annual mean for **all** roadside sites in NI was  $25 \mu\text{g m}^{-3}$

2 - the unadjusted annual mean for **all** urban background sites in NI was  $16 \mu\text{g m}^{-3}$

The Intermediate site category ceased in 2000.

Average concentrations appear to have fallen since the mid 1990s. Regression analysis shows that this downward trend in average NO<sub>2</sub> concentration is significant (with 95% confidence limit) for all three site categories. However, average NO<sub>2</sub> concentrations (over all the diffusion tube sites) appear to have remained stable from 2001 to 2003.

## 5 Sulphur Dioxide

Sulphur dioxide (SO<sub>2</sub>) is formed during the combustion of fuels containing sulphur. Nationally, the most significant source of this pollutant is fossil fuelled power generation. In Northern Ireland, domestic solid fuel and oil burning is a major source of SO<sub>2</sub>. Sulphur dioxide is a respiratory irritant, and is toxic at high concentrations. It is also damaging to ecosystems and a major precursor in the formation of acid rain.

In this report, concentrations of sulphur dioxide are expressed as microgrammes per cubic metre ( $\mu\text{g m}^{-3}$ ). To convert to parts per billion (ppb) if necessary, the following relationship should be used:

1 ppb =  $2.66 \mu\text{g m}^{-3}$  for sulphur dioxide at 293K (20°C) and 1013mb.

### 5.1 MONITORING OF SULPHUR DIOXIDE

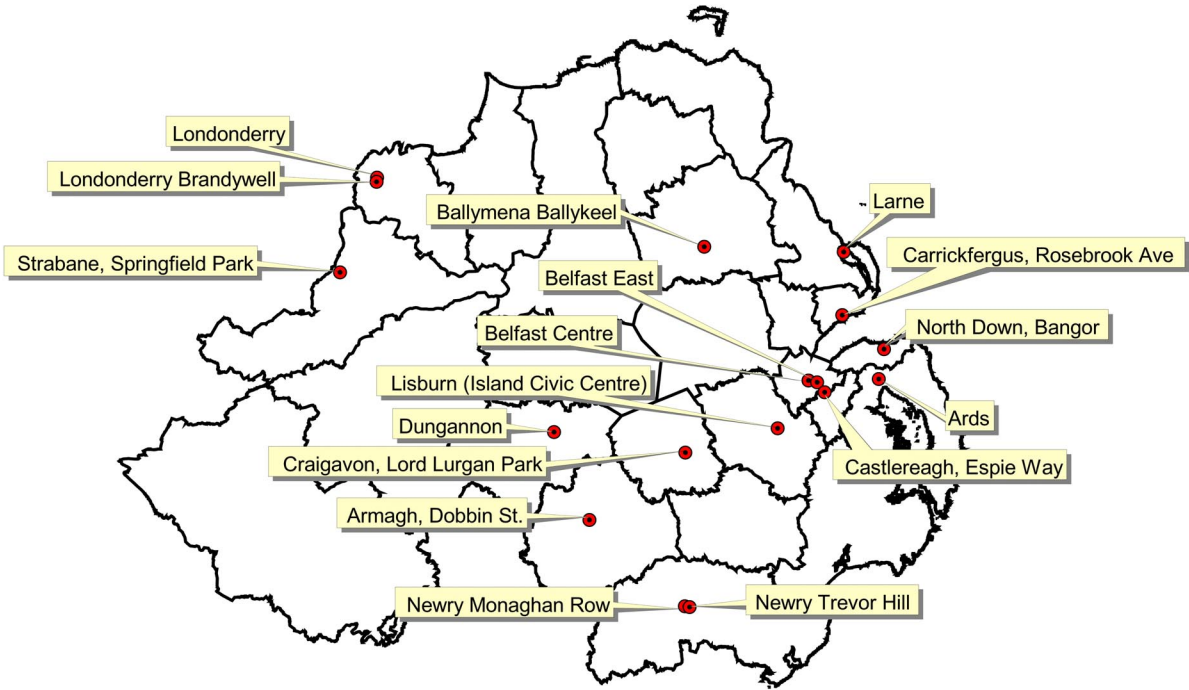
Monitoring of SO<sub>2</sub> is carried out by three methods: continuous automatic analysers, the non-automatic net acidity method (using the 8-port sampler) and diffusion tubes.

Automatic analysers (based on the Ultraviolet Fluorescence method, which is the reference method for the EC 1<sup>st</sup> Daughter Directive, 1999/30/EC) provide continuous monitoring of SO<sub>2</sub>, and the data can be compared with air quality limit values and objectives based on short-term and longer averaging periods. Three new automatic SO<sub>2</sub> monitoring sites started operation in Northern Ireland during 2003, at Armagh (Dobbin Street), Larne Harbour and North Down (Bangor). These bring the total to sixteen. These are listed in Table 5.1 and their locations are shown in Figure 5.1:

**Table 5.1 Automatic SO<sub>2</sub> Monitoring Sites**

| Site                           | Grid Reference | Classification   | Network             |
|--------------------------------|----------------|------------------|---------------------|
| Ards, Glen Estate              | J487 747       | Urban Background | Ards                |
| Armagh, Dobbin Street          | H877 450       | Urban Background | Armagh              |
| Ballymena, Ballykeel           | D120 026       | Urban Background | Ballymena           |
| Bangor                         | J 498 810      | Urban Background | North Down          |
| Belfast Centre, Lombard Street | J339 744       | Urban Centre     | AURN                |
| Belfast East, Templemore Ave   | J357 740       | Urban Background | AURN                |
| Carrickfergus, Rosebrook Ave   | J411 882       | Urban Background | Carrickfergus       |
| Castlereagh, Espie Way         | J373 720       | Urban Background | Castlereagh         |
| Craigavon, Lord Lurgan Park    | J079 592       | Urban Background | Craigavon           |
| Dungannon, Lambfield           | H802 635       | Urban Background | Dungannon           |
| Larne - Larne Harbour          | D414 016       | Urban Background | Larne               |
| Lisburn Island Civic Centre    | J274 643       | Urban Background | Lisburn             |
| Londonderry, Brooke Park       | C429 172       | Urban Background | AURN                |
| Londonderry Brandywell         | C428 163       | Urban Background | AURN affiliated     |
| Newry, Monaghan Row            | J078 268       | Urban Background | Newry & Mourne (CC) |
| Newry, Trevor Hill             | J088 266       | Roadside         | Newry & Mourne(CC)  |
| Strabane, Springfield Park     | H 351 972      | Urban Background | Strabane (CC)       |

CC = Calibration Club member



**Figure 5.1 Automatic SO<sub>2</sub> Monitoring Sites**

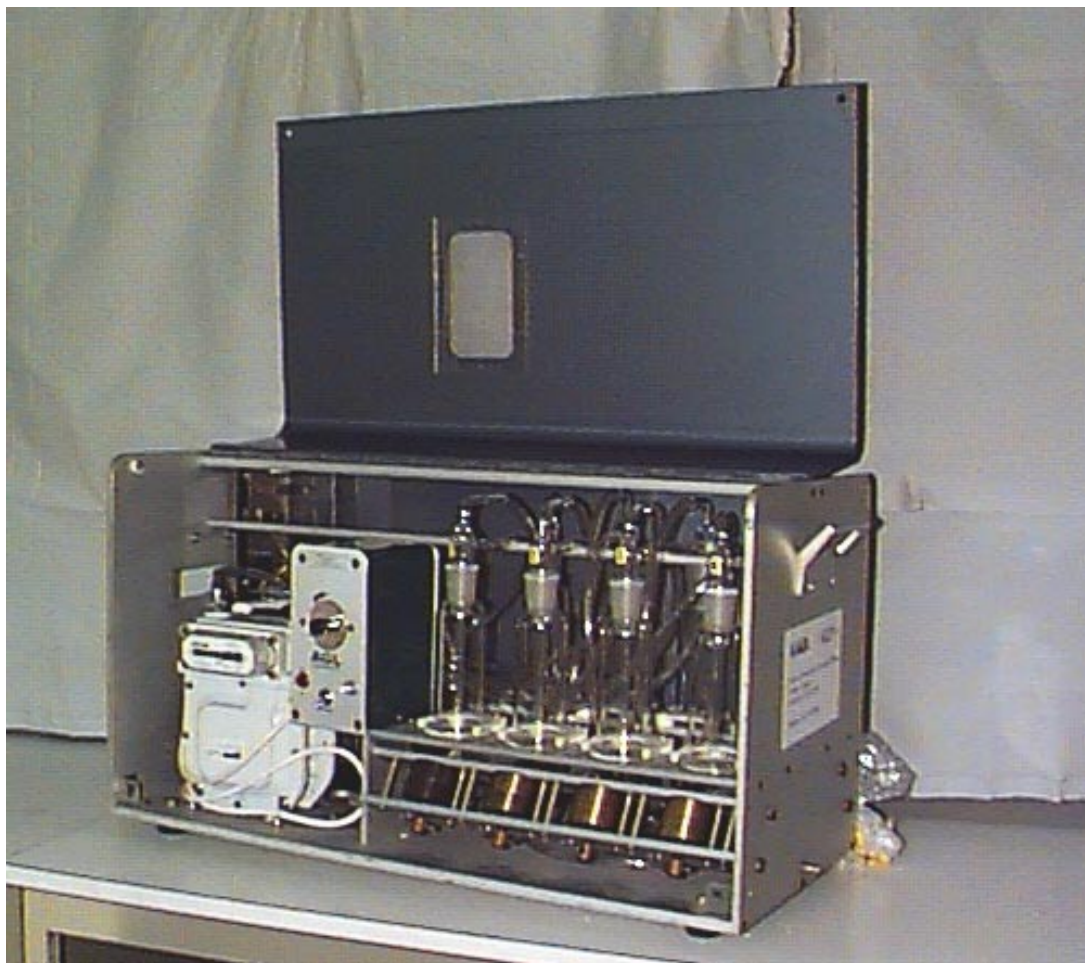
One of the new automatic SO<sub>2</sub> monitoring sites is located at Bangor in North Down. This urban background site is shown in Figure 5.2.



**Figure 5.2 Automatic SO<sub>2</sub> Monitoring Site at Bangor, North Down**



Despite the recent increase in the number of automatic monitoring sites, the most widespread method of measuring SO<sub>2</sub> in Northern Ireland remains the 8-port sampler apparatus. This also measures suspended particulate matter as black smoke (see Section 6). This technique technically measures total net acidity rather than sulphur dioxide, and is therefore an indicative method only for SO<sub>2</sub>. However, it is widely used for low-cost indicative measurement of SO<sub>2</sub>. A typical 8-port sampler is shown in Figure 5.3.



**Figure 5.3 8-port Sampler for Smoke and SO<sub>2</sub>**

This non-automatic method samples on a 24-hour basis, so results are not suitable for comparison with air quality objectives based on shorter periods. However, it has been in widespread use since the early 1960's, so there is an extensive historical dataset which can be used to assess trends. During 2003, there were 37 urban smoke and SO<sub>2</sub> monitoring sites operating in Northern Ireland, all but three belonging to the Smoke and SO<sub>2</sub> Network. A further two sites (Bentra and Fermoy) were part of the Rural SO<sub>2</sub> Network, monitoring SO<sub>2</sub> only (with analysis by ion chromatography rather than the net acidity method). These are shown in Table 5.2 and Figure 5.4.

**Table 5.2 Non-Automatic Smoke and SO<sub>2</sub> Monitoring Sites**

| <b>Site name</b>       | <b>Grid Ref.</b> | <b>District Council</b> | <b>Network</b>          |
|------------------------|------------------|-------------------------|-------------------------|
| ANTRIM 1               | J 162869         | Antrim                  | Smoke & SO <sub>2</sub> |
| ARMAGH 1               | H 877 450        | Armagh                  | Smoke & SO <sub>2</sub> |
| BALLYMENA 5            | D 109 053        | Ballymena               | Smoke & SO <sub>2</sub> |
| BALLYMENA 6            | D 120 026        | Ballymena               | Smoke & SO <sub>2</sub> |
| BALLYMONEY 4           | C 954 259        | Ballymoney              | Smoke & SO <sub>2</sub> |
| BELFAST 12             | J 324 737        | Belfast                 | Smoke & SO <sub>2</sub> |
| BELFAST 13             | J 357 740        | Belfast                 | Smoke & SO <sub>2</sub> |
| BELFAST 33             | J 346 755        | Belfast                 | Smoke & SO <sub>2</sub> |
| BELFAST 42             | J 322 748        | Belfast                 | Smoke & SO <sub>2</sub> |
| BELFAST 44             | J 338 740        | Belfast                 | Smoke & SO <sub>2</sub> |
| BELFAST 45             | J 335 723        | Belfast                 | Smoke & SO <sub>2</sub> |
| BELFAST 46             | J 803 334        | Belfast                 | Smoke & SO <sub>2</sub> |
| PORTADOWN 6            | J 004 548        | Craigavon               | Smoke & SO <sub>2</sub> |
| LONDONDERRY 14         | C 443 174        | Derry                   | Smoke & SO <sub>2</sub> |
| DUNGANNON 1            | H 802 629        | Dungannon               | Smoke & SO <sub>2</sub> |
| LARNE 4                | D 386 037        | Larne                   | Smoke & SO <sub>2</sub> |
| LARNE 5                | D 401 033        | Larne                   | Smoke & SO <sub>2</sub> |
| DUNMURRY 3             | J 287 875        | Lisburn                 | Smoke & SO <sub>2</sub> |
| LISBURN 3              | J 263 636        | Lisburn                 | Smoke & SO <sub>2</sub> |
| TWINBROOK 1            | J 281 689        | Lisburn                 | Smoke & SO <sub>2</sub> |
| MAGHERAFELT 1          | H 896 901        | Magherafelt             | Smoke & SO <sub>2</sub> |
| NEWRY 3                | J 078 268        | Newry and Mourne        | Smoke & SO <sub>2</sub> |
| NEWTOWNABBEY 3         | J 321 851        | Newtownabbey            | Smoke & SO <sub>2</sub> |
| NEWTOWNABBEY 4         | J 283 907        | Newtownabbey            | Smoke & SO <sub>2</sub> |
| BANGOR (CO DOWN) 5     | J 497 810        | North Down              | Smoke & SO <sub>2</sub> |
| HOLYWOOD 1             | J 397 784        | North Down              | Smoke & SO <sub>2</sub> |
| STRABANE 2             | H 351 972        | Strabane                | Smoke & SO <sub>2</sub> |
| COLERAINE 3            | C 861 328        | Coleraine               | Smoke & SO <sub>2</sub> |
| COOKSTOWN 1            | H 774 806        | Cookstown               | Smoke & SO <sub>2</sub> |
| BUSHMILLS 1            | C 940 409        | Moyle                   | Smoke & SO <sub>2</sub> |
| BUSHMILLS 2            | C 940 407        | Moyle                   | Smoke & SO <sub>2</sub> |
| ANTRIM 1               | J 162 869        | Antrim                  | Smoke & SO <sub>2</sub> |
| NEWTOWNARDS            | J 481 736        | Ards                    | Local Auth.             |
| NEWCASTLE              | J 377 317        | Down                    | Local Auth.             |
| COLERAINE (Pates Lane) | C 844 323        | Coleraine               | Local Auth.             |
| BENTRA                 | J 458 923        | Defra                   | Rural SO <sub>2</sub>   |
| FERMOYLE               | C 767 291        | Defra                   | Rural SO <sub>2</sub>   |

(Rural SO<sub>2</sub> sites monitor SO<sub>2</sub> only, not smoke.)

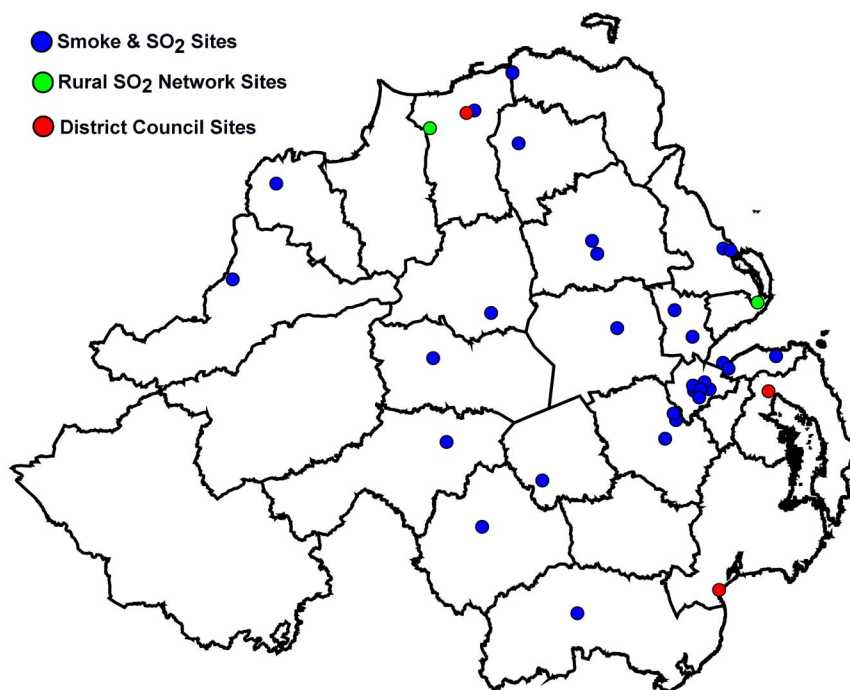


Figure 5.4 8-port Smoke and SO<sub>2</sub> Sampler Sites, 2003

## 5.2 LIMIT VALUES AND OBJECTIVES FOR SULPHUR DIOXIDE

Sulphur dioxide is covered by the following limit values and objectives as shown in Table 5.3. All these limits are for protection of human health except where stated.

Table 5.3 Limit Values and Objectives for Sulphur Dioxide

| Averaging period  | EC Limit or AQS Objective | No. of Permitted exceedences | To be achieved by |
|---|---------------------------|------------------------------|-------------------|
| <b>WHO (non-mandatory)</b>  |                           |                              |                   |
| 10 minute   | 500 µg m <sup>-3</sup>    | -                            | -                 |
| 24 hour   | 125 µg m <sup>-3</sup>    | -                            | -                 |
| Year  | 50 µg m <sup>-3</sup>     | -                            | -                 |
| <b>EC 1<sup>st</sup> Daughter Directive (1999/30/EC)</b>  |                           |                              |                   |
| 1 hour  | 350 µg m <sup>-3</sup>    | 24 per year                  | 1 January 2005    |
| 24 hour   | 125 µg m <sup>-3</sup>    | 3 per year                   | 1 January 2005    |
| Calendar year and winter (1 <sup>st</sup> October – 31 <sup>st</sup> March), for protection of vegetation (relevant in rural areas) | 20 µg m <sup>-3</sup>     | -                            | 19 July 2001      |
| <b>Air Quality Strategy</b>   |                           |                              |                   |
| 15 minute   | 266 µg m <sup>-3</sup>    | 35 per year                  | 31 December 2005  |
| 1 hour  | 350 µg m <sup>-3</sup>    | 24 per year                  | 31 December 2004  |
| 24 hour   | 125 µg m <sup>-3</sup>    | 3 per year                   | 31 December 2004  |
| Calendar year and winter (1 <sup>st</sup> October – 31 <sup>st</sup> March), for protection of vegetation (relevant in rural areas) | 20 µg m <sup>-3</sup>     | -                            | 31 December 2000  |

Before the 1<sup>st</sup> Daughter Directive came into force, SO<sub>2</sub> was covered by EC Directive 80/779/EEC on Sulphur Dioxide and Suspended Particulates. This Directive has been superseded by the 1<sup>st</sup> Daughter Directive. Although the limits of this older Directive remain in force until they are fully repealed in 2005, they are less stringent than those in the later 1<sup>st</sup> Daughter Directive and have been fully met in Northern Ireland since the early 1990s. The current report therefore compares current SO<sub>2</sub> results with the limit values of the 1<sup>st</sup> Daughter Directive, rather than Directive 80/779/EEC.

### 5.3 AUTOMATIC SULPHUR DIOXIDE RESULTS

Table 5.4 shows results from the automatic SO<sub>2</sub> monitoring sites, for 2003. Previous years' data are provided in Appendix 2.

Of the 17 sites, 11 achieved at least 90% data capture. Of the six which did not, three (Armagh Dobbin Street, Larne and North Down, Bangor) were new sites, commissioned part way through 2003. Three sites (Armagh Dobbin Street, Ballymena Ballykeel and Craigavon Lord Lurgan Park) had less than 50% data capture for the year, so annual statistics from these sites may not be representative.

On the basis of the available data, all sites in Northern Ireland met the requirements of the 1<sup>st</sup> Daughter Directive, and the objectives of the Air Quality Strategy during 2003.

Two sites, Larne and Londonderry Brandywell, recorded one or more 15-minute means greater than the AQS objective of 266  $\mu\text{g m}^{-3}$ . However, no sites exceeded this objective on more than the permitted 35 occasions. Where data capture is less than 90%, it is not valid to simply count the total number of exceedences of the 15-minute objective. Instead, according to the Technical Guidance<sup>1</sup> the 99.9<sup>th</sup> percentile of 15-minute means should be compared with the 15-minute SO<sub>2</sub> objective itself (266  $\mu\text{g m}^{-3}$ ). On this basis, the sites with less than 90% data capture all appeared to meet the AQS objective for 15-minute mean SO<sub>2</sub>. Figure 5.5a shows a comparison of 15-minute mean SO<sub>2</sub> concentrations with the relevant objective, and Figure 5.5b shows the number of exceedences.

No sites recorded *any* exceedences of the 1-hour mean objective of 350  $\mu\text{g m}^{-3}$ . Where data capture is less than 90%, according to the Technical Guidance<sup>1</sup> the 99.7<sup>th</sup> percentile of 1-hour means must not exceed the 1-hour objective: all the sites with less than 90% data capture met this condition. This is illustrated in Figure 5.6.

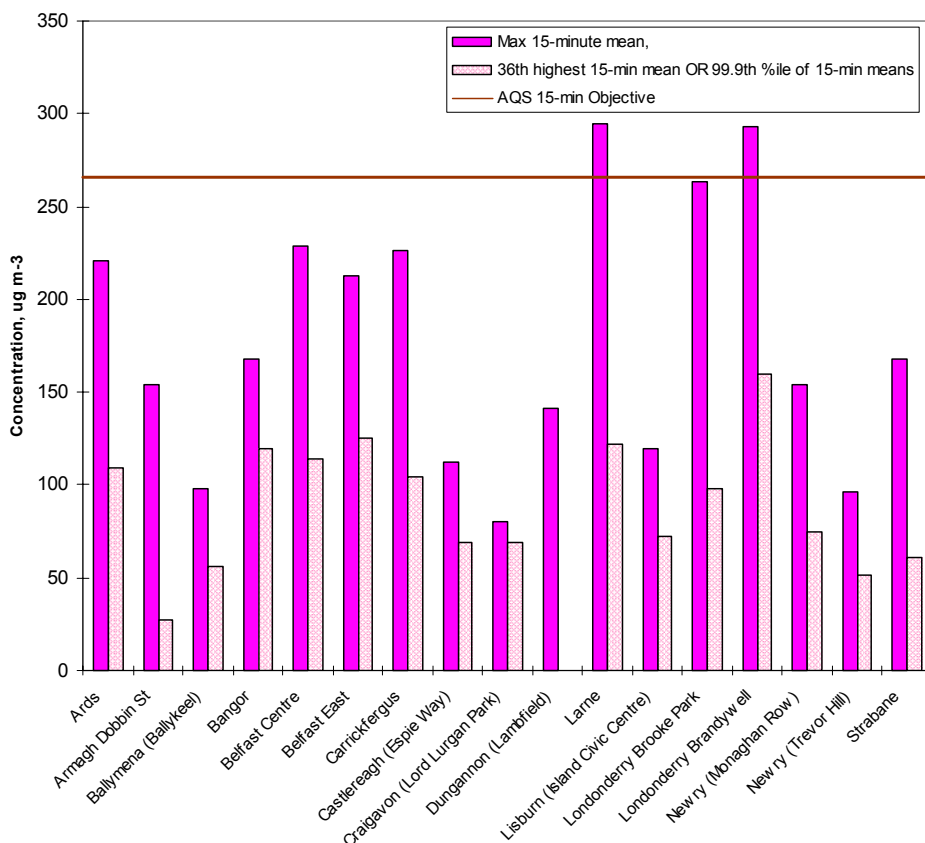
Also, no sites recorded *any* exceedences of the 24-hour mean objective (125  $\mu\text{g m}^{-3}$ ). Where data capture is less than 90%, the Technical Guidance<sup>1</sup> states that the 99<sup>th</sup> percentile of 24-hour means must not exceed the relevant objective: again, all the sites with less than 90% data capture met this condition. This is illustrated in Figure 5.7.

2003 was the second year in which Belfast East met the objective for both the 15-minute and 24-hour average, and the first year in which this site had no 15-minute means greater than 266  $\mu\text{g m}^{-3}$ . As reported in the previous (2002) report, many domestic properties in the area have switched from solid fuel to natural gas in recent years. This is the most likely reason for the decrease in SO<sub>2</sub> in the area.

**Table 5.5 SO<sub>2</sub> Results from Automatic Monitoring Sites, 2003**

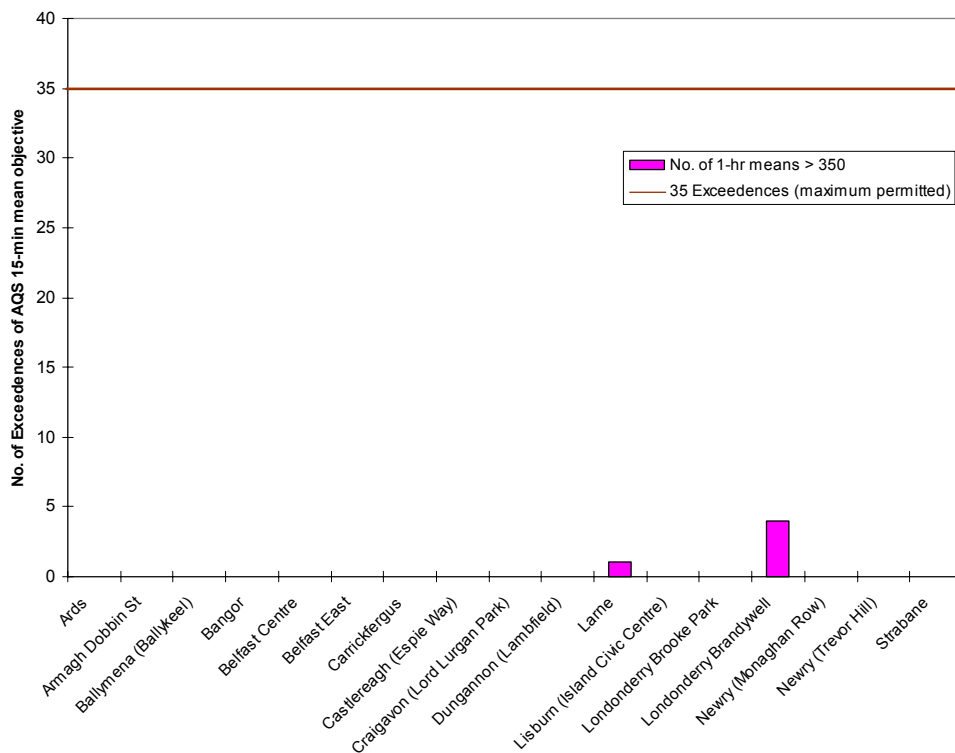
| Site                           | % Data Capture | Max 15-minute mean, $\mu\text{g m}^{-3}$ | No. of 15-minute means > 266 $\mu\text{g m}^{-3}$ | 36 <sup>th</sup> highest 15-min mean OR 99.9 <sup>th</sup> %ile of 15-min means | Max 1-hr mean $\mu\text{g m}^{-3}$ | No. of 1-hr means > 350 $\mu\text{g m}^{-3}$ | 25 <sup>th</sup> highest 1-hour mean OR 99.7 <sup>th</sup> %ile of 1-hour means | Max 24-hr mean $\mu\text{g m}^{-3}$ | No. of 24-hour means > 125 $\mu\text{g m}^{-3}$ | 4th highest 24-hr mean OR 99 <sup>th</sup> %ile of 24-hr means | Annual mean, $\mu\text{g m}^{-3}$ |
|--------------------------------|----------------|--|---|---|------------------------------------|--|---|-------------------------------------|---|--|-----------------------------------|
| Ards, Glen Est.                | 93             | 221                                      | 0   | 109   | 192                                | 0  | 85  | 55                                  | 0   | 42   | 9                                 |
| Armagh, Dobbins St.            | 36             | 154                                      | 0   | 27  | 82                                 | 0  | 19  | 14                                  | 0   | 10   | 4                                 |
| Ballymena, Ballykeel           | 49             | 98                                       | 0   | 56  | 51                                 | 0  | 40  | 35                                  | 0   | 14   | 8                                 |
| Bangor                         | 80             | 168                                      | 0   | 120   | 144                                | 0  | 90  | 33                                  | 0   | 30   | 8                                 |
| Belfast Centre, Lombard Street | 91             | 229                                      | 0   | 114   | 186                                | 0  | 88  | 54                                  | 0   | 40   | 8                                 |
| Belfast East                   | 97             | 213                                      | 0   | 125   | 194                                | 0  | 85  | 69                                  | 0   | 41   | 8                                 |
| Carrickfergus, Rosebrook Ave   | 97             | 226                                      | 0   | 104   | 176                                | 0  | 72  | 48                                  | 0   | 27   | 8                                 |
| Castlereagh, Espie Way         | 96             | 112                                      | 0   | 69  | 93                                 | 0  | 53  | 43                                  | 0   | 27   | 4                                 |
| Craigavon, Ld. Lurgan Park.    | 17             | 80                                       | 0   | 69  | 67                                 | 0  | 63  | 29                                  | 0   | 25   | 10                                |
| Dungannon, Lambfield           | 96             | 141                                      | 0   | ns  | 78                                 | 0  | ns  | 35                                  | 0   | ns   | 2                                 |
| Larne - Harbour                | 73             | 295                                      | 1   | 122   | 128                                | 0  | 69  | 42                                  | 0   | 18   | 4                                 |
| Lisburn, Island Civic Centre   | 79             | 120                                      | 0   | 72  | 88                                 | 0  | 48  | 38                                  | 0   | 21   | 5                                 |
| Londonderry, Brooke Park       | 97             | 263                                      | 0   | 98  | 125                                | 0  | 69  | 45                                  | 0   | 37   | 11                                |
| Londonderry, Brandywell        | 98             | 293                                      | 4   | 160   | 293                                | 0  | 120   | 89                                  | 0   | 54   | 15                                |
| Newry, Monaghan Row            | 96             | 154                                      | 0   | 75  | 109                                | 0  | 56  | 35                                  | 0   | 29   | 7                                 |
| Newry, Trevor Hill             | 97             | 96                                       | 0   | 51  | 59                                 | 0  | 43  | 28                                  | 0   | 27   | 8                                 |
| Strabane, Springhill Pk        | 95             | 168                                      | 0   | 61  | 69                                 | 0  | 51  | 30                                  | 0   | 24   | 8                                 |

*ns = not specified*



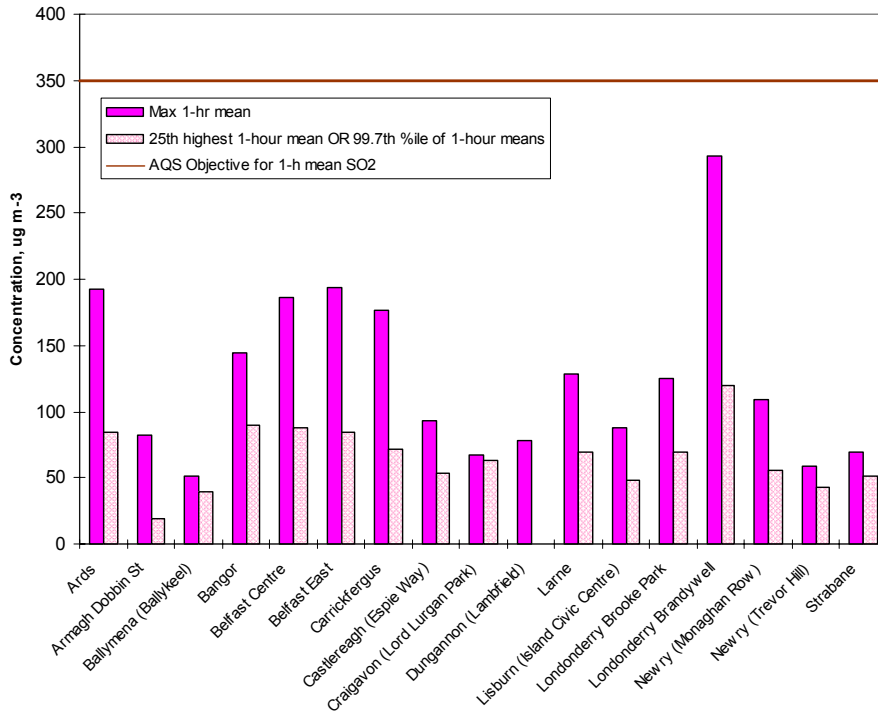
**Figure 5.5a Comparison of 15-minute Mean SO<sub>2</sub> Data with AQS Objective**

Figure 5.5a shows the maximum 15-min. mean and the 36<sup>th</sup> highest 15-min. mean (or 99.9<sup>th</sup> percentile where data capture was less than 90%). If the latter (shown by the lighter coloured bar) is greater than 266µg m<sup>-3</sup>, the site has not met the objective. All sites met the 15-min. objective in 2003.

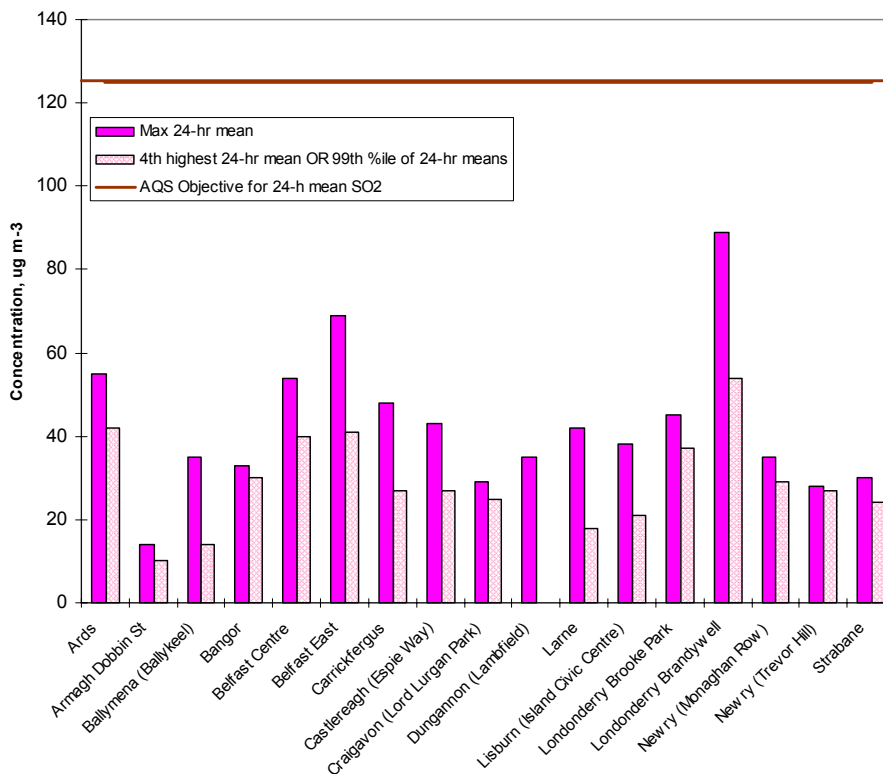


**Figure 5.5b Number of Exceedences of 15-minute Mean SO<sub>2</sub> Objective**

No sites recorded more than the permitted maximum of 35 exceedences.



**Fig. 5.6 Comparison of 1-hour Mean SO<sub>2</sub> Concentrations (2003) With AQS 1-hour Objective** Figure 5.6 shows the maximum 1-hour mean and the 25<sup>th</sup> 1-hour mean (or 99.7<sup>th</sup> percentile where data capture was less than 90%). If the latter (shown by the lighter coloured bar) is greater than 350µg m<sup>-3</sup>, the site has not met the objective. All sites met the 1-hour objective in 2003.



**Fig. 5.7 Comparison of 24-hour Mean SO<sub>2</sub> Concentrations (2003) with AQS 24-hour Objective.** Shows the maximum and 4<sup>th</sup> highest 24-hr mean (or 99<sup>th</sup> percentile if data capture < 90%). The latter (shown by the lighter coloured bar) must not exceed 125µg m<sup>-3</sup>. All sites met this objective in 2003.

## 5.4 NON-AUTOMATIC SULPHUR DIOXIDE RESULTS

A summary of results from all Smoke and SO<sub>2</sub> Network sites in Northern Ireland is provided in Appendix 3, for year 2003. Relatively high concentrations of net acidity have been measured in Northern Ireland, particularly Belfast, for many years. The historically limited availability of natural gas in previous years has led to greater domestic use of solid fuels and oil. This has led to higher concentrations of pollutants such as SO<sub>2</sub>, particularly in residential areas. However, the average annual mean net acidity (as SO<sub>2</sub> equivalent) for all Smoke and SO<sub>2</sub> Network sites in Northern Ireland appears to be falling: from 27 µg m<sup>-3</sup> in 2000, 20 µg m<sup>-3</sup> in 2001, 18 µg m<sup>-3</sup> in 2002 and 15 µg m<sup>-3</sup> in 2003. (For comparison, the 2003 average for the whole UK was also 15 µg m<sup>-3</sup>).

The 8-port sampler produces daily 24-hour averages, which are not comparable with air quality limits based on shorter averaging periods. Nor is it relevant to compare data from urban sites with the annual and winter mean limit values set for the protection of ecosystems. However, data from such samplers can be compared with the limit value and objective of 125 µg m<sup>-3</sup> for the 24-hour mean (not to be exceeded more than 3 times per calendar year) set by the EC 1<sup>st</sup> Daughter Directive, and the Air Quality Strategy.

No Smoke and SO<sub>2</sub> Network sites in Northern Ireland had more than three days during calendar year 2003 when the 24-hour average net acidity was greater than the Daughter Directive limit value and AQS objective for SO<sub>2</sub> of 125 µg m<sup>-3</sup>.

The 2003 annual mean net acidity (as SO<sub>2</sub>) concentrations at the non-network sites in Newcastle (operated by Down DC) and Newtownards (Ards DC) were 14 µg m<sup>-3</sup> and 9 µg m<sup>-3</sup> respectively. No annual mean was supplied for the non-Network site at Coleraine.

Annual and winter mean sulphur dioxide concentrations at the two Rural SO<sub>2</sub> Network sites (Bentra and Fermoy) were less than 5 µg m<sup>-3</sup> : well within the limit of 20 µg m<sup>-3</sup> set for protection of vegetation in rural areas.

## 5.5 SULPHUR DIOXIDE TRENDS

For reasons outlined in Sections 1.1 and 5.4, widespread reliance on solid fuels and oil for domestic heating continued throughout the 1970s, 1980s and 1990s. Based on 1997 Greater Belfast emissions information, domestic combustion accounts for an estimated 28% of total annual SO<sub>2</sub> emission in the Belfast area<sup>2</sup>, compared with 4% of total annual SO<sub>2</sub> emission in the UK as a whole. Sulphur dioxide emissions and source distribution have been different in Northern Ireland than in other parts of the UK for many years, and it cannot be assumed that UK trends in either emissions or ambient concentrations are necessarily representative of Northern Ireland. However, UK emission data from the NAEI ([www.naei.org.uk](http://www.naei.org.uk)) show a decrease of 73% between 1990 and 2002.

New legislation on the sulphur content of solid fuel and fuel oils came into force on 15<sup>th</sup> October 1998 and 11<sup>th</sup> March 2002 respectively. The Sulphur Content of Solid Fuel Regulations (Northern Ireland) came into force on 15 October 1998 and apply to Northern Ireland only. Under the regulations it is prohibited for any person to sell by retail or deliver for the purpose of retail, any solid fuel with a sulphur content of more than 2 percent. The Sulphur Content of Liquid Fuels Regulations (Northern Ireland) make it an offence, from 1<sup>st</sup> January 2003, to burn fuel oil with a sulphur content of greater than 1% by mass, with some derogations. In addition, it is an offence from 11 March 2002 to use any gas oil, or marine gas oil, with a sulphur content greater than 0.2% by mass. This limit will be further tightened to 0.1% by mass as of 1 January 2008.

This legislation will reduce emissions of sulphur dioxide from industrial and domestic premises burning fuel oil, and domestic premises burning solid fuel and are expected to lead to a reduction in ambient concentrations of SO<sub>2</sub>.

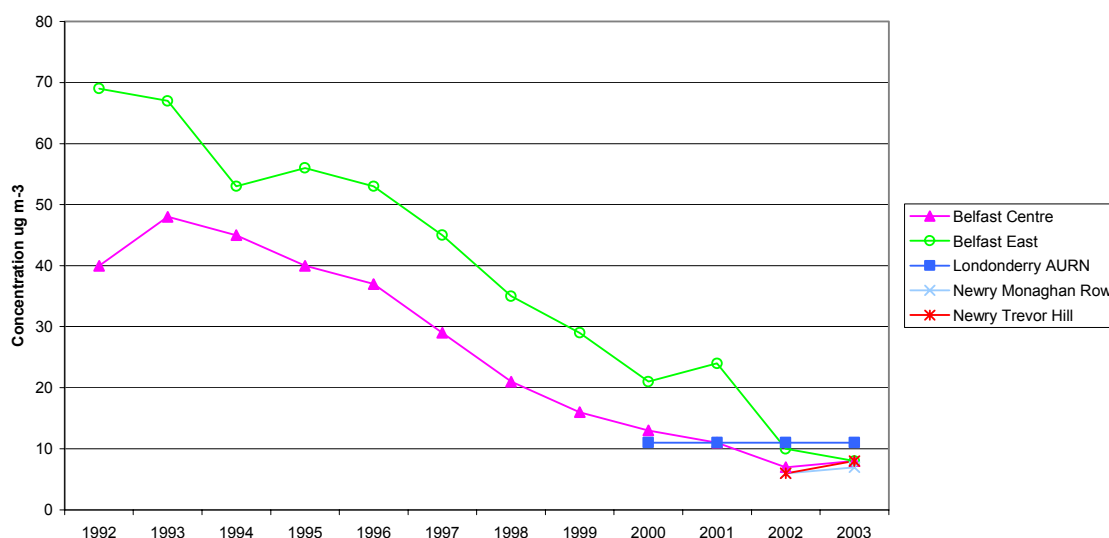


### 5.5.1 Trends at Automatic Sulphur Dioxide Sites

Figure 5.8 shows annual mean SO<sub>2</sub> concentrations from 1992 onwards. Although there are now 17 automatic SO<sub>2</sub> sites in Northern Ireland, this chart shows data from only five sites. This is because (i) annual means are only included where data capture is at least 75%, and (ii) only sites with two or more valid annual means are shown. The remaining 12 sites do not have more than one full year of data, and therefore, for clarity, they have not been included in the trend plot.

A minimum of five years' data are required in order to investigate trends: only two sites meet this criterion: Belfast Centre and Belfast East. Both sites show a clear downward trend in annual mean SO<sub>2</sub> concentration. By contrast, mean SO<sub>2</sub> concentrations at Londonderry AURN site have remained stable over the past four years of operation.

It is also noticeable that the 2003 annual mean SO<sub>2</sub> concentrations at Belfast Centre and the two Newry sites are slightly higher than those recorded for 2002.



**Figure 5.8 Annual Mean SO<sub>2</sub> concentrations at Automatic Sites (data capture at least 75%)**

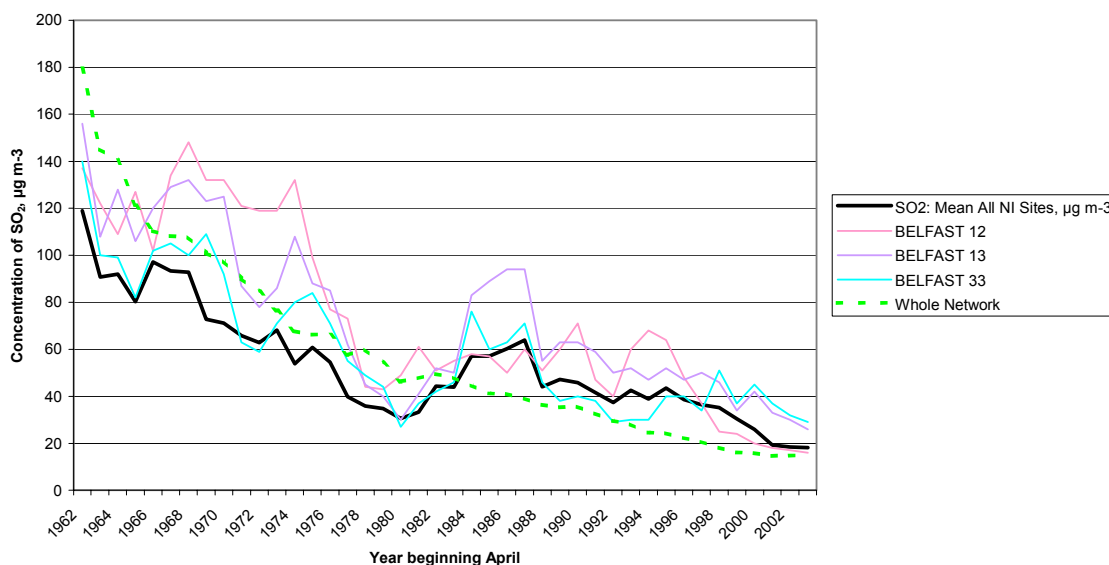
### 5.5.2 Trends at Non-Automatic Sulphur Dioxide sites

Most of the non-automatic (8-port sampler) sites belong to the Smoke and SO<sub>2</sub> Network, and many have a long-running historical dataset. Thus, it is possible to identify how concentrations of sulphur dioxide, as measured by the net acidity technique, have decreased since the early 1960s. This trend is shown in Figure 5.9, a graph of the average SO<sub>2</sub> concentration at all Network sites in Northern Ireland since 1962. For historical reasons the annual averaging periods run April -March. The annual mean is based only upon sites with at least 75% data capture for the year, which in most years totalled between 14 and 27.

The annual average concentration of SO<sub>2</sub> has fallen, from over 80 µg m<sup>-3</sup> in the 1960s to around 30 µg m<sup>-3</sup> in 1980. From 1980 – 1987, average concentrations rose before the downward trend continued again from the late 1980s. A possible explanation for the rise in the early 1980s is that it may have resulted from a rise in coal and oil burning, as the use of town gas was phased out. Town gas use decreased through the late 1970s and early 1980s, and the eventual shut-down of the supply began in 1984 and was completed in 1988.

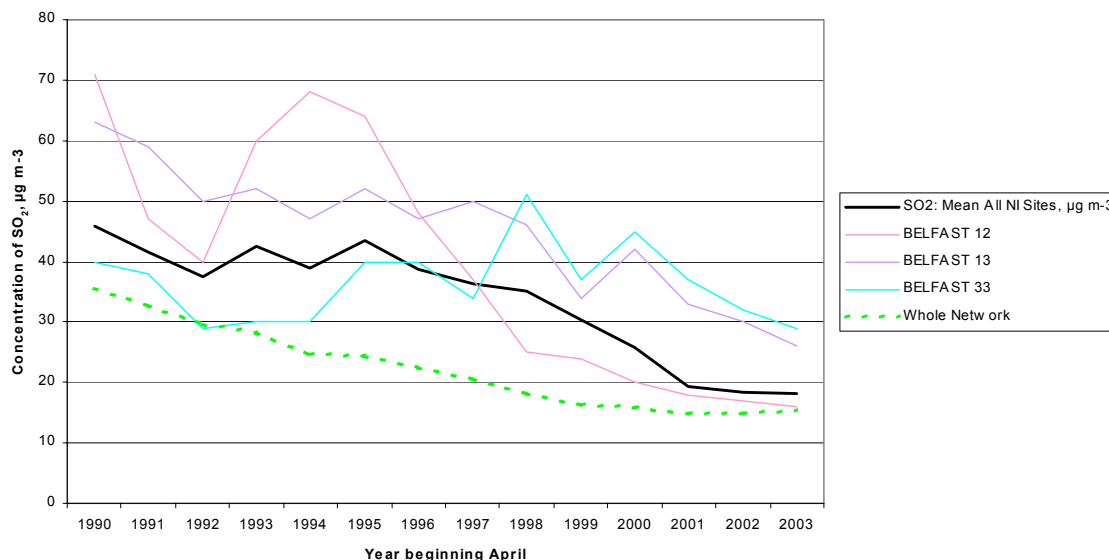
Figure 5.9 also shows the trend in annual mean for three particular sites in Belfast: BELFAST 12 (at the Royal Victoria Hospital), BELFAST 13 (at Templemore Avenue, co-located with the Belfast East

automatic monitoring site) and BELFAST 33 (Dufferin Road, an industrial area of the city centre). All of these have been in continuous operation since the early 1960s. These three individual sites show a similar pattern to the average, including the period during the early 1980s when the general downward trend appeared to be reversed.



**Figure 5.9 Annual Mean SO<sub>2</sub> Concentration at Smoke & SO<sub>2</sub> Sites in Northern Ireland. Network average and 3 long-running Belfast sites.**

Figure 5.9 also shows the annual means for the UK as a whole. It is noticeable that since the mid 1980s, Northern Ireland’s average SO<sub>2</sub> levels have typically been higher than the UK average, due to continued reliance on oil and coal.



**Figure 5.10 Annual Mean SO<sub>2</sub> Concentration at Smoke & SO<sub>2</sub> Sites in Northern Ireland. Network average and 3 long-running Belfast sites, 1990 onwards.**

However, as natural gas becomes more available in Northern Ireland, the gap is closing. Figure 5.10 shows this: since 2001 the difference between the average for all Northern Ireland sites, and the Network as a whole, has been less than 5 µg m<sup>-3</sup>.

## 6 Particulate Matter

Ambient suspended particulate matter consists of a “primary” component (i.e. emitted directly into the atmosphere and therefore usually local to source), and a “secondary” component (formed in the atmosphere by chemical reactions, and therefore often a long-range pollutant). The primary component mostly consists of combustion related particles (emitted from sources such as vehicles, domestic and industrial coal and fuel oil burning), but includes other material such as entrained dust, and salt from sea spray. The secondary material consists mostly of sulphate and nitrate particles formed by oxidation of sulphur dioxide and oxides of nitrogen, and ammonium salts. Ambient particulate matter, when inhaled, can affect human health, particularly in sensitive individuals.

The two particulate metrics most widely used in the UK are PM<sub>10</sub> and Black Smoke. The term “PM<sub>10</sub>” refers to the mass fraction of particles collected by a sampler with a 50% cut-off at aerodynamic diameter 10  $\mu\text{m}$ . PM<sub>10</sub> is measured by automatic techniques, such as the Tapered Element Oscillating Microbalance (TEOM), gravimetric samplers and Beta Attenuation Monitors (BAM). The term “black smoke” refers to any fine dark suspended particulate which can be measured by the smoke stain technique, not necessarily particulate resulting from combustion sources. Black smoke is defined by the ISO standard for the method (ISO 9835) as “strongly light absorbing particulate material suspended in the ambient atmosphere.... The major contributor to black smoke is soot particles; i.e. particles containing carbon in its elemental form”. Concentrations of particulate matter are expressed as microgrammes per cubic metre ( $\mu\text{g m}^{-3}$ ).

### 6.1 MONITORING OF PARTICULATE MATTER

#### 6.1.1 PM<sub>10</sub> Monitoring

Five new automatic monitoring sites for particulate matter as PM<sub>10</sub> started up in Northern Ireland during 2003, taking the total from 18 to 23. Site details and monitoring techniques are shown in Table 6.1 and Figure 6.1. The most widely used automatic PM<sub>10</sub> monitoring technique is the Tapered Element Oscillating Microbalance (TEOM), but Beta Attenuation Monitors (BAM or Beta Gauge) are also in use at some sites.

The reference method for PM<sub>10</sub> is the gravimetric technique, in which the ambient concentration of PM<sub>10</sub> is calculated from the mass of particulate matter collected on a filter. The more widely-used TEOM has been found to underestimate relative to this reference method. Therefore, by convention PM<sub>10</sub> concentrations measured using the TEOM (or using a Beta Attenuation Monitor, if it has a heated inlet) must be multiplied by a factor of 1.3 to convert to gravimetric equivalent, before comparison with EC Directive or AQS limit values. **All TEOM measurements in this report have been converted to gravimetric equivalent.**

The locations of all sites are shown in Figure 6.1. One of the sites which began monitoring PM<sub>10</sub> in 2003 is at Holywood, North Down - shown in Figure 6.2. This roadside site also monitors oxides of nitrogen.

#### 6.1.2 Black Smoke Monitoring

The principle of the smoke stain method involves drawing air at a constant, measured flowrate through a paper filter. Suspended particulate matter is collected on the filter, forming a dark stain. An instrument known as a reflectometer is used to measure the darkness of the stain, and this reflectometer measurement is then used to calculate the concentration of particulate matter in the sampled air from a standard calibration. The sampler inlet funnel has a 50% cut-off at around 4.5  $\mu\text{m}$ ; thus black smoke can be considered an approximation to dark PM<sub>5</sub>.

During 2003, there were 35 sites in Northern Ireland measuring particulate as black smoke, 32 of which were part of the Smoke and SO<sub>2</sub> Network. Black smoke is monitored using the same 8-port

sampler apparatus as non-automatic SO<sub>2</sub>, shown in Figure 5.3 (Section 5.1). Site details are therefore identical to those presented in Table 5.3 and Figure 5.4 (for SO<sub>2</sub>) in Section 5.1, (with the exception of the Rural SO<sub>2</sub> Network sites, which monitor SO<sub>2</sub> only). Many of these black smoke monitoring sites have been in operation since the 1960s or 1970s: hence there is an extensive historical dataset for smoke.

**Table 6.1 Automatic PM<sub>10</sub> Monitoring Sites, 2003**

| Site                            | Grid Ref. | Classification                                | Technique                                   | Network/operator    |
|---------------------------------|-----------|---|---|---------------------|
| Ards, Glen Estate               | J 487 747 | Urban Background *                            | TEOM  | Ards                |
| Armagh, Lonsdale Road           | H 876 458 | Roadside                                      | TEOM  | Armagh              |
| Bangor                          | J 498 810 | Urban Background                              | TEOM  | North Down          |
| Belfast Centre, Lombard Street  | J 339 744 | Urban Centre                                  | TEOM, KFG Gravimetric, Partisol Gravimetric | AURN                |
| Belfast, Clara Street           | J 360 734 | Suburban                                      | Beta Attenuation Monitor                    | AURN                |
| Belfast, Westlink               | J 330 737 | Roadside                                      | TEOM  | Belfast             |
| Carrickfergus, Rosebrook Avenue | J 411 882 | Urban Background *                            | TEOM  | Carrickfergus       |
| Castlereagh, Loughview Drive    | J 357 570 | Roadside                                      | TEOM  | Castlereagh         |
| Castlereagh, Espie Way          | J 373 719 | Urban Background *                            | TEOM  | Castlereagh         |
| Craigavon, Lord Lurgan Park     | J 079 592 | Urban Background *                            | TEOM  | Craigavon           |
| Dungannon, Lambfield            | J 802 635 | Urban Background *                            | TEOM  | Dungannon           |
| Holywood                        | J 396 792 | Roadside                                      | TEOM  | North Down          |
| Larne - Harbour                 | D414 016  | Urban Background                              | Beta Attenuation Monitor                    | Larne               |
| Lisburn, Island Civic Centre    | J 274 643 | Urban Background *                            | TEOM  | Lisburn             |
| Lisburn, Lagan Valley Hospital  | J 265 637 | Roadside                                      | TEOM  | Lisburn             |
| Lisburn, Dunmurry               | J 287 675 | Urban Background                              | TEOM  | Lisburn             |
| Londonderry, Brooke Park        | C 429 172 | Urban Background                              | TEOM  | AURN                |
| Londonderry, Brandywell         | C 428 163 | Urban Background                              | TEOM  | AURN Affiliated     |
| Lough Navar                     | H 065 545 | Rural   | TEOM  | Rural               |
| Newry, Monaghan Row             | J 078 268 | Urban Background (residential, smoke control) | TEOM  | Newry & Mourne (CC) |
| Newry, Trevor Hill              | J 088 266 | Roadside, town centre                         | TEOM  | Newry & Mourne (CC) |
| Omagh, Tamlaght                 | H 422 722 | Roadside                                      | TEOM  | Omagh               |
| Strabane, Springfield Park      | H 351 972 | Urban Background (Residential)                | Beta Attenuation Monitor                    | Strabane (CC)       |

CC = Calibration Club member.

\* in a coal burning residential area.

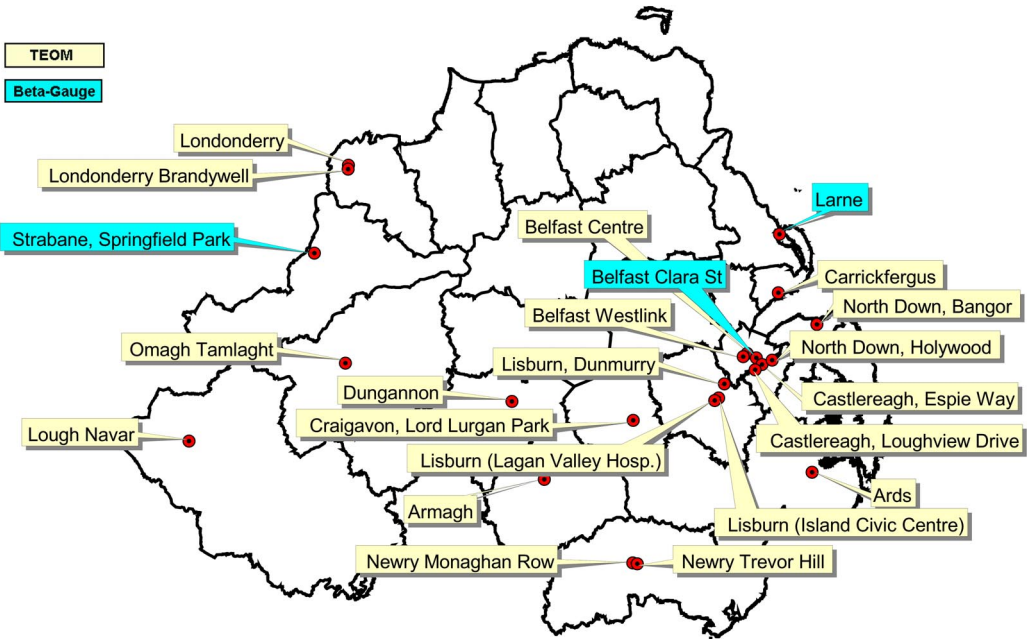


Figure 6.1 Locations of PM<sub>10</sub> Monitoring Sites, 2003.



Figure 6.2 New Roadside Monitoring Site at Hollywood, North Down for PM<sub>10</sub> (and NO<sub>x</sub>)

## 6.2 LIMIT VALUES AND OBJECTIVES FOR SUSPENDED PARTICULATE MATTER

### 6.2.1 Limit Values and Objectives for PM<sub>10</sub>

Particulate matter, when measured as PM<sub>10</sub>, is covered by the EC 1<sup>st</sup> Daughter Directive (1999/30/EC), which contains a two-stage set of limit values. The UK Air Quality Strategy sets objectives for PM<sub>10</sub> that are almost identical to the first stage limit values set by the EC Daughter Directive. These are outlined in Table 6.2.

**Table 6.2 Limit Values and Objectives for Particulate Matter as PM<sub>10</sub>**

| Averaging period   | EC Limit or AQS Objective | Number of Permitted Exceedences | To be achieved by              |
|--|---------------------------|---------------------------------|--------------------------------|
| <b>EC 1<sup>st</sup> Daughter Directive (1999/30/EC) Stage 1</b>                   |                           |                                 |                                |
| 24 hour  | 50 $\mu\text{g m}^{-3}$   | 35 per year                     | 1 <sup>st</sup> January 2005   |
| Annual Mean  | 40 $\mu\text{g m}^{-3}$   | -                               | 1 <sup>st</sup> January 2005   |
| <b>EC 1<sup>st</sup> Daughter Directive (1999/30/EC) Stage 2 (to be confirmed)</b> |                           |                                 |                                |
| 24 hour  | 50 $\mu\text{g m}^{-3}$   | 7 per year                      | 1 <sup>st</sup> January 2010   |
| Annual Mean  | 20 $\mu\text{g m}^{-3}$   | -                               | 1 <sup>st</sup> January 2010   |
| <b>Air Quality Strategy (as currently adopted in Northern Ireland)</b>             |                           |                                 |                                |
| 24 hour  | 50 $\mu\text{g m}^{-3}$   | 35 per year                     | 31 <sup>st</sup> December 2004 |
| 24 hour *  | 50 $\mu\text{g m}^{-3}$   | 7 per year                      | 31 <sup>st</sup> December 2010 |
| Annual Mean  | 40 $\mu\text{g m}^{-3}$   | -                               | 31 <sup>st</sup> December 2004 |
| Annual Mean *  | 20 $\mu\text{g m}^{-3}$   | -                               | 31 <sup>st</sup> December 2010 |

\* not prescribed in regulations for the purposes of local air quality management.  
All limit values refer to gravimetric equivalent measurements.

### 6.2.2 Limits and Guide Values for Black Smoke

Before the 1<sup>st</sup> Daughter Directive and Air Quality Strategy set objectives for PM<sub>10</sub>, smoke was covered by EC Directive 80/779/EEC on sulphur dioxide and suspended particulates. This Directive has been superseded by the 1<sup>st</sup> Daughter Directive; however, the limits relating to smoke were in force until 1<sup>st</sup> January 2005, and the new Daughter Directive deals only with PM<sub>10</sub>. The current report therefore compares 2003 results with the smoke limits and guidelines of Directive 80/779/EEC. The limit values are presented in Table 6.3 below, along with the non-mandatory guide values.

**Table 6.3 EC Directive 80/779/EEC Limit Values For Smoke  
(To be fully repealed 1<sup>st</sup> Jan 2005)**

| Limit Values (mandatory)                                      | Smoke $\mu\text{g m}^{-3}$ BS | Sulphur Dioxide $\mu\text{g m}^{-3}$              |
|---|-------------------------------|---|
| YEAR (median of daily values)                                 | 68                            | if smoke $\leq$ 34: 120<br>if smoke $>$ 34: 80    |
| WINTER (median of daily values, October-March)                | 111                           | if smoke $\leq$ 51: 180<br>if smoke $>$ 51: 130   |
| YEAR (Peak, i.e. 98 <sup>th</sup> Percentile of daily values) | 213                           | if smoke $\leq$ 128: 350<br>if smoke $>$ 128: 250 |
| <b>Guide Values (advisory only)</b>                           |                               |   |
| YEAR (arithmetic mean of daily values)                        | 34 to 51                      | 40 to 60  |
| 24 HOURS (daily mean value)                                   | 85 to 128                     | 100 to 150  |

NOTE: The Limit and Guide Values given above for smoke according to the BS calibration are calculated from the original OECD calibration figures given in the EC Directive using the relationship: BS concentration = OECD concentration multiplied by 0.85

## 6.3 PARTICULATE MATTER RESULTS

### 6.3.1 PM<sub>10</sub> Results

Table 6.4 presents data from the automatic PM<sub>10</sub> monitoring sites. TEOM data have been converted to gravimetric equivalent by multiplying by the appropriate factor of 1.3. Figures in **bold** indicate more than the permitted number of exceedences of the relevant limit or objective. To keep the table to a manageable size, only 2003 data are included: the full historical dataset is provided in Appendix 2.

**Table 6.4 2003 PM<sub>10</sub> Results from Automatic Monitoring Sites  
( $\mu\text{g m}^{-3}$  Gravimetric Equivalent)**

| Site                           | 2003 Data Capture % | Annual Mean $\mu\text{g m}^{-3}$ | Max Daily Mean $\mu\text{g m}^{-3}$ | No. of Daily means > 50 $\mu\text{g m}^{-3}$ | 36 <sup>th</sup> Highest Day | 90 <sup>th</sup> %ile of daily means | 36 <sup>th</sup> highest day (OR 90 <sup>th</sup> %ile if DC < 90%) |
|--------------------------------|---------------------|----------------------------------|-------------------------------------|--|------------------------------|--------------------------------------|---|
| Ards, Glen Estate              | 82                  | 24                               | 71                                  | 11   | 41                           | 43                                   | 43  |
| Armagh, Lonsdale Road          | 100                 | 33                               | 121                                 | <b>46</b>                                    | <b>54</b>                    | <b>54</b>                            | <b>54</b>   |
| Bangor                         | 57                  | 27                               | 86                                  | 12   | 38                           | 45                                   | 45  |
| Belfast Centre, Lombard Street | 97                  | 24                               | 91                                  | 26   | 47                           | 47                                   | 47  |
| Belfast Clara Street           | 95                  | 22                               | 121                                 | 34   | 49                           | 49                                   | 49  |
| Belfast Westlink               | 98                  | 36                               | 105                                 | <b>63</b>                                    | <b>60</b>                    | -                                    | <b>60</b>   |
| Carrickfergus, Rosebrook Ave   | 76                  | 25                               | 71                                  | 13   | 40                           | 44                                   | 44  |
| Castlereagh, Loughview Drive   | 76                  | 23                               | 61                                  | 9  | 36                           | 38                                   | 38  |
| Castlereagh, Espie Way         | 67                  | 19                               | 53                                  | 4  | 29                           | 31                                   | 31  |
| Craigavon, Lord Lurgan Park    | 18                  | 25                               | 70                                  | 3  | 20                           | 38                                   | 38  |
| Dungannon, Lambfield           | 88                  | 28                               | 63                                  | 25   | n/a                          | n/a                                  | -   |
| Hollywood                      | 71                  | 27                               | 68                                  | 11   | 41                           | 44                                   | 44  |
| Larne -Harbour                 | 74                  | 22                               | 189                                 | 18   | 35                           | 43                                   | 43  |
| Lisburn, Dunmurry High School  | 16                  | 28                               | 70                                  | 6  | 22                           | 48                                   | 48  |
| Lisburn, Island Civic Centre   | 76                  | 22                               | 77                                  | 7  | 34                           | 36                                   | 36  |
| Lisburn, (LVH)                 | 63                  | 26                               | 98                                  | 15   | 35                           | 46                                   | 46  |
| Londonderry, Brooke Park       | 97                  | 24                               | 90                                  | 20   | 41                           | 41                                   | 41  |
| Londonderry, Brandywell        | 99                  | 29                               | 114                                 | 34   | 50                           | 50                                   | 50  |
| Lough Navar                    | 99                  | 15                               | 55                                  | 1  | 28                           | 27                                   | 28  |
| Newry, Monaghan Row            | 95                  | 23                               | 79                                  | 22   | 43                           | 43                                   | 43  |
| Newry, Trevor Hill             | 97                  | 37                               | 91                                  | <b>71</b>                                    | <b>62</b>                    | <b>62</b>                            | <b>62</b>   |
| Omagh, Tamlaght                | 26                  | 23                               | 64                                  | 2  | 24                           | 34                                   | 34  |
| Strabane, Springfield Pk.      | 97                  | <b>43</b>                        | 164                                 | <b>101</b>                                   | <b>78</b>                    | <b>78</b>                            | <b>78</b>   |

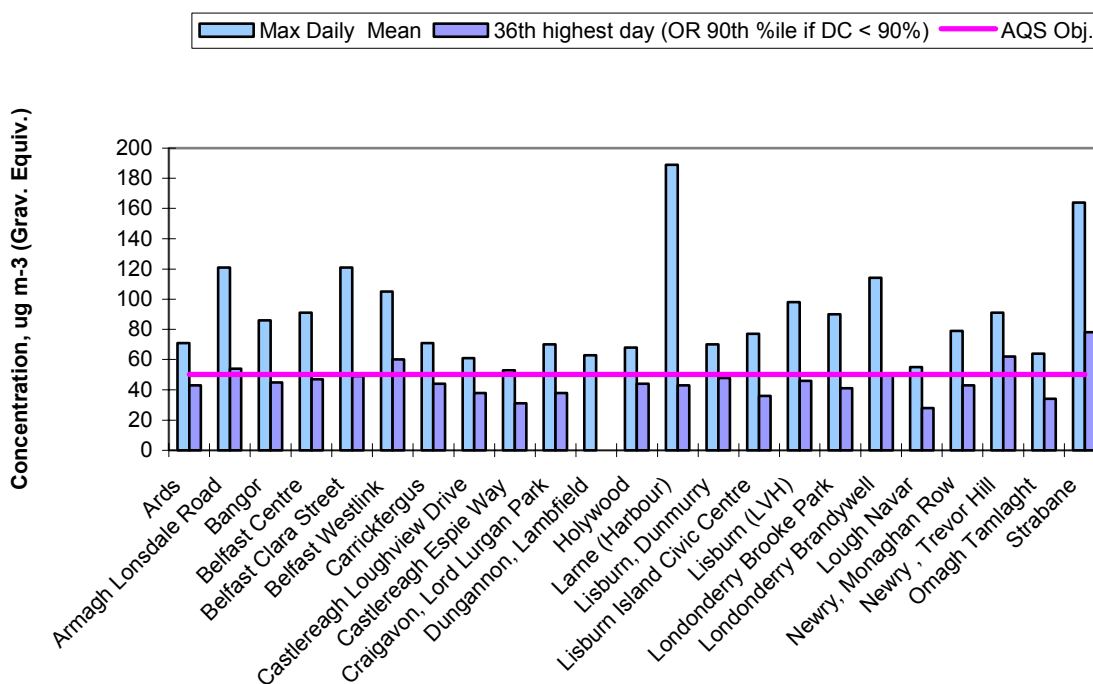
n/a = not available.

Ten of the 23 automatic PM<sub>10</sub> monitoring sites achieved at least 90% data capture for the year. Of the 13 that did not, four (Larne, Bangor, Holywood and Omagh) were new sites which started operation part way through 2003. Three sites (Craigavon Lord Lurgan Park, Lisburn Dunmurry and Omagh) had data capture below 50%: in such cases annual statistics may not be representative.

Four sites exceeded the AQS objective of 50 µg m<sup>-3</sup> (gravimetric equivalent) for the 24-hour mean, on more than the permitted 35 occasions: these were Armagh Lonsdale Road, Belfast Westlink, Newry Trevor Hill, and Strabane Springfield Park. Where data capture is less than 90%, rather than counting the total number of exceedences of the objective, the Technical Guidance<sup>1</sup> states that the 90<sup>th</sup> percentile of 24-hour means should be compared with the objective itself (50 µg m<sup>-3</sup>). On this basis, the sites with less than 90% data capture all appeared to meet the AQS objective for 24-hour mean PM<sub>10</sub>. Figures 6.3a and 6.3b illustrate how data from the monitoring sites compares with applicable AQS objectives.

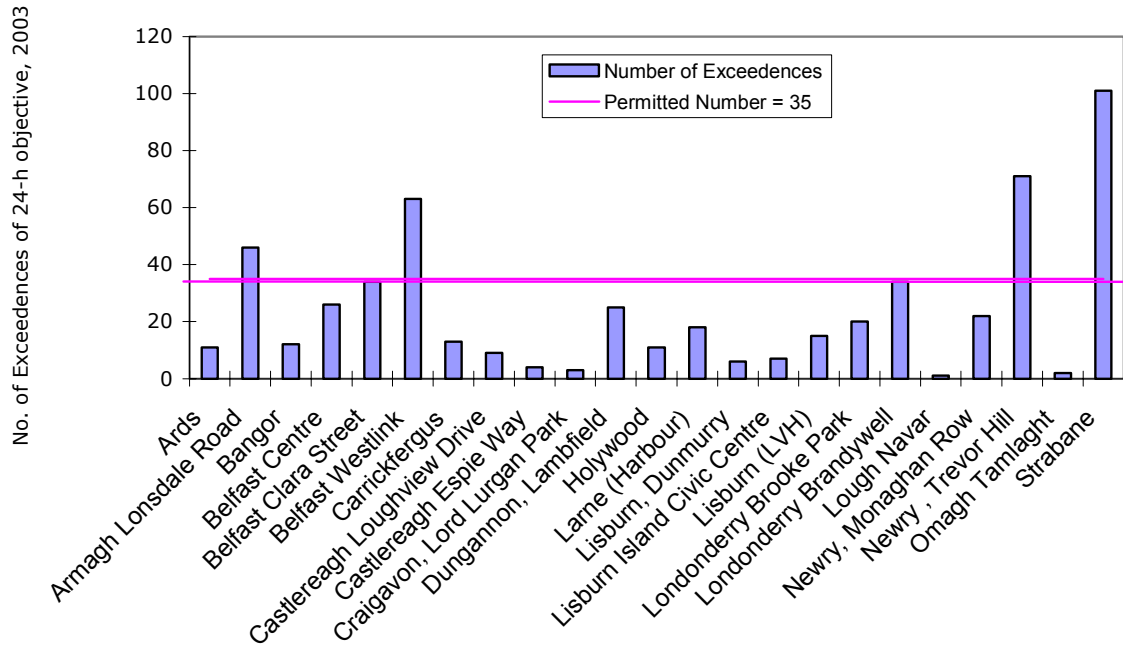
Of these sites, Armagh Lonsdale Road, Belfast Westlink and Newry Trevor Hill are roadside sites near major or busy roads. The Strabane site is located on a housing estate where solid fuel use is prevalent, and where local topography is thought to impede dispersion: high concentrations of black smoke were identified at this site before automatic PM<sub>10</sub> monitoring began.

Only one site (Strabane, Springfield Park) recorded an annual mean PM<sub>10</sub> concentration in excess of the AQS objective of 40 µg m<sup>-3</sup>. Comparison with the annual mean objective is shown in Figure 6.4.

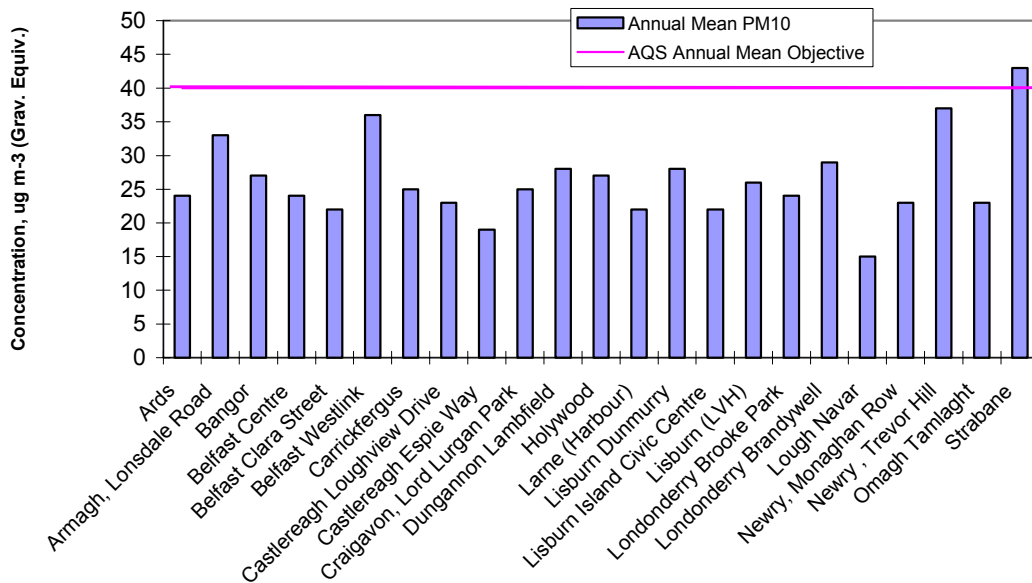


**Figure 6.3a Comparison of 2003 PM<sub>10</sub> Results from Automatic Sites with AQS 24-hour mean Objective.** Figure 6.3a shows the maximum, and the 36<sup>th</sup> highest 24-hour mean (or 90<sup>th</sup> percentile where data capture was less than 90%). If the latter (shown by the darker coloured bar) is greater than 50 µg m<sup>-3</sup>, the site has not met the objective. Four sites did not meet the AQS 24-hour objective of 50µg m<sup>-3</sup> in 2003: Armagh Lonsdale Road, Belfast Westlink, Newry Trevor Hill and Strabane Springfield Park.





**Figure 6.3b Number of Exceedences of 24-hour Mean AQS Objective for PM<sub>10</sub>, 2003. 35 exceedences permitted per calendar year.** Figure 6.3b shows the number of exceedences of the 24-hour mean AQS objective for PM<sub>10</sub>, compared with the maximum permitted total of 35.



**Figure 6.4 Comparison of Annual Mean PM<sub>10</sub> with AQS Objective, 2003.** Only one site (Strabane, Springfield Park) exceeded the annual mean objective in 2003.

Figure 6.4 shows a comparison of annual mean PM<sub>10</sub> concentrations at all automatic sites, with the AQS objective of 40 µg m<sup>-3</sup> for the annual mean PM<sub>10</sub>, as gravimetric equivalent. Although (as noted above) data capture was less than 90% for some sites, on the basis of the available data, it appears that all sites meet this AQS objective, with the exception of Strabane Springfield Park. As noted above, the Strabane site is in an area where domestic solid fuel use is prevalent: high concentrations of black smoke were identified at this site before automatic PM<sub>10</sub> monitoring began.

### 6.3.2 Black Smoke Results

A summary of smoke data for calendar year 2003 for all Smoke and SO<sub>2</sub> Network sites in Northern Ireland is shown in Appendix 3. Annual mean smoke concentrations in Northern Ireland ranged from 3 µg m<sup>-3</sup> to 21 µg m<sup>-3</sup>. The 2003 average for Northern Ireland was 9.3 µg m<sup>-3</sup>; this is slightly higher than the 2003 average of 7.1 µg m<sup>-3</sup> obtained for the Network as a whole.

The highest annual mean smoke concentration of 21 µg m<sup>-3</sup> was measured at STRABANE 2. This site is of particular interest as it is;

- (i) co-located with the automatic PM<sub>10</sub> monitor at Springhill Park, which also recorded high concentrations, and
- (ii) on a housing estate with considerable domestic coal and oil burning,
- (iii) in a location where it is thought that local topography may impede dispersion.

However, the 2003 annual mean represents a substantial reduction on the annual mean smoke concentration of 27 µg m<sup>-3</sup> measured at this site over the previous year.

Two non-Network smoke sites reported annual mean smoke concentrations: these were Newtownstewart (operated by Strabane DC), and Newcastle (operated by Down DC). The 2003 annual mean smoke concentrations at these two sites were 13.1 µg m<sup>-3</sup> and 4.5 µg m<sup>-3</sup> respectively.

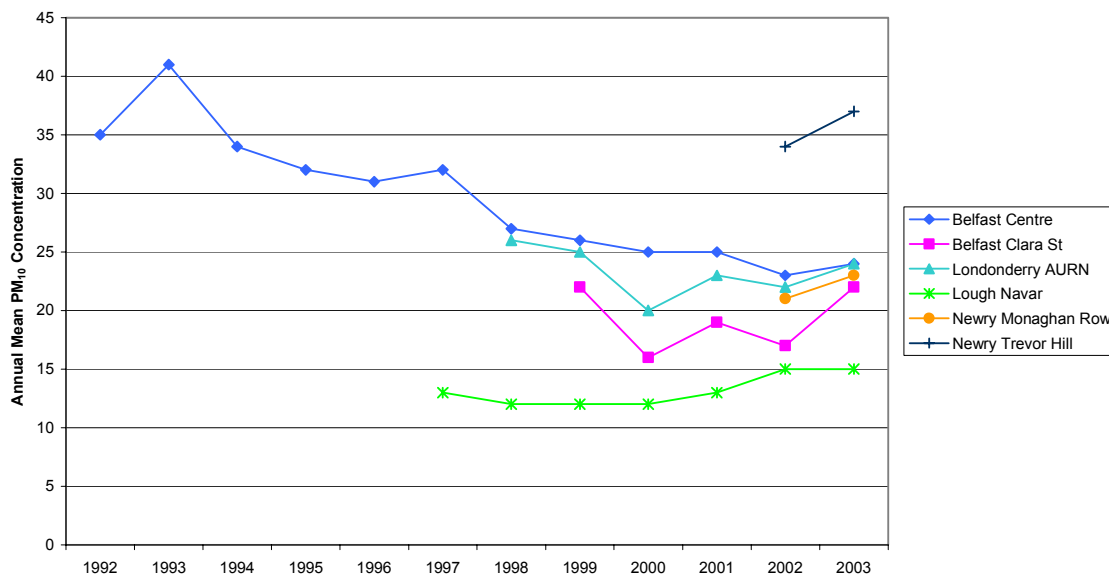
All the sites in Northern Ireland meet the limit values of 80/779/EEC for smoke, and have done so since 1990. During 2003, the annual arithmetic mean was well below the lower guide value of 34 µg m<sup>-3</sup> at all sites in Northern Ireland. However, the maximum daily mean exceeded both the upper and lower 24-hour guide values at several sites in Northern Ireland.

## 6.4 PARTICULATE MATTER TRENDS

In the Greater Belfast area, the contribution to primary PM<sub>10</sub> emissions from domestic contribution is around 26%<sup>3</sup>, a substantially higher proportion than in most UK cities. Therefore, trends in PM<sub>10</sub> and black smoke emissions for Northern Ireland will not necessarily be the same as for other regions. However, UK data from the NAEI ([www.naei.org.uk](http://www.naei.org.uk)) show a substantial decrease of almost 50% in total UK PM<sub>10</sub> emissions between 1990 and 2002, so it is not unreasonable to expect a decreasing trend for Northern Ireland.

### 6.4.1 PM<sub>10</sub> Trends

Figure 6.5 shows annual mean PM<sub>10</sub> concentrations for the longer-running sites in Northern Ireland. Only sites with at least two consecutive years' annual means are shown, and annual means have only been included where data capture is at least 75%. The majority of the 22 sites now in operation are not included as they do not yet have two valid annual means.



**Figure 6.5 Annual Mean PM<sub>10</sub> Concentrations at Automatic Monitoring Sites, Gravimetric Equivalent. (Data capture at least 75%).**

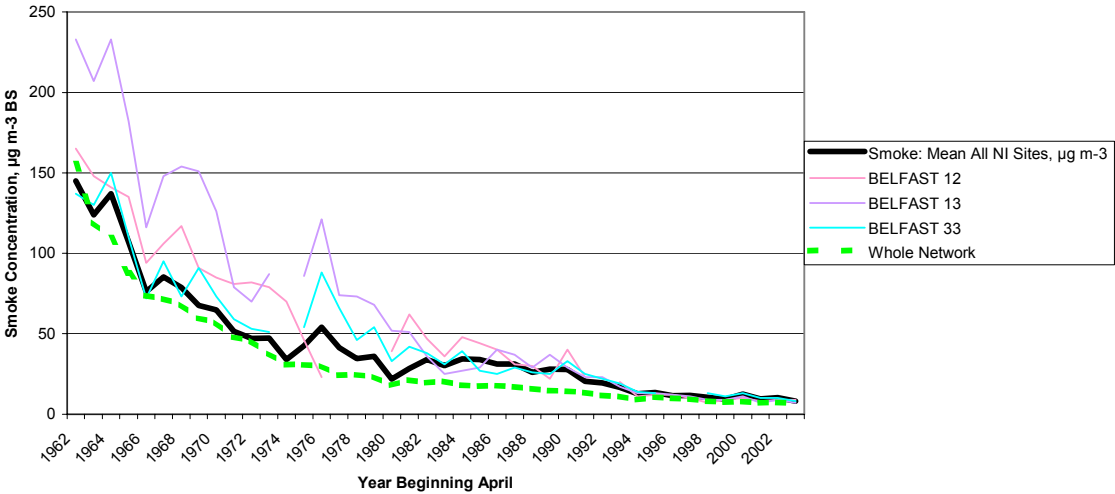
Five years’ data are usually required to assess trends in air quality. The longest running site is Belfast Centre, which has been in operation since 1992. The annual mean PM<sub>10</sub> concentration at this site has shown a steady decrease over this period. However, there is no clear trend at Belfast Clara Street, Londonderry, Brooke Park, or Lough Navar. (At the two Newry sites there is not yet enough data to assess trends).

Despite the long-term decreasing trend evident from Belfast Centre, it is noticeable that annual mean PM<sub>10</sub> concentrations at all these sites except Lough Navar were higher in 2003 than in 2002. This is likely to be due to meteorological conditions during 2003, which gave rise to several periods of high levels of particulate pollution, due to Saharan dust (April 2003) and long-range transport of pollution from mainland Europe (summer).

### 6.4.2 Black Smoke Trends

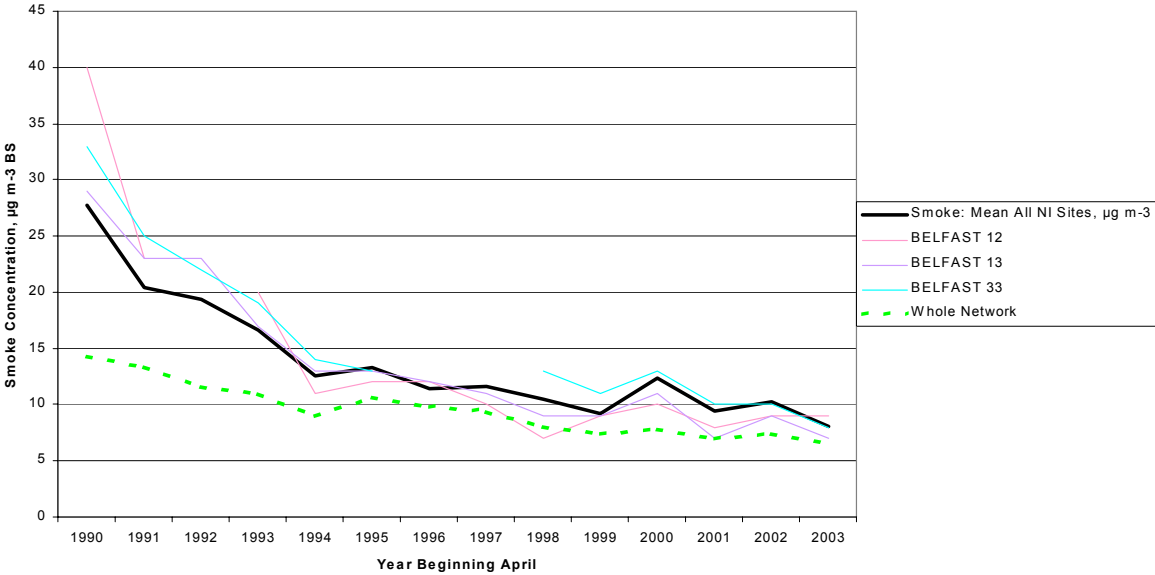
The long-running historical dataset for the Smoke and SO<sub>2</sub> Network gives an indication of how concentrations of fine suspended primary particulate, as measured by this technique, have decreased since the early 1960s. This trend is shown in Figure 6.6, a graph of the average smoke concentration at all Network sites in Northern Ireland since 1962. For historical reasons the annual averaging periods run April -March. The annual mean is based only upon sites with at least 75% data capture for the year, which in most years totalled between 14 and 24. The annual average concentration of smoke has fallen, from over 100 µg m<sup>-3</sup> in the early 1960s to less than 10 µg m<sup>-3</sup> in 2003.

Figure 6.6 shows the trend in annual mean for three particular sites in Belfast: BELFAST 12 (at the Royal Victoria Hospital), BELFAST 13 (the suburban Templemore Avenue) and BELFAST 33 (the industrial centre Dufferin Road), all of which have been in continuous operation since the early 1960s. These three individual sites show a similar pattern.



**Figure 6.6 Trends in Black Smoke Concentration, Northern Ireland. NI average, UK Network average, and 3 long-running Belfast sites.**

Figure 6.6 also shows the annual means for the UK as a whole, as a dotted line. Throughout the Network’s operation, Northern Ireland’s average levels of black smoke have typically been slightly higher than the UK average. However, since the mid 1990s the difference has been very small, and this is illustrated by Figure 6.7, which shows trends from 1990 onwards.



**Figure 6.7 Trends in Black Smoke Concentration, Northern Ireland and UK Network average, 1990 onwards**

# 7 Ozone

Ozone (O<sub>3</sub>) is a form of oxygen, with three atoms per molecule (unlike normal oxygen, O<sub>2</sub>, which has two). In the upper atmosphere it is beneficial, forming the "ozone layer" which protects living things from harmful UV radiation. However, at ground level it is a pollutant, having an irritant effect on the respiratory system.

Ground level ozone is not emitted directly from source, but formed by chemical reactions involving the action of sunlight and high temperatures on oxides of nitrogen and volatile organic compounds (VOCs). These reactions may happen over several hours, so the highest ozone concentrations may occur a long distance downwind of the sources of the primary pollutants. Also, O<sub>3</sub> may persist for several days. Ozone pollution can therefore be a transboundary problem, and difficult to control by local action. Ambient concentrations of ozone depend on year-to-year variations in weather.

O<sub>3</sub> concentrations are usually therefore lowest in towns, and highest in the rural areas downwind of them. Because ozone formation requires sunlight, concentrations are highest in the summer, and during daylight hours.

The summer of 2003 was particularly hot and sunny, and meteorological conditions gave rise to high levels of ozone throughout the UK and Europe. High levels of this pollutant were recorded as early as April and as late as September<sup>5</sup>.

In this report, concentrations of ozone are expressed as microgrammes per cubic metre ( $\mu\text{g m}^{-3}$ ). To convert to parts per billion (ppb) if necessary, the following relationship should be used:

$$1 \text{ ppb} = 2.0 \mu\text{g m}^{-3} \text{ for ozone at } 293\text{K (} 20^\circ\text{C) and } 1013\text{mb.}$$

## 7.1 MONITORING OF OZONE

Monitoring of O<sub>3</sub> in Northern Ireland is carried out largely using continuous automatic analysers. Diffusion tubes are also available for this pollutant, but are used routinely at only one site in Northern Ireland, which is operated by Fermanagh District Council. Monitoring of ozone is carried out at the sites shown in Table 7.1 below, and in Figure 7.1.

**Table 7.1 Automatic O<sub>3</sub> Monitoring Sites**

| Site                        | Method     | Grid Ref. | Classification   | Network         |
|-----------------------------|------------|-----------|------------------|-----------------|
| Belfast Centre              | Automatic  | J 339 744 | Urban Centre     | AURN            |
| Londonderry,<br>Brooke Park | Automatic  | C 429 172 | Urban Background | AURN            |
| Lough Navar                 | Automatic  | H 065 545 | Rural            | AURN<br>(Rural) |
| Fermanagh                   | Diff. tube | H 232 429 | Urban Background | Fermanagh       |

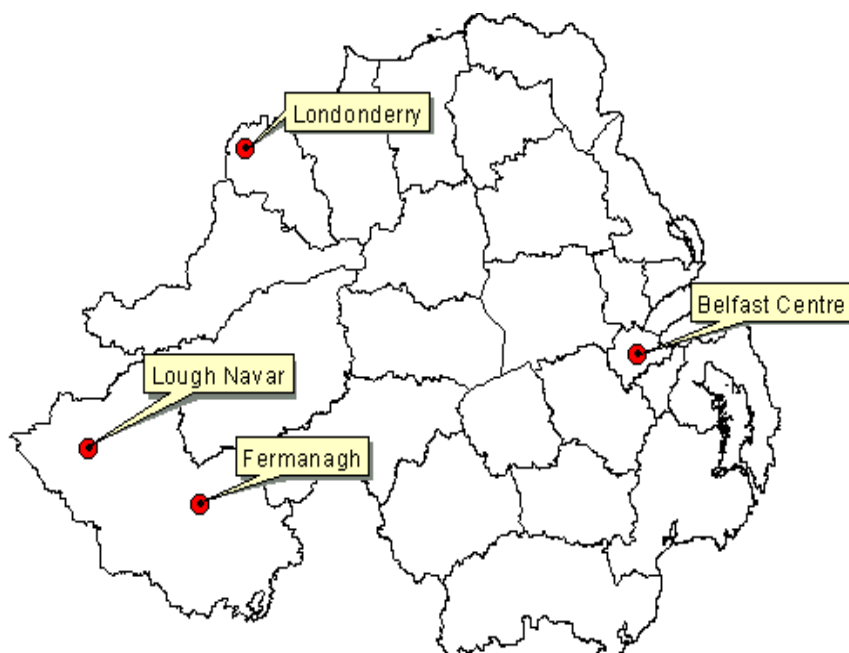


Figure 7.1 Location of Ozone Monitoring Sites

## 7.2 LIMIT VALUES AND OBJECTIVES FOR OZONE

Ozone is covered by the target values and objectives in Table 7.2. The third Daughter Directive, 2002/3/EC, which sets “target values” rather than limits, was transposed into Northern Ireland’s legislation in July 2003 by the Air Quality (Ozone) Regulations (Northern Ireland) 2003. The AQS objective, with its objective of  $100 \mu\text{g m}^{-3}$  for the maximum daily 8-hour mean, is more stringent than the EC target value for this statistic, so if a site meets the AQS objective it will also meet the EC target value for human health.

Table 7.2 Target Values and Objectives for Ozone

| Averaging period   | Target or Objective   | Number of Permitted Exceedences | To be achieved by                      |
|--|---|---------------------------------|--|
| <b>WHO (non-mandatory guide)</b>   |   |                                 |  |
| Day  | $\text{O}_3$ concentrations not to exceed $120 \mu\text{g m}^{-3}$ for more than eight hours per day. |                                 |  |
| <b>EC Ozone Directive (2002/3/EC)</b>  |   |                                 |  |
| Max. daily 8-hour mean. Compliance assessment to be based on the average number of days exceedence over 3 consecutive years. | $120 \mu\text{g m}^{-3}$  | 25 days per calendar year       | Averaged over 3 years, beginning 2010. |
| AOT40 <sup>a</sup> , calculated from 1h values May- July. For protection of vegetation.                                      | $18,000 \mu\text{g m}^{-3} \text{ h}$   | -                               | Averaged over 5 years, beginning 2010  |
| <b>Air Quality Strategy<sup>b</sup></b>  |   |                                 |  |
| Max. daily running 8-hour mean   | $100 \mu\text{g m}^{-3}$  | 10 days per year                | 31 December 2005                       |

a) AOT 40 is the sum of the differences between hourly concentrations greater than  $80 \mu\text{g m}^{-3}$  (=40ppb) and  $80 \mu\text{g m}^{-3}$ , over a given period using only the 1-hour averages measured between 0800 and 2000.  
 b) Not included in the Air Quality Regulations.

## 7.3 OZONE RESULTS

Table 7.3 shows the annual maximum daily 8-hour running mean ozone concentration for each site during 2003, and also the number of days during the year on which this parameter exceeded  $100 \mu\text{g m}^{-3}$ . The historic dataset is included in Appendix 2.

Where the AQS objective was exceeded on more than 10 days, this is highlighted in ***bold italics***. Table 7.3 shows that Belfast Centre and Lough Navar met the AQS objective for ozone in 2003. However, Londonderry, Brooke Park exceeded the AQS objective limit value for ozone on more than the permitted 10 days (for the second year running). This objective is to be met by 31 December 2005.

No sites in Northern Ireland exceeded the less stringent EC 3<sup>rd</sup> Daughter Directive target of  $120 \mu\text{g m}^{-3}$ , not to be exceeded on more than 25 days.

The exceedences at Londonderry were spread over a period of several months, April to September. Levels of ozone were particularly high during the summer of 2003, due to the prolonged hot and sunny weather<sup>5</sup>.

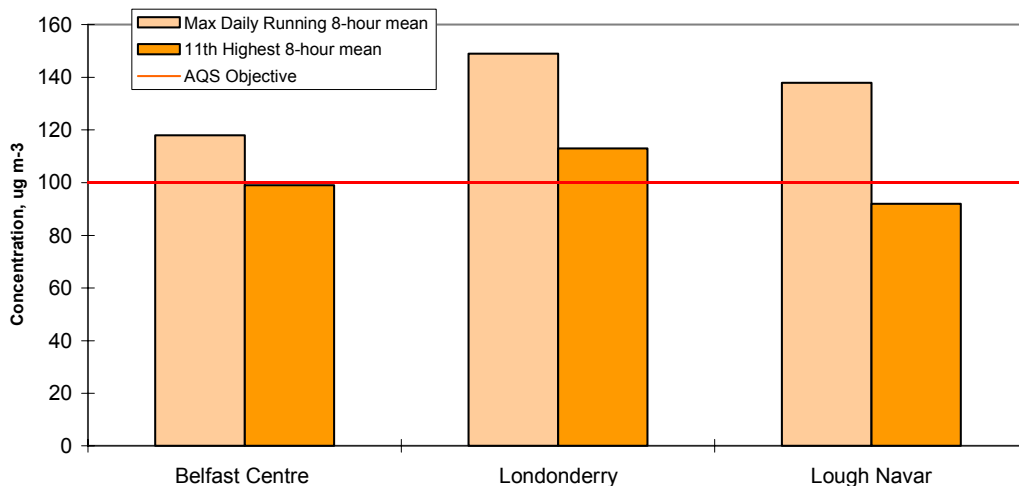
However, it should be noted that the Lough Navar site recorded no valid data during the period May to July, when highest ozone levels might be expected. It is therefore possible that some exceedences at this site went unrecorded, and that the annual statistics for 2003 at this site are under-estimated.

The EC 3<sup>rd</sup> Daughter Directive also sets a target value for protection of vegetation, based on the AOT40 statistic. This is only applicable in rural locations, so of the three automatic sites, it is only applicable to Lough Navar. Ozone data from Lough Navar, for the five years 1998 to 2003, were compared with this AOT40 target value for protection of vegetation. Lough Navar met the target value.

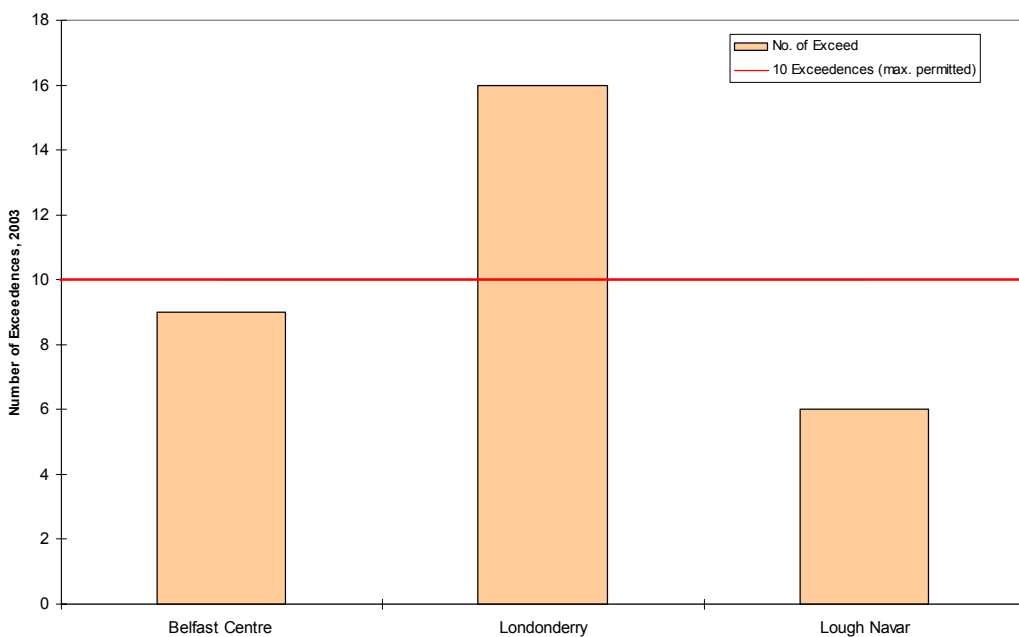
The 2003 annual mean ozone concentration at the Fermanagh diffusion tube site was  $86 \mu\text{g m}^{-3}$ . This is comparable with the annual means recorded at this site in 2001 and 2002, but very high compared with the automatic analyser results.

**Table 7.3 O<sub>3</sub> Results from Automatic Monitoring Sites**

| Calendar Year         | Data Capture, % | Max Daily 8 Hour Mean $\mu\text{g m}^{-3}$ | Days with max. daily 8hr mean > $100 \mu\text{g m}^{-3}$ | Annual Mean $\mu\text{g m}^{-3}$ |
|-----------------------|-----------------|--|--|----------------------------------|
| <b>Belfast Centre</b> | 97              | 118  | 9  | 42                               |
| <b>Londonderry</b>    | 93              | 149  | <b><i>16</i></b>   | 52                               |
| <b>Lough Navar</b>    | 64              | 138  | 6  | 47                               |



**Figure 7.2 Comparison of 2003 Ozone Results from Automatic Sites with AQS Objective.**

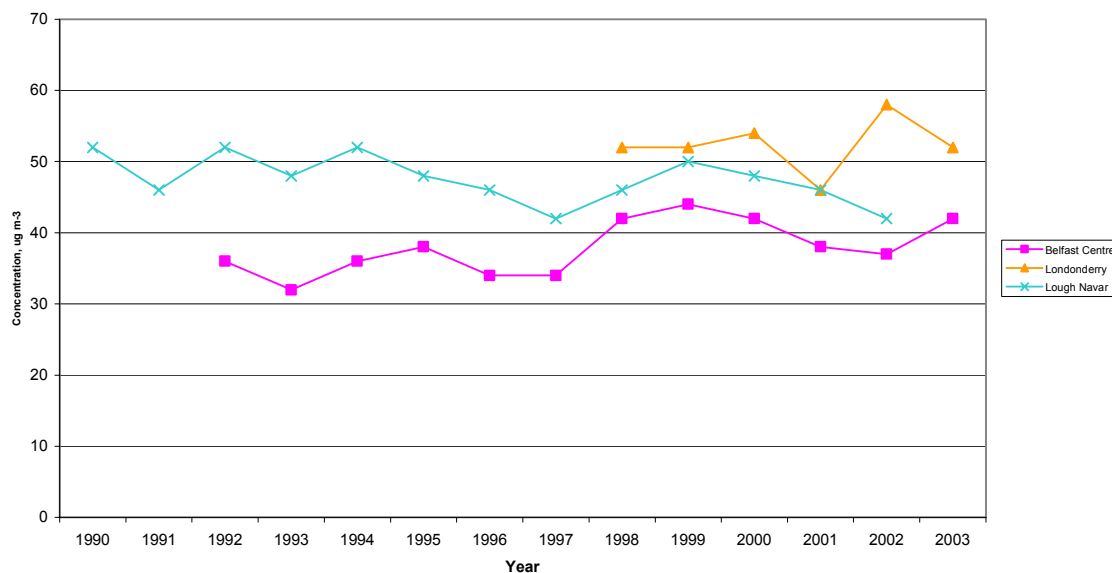


**Figure 7.3 Number of Exceedences of AQS Objective for Ozone, 2003.**



## 7.4 OZONE TRENDS

Figure 7.4 shows a time series plot of the annual mean ozone concentration. There appear to be no clear trends, although there is some year-to-year variation. If ozone concentrations remain around their current levels, occasional exceedences of the AQS objective may continue to occur, such as that observed at Londonderry in 2002 and 2003.



**Figure 7.4 Trends in Annual Mean Ozone Concentration**

## 8 Hydrocarbons

There are many hydrocarbon compounds that have the potential to be pollutants when released into the atmosphere. Some occur naturally, others are man-made.

### (i) Benzene and 1,3-butadiene

A range of hydrocarbons is found in vehicle fuel, and occurs in vehicle emissions. In most urban areas, vehicle emissions constitute a major source of hydrocarbons, including benzene and 1,3-butadiene. Also, there is the potential that they may be released to the air from facilities where fuels are stored or handled.

Benzene is of most concern, as it is a known human carcinogen; long-term exposure can cause leukaemia. It is found in petrol and other liquid fuels, in small concentrations. In urban areas, the major source is vehicle emissions.

1,3-butadiene is also found in vehicle emissions: although not actually present in petrol or diesel, it is formed as these fuels undergo combustion. 1,3-butadiene is a suspected human carcinogen and therefore an air quality objective has been set for it.

In this report, concentrations of benzene and 1,3-butadiene are expressed as microgrammes per cubic metre ( $\mu\text{g m}^{-3}$ ). To convert to parts per billion (ppb) if necessary, the following relationships should be used:

$$1 \text{ ppb} = 3.25 \mu\text{g m}^{-3} \text{ for benzene at 293K (20°C) and 1013mb.}$$

$$1 \text{ ppb} = 2.25 \mu\text{g m}^{-3} \text{ for 1,3-butadiene at 293K (20°C) and 1013mb.}$$

### (ii) Polycyclic Aromatic Hydrocarbons

Another class of organic pollutants is the polycyclic aromatic hydrocarbons, (PAHs). These include the following compounds: Acenaphthene, Acenaphthylene, Anthracene, Benz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(ghi)perylene, Benzo(k)fluoranthene, Chrysene, Dibenz(ah)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Naphthalene, Phenanthrene, Pyrene. They are all, to varying degrees, toxic or carcinogenic, and are therefore classified as Hazardous Air Pollutants. Concentrations of these hazardous compounds in ambient air are usually very small, and are reported as nanogrammes (i.e.  $10^{-9}$  grammes) per cubic metre ( $\text{ngm}^{-3}$ ).

According to the NAEI website ([www.naei.org.uk](http://www.naei.org.uk)), the largest source of PAHs in the UK at present is road transport, which in 2002 contributed 52% to the total UK PAH emissions. Non-ferrous metal processes such as aluminium smelting can also be a significant source, although there are no aluminium smelting plant in Northern Ireland at present. However, there is one significant source particularly relevant to parts of Northern Ireland: domestic solid fuel combustion. For this reason, it is important to continue monitoring PAH in areas where domestic solid fuel use is widespread.

PAHs can be adsorbed onto the surface of fine particulate: therefore they are monitored in the particulate phase, by sampling the  $\text{PM}_{10}$  fraction and analysing for the compounds of concern.

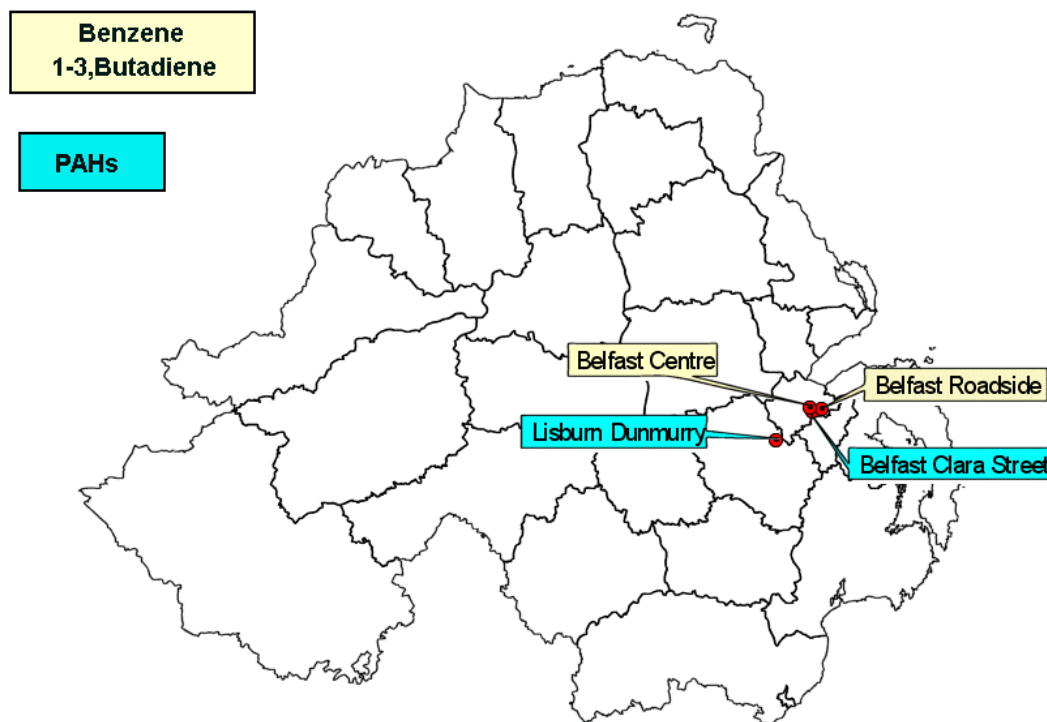
## 8.1 MONITORING OF HYDROCARBONS

From 1993 until 2000, a range of 27 hydrocarbons including benzene and 1,3-butadiene were monitored at a site named Belfast South. However, this site ceased operation at the end of 2000. Benzene and 1,3-butadiene data from Belfast South are reported in previous reports in this series.

In July 2002, monitoring of benzene, using pumped samplers commenced at two sites in Belfast. These are the existing Belfast Centre AURN site at Lombard Street, and a new site, Belfast Roadside, located on the Upper Newtownards Road in Ballyhackamore. In May 2003, monitoring of

1,3-butadiene also commenced at the same two sites, using passive samplers. Hydrocarbon monitoring at these sites is carried out by NPL.

A range of polycyclic aromatic hydrocarbons (PAHs) in the particulate phase is monitored at two sites in Northern Ireland as part of Defra’s Hazardous Air Pollutants (HAPS) Network. These are Belfast (at Clara Street) and Lisburn (at Dunmurry High School). The sites are shown in Table 8.1 below, and site locations are shown in Figure 8.1.



**Figure 8.1 Locations of Hydrocarbon Monitoring Sites**

**Table 8.1 Hydrocarbon Monitoring Sites**

| Site                           | Grid Ref. | Classification   | Pollutants             | Network                  |
|--------------------------------|-----------|------------------|------------------------|--------------------------|
| Belfast Centre                 | J 339 744 | Urban Centre     | Benzene, 1,3-butadiene | Non-Auto. Hydrocarbon    |
| Belfast Roadside               | J 379 739 | Roadside         | Benzene, 1,3-butadiene | Non-Auto. Hydrocarbon    |
| Lisburn (Dunmurry High School) | J 287 675 | Urban Background | Range of PAH           | Hazardous Air Pollutants |
| Belfast (Clara Street)         | J 360 734 | Suburban         | Range of PAH           | Hazardous Air Pollutants |

All these sites are part of national monitoring networks and are subject to appropriate QA/QC programmes.

## 8.2 LIMIT VALUES AND OBJECTIVES FOR HYDROCARBONS

Within the European Community, benzene is covered by EC Directive 2000/69/EC (the 2<sup>nd</sup> Daughter Directive). In February 2003, Defra and the Devolved Administrations published an addendum to the Air Quality Strategy. The addendum brings into line objectives for carbon monoxide and benzene set by the 2<sup>nd</sup> Daughter Directive. An objective was added for PAHs. In

Northern Ireland a corrigendum was issued in 2003 which adopted a PAH objective of 0.25 ng m<sup>-3</sup> to be met by 31<sup>st</sup> December 2010. EC limits and AQS objectives for these three hydrocarbon pollutants are summarised in Table 8.2:

**Table 8.2 Limit Values and Objectives for Hydrocarbons**

| Averaging period   | EC Limit or AQS Objective | To be achieved by              |
|--|---------------------------|--------------------------------|
| <b>EC 2<sup>nd</sup> Daughter Directive (2000/69/EC)</b> |                           |                                |
| BENZENE:<br>Calendar Year Mean                           | 5 µg m <sup>-3</sup>      | 1 <sup>st</sup> January 2010   |
| <b>Air Quality Strategy</b>                              |                           |                                |
| BENZENE:<br>Running annual mean *                        | 16.25 µg m <sup>-3</sup>  | 31 <sup>st</sup> December 2003 |
| Calendar Year Mean                                       | 3.25 µg m <sup>-3</sup>   | 31 <sup>st</sup> December 2010 |
| 1,3 BUTADIENE:<br>Running annual mean *                  | 2.25 µg m <sup>-3</sup>   | 31 <sup>st</sup> December 2003 |
| <b>Air Quality Strategy for PAH</b>                      |                           |                                |
| PAHs (using B(a)P as an indicator)<br>Calendar year mean | 0.25 ng m <sup>-3</sup>   | 31 <sup>st</sup> December 2010 |

\*The running annual mean and the calendar year mean are equivalent in this case.

PAHs are to be covered by a fourth Daughter Directive, still under discussion. This specifies a range of PAHs to be monitored, but proposes a target value for just one PAH compound, benzo(a)pyrene, which will be used as a marker of carcinogenic risk from PAHs in ambient air. The proposed 2010 target value for benzo(a)pyrene (B(a)P) is **1 ngm<sup>-3</sup> for the annual mean total benzo(a)pyrene in the PM<sub>10</sub> particulate fraction**. This target value is not a mandatory limit value, but rather "must be attained as far as possible and without entailing excessive costs". Industrial installations would be required to employ Best Available Techniques (BAT) to minimise their PAH emissions, but no measures beyond this (such as closing down plant) would be imposed. However, the draft Directive does specifically "require Member States to take all cost-effective abatement measures in the relevant sectors, e.g. domestic heating by solid fuels".

## 8.3 HYDROCARBON RESULTS

### 8.3.1 Benzene and 1,3 Butadiene

Table 8.3 shows calendar year mean concentrations of benzene at Belfast Centre and Belfast Roadside for 2003.

**Table 8.3 Concentrations of Benzene, 2003**

| Site                    | Data Capture, % | Calendar Year Mean Concentration 2003, µg m <sup>-3</sup> | Running Annual Mean Concentration 2003, µg m <sup>-3</sup> |
|-------------------------|-----------------|---|--|
| <b>Belfast Centre</b>   | 96              | 1.17  | -  |
| <b>Belfast Roadside</b> | 100             | 2.62  | -  |

The annual means for 2003 means of 1.17 µg m<sup>-3</sup> and 2.62 µg m<sup>-3</sup> for the two sites respectively are within the 2003 Air Quality Strategy objective for the region (16.25 µg m<sup>-3</sup>), also the 2010 objective of 3.25 µg m<sup>-3</sup>, and the EC 2<sup>nd</sup> Daughter Directive limit value of 5 µg m<sup>-3</sup> for this pollutant. Both sites have therefore achieved the AQS objectives for benzene and 1,3-butadiene by the due date of 31<sup>st</sup> December 2003. These results are also consistent with those obtained by the former Belfast South hydrocarbon site, at which annual mean benzene concentration was consistently below 5 µg m<sup>-3</sup> since 1994.

1,3-butadiene monitoring began in May 2003. Table 8.4 shows calendar year mean concentrations of this pollutant.

**Table 8.4 Concentrations of 1,3-Butadiene, 2003**

| Site                    | Data Capture, % | Calendar Year Mean Concentration 2003, $\mu\text{g m}^{-3}$ | Running Annual Mean Concentration 2003, $\mu\text{g m}^{-3}$ |
|-------------------------|-----------------|---|--|
| <b>Belfast Centre</b>   | 50              | 0.073   | -  |
| <b>Belfast Roadside</b> | 73              | 0.103   | -  |

Although data capture is considerably less than 90%, the results indicate that levels of this pollutant at both sites are less than  $0.2 \mu\text{g m}^{-3}$ , and therefore well within the applicable Air Quality Strategy objective of  $2.25 \mu\text{g m}^{-3}$ . This is consistent with the findings from the former Belfast South hydrocarbon monitoring site, at which running annual mean concentrations of 1,3-butadiene were consistently less than  $2.25 \mu\text{g m}^{-3}$  throughout its operational period of 1994 - 2000.

### 8.3.2 Polycyclic Aromatic Hydrocarbons

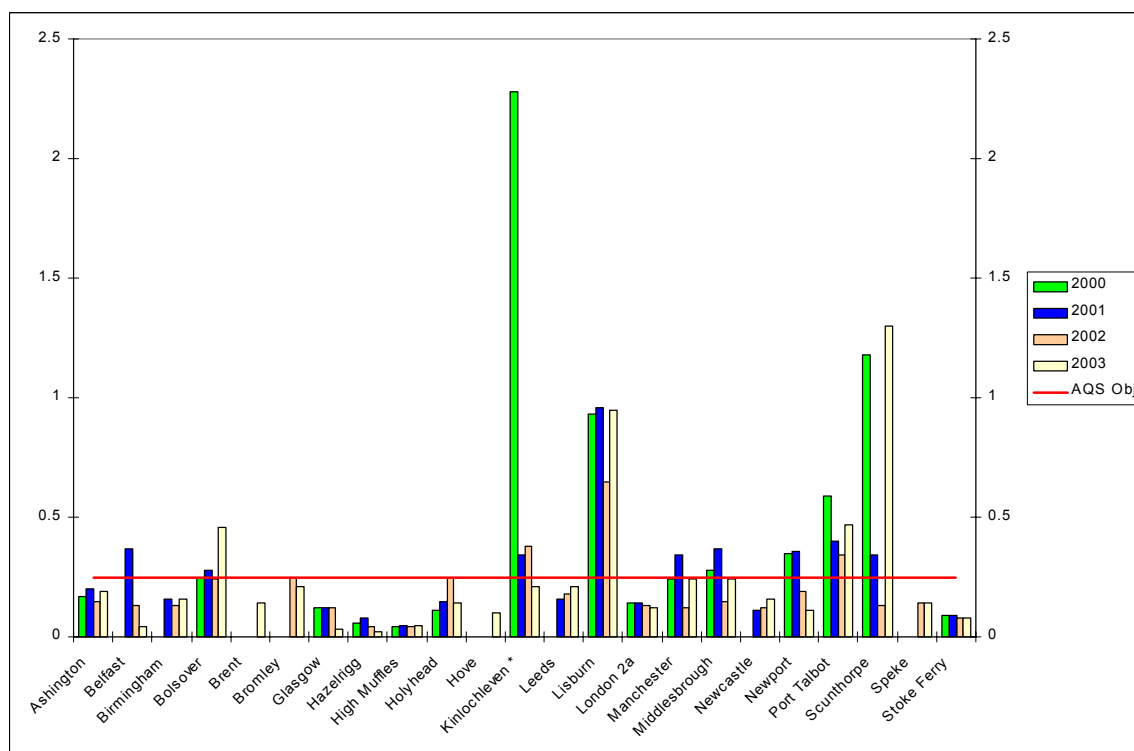
The 2003 annual mean benzo(a)pyrene concentration was  $0.95 \text{ ng m}^{-3}$  at Lisburn, Dunmurry, and  $0.08 \text{ ng m}^{-3}$  at Belfast Clara Street. Both sites are therefore within the proposed EC target value of  $1.0 \text{ ng m}^{-3}$  for this PAH. The 2010 AQS objective for benzo(a)pyrene is  $0.25 \text{ ng m}^{-3}$ . Lisburn currently exceeds this value by a considerable margin.

To put these values into context, they should be compared with results from other sites in the HAPS Network – see Table 8.5 and Figure 8.2. The two sites in Northern Ireland are shown in ***bold italics***. In some cases, including Belfast, the annual mean was reported as “less than” a given value. In these cases, the annual mean has been shown as half that value in Figure 8.2.

**Table 8.5 Annual Mean Benzo(a)pyrene Concentrations at all HAPS Network Sites**

| Site                  | Type                | 2000 $\text{ng m}^{-3}$ | 2001 $\text{ng m}^{-3}$ | 2002 $\text{ng m}^{-3}$ | 2003 $\text{ng m}^{-3}$ |
|-----------------------|---------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Ashington             | Urban               | 0.17                    | 0.2                     | 0.15                    | 0.19                    |
| <b><i>Belfast</i></b> | <b><i>Urban</i></b> | -                       | <b><i>0.37</i></b>      | <b><i>0.13</i></b>      | <b><i>&lt; 0.08</i></b> |
| Birmingham            | Urban               | -                       | 0.16                    | 0.13                    | 0.16                    |
| Bolsover              | Urban               | 0.25                    | 0.28                    | 0.24                    | 0.46                    |
| Brent                 | Urban               | -                       | -                       | -                       | 0.14                    |
| Bromley               | Urban               | -                       | -                       | 0.25                    | 0.21                    |
| Glasgow               | Urban               | 0.12                    | 0.12                    | 0.12                    | < 0.065                 |
| Hazelrigg             | Semi-Rural          | 0.06                    | 0.08                    | 0.04                    | < 0.043                 |
| High Muffles          | Rural               | 0.04                    | 0.05                    | 0.04                    | 0.045                   |
| Holyhead              | Urban               | 0.11                    | 0.15                    | 0.25                    | 0.14                    |
| Hove                  |                     | -                       | -                       | -                       | 0.1                     |
| Kinlochleven *        | Urban               | 2.28                    | 0.34                    | 0.38                    | 0.21                    |
| Leeds                 | Urban               | -                       | 0.16                    | 0.18                    | 0.21                    |
| <b><i>Lisburn</i></b> | <b><i>Urban</i></b> | <b><i>0.93</i></b>      | <b><i>0.96</i></b>      | <b><i>0.65</i></b>      | <b><i>0.95</i></b>      |
| London 2a             | Urban               | 0.14                    | 0.14                    | 0.13                    | 0.12                    |
| Manchester            | Urban               | 0.24                    | 0.34                    | 0.12                    | 0.24                    |
| Middlesbrough         | Urban               | 0.28                    | 0.37                    | 0.15                    | 0.24                    |
| Newcastle             | Urban               | -                       | 0.11                    | 0.12                    | 0.16                    |
| Newport               | Urban               | 0.35                    | 0.36                    | 0.19                    | 0.11                    |
| Port Talbot           | Urban               | 0.59                    | 0.4                     | 0.34                    | 0.47                    |
| Scunthorpe            | Urban               | 1.18                    | 0.34                    | 0.13                    | 1.3                     |
| Speke                 | Urban               | -                       | -                       | 0.14                    | 0.14                    |
| Stoke Ferry           | Rural               | 0.09                    | 0.09                    | 0.08                    | 0.08                    |

\*Kinlochleven site (Scotland) was near an aluminium smelter, which closed in July 2000, hence the reduced annual mean in 2001.



**Figure 8.2 Annual Mean Benzo(a)pyrene Concentrations at HAPS Network sites, ng m<sup>-3</sup> 2000 to 2003**

Annual mean benzo(a)pyrene at rural sites (Hazelrigg, High Muffles, Stoke Ferry), ranged from less than 0.04 to 0.08 ng m<sup>-3</sup>, well within the Air Quality Strategy's new 2010 objective of 0.25 ng m<sup>-3</sup>. Urban sites (including Belfast Clara Street) typically had higher annual mean concentrations, ranging from less than 0.06 to 1.3 ng m<sup>-3</sup>. Four sites out of 23 exceeded the AQS objective of 0.25 ng m<sup>-3</sup>, compared with nine out of nineteen in 2001. One site (Scunthorpe, which is in an industrial area) exceeded the proposed EC limit value for benzo(a)pyrene of 1.0 ng m<sup>-3</sup>. Annual mean benzo(a)pyrene concentrations for 2003 were higher than those reported for 2002 at several of the HAPS network sites.

The mean benzo(a)pyrene level at Belfast Clara Street in 2003 was measured as less than 0.08 ng m<sup>-3</sup>. This is substantially lower than in the previous two years, and lower than at other city centre sites such as Birmingham, London and Manchester. Belfast Clara Street was well within the proposed AQS objective of 0.25 ng m<sup>-3</sup>.

The 2003 mean benzo(a)pyrene concentration at the Lisburn was 0.95 ng m<sup>-3</sup>. It therefore remains one of the highest in the HAPS network, comparable with sites in or near industrial areas such as Scunthorpe, Port Talbot and Bolsover. The Lisburn site does not currently meet the AQS objective of 0.25 ng m<sup>-3</sup>, and approaches the proposed EC limit value for benzo(a)pyrene of 1.0 ng m<sup>-3</sup>. Lisburn Dunmurry is in a non-industrial residential area, and it is likely that domestic fuel burning is the dominant source of PAHs.

As there are only four years' data for PAHs in Northern Ireland, it is not possible to assess trends. A study<sup>4</sup> carried out by **netcen** for Defra has predicted that the continued high use of solid fuels in Northern Ireland for domestic purposes may result in some urban areas exceeding the AQS objective of 0.25 ng m<sup>-3</sup> for benzo(a)pyrene in 2010. Exceedences result from domestic solid fuel use and other local activities. These sources could be addressed, by measures based upon Local Air Quality Management, such as the extension of smoke control orders. The study predicts that the continuation of the Northern Ireland Housing Executive's ongoing programme to replace solid fuel use with gas or oil will reduce ambient levels of benzo(a)pyrene to below the target value in most parts of Northern Ireland, as well as reducing ambient SO<sub>2</sub>.

## 8.4 HYDROCARBON TRENDS

As the two benzene and 1,3 butadiene monitoring sites in Belfast only began operation in 2002, there are insufficient data to assess trends.

However, the former Belfast South hydrocarbon site, which operated over the period 1994-2000, produced a long time series of data, from which trends for this period could be assessed. This information is presented fully in a previous report in this series, "Air Quality in Northern Ireland 2000-2001". A brief summary is provided here:

- Average benzene concentrations at Belfast South clearly decreased over the 8 years of monitoring.
- A regression analysis (Theil's non-parametric analysis) confirmed a downward trend in the annual mean benzene concentration, statistically significant at the 95% confidence level.
- For 1,3-butadiene, by contrast, regression analysis identified no statistically significant trend in the annual mean. However, levels were low and did not appear to be rising.

Thus, trend data from this former site indicated that concentrations of both benzene and 1,3, butadiene were low and likely to remain low.

## 9 Conclusions

1. Meteorological conditions during 2003 contributed to higher UK levels (compared with recent years) of several pollutants including oxides of nitrogen, PM<sub>10</sub> and ozone. This was reflected in the results obtained for some Northern Ireland sites.

### Carbon Monoxide

2. Carbon Monoxide was measured at two sites: Belfast Centre and Londonderry. Both currently meet the EC limit value and the Air Quality Strategy objective for CO, and have achieved the AQS objective for CO by the due date of 31<sup>st</sup> December 2003. There is a significant downward trend in the annual mean CO at both sites.

### Nitrogen Dioxide

3. Nitrogen Dioxide was monitored at fourteen automatic sites, of which four were new in 2003. Only one, Belfast Westlink (which is beside a major urban road) had more than the permitted 18 exceedences of the 1-hour mean objective of 200  $\mu\text{g m}^{-3}$  during 2003. Four roadside automatic sites (Belfast Westlink, Belfast Newtownards Road, Derry, Dale's Corner and Newry Trevor Hill) had annual mean NO<sub>2</sub> concentrations greater than the EC limit value and the Air Quality Strategy objective of 40  $\mu\text{g m}^{-3}$ . (Dale's Corner began operation late in 2003 and data capture was limited; however, 2004 data from this site confirm that it may have difficulty in meeting the annual mean objective for NO<sub>2</sub>).
4. It is predicted, using the methods set out in the Technical Guidance<sup>1</sup>, that Belfast Westlink may not meet the EC limit value of 40  $\mu\text{g m}^{-3}$  for annual mean NO<sub>2</sub> in 2010.
5. NO<sub>2</sub> was also monitored using diffusion tubes at 263 sites in 2003. After application of bias adjustment factors as set out in the Technical Guidance, 18 diffusion tube sites (mostly roadside) had annual mean NO<sub>2</sub> concentrations greater than the EC Directive and AQS objective of 40  $\mu\text{g m}^{-3}$ . Of these, it is predicted that 13 may not meet the AQS objective by 2005, and two may not meet the EC limit value by 2010. However, it must be emphasised that diffusion tube monitoring should only be considered indicative. The application of bias adjustment factors is subject to considerable uncertainty.
6. Annual mean NO<sub>2</sub> concentrations at long-running sites were higher during 2003 than the previous year, probably due to meteorological factors. This is in contrast to the longer-term downward trend identified for this pollutant in recent years.

### Sulphur Dioxide

7. Sulphur Dioxide is monitored at seventeen automatic sites, of which three were new in 2003. All automatic sites met the requirements of the 1<sup>st</sup> Daughter Directive and the objectives of the Air Quality Strategy in 2003. No sites recorded *any* exceedences of the 1-hour or 24-hour mean objectives for SO<sub>2</sub>. Belfast East, a long-running site that has until recently recorded relatively high SO<sub>2</sub> concentrations, now appears to meet objectives.
8. Data from long-running sites indicate that SO<sub>2</sub> levels in Northern Ireland are decreasing, with significant downward trends in annual mean SO<sub>2</sub> concentration at Belfast Centre and Belfast East. However, 2003 annual mean SO<sub>2</sub> concentrations at some sites were slightly higher than those measured in the previous year.
9. Net acidity data from the 38 urban non-automatic SO<sub>2</sub> (8-port sampler) sites also indicate that SO<sub>2</sub> levels in Northern Ireland are falling. In 2003, no sites exceeded the EC limit value and AQS objective for the 24-hour mean on more than the permitted three occasions. This is the second year for which this has been the case. The historical dataset from this network show a



clear decrease in annual mean SO<sub>2</sub> concentrations since the 1960s, which remains evident in recent years' data.

### **Particulate Matter**

10. The number of automatic sites monitoring particulate matter as PM<sub>10</sub> increased from 18 to 23 during 2003. Four sites exceeded the AQS objective of 50 µg m<sup>-3</sup> (gravimetric equivalent) for the 24-hour mean, on more than the permitted 35 occasions: these were Armagh Lonsdale Road, Belfast Westlink, Newry Trevor Hill, and Strabane Springfield Park.
11. Several PM<sub>10</sub> monitoring sites had less than 90% data capture for the year, and were therefore assessed by comparing the 90<sup>th</sup> percentile of 24-hour means with the 24-hour objective (as specified by the Technical Guidance). However, all these sites met the 24-hour mean objective in 2003.
12. One site, Strabane Springfield Park, also exceeded the AQS objective of 40 µg m<sup>-3</sup> for the annual mean PM<sub>10</sub>, as gravimetric equivalent. This site is on a housing estate where coal and oil burning is prevalent.
13. Of the long-running sites, Belfast Centre and Londonderry (though not Belfast East or the rural Lough Navar) continue to show a significant downward trend in annual mean PM<sub>10</sub> concentrations.
14. Particulate matter as black smoke is measured at 35 sites, of which 33 are part of a long-running network. The historical dataset from this network show a clear and consistent decrease in annual mean smoke concentrations from the 1960s to the mid 1990s; however the downward trend has levelled off in the past five years. There is a black smoke site co-located with the Strabane PM<sub>10</sub> monitor: this smoke sampler confirms that levels of suspended particulate are high at this location.

### **Ozone**

15. Ozone is measured at three automatic sites in Northern Ireland: the AUN sites Belfast Centre and Londonderry and the rural site Lough Navar. The AQS objective (although not the less stringent EC 3<sup>rd</sup> Daughter Directive target) was exceeded on more than the permitted 10 days in 2003 at Londonderry. The majority of these days occurred during the summer.

### **Hydrocarbons**

16. Benzene is monitored at Belfast Centre and Belfast Roadside. The 2003 annual means were well within the AQS objective and also within the EC 2<sup>nd</sup> Daughter Directive limit value, and have achieved the AQS objective for benzene by the due date of 31<sup>st</sup> December 2003.
17. 1,3-butadiene is also monitored at Belfast Centre and Belfast Roadside. The 2003 annual means were well within the applicable Air Quality Strategy objective of 2.25 µg m<sup>-3</sup>, and have achieved the AQS objective for 1,3-butadiene by the due date of 31<sup>st</sup> December 2003.
18. Polycyclic aromatic hydrocarbons were monitored at two sites (Belfast Clara Street and Lisburn Dunmurry). Belfast Clara Street showed a substantial reduction in annual mean benzo(a)pyrene concentration in 2003, and now meets the 2010 AQS objective and proposed EC Target Value for B(a)P. However, Lisburn remains significantly above the AQS objective and is at risk of exceeding the proposed EC Target Value.

### **Local Air Quality Management**

19. Good progress has been made by District Councils in implementing local air quality management. Review and assessments have been completed by 25 District Councils. Nine Councils have identified areas likely to exceed AQS objectives of which six have declared Air Quality Management Areas. A further two Councils have indicated their intention to declare.

# 10 Acknowledgements

Netcen would like to thank the District Councils and other organisations that carried out the air quality measurements detailed in this report.

# 11 References

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# Appendix 1

## Diffusion Tube Site Details and Data

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Table A1.1

NO<sub>2</sub> Diffusion Tube Data, 2003

| Local Authority | Location of Sampler                               | Grid Ref. Easting to nearest 100m, | Grid Ref. Northing to nearest 100m. | Part of NO2 Network? | NO2 Network Name if applicable | Site Classification | No. of months data if < 12 | Uncorrected annual    | Bias-adjusted annual  | BAF  | Lab used                     |
|-----------------|---|------------------------------------|-------------------------------------|----------------------|--------------------------------|---------------------|----------------------------|-----------------------|-----------------------|------|------------------------------|
|                 |   |                                    |                                     |                      |                                |                     |                            | mean NO2, 2003, ug/m3 | mean NO2, 2003, ug/m3 |      |                              |
| Antrim          | Ballycraig Road/ Greystone Road                   | 3171                               | 3868                                | NO                   |                                | A                   |                            | 33.0                  | 31.7                  | 0.96 | Gradko *                     |
| Antrim          | Ballymena Road /Stiles Way                        | 3144                               | 3883                                | NO                   |                                | A                   |                            | 23.0                  | 22.1                  | 0.96 | Gradko *                     |
| Antrim          | Ballymena Road North of Dunsilly                  | 3135                               | 3905                                | NO                   |                                | A                   |                            | 30.6                  | 29.4                  | 0.96 | Gradko *                     |
| Antrim          | Ballymena Road, Antrim                            | 3146                               | 3875                                | NO                   |                                | A                   | 9                          | 22.0                  | 21.1                  | 0.96 | Gradko *                     |
| Antrim          | Ballymena Road, north of Dunsilly                 | 3135                               | 3905                                | NO                   |                                | A                   |                            | 34.0                  | 32.6                  | 0.96 | Gradko *                     |
| Antrim          | Ballymena Road/Oriel Road junction (started Nov   | 3163                               | 3876                                | NO                   |                                | A                   |                            | 34.0                  | 32.6                  | 0.96 | Gradko *                     |
| Antrim          | Belfast Road/Ballyclare Road                      | 3235                               | 3859                                | NO                   |                                | A                   |                            | 25.0                  | 24.0                  | 0.96 | Gradko *                     |
| Antrim          | Donegore Bridge, Antrim                           | 3208                               | 3874                                | NO                   |                                | B                   |                            | 22.0                  | 21.1                  | 0.96 | Gradko *                     |
| Antrim          | Fountain St, Antrim                               | 3153                               | 3865                                | NO                   |                                | A                   |                            | 28.0                  | 26.9                  | 0.96 | Gradko *                     |
| Antrim          | Fountain Street, Antrim                           | 3154                               | 3865                                | NO                   |                                | A                   |                            | 22.6                  | 21.7                  | 0.96 | Gradko *                     |
| Antrim          | M2/Ballyclare Road                                | 3244                               | 3864                                | NO                   |                                | A                   |                            | 25.0                  | 24.0                  | 0.96 | Gradko *                     |
| Antrim          | Main St, Crumlin                                  | 3169                               | 3891                                | NO                   |                                | A                   |                            | 25.0                  | 24.0                  | 0.96 | Gradko *                     |
| Antrim          | Main St, Randalstown                              | 3082                               | 3904                                | NO                   |                                | A                   |                            | 37.0                  | 35.5                  | 0.96 | Gradko *                     |
| Antrim          | Main St, Randalstown                              | 3082                               | 3904                                | NO                   |                                | A                   |                            | 34.2                  | 32.8                  | 0.96 | Gradko *                     |
| Antrim          | Main Street, Templepatrick                        | 3233                               | 3858                                | NO                   |                                | A                   |                            | 31.8                  | 30.5                  | 0.96 | Gradko *                     |
| Antrim          | Oldstone Road/ A57                                | 3175                               | 3817                                | NO                   |                                | A                   |                            | 32.0                  | 30.7                  | 0.96 | Gradko *                     |
| Antrim          | Tully Road, Crumlin                               | 3175                               | 3775                                | NO                   |                                | A                   |                            | 38.0                  | 36.5                  | 0.96 | Gradko *                     |
| Ards            | 19 Islandmore Avenue, Newtownards                 | 3495                               | 3750                                | YES                  | NEWTOWNARDS 6N                 | C                   |                            | 10.0                  | 10.4                  | 1.04 | Ruddock & Sherratt *         |
| Ards            | 7 Ashgrove, Newtownards                           | 3485                               | 3745                                | YES                  | NEWTOWNARDS 3N                 | C                   |                            | 11.0                  | 11.4                  | 1.04 | Ruddock & Sherratt *         |
| Ards            | 8 Court Street, Newtownards                       | 3485                               | 3735                                | YES                  | NEWTOWNARDS 1N                 | A                   |                            | 26.0                  | 26.9                  | 1.04 | Ruddock & Sherratt *         |
| Ards            | Rear of Town Hall opposite 18 Frances Street, Ne  | 3481                               | 3741                                | YES                  | NEWTOWNARDS 7N                 | A                   |                            | 30.0                  | 31.1                  | 1.04 | Ruddock & Sherratt *         |
| Armagh          | 17 Folly Lane, Armagh                             | 2882                               | 3448                                | YES                  | ARMAGH 4N                      | C                   |                            | 18.5                  | 13.5                  | 0.73 | Harwell Scientifics *        |
| Armagh          | 25 Railway Street, Armagh                         | 2875                               | 3458                                | YES                  | ARMAGH 1N                      | A                   |                            | 30.9                  | 22.6                  | 0.73 | Harwell Scientifics *        |
| Armagh          | 7 Desart Lane, Armagh                             | 2868                               | 3457                                | YES                  | ARMAGH 3N                      | C                   |                            | 18.0                  | 13.1                  | 0.73 | Harwell Scientifics *        |
| Armagh          | Bridge House, Barrack Street, Armagh              | 2879                               | 3450                                | YES                  | ARMAGH 5N                      | A                   |                            | 37.8                  | 27.6                  | 0.73 | Harwell Scientifics *        |
| Armagh          | Lower Irish Street, Armagh                        | 2874                               | 3448                                | NO                   |                                | A                   |                            | 35.1                  | 25.7                  | 0.73 | Harwell Scientifics *        |
| Armagh          | Mallview Terrace                                  | 2879                               | 3452                                | NO                   |                                | A                   |                            | 24.0                  | 17.5                  | 0.73 | Harwell Scientifics *        |
| Armagh          | Portadown Road, Armagh                            | 2887                               | 3459                                | NO                   |                                | A                   |                            | 17.0                  | 12.4                  | 0.73 | Harwell Scientifics *        |
| Armagh          | St Patricks Fold, Scotch Street, Armagh           | 2877                               | 3450                                | NO                   |                                | A                   |                            | 10.1                  | 7.4                   | 0.73 | Harwell Scientifics *        |
| Ballymena       | 29 Galgorm Road, Ballymena                        | 3103                               | 4032                                | YES                  | BALLYMENA 2N                   | A                   |                            | 26.4                  | 27.7                  | 1.05 | Lambeth Scientific Services* |
| Ballymena       | 8 Ballyloughan Avenue, Ballymena                  | 3095                               | 4044                                | YES                  | BALLYMENA 4N                   | C                   |                            | 13.7                  | 14.4                  | 1.05 | Lambeth Scientific Services  |
| Ballymena       | Ballymoney Street, Ballymena                      | 3108                               | 4035                                | YES                  | BALLYMENA 5N                   | A                   |                            | 26.8                  | 28.1                  | 1.05 | Lambeth Scientific Services* |
| Ballymena       | Cullybackey Road, Ballymena                       | 3103                               | 4034                                | NO                   |                                | A                   |                            | 26.5                  | 27.8                  | 1.05 | Lambeth Scientific Services* |
| Ballymena       | George Street, Ballymena                          | 3105                               | 4032                                | NO                   |                                | A                   |                            | 28.8                  | 30.2                  | 1.05 | Lambeth Scientific Services* |
| Ballymena       | Larne St, Ballymena                               | 3106                               | 4029                                | NO                   |                                | A                   |                            | 23.4                  | 24.6                  | 1.05 | Lambeth Scientific Services* |
| Ballymena       | Leighmore Avenue, Ballymena                       | 3102                               | 4025                                | YES                  | BALLYMENA 1N                   | C                   |                            | 14.9                  | 15.6                  | 1.05 | Lambeth Scientific Services  |
| Ballymena       | Lisnevenagh Road, Ballymena                       | 3119                               | 3970                                | NO                   |                                | A                   |                            | 21.7                  | 22.8                  | 1.05 | Lambeth Scientific Services* |
| Ballymena       | Main Street, Cullybackey                          | 3058                               | 4056                                | NO                   |                                | A                   |                            | 21.2                  | 22.3                  | 1.05 | Lambeth Scientific Services* |
| Ballymena       | North Road, Ballymena                             | 3106                               | 4030                                | NO                   |                                | A                   |                            | 26.7                  | 28.0                  | 1.05 | Lambeth Scientific Services* |
| Ballymena       | Parkway, Ballymena                                | 3110                               | 4039                                | NO                   |                                | A                   |                            | 23.0                  | 24.2                  | 1.05 | Lambeth Scientific Services* |
| Ballymena       | Queen Street, Ballymena                           | 3107                               | 4022                                | NO                   |                                | A                   |                            | 26.9                  | 28.2                  | 1.05 | Lambeth Scientific Services* |
| Ballymena       | Wellington Street, Ballymena                      | 3108                               | 4033                                | NO                   |                                | A                   |                            | 17.8                  | 18.7                  | 1.05 | Lambeth Scientific Services* |
| Ballymoney      | 19 Linenhall Street, Ballymoney                   | 2948                               | 4259                                | YES                  | BALLYMONEY 1N                  | A                   |                            | 26.0                  | 27.3                  | 1.05 | Lambeth Scientific Services  |
| Ballymoney      | 2/4 Semicock Avenue, Ballymoney                   | 2948                               | 4268                                | YES                  | BALLYMONEY 4N                  | C                   |                            | 12.8                  | 13.4                  | 1.05 | Lambeth Scientific Services  |
| Ballymoney      | 31 Charles Street, Ballymoney                     | 2946                               | 4261                                | NO                   |                                | A                   |                            | 21.8                  | 22.9                  | 1.05 | Lambeth Scientific Services  |
| Ballymoney      | 6 Church Street, Ballymoney                       | 2948                               | 4258                                | NO                   |                                | A                   |                            |                       |                       | 1.05 | Lambeth Scientific Services  |
| Ballymoney      | Adjacent 8 Ballybogey Road, Ballymoney            | 2942                               | 4269                                | YES                  | BALLYMONEY 5N                  | A                   |                            | 18.3                  | 19.2                  | 1.05 | Lambeth Scientific Services  |
| Ballymoney      | Ballymena Road, Ballymoney                        | 2960                               | 4257                                | NO                   |                                | A                   |                            |                       |                       | 1.05 | Lambeth Scientific Services  |
| Ballymoney      | Castle St, Gate End                               | 2947                               | 4253                                | NO                   |                                | A                   |                            |                       |                       | 1.05 | Lambeth Scientific Services  |
| Ballymoney      | Frosses Road / Kilraughts Road junction           | 2964                               | 4261                                | NO                   |                                | A                   |                            |                       |                       | 1.05 | Lambeth Scientific Services  |
| Ballymoney      | Opposite 16 Armour Avenue, Ballymoney             | 2953                               | 4256                                | YES                  | BALLYMONEY 3N                  | C                   |                            | 14.6                  | 15.4                  | 1.05 | Lambeth Scientific Services  |
| Ballymoney      | Opposite 51 Queen Street, Ballymoney              | 2952                               | 4258                                | NO                   |                                | A                   |                            | 23.8                  | 25.0                  | 1.05 | Lambeth Scientific Services  |
| Banbridge       | 17 Springfield, Banbridge                         | 3121                               | 3444                                | NO                   |                                | C                   |                            |                       |                       | 1.05 | Lambeth Scientific Services  |
| Banbridge       | 9 Fortfield, Dromore                              | 3199                               | 3535                                | NO                   |                                | D                   |                            |                       |                       | 1.05 | Lambeth Scientific Services  |
| Banbridge       | Dromore Street, Banbridge                         | 3128                               | 3462                                | NO                   |                                | A                   |                            | 34.4                  | 34.4                  | 1.05 | Lambeth Scientific Services  |
| Banbridge       | Fortfield, Dromore (fence beside dual carriageway | 3199                               | 3536                                | NO                   |                                | A                   |                            | 32.8                  | 32.8                  | 1.05 | Lambeth Scientific Services  |

| Local Authority | Location of Sampler                               | Grid Ref. Easting to nearest 100m, | Grid Ref. Northing to nearest 100m. | Part of NO2 Network? | NO2 Network Name if applicable | Site Classification | No. of months data if < 12 | Uncorrected annual    | Bias-adjusted annual  | BAF  | Lab used                      |
|-----------------|---|------------------------------------|-------------------------------------|----------------------|--------------------------------|---------------------|----------------------------|-----------------------|-----------------------|------|-------------------------------|
|                 |   |                                    |                                     |                      |                                |                     |                            | mean NO2, 2003, ug/m3 | mean NO2, 2003, ug/m3 |      |                               |
| Belfast         | 301 Ormeau Road, Southern approaches              | 3345                               | 3722                                | NO                   |                                | A                   |                            | 37.0                  | 43.3                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | 400 Ormeau Road, Southern approaches              | 3350                               | 3709                                | NO                   |                                | A                   |                            | 27.0                  | 31.6                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Belfast City Hall, Donegall Square South          | 3338                               | 3739                                | Yes                  | BELFAST 1N                     | A                   |                            | 41.0                  | 48.0                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Black's Road                                      | 3297                               | 3695                                | NO                   |                                | A                   |                            | 38.0                  | 44.5                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Cromac Street (A)                                 | 3341                               | 3735                                | NO                   |                                | A                   |                            | 38.0                  | 44.5                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Cromac Street (B), Southern approaches            | 3342                               | 3737                                | NO                   |                                | A                   |                            | 35.0                  | 41.0                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Great George's Street                             | 3339                               | 3750                                | NO                   |                                | A                   |                            | 47.0                  | 55.0                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Lombard Street                                    | 3339                               | 3743                                | NO                   |                                | C                   |                            | 32.0                  | 37.4                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Milner Street                                     | 3324                               | 3734                                | Yes                  | BELFAST 5N                     | A                   |                            | 38.0                  | 44.5                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Primary School, North Road                        | 3375                               | 3741                                | Yes                  | BELFAST 4N                     | B                   |                            | 17.0                  | 19.9                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Royal Victoria Hospital, 12 Grosvenor Road Belfa  | 3324                               | 3735                                | Yes                  | BELFAST 3N                     | C                   |                            | 26.0                  | 30.4                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Saintfield Road, Southern approaches              | 3353                               | 3698                                | NO                   |                                | A                   |                            | 38.0                  | 44.5                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Station Road                                      | 3373                               | 3755                                | NO                   |                                | C                   |                            | 24.0                  | 28.1                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Stockman's Lane                                   | 3312                               | 3710                                | NO                   |                                | A                   |                            | 35.0                  | 41.0                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Upper Malone Road                                 | 3332                               | 3699                                | NO                   |                                | A                   |                            | 25.0                  | 29.3                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Upper Newtownards Road (Ballyhackamore)           | 3385                               | 3740                                | NO                   |                                | A                   |                            | 34.0                  | 39.8                  | 1.17 | Lambeth Scientific Services   |
| Belfast         | Westlink, near Grosvenor Road roundabout          | 3330                               | 3737                                | NO                   |                                | A                   |                            | 45.0                  | 52.7                  | 1.17 | Lambeth Scientific Services   |
| Carrickfergus   | 27 Upper Road, Greenisland                        | 3362                               | 3857                                | NO                   |                                | A                   |                            | 17.9                  | 18.5                  | 1.04 | Ruddock & Sherratt *          |
| Carrickfergus   | 28 Bentra Road, Whitehead                         | 3454                               | 3919                                | NO                   |                                | D                   | 10                         | 10.2                  | 10.6                  | 1.04 | Ruddock & Sherratt *          |
| Carrickfergus   | 32 Mullaghmore Park, Greenisland                  | 3369                               | 3856                                | YES                  | CARRICKFERGUS 3N               | C                   |                            | 9.8                   | 10.2                  | 1.04 | Ruddock & Sherratt *          |
| Carrickfergus   | 42 Albert Road Carrickfergus                      | 3413                               | 3876                                | NO                   |                                | A                   | 10                         | 17.1                  | 17.7                  | 1.04 | Ruddock & Sherratt *          |
| Carrickfergus   | 59 Shore Road, Greenisland                        | 3379                               | 3849                                | YES                  | CARRICKFERGUS 1N               | A                   |                            | 18.3                  | 18.9                  | 1.04 | Ruddock & Sherratt *          |
| Carrickfergus   | 93 Belfast Road Carrickfergus                     | 3399                               | 3867                                | NO                   |                                | A                   |                            | 17.3                  | 17.9                  | 1.04 | Ruddock & Sherratt *          |
| Carrickfergus   | College North Road, Carrickfergus                 | 3411                               | 3889                                | YES                  | CARRICKFERGUS 4N?              | C                   |                            | 14.9                  | 15.4                  | 1.04 | Ruddock & Sherratt *          |
| Carrickfergus   | Islandmagee Road, Whitehead                       | 3476                               | 3923                                | NO                   |                                | A                   |                            | 12.5                  | 13.0                  | 1.04 | Ruddock & Sherratt *          |
| Carrickfergus   | Lough Road, Loughmourne                           | 3412                               | 3921                                | NO                   |                                | D                   |                            | 7.2                   | 7.5                   | 1.04 | Ruddock & Sherratt *          |
| Carrickfergus   | Model PS 4 Belfast Road Carrickfergus             | 3408                               | 3871                                | NO                   |                                | A                   | 9                          | 23.8                  | 24.7                  | 1.04 | Ruddock & Sherratt *          |
| Carrickfergus   | Railway Station, Fergus Avenue, Carrickfergus     | 3412                               | 3878                                | NO                   |                                | B                   | 7                          | 11.8                  | 12.2                  | 1.04 | Ruddock & Sherratt *          |
| Castlereagh     | 2 Newtownbreda Road                               | 3352                               | 3701                                | NO                   |                                | A                   |                            | 23.3                  | 24.1                  | 1.04 | Ruddock & Sherratt *          |
| Castlereagh     | 74 Downshire Park East                            | 3365                               | 3714                                | YES                  | CASTLEREAGH 6N                 | D                   |                            | 12.0                  | 12.4                  | 1.04 | Ruddock & Sherratt *          |
| Castlereagh     | 985 Upper Newtownards Road, Dundonald             | 3420                               | 3740                                | NO                   |                                | A                   |                            | 30.4                  | 31.5                  | 1.04 | Ruddock & Sherratt *          |
| Castlereagh     | Council Offices, 368 Cregagh Road, BT6 9EZ        | 3362                               | 3713                                | YES                  | CASTLEREAGH 1N                 | A                   |                            | 19.4                  | 20.1                  | 1.04 | Ruddock & Sherratt *          |
| Castlereagh     | Lamp post, 17/19 Everton Drive, Castlereagh       | 3361                               | 3712                                | YES                  | CASTLEREAGH 5N                 | C                   |                            | 13.0                  | 13.5                  | 1.04 | Ruddock & Sherratt *          |
| Coleraine       | Crocknamuck Road / Dunluce Ave, Portrush          | 2861                               | 4400                                | NO                   |                                | A                   |                            | 17.2                  | 17.8                  | 1.04 | Ruddock & Sherratt *          |
| Coleraine       | Dunnes car park / Coleraine Bridge, Coleraine     | 2846                               | 4325                                | NO                   |                                | A                   |                            | 14.9                  | 15.4                  | 1.04 | Ruddock & Sherratt *          |
| Coleraine       | Lower Union Street / Minburn Road, Coleraine      | 2848                               | 4328                                | NO                   |                                | A                   |                            | 24.8                  | 25.7                  | 1.04 | Ruddock & Sherratt *          |
| Coleraine       | Railway Road, Coleraine                           | 2852                               | 4327                                | NO                   |                                | A                   |                            | 14.0                  | 14.5                  | 1.04 | Ruddock & Sherratt *          |
| Coleraine       | Ring Road, Lodge Road Roundabout, Coleraine       | 2858                               | 4314                                | NO                   |                                | A                   |                            | 18.2                  | 18.8                  | 1.04 | Ruddock & Sherratt *          |
| Coleraine       | Spanboard, Coleraine                              | 2859                               | 4299                                | NO                   |                                | E                   |                            | 6.6                   | 6.8                   | 1.04 | Ruddock & Sherratt *          |
| Coleraine       | University, Coleraine                             | 2845                               | 4235                                | NO                   |                                | E                   |                            | 7.8                   | 8.1                   | 1.04 | Ruddock & Sherratt *          |
| Coleraine       | Upper Union Street, Railway Road, Coleraine       | 2851                               | 4328                                | NO                   |                                | A                   |                            | 16.2                  | 16.7                  | 1.04 | Ruddock & Sherratt *          |
| Coleraine       | Waterside traffic lights / Strand Road, Coleraine | 2845                               | 4325                                | NO                   |                                | A                   |                            | 15.0                  | 15.5                  | 1.04 | Ruddock & Sherratt *          |
| Cookstown       | Church St, Cookstown                              | 2811                               | 3775                                | NO                   |                                | A                   |                            | 41.0                  | 43.1                  | 1.05 | Lambeth Scientific Services * |
| Cookstown       | High Street, Moneymore                            | 2857                               | 3834                                | NO                   |                                | A                   |                            | 36.0                  | 37.8                  | 1.05 | Lambeth Scientific Services * |
| Cookstown       | James St, Cookstown                               | 2810                               | 3783                                | NO                   |                                | A                   |                            | 42.0                  | 44.1                  | 1.05 | Lambeth Scientific Services * |
| Cookstown       | Killymoon St, Cookstown                           | 2812                               | 3769                                | NO                   |                                | A                   |                            | 31.0                  | 32.6                  | 1.05 | Lambeth Scientific Services * |
| Cookstown       | William St, Moneymore                             | 2810                               | 3784                                | NO                   |                                | B                   |                            | 37.0                  | 38.9                  | 1.05 | Lambeth Scientific Services * |
| Craigavon       | 21 Ballyhannon Road, Portadown                    | 3081                               | 3578                                | YES                  | CRAIGAVON 8N                   | C                   |                            | 9.0                   | 9.5                   | 1.05 | Lambeth Scientific Services * |
| Craigavon       | 36 Ardboe Drive, Lurgan                           | 3080                               | 3577                                | YES                  | CRAIGAVON 7N                   | C                   |                            | 17.0                  | 17.9                  | 1.05 | Lambeth Scientific Services * |
| Craigavon       | 4 Cluandara, Derrymacash, Craigavon               | 3044                               | 3593                                | No                   |                                | A                   |                            | 25.0                  | 26.3                  | 1.05 | Lambeth Scientific Services * |
| Craigavon       | Ashgrove community centre, Garvaghy Road, Por     | 3004                               | 3548                                | No                   |                                | B                   |                            | 16.0                  | 16.8                  | 1.05 | Lambeth Scientific Services * |
| Craigavon       | Castle Lane (toilets), Lurgan                     | 3082                               | 3585                                | No                   |                                | C                   |                            | 18.0                  | 18.9                  | 1.05 | Lambeth Scientific Services * |
| Craigavon       | Holmes Bakery, 16 West Street, Portadown          | 3010                               | 3538                                | YES                  | CRAIGAVON 9N                   | A                   |                            | 28.0                  | 29.4                  | 1.05 | Lambeth Scientific Services * |
| Craigavon       | Lord Lurgan Park, Lurgan                          | 3080                               | 3593                                | No                   |                                | C                   |                            | 13.0                  | 13.7                  | 1.05 | Lambeth Scientific Services * |
| Craigavon       | Town Hall, Union Street, Lurgan                   | 3083                               | 3583                                | YES                  | CRAIGAVON 5N                   | A                   |                            | 17.0                  | 17.9                  | 1.05 | Lambeth Scientific Services * |

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|-----------------|---|------------------------------------|-------------------------------------|----------------------|--------------------------------|---------------------|----------------------------|-----------------------|-----------------------|------|-----------------------------|
|                 |   |                                    |                                     |                      |                                |                     |                            | mean NO2, 2003, ug/m3 | mean NO2, 2003, ug/m3 |      |                             |
| Derry           | 1 Simpson Brae, Derry                           | 2442                               | 4163                                | NO                   |                                | A                   |                            | 23.1                  | 21.8                  | 0.94 | Lambeth Scientific Services |
| Derry           | 123a Strand Road, Derry                         | 2437                               | 4182                                | NO                   |                                | A                   | 8                          | 28.7                  | 27.0                  | 0.94 | Lambeth Scientific Services |
| Derry           | 19 St Patricks Terrace, Derry                   | 2434                               | 4189                                | NO                   |                                | A                   | 11                         | 31.1                  | 29.3                  | 0.94 | Lambeth Scientific Services |
| Derry           | 26 Rosdowney Park (Irish St Lights)             | 2449                               | 4162                                | NO                   |                                | A                   |                            | 19.3                  | 18.2                  | 0.94 | Lambeth Scientific Services |
| Derry           | 27 Park Avenue                                  | 2429                               | 4177                                | NO                   |                                | A                   |                            | 26.0                  | 24.5                  | 0.94 | Lambeth Scientific Services |
| Derry           | 3 Creggan Road, Derry                           | 2428                               | 4173                                | YES                  | LONDONDERRY 8N                 | A                   | 9                          | 42.8                  | 40.3                  | 0.94 | Lambeth Scientific Services |
| Derry           | 3 Farren park, Derry                            | 2438                               | 4187                                | NO                   |                                | A                   | 11                         | 21.6                  | 20.3                  | 0.94 | Lambeth Scientific Services |
| Derry           | 3 Glendermot Road, Derry                        | 2443                               | 4167                                | YES                  | LONDONDERRY 9N                 | A                   |                            | 28.1                  | 26.4                  | 0.94 | Lambeth Scientific Services |
| Derry           | 3 Silverbirch Crescent, Derry                   | 2453                               | 4167                                | YES                  | LONDONDERRY 11N                | C                   |                            | 15.9                  | 14.9                  | 0.94 | Lambeth Scientific Services |
| Derry           | 34 Northland Terrace, Derry                     | 2433                               | 4179                                | NO                   |                                | A                   |                            | 19.7                  | 18.5                  | 0.94 | Lambeth Scientific Services |
| Derry           | 54 William Street                               | 2433                               | 4169                                | NO                   |                                | A                   | 9                          | 21.2                  | 20.0                  | 0.94 | Lambeth Scientific Services |
| Derry           | 6 Dacre Terrace                                 | 2436                               | 4163                                | NO                   |                                | A                   | 11                         | 21.2                  | 20.0                  | 0.94 | Lambeth Scientific Services |
| Derry           | 67 Clarendon Street                             | 2432                               | 4173                                | NO                   |                                | A                   |                            | 26.9                  | 25.4                  | 0.94 | Lambeth Scientific Services |
| Derry           | 7 Harberton Park (Altnagelvin Lights)           | 2452                               | 4156                                | NO                   |                                | A                   | 10                         | 18.1                  | 17.1                  | 0.94 | Lambeth Scientific Services |
| Derry           | Brooke Park, Infirmary Road                     | 2429                               | 4173                                | YES                  | LONDONDERRY 10N                | C                   | 9                          | 42.8                  | 40.3                  | 0.94 | Lambeth Scientific Services |
| Derry           | Brooke Park, Infirmary Road                     | 2429                               | 4173                                | YES                  | LONDONDERRY 10N                | C                   |                            | 13.9                  | 13.1                  | 0.94 | Lambeth Scientific Services |
| Derry           | Brooke Park, Infirmary Road                     | 2429                               | 4173                                | YES                  | LONDONDERRY 10N                | C                   |                            | 15.1                  | 14.2                  | 0.94 | Lambeth Scientific Services |
| Derry           | Spencer Road / Victoria Road Flats              | 2438                               | 4159                                | NO                   |                                | A                   | 11                         | 38.4                  | 36.2                  | 0.94 | Lambeth Scientific Services |
| Down            | 11 Orchard Way, Strangford Road, Downpatrick, I | 3489                               | 3459                                | YES                  | DOWNPATRICK 4N                 | C                   |                            | 8.3                   | 8.6                   | 1.04 | Ruddock & Sherratt *        |
| Down            | 19 Church Street, Ballynahinch BT24 8AF         | 3366                               | 3422                                | YES                  | BALLYNAHINCH 9N                | A                   |                            | 23.7                  | 24.5                  | 1.04 | Ruddock & Sherratt *        |
| Down            | 4 Main Street, Newcastle                        | 3378                               | 3316                                | NO                   |                                | A                   |                            | 21.6                  | 22.4                  | 1.04 | Ruddock & Sherratt *        |
| Down            | 5 St Patrick's Avenue, Downpatrick, BT30 6DW    | 3486                               | 3445                                | YES                  |                                | A                   |                            | 28.8                  | 29.8                  | 1.04 | Ruddock & Sherratt *        |
| Down            | 7 St Patrick's Drive, Downpatrick, BT30 6NR     | 3486                               | 3442                                | YES                  | DOWNPATRICK 3N                 | C                   |                            | 11.1                  | 11.5                  | 1.04 | Ruddock & Sherratt *        |
| Down            | 9 Irish Street, Downpatrick, BT30 6BN           | 3487                               | 3446                                | YES                  | DOWNPATRICK 1N                 | A                   |                            | 30.5                  | 31.6                  | 1.04 | Ruddock & Sherratt *        |
| Down            | Main Street, Saintfield BT24 7AA                | 3407                               | 3591                                | NO                   |                                | A                   |                            | 18.7                  | 19.4                  | 1.04 | Ruddock & Sherratt *        |
| Down            | Stream Street, Downpatrick BT30 6DD             | 3489                               | 3442                                | NO                   |                                | A                   |                            | 21.4                  | 22.1                  | 1.04 | Ruddock & Sherratt *        |
| Dungannon       | 11 Bushvale                                     | 2811                               | 3623                                | YES                  | DUNGANNON 4N                   | C                   |                            | 9.7                   | 10.0                  | 1.04 | Ruddock & Sherratt *        |
| Dungannon       | 4 Ardgannon                                     | 2796                               | 3630                                | YES                  | DUNGANNON 3N                   | B                   |                            | 15.1                  | 15.6                  | 1.04 | Ruddock & Sherratt *        |
| Dungannon       | Church St                                       | 2798                               | 3624                                | NO                   |                                | A                   |                            | 43.7                  | 45.3                  | 1.04 | Ruddock & Sherratt *        |
| Dungannon       | Howard Primary School, Moy Road                 | 2812                               | 3607                                | YES                  | DUNGANNON 5N                   | A                   |                            | 21.3                  | 22.1                  | 1.04 | Ruddock & Sherratt *        |
| Dungannon       | Market Square                                   | 2798                               | 3625                                | YES                  | DUNGANNON 1N                   | A                   |                            | 16.6                  | 17.2                  | 1.04 | Ruddock & Sherratt *        |
| Fermanagh DC    | 29 Henry St Enniskillen                         | 2231                               | 3443                                | NO                   |                                | A                   |                            | 29.0                  | 30.5                  | 1.05 | Lambeth Scientific Services |
| Fermanagh DC    | Belmore Street, Enniskillen                     | 2239                               | 3440                                | NO                   |                                | A                   |                            | 23.4                  | 24.6                  | 1.05 | Lambeth Scientific Services |
| Fermanagh DC    | Everglades, Tempo Road, Enniskillen             | 2256                               | 3447                                | NO                   |                                | B                   |                            | 6.8                   | 7.1                   | 1.05 | Lambeth Scientific Services |
| Fermanagh DC    | Rossole Road, Enniskillen                       | 2230                               | 3432                                | NO                   |                                | C                   |                            | 6.7                   | 7.0                   | 1.05 | Lambeth Scientific Services |
| Fermanagh DC    | Town Hall, Enniskillen BT74 7BA                 | 2235                               | 3441                                | NO                   |                                | A                   |                            | 16.2                  | 17.0                  | 1.05 | Lambeth Scientific Services |
| Fermanagh DC    | Westbridge House Anne St, Enniskillen           | 2233                               | 3443                                | NO                   |                                | A                   |                            | 22.3                  | 23.4                  | 1.05 | Lambeth Scientific Services |
| Larne           | Antville Road/A8 junction                       | 3386                               | 4021                                | NO                   |                                | A                   |                            | 18.6                  | 21.4                  | 1.15 | Lambeth Scientific Services |
| Larne           | Ballylumford Road                               | 3421                               | 4020                                | NO                   |                                | A                   |                            | 13.6                  | 15.6                  | 1.15 | Lambeth Scientific Services |
| Larne           | Coastguard Road                                 | 3413                               | 4017                                | NO                   |                                | A                   |                            | 13.0                  | 14.9                  | 1.15 | Lambeth Scientific Services |
| Larne           | Larne Harbour Roundabout                        | 3412                               | 4020                                | NO                   |                                | A                   |                            | 19.9                  | 22.8                  | 1.15 | Lambeth Scientific Services |
| Larne           | Main St   | 3402                               | 4026                                | NO                   |                                | A                   |                            | 20.3                  | 23.3                  | 1.15 | Lambeth Scientific Services |
| Larne           | Riverdale                                       | 3397                               | 4025                                | NO                   |                                | A                   |                            | 24.8                  | 28.6                  | 1.15 | Lambeth Scientific Services |
| Larne           | Upper Cairncastle Road                          | 3392                               | 4032                                | NO                   |                                | A                   |                            | 19.7                  | 22.6                  | 1.15 | Lambeth Scientific Services |
| Larne           | Victoria Road/Agnew Street junction             | 3403                               | 4029                                | NO                   |                                | A                   |                            | 24.3                  | 27.9                  | 1.15 | Lambeth Scientific Services |
| Limavady        | Clooney Road, Greysteel                         | 2571                               | 4211                                | NO                   |                                | A                   | 10                         | 17.1                  | 16.4                  | 0.96 | Gradko *                    |
| Limavady        | Greystone Road, Limavady                        | 2682                               | 4225                                | NO                   |                                | A                   | 8                          | 24.0                  | 23.0                  | 0.96 | Gradko *                    |
| Limavady        | Irish Green St, Limavady                        | 2672                               | 4229                                | NO                   |                                | A                   | 9                          | 40.9                  | 39.2                  | 0.96 | Gradko *                    |
| Limavady        | Junction of Ballyquin Road / Main St, Dungiven  | 2688                               | 4095                                | NO                   |                                | A                   | 11                         | 39.8                  | 38.2                  | 0.96 | Gradko *                    |
| Limavady        | Junction of Garvagh Road / Main St, Dungiven    | 2693                               | 4092                                | NO                   |                                | A                   | 11                         | 39.8                  | 38.2                  | 0.96 | Gradko *                    |
| Limavady        | Junction of Rathmore Road / Scroggy Road, Lima  | 2678                               | 4233                                | NO                   |                                | A                   | 10                         | 26.3                  | 25.2                  | 0.96 | Gradko *                    |
| Limavady        | Linenhall St, Limavady                          | 2669                               | 4231                                | NO                   |                                | A                   | 4                          |                       |                       |      | Gradko *                    |
| Limavady        | Main St, Ballykelly                             | 2629                               | 4223                                | NO                   |                                | A                   | 10                         | 30.1                  | 28.9                  | 0.96 | Gradko *                    |

| Local Authority | Location of Sampler                             | Grid Ref.<br>Easting to<br>nearest<br>100m, | Grid Ref.<br>Northing to<br>nearest<br>100m. | Part of NO2<br>Network? | NO2 Network Name if<br>applicable | Site<br>Classification | No. of months data<br>if < 12 | Uncorrected annual       | Bias-adjusted annual     | BAF  | Lab used                      |
|-----------------|---|---|--|-------------------------|-----------------------------------|------------------------|-------------------------------|--------------------------|--------------------------|------|-------------------------------|
|                 |   |   |  |                         |                                   |                        |                               | mean NO2, 2003,<br>ug/m3 | mean NO2, 2003,<br>ug/m3 |      |                               |
| Lisburn         | 10 Beechlaw Park, Dunmurry                      | 3296  | 3691   | NO                      |                                   | B                      |                               | 19.7                     | 20.4                     | 1.04 | Ruddock & Sherratt            |
| Lisburn         | 18 Kingsway, Dunmurry                           | 3295  | 3689   | YES                     | LISBURN 7N                        | A                      |                               | 23.0                     | 23.8                     | 1.04 | Ruddock & Sherratt            |
| Lisburn         | 22 Ventnor Park, Lambeg                         | 3269  | 3620   | YES                     | LISBURN 3N                        | C                      |                               | 11.5                     | 11.9                     | 1.04 | Ruddock & Sherratt            |
| Lisburn         | 75 Edgewater, Lisburn                           | 3272  | 3637   | YES                     | LISBURN 6N                        | C                      |                               | 12.8                     | 13.2                     | 1.04 | Ruddock & Sherratt            |
| Lisburn         | Antrim Road, Lisburn                            | 3263  | 3646   | NO                      |                                   | B                      |                               | 19.3                     | 20.0                     | 1.04 | Ruddock & Sherratt            |
| Lisburn         | Lagan Valley Hospital grounds                   | 3265  | 3637   | NO                      |                                   | B                      |                               | 16.6                     | 17.2                     | 1.04 | Ruddock & Sherratt            |
| Lisburn         | Main Street, Moira                              | 3151  | 3606   | NO                      |                                   | C                      |                               | 27.1                     | 28.0                     | 1.04 | Ruddock & Sherratt            |
| Lisburn         | Northern Bank, 62 Bow Street, Lisburn, BT28 1BH | 3265  | 3644   | YES                     | LISBURN 1N                        | A                      |                               | 25.8                     | 26.7                     | 1.04 | Ruddock & Sherratt            |
| Magherafelt     | Boyne Row, Castledawson                         | 2925  | 3932   | NO                      |                                   | A                      |                               | 22.0                     | 23.1                     | 1.05 | Lambeth Scientific Services * |
| Magherafelt     | Church Street, Magherafelt                      | 2897  | 3909   | NO                      |                                   | A                      |                               | 37.0                     | 38.9                     | 1.05 | Lambeth Scientific Services * |
| Magherafelt     | Eel fishery, Toomebridge                        | 2989  | 3908   | NO                      |                                   | A                      |                               | 17.0                     | 17.9                     | 1.05 | Lambeth Scientific Services * |
| Magherafelt     | King St, Magherafelt                            | 2898  | 3907   | NO                      |                                   | A                      |                               | 26.0                     | 27.3                     | 1.05 | Lambeth Scientific Services * |
| Magherafelt     | Main Street, Maghera                            | 2853  | 4004   | NO                      |                                   | A                      |                               | 34.0                     | 35.7                     | 1.05 | Lambeth Scientific Services * |
| Magherafelt     | Queen Street, Magherafelt                       | 2896  | 3905   | NO                      |                                   | A                      |                               | 31.0                     | 32.6                     | 1.05 | Lambeth Scientific Services * |
| Magherafelt     | Wesleyan Mews, Magherafelt                      | 2899  | 3907   | NO                      |                                   | B                      |                               | 24.0                     | 25.2                     | 1.05 | Lambeth Scientific Services * |
| Moyle           | Bush/Dundarave estate entrance, Bushmills       | 2942  | 4409   | NO                      |                                   | A                      |                               | 10.0                     | 10.5                     | 1.05 | Lambeth Scientific Services * |
| Moyle           | Elmwood car park, Bushmills                     | 2947  | 4406   | NO                      |                                   | B                      |                               | 9.0                      | 9.5                      | 1.05 | Lambeth Scientific Services * |
| Moyle           | Leyland Road, Ballycastle                       | 3101  | 4415   | NO                      |                                   | B                      |                               | 11.0                     | 11.6                     | 1.05 | Lambeth Scientific Services * |
| Moyle           | Light pole, Dunluce Road, Bushmills             | 2937  | 4408   | NO                      |                                   | A                      |                               | 10.0                     | 10.5                     | 1.05 | Lambeth Scientific Services * |
| Moyle           | Middle Park Road, Cushendall                    | 3239  | 4272   | NO                      |                                   | A                      |                               | 8.0                      | 8.4                      | 1.05 | Lambeth Scientific Services * |
| Moyle           | Mill Street car park, Cushendall                | 3237  | 4275   | NO                      |                                   | B                      |                               | 7.0                      | 7.4                      | 1.05 | Lambeth Scientific Services * |
| Moyle           | Shesburn House, 7 Mary St, Ballycastle          | 3122  | 4412   | NO                      |                                   | B                      |                               | 8.0                      | 8.4                      | 1.05 | Lambeth Scientific Services * |
| Moyle           | St Patricks' PS, 244 Garron Road, Glenariff     | 3243  | 4252   | NO                      |                                   | B                      |                               | 10.0                     | 10.5                     | 1.05 | Lambeth Scientific Services * |
| Newry & Mourne  | 19 Balmoral Park, Newry                         | 3094  | 3275   | YES                     | NEWRY 9N                          | C                      | 11                            | 14.8                     | 15.3                     | 1.04 | Ruddock & Sherratt *          |
| Newry & Mourne  | 20a Water Street, Newry, Alexander Hanna        | 3086  | 3265   | YES                     | NEWRY 6N                          | A                      | 11                            | 41.6                     | 43.1                     | 1.04 | Ruddock & Sherratt *          |
| Newry & Mourne  | Bridge Street, Main Dublin Road                 |   |  |                         |                                   | A                      | 9                             | 37.0                     | 38.3                     | 1.04 | Ruddock & Sherratt *          |
| Newry & Mourne  | Kildare Street                                  |   |  |                         |                                   | A                      | 8                             | 28.5                     | 29.5                     | 1.04 | Ruddock & Sherratt *          |
| Newry & Mourne  | Kilmorey Street                                 |   |  |                         |                                   | A                      | 9                             | 42.8                     | 44.3                     | 1.04 | Ruddock & Sherratt *          |
| Newry & Mourne  | Monaghan Row, Newry                             | 3078  | 3268   | YES                     | NEWRY 11N                         | C                      | 11                            | 15.3                     | 15.8                     | 1.04 | Ruddock & Sherratt *          |
| Newry & Mourne  | Rathfriland Road, Newry                         |   |  |                         |                                   | A                      | 7                             | 25.6                     | 26.5                     | 1.04 | Ruddock & Sherratt            |
| Newry & Mourne  | Stone Bridge                                    |   |  |                         |                                   | A                      | 10                            | 30.2                     | 31.3                     | 1.04 | Ruddock & Sherratt            |
| Newry & Mourne  | Trevor Hill, Newry                              | 3088  | 3268   | YES                     | NEWRY 10N                         | A                      | 8                             | 37.0                     | 38.3                     | 1.04 | Ruddock & Sherratt *          |



| Local Authority | Location of Sampler                            | Grid Ref. Easting to nearest 100m, | Grid Ref. Northing to nearest 100m. | Part of NO2 Network? | NO2 Network Name if applicable | Site Classification | No. of months data if < 12 | Uncorrected annual    | Bias-adjusted annual  | BAF                         | Lab used |
|-----------------|--|------------------------------------|-------------------------------------|----------------------|--------------------------------|---------------------|----------------------------|-----------------------|-----------------------|-----------------------------|----------|
|                 |  |                                    |                                     |                      |                                |                     |                            | mean NO2, 2003, ug/m3 | mean NO2, 2003, ug/m3 |                             |          |
| Newtownabbey    | 145 Jordanstown Road, Newtownabbey             | 3352                               | 3844                                | NO                   |                                | A                   | 19.0                       | 18.0                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | 174 Monkstown Road, Newtownabbey               | 3343                               | 3852                                | NO                   |                                | A                   | 16.0                       | 15.2                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | 189 Doagh Road, Newtownabbey                   | 3344                               | 3829                                | NO                   |                                | A                   | 22.0                       | 20.9                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | 44 Sandyknowes Av, Newtownabbey                | 3306                               | 3827                                | NO                   |                                | A                   | 38.0                       | 36.0                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | 49 Main Street, Ballyclare                     | 3288                               | 3911                                | YES                  | NEWTOWNABBEY 1N                | A                   | 34.0                       | 32.2                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | 690 Shore Road, Newtownabbey                   | 3367                               | 3837                                | YES                  | NEWTOWNABBEY 12N               | A                   | 20.0                       | 19.0                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | A8 motorway Sandyknowes, Newtownabbey          | 3305                               | 3832                                | NO                   |                                | A                   | 32.0                       | 30.3                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Antrim Road, Sandyknowes, Newtownabbey         | 3306                               | 3829                                | NO                   |                                | C                   | 26.0                       | 24.6                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Ballyclare Road/Manse Road roundabout, Newtow  | 3314                               | 3838                                | NO                   |                                | A                   | 33.0                       | 31.3                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Bernice Road/Mallusk Road                      | 3277                               | 3835                                | NO                   |                                | A                   | 15.0                       | 14.2                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Braden Heights, Rathcoole, Newtownabbey        | 3339                               | 3819                                | YES                  | NEWTOWNABBEY 13N               | A                   | 17.0                       | 16.1                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Burnthill Road, Newtownabbey                   | 3315                               | 3819                                | NO                   |                                | A                   | 26.0                       | 24.6                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Doagh Village, Doagh Road, Doagh               | 3262                               | 3895                                | NO                   |                                | A                   | 19.0                       | 18.0                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Greenacres, Glebe Road, Newtownabbey           | 3324                               | 3832                                | NO                   |                                | A                   | 21.0                       | 19.9                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Henryville Court, Ballyclare                   | 3296                               | 3910                                | NO                   |                                | C                   | 38.0                       | 36.0                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Hightown Road/Mallusk Road, Newtownabbey       | 3314                               | 3821                                | NO                   |                                | A                   | 26.0                       | 24.6                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Hillhead Road/Mill Road junction               | 3291                               | 3909                                | NO                   |                                | A                   | 23.0                       | 21.8                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Junction at A8 Doagh Road, Newtownabbey        | 3310                               | 3859                                | NO                   |                                | A                   | 21.0                       | 19.9                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Longshot Road, Doagh, Newtownabbey             | 3268                               | 3885                                | NO                   |                                | A                   | 17.0                       | 16.1                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | M5 @ Shore Road, Newtownabbey                  | 3354                               | 3815                                | NO                   |                                | A                   | 32.0                       | 30.3                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Main Street, Ballynure, Ballyclare             | 3319                               | 3936                                | NO                   |                                | A                   | 22.0                       | 20.9                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | McMillan House, 323 Antrim Road, Glengormley   | 3318                               | 3882                                | NO                   |                                | A                   | 31.0                       | 29.4                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Merville Garden Village                        | 3348                               | 3807                                | NO                   |                                | A                   | 24.0                       | 22.8                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Nortel, Doagh Road, Newtownabbey               | 3342                               | 3838                                | NO                   |                                | A                   | 21.0                       | 19.9                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | North End, Ballyclare                          | 3287                               | 3913                                | NO                   |                                | A                   | 19.0                       | 18.0                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Nox Analyser, Antrim Road                      | 3305                               | 3830                                | NO                   |                                | A                   | 17.0                       | 16.1                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Nox Analyser, Antrim Road                      | 3305                               | 3830                                | NO                   |                                | A                   | 24.0                       | 22.8                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Nox Analyser, Antrim Road                      | 3305                               | 3830                                | NO                   |                                | A                   | 24.0                       | 22.8                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Nox Analyser, Shore Road                       | 3305                               | 3830                                | NO                   |                                | A                   | 21.0                       | 19.9                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Nox Analyser, Shore Road                       | 3305                               | 3830                                | NO                   |                                | A                   | 25.0                       | 23.7                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Nox Analyser, Shore Road                       | 3305                               | 3830                                | NO                   |                                | A                   | 25.0                       | 23.7                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Oaklands, Old Carrick Road, Newtownabbey       | 3344                               | 3852                                | NO                   |                                | C                   | 16.0                       | 15.2                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | O'Neill Road/Doagh Road roundabout, Newtowna   | 3355                               | 3823                                | NO                   |                                | A                   | 20.0                       | 19.0                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | opposite 1A Jordanstown Road, Newtownabbey     | 3365                               | 3836                                | NO                   |                                | A                   | 25.0                       | 23.7                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Prince Charles Way/Manse Road                  | 3314                               | 3838                                | NO                   |                                | C                   | 29.0                       | 27.5                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Roundabout @ bottom of Main St, Ballyclare     | 3291                               | 3909                                | NO                   |                                | A                   | 20.0                       | 19.0                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Scullions Road, Mallusk, Newtownabbey          | 3304                               | 3829                                | NO                   |                                | A                   | 29.0                       | 27.5                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | St Bernards' Road School, Antrim Road, Newtowr | 3323                               | 3819                                | NO                   |                                | A                   | 27.0                       | 25.6                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Station Road, Newtownabbey                     | 3355                               | 3824                                | NO                   |                                | A                   | 26.0                       | 24.6                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Tudor Park, Newtownabbey                       | 3298                               | 3834                                | NO                   |                                | A                   | 16.0                       | 15.2                  | 0.95                  | Lambeth Scientific Services |          |
| Newtownabbey    | Valley Leisure centre, Newtownabbey            | 3336                               | 3814                                | NO                   |                                | A                   | 26.0                       | 24.6                  | 0.95                  | Lambeth Scientific Services |          |
| North Down      | 1 Rathmore Road, Bangor                        | 3483                               | 3815                                | YES                  | BANGOR NI 8N                   | C                   | 11.7                       | 12.1                  | 1.04                  | Ruddock & Sherratt *        |          |
| North Down      | 132 Main Street, Bangor                        | 3504                               | 3815                                | YES                  | BANGOR NI 6N                   | A                   | 22.8                       | 23.6                  | 1.04                  | Ruddock & Sherratt *        |          |
| North Down      | 52 Bingham Street, Bangor                      | 3507                               | 3819                                | YES                  | BANGOR NI 7N                   | A                   | 22.1                       | 22.9                  | 1.04                  | Ruddock & Sherratt *        |          |
| North Down      | 68 Groomsport Road, Bangor                     | 3520                               | 3819                                | YES                  | BANGOR NI 4N                   | C                   | 10.8                       | 11.2                  | 1.04                  | Ruddock & Sherratt *        |          |
| North Down      | Bangor Road Ballyrobert                        | 3450                               | 3808                                | NO                   |                                | C                   | 25.1                       | 26.0                  | 1.04                  | Ruddock & Sherratt *        |          |
| North Down      | Bangor Road Seahill                            | 3433                               | 3808                                | NO                   |                                | C                   | 25.6                       | 26.5                  | 1.04                  | Ruddock & Sherratt *        |          |
| North Down      | Marine Parade Holywood                         | 3400                               | 3793                                | NO                   |                                | A                   | 28.2                       | 29.2                  | 1.04                  | Ruddock & Sherratt *        |          |
| North Down      | Station Road Cultra                            | 3416                               | 3800                                | NO                   |                                | C                   | 32.0                       | 33.1                  | 1.04                  | Ruddock & Sherratt *        |          |

| Local Authority | Location of Sampler         | Grid Ref.                 | Grid Ref.                 | Part of NO2 Network? | NO2 Network Name if applicable | Site Classification | No. of months data if < 12 | Uncorrected annual    | Bias-adjusted annual  | BAF  | Lab used             |
|-----------------|-----------------------------|---------------------------|---------------------------|----------------------|--------------------------------|---------------------|----------------------------|-----------------------|-----------------------|------|----------------------|
|                 |                             | Eastings to nearest 100m, | Northing to nearest 100m. |                      |                                |                     |                            | mean NO2, 2003, ug/m3 | mean NO2, 2003, ug/m3 |      |                      |
| Omagh           | Campsie Road, Omagh         | 2457                      | 3727                      | NO                   |                                | A                   |                            | 15.7                  | 16.2                  | 1.04 | Ruddock & Sherratt * |
| Omagh           | Dromore Road, Omagh         | 2445                      | 3270                      | NO                   |                                | A                   |                            | 33.9                  | 35.1                  | 1.04 | Ruddock & Sherratt * |
| Omagh           | Dublin Road, Omagh          | 2456                      | 3724                      | YES                  | OMAGH 1N                       | A                   |                            | 11.7                  | 12.1                  | 1.04 | Ruddock & Sherratt * |
| Omagh           | Great Northern Road, Omagh  | 2453                      | 3735                      | NO                   |                                | A                   |                            | 10.3                  | 10.7                  | 1.04 | Ruddock & Sherratt * |
| Omagh           | Hospital Road, Omagh        | 2465                      | 3725                      | NO                   |                                | A                   |                            | 20.2                  | 20.9                  | 1.04 | Ruddock & Sherratt * |
| Omagh           | Lisanelly Avenue, Omagh     | 2452                      | 3733                      | NO                   |                                | A                   |                            | 25.8                  | 26.7                  | 1.04 | Ruddock & Sherratt * |
| Omagh           | McConnell Place, Omagh      | 2445                      | 3725                      | YES                  | OMAGH 7N                       | A                   |                            | 13.3                  | 13.8                  | 1.04 | Ruddock & Sherratt * |
| Omagh           | Sedan Avenue, Omagh         | 2451                      | 3729                      | NO                   |                                | A                   |                            | 10.8                  | 11.2                  | 1.04 | Ruddock & Sherratt * |
| Omagh           | Swingbars Roundabout, Omagh | 2460                      | 3728                      | NO                   |                                | A                   |                            | 18.1                  | 18.7                  | 1.04 | Ruddock & Sherratt * |
| Omagh           | Tamlaght Road, Omagh        | 2422                      | 3722                      | YES                  | OMAGH 5N                       | A                   |                            | 14.9                  | 15.4                  | 1.04 | Ruddock & Sherratt * |
| Strabane        | Main St, Castlederg         | 2262                      | 3844                      | NO                   |                                | A                   |                            | 13.5                  | 14.0                  | 1.04 | Ruddock & Sherratt * |
| Strabane        | Main St, Newtownstewart     | 2402                      | 3857                      | NO                   |                                | A                   |                            | 12.0                  | 12.4                  | 1.04 | Ruddock & Sherratt * |
| Strabane        | Main St, Strabane           | 2345                      | 3975                      | NO                   |                                | A                   |                            | 14.9                  | 15.4                  | 1.04 | Ruddock & Sherratt * |
| Strabane        | Meimount Road, Strabane     | 2339                      | 3962                      | NO                   |                                | A                   |                            | 13.4                  | 13.9                  | 1.04 | Ruddock & Sherratt * |
| Strabane        | Urney Road, Strabane        | 2337                      | 3974                      | NO                   |                                | A                   |                            | 16.2                  | 16.8                  | 1.04 | Ruddock & Sherratt * |

Shaded text indicates new sites in 2003.

\* In "Laboratory" column, asterisk indicates that the bias adjustment factor used was not supplied by the Local Authority, but has been obtained by Netcen from other sources, e.g. the Defra Review and Assessment Website.

A = kerbside, 1-5m from the kerb of a busy road

B = intermediate site, 20-30m from the same or an equivalent road

C = urban background site, greater than 50m from any busy road

D = rural background site

E = special site; monitoring air pollution from some industrial process, etc.

## **Appendix 2**

### **Historic Datasets for CO, NO<sub>2</sub>, SO<sub>2</sub> PM<sub>10</sub> and O<sub>3</sub>**

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Table A2.1 CO Results from Automatic Monitoring Sites 1992 – 2003.

| Calendar Year                  | Data Capture % | Annual Mean $\text{mg m}^{-3}$ | Max running 8-Hour Mean $\text{Mg m}^{-3}$ | Number of Exceedences of EC Limit Value | Number of Exceedences of AQS Objective |
|--------------------------------|----------------|--------------------------------|--|---|--|
| <b>Belfast Centre</b>          |                |                                |  |   |  |
| 1992                           | 79             | 0.9                            | 11.9                                       | 5                                       | 5                                      |
| 1993                           | 97             | 0.8                            | 12.3                                       | 1                                       | 1                                      |
| 1994                           | 97             | 0.8                            | 15.6                                       | 2                                       | 2                                      |
| 1995                           | 95             | 0.7                            | 16.3                                       | 4                                       | 4                                      |
| 1996                           | 96             | 0.6                            | 9.4  | 0                                       | 0                                      |
| 1997                           | 96             | 0.8                            | 8.2  | 0                                       | 0                                      |
| 1998                           | 91             | 0.5                            | 4.0  | 0                                       | 0                                      |
| 1999                           | 94             | 0.5                            | 4.3  | 0                                       | 0                                      |
| 2000                           | 81             | 0.4                            | 3.5  | 0                                       | 0                                      |
| 2001                           | 60             | 0.4                            | 5.5  | 0                                       | 0                                      |
| 2002                           | 97             | 0.3                            | 3.6  | 0                                       | 0                                      |
| 2003                           | 79             | 0.2                            | 2.7  | 0                                       | 0                                      |
| <b>Londonderry, Brook Park</b> |                |                                |  |   |  |
| 1997                           | 60             | 0.4                            | 3.9  | 0                                       | 0                                      |
| 1998                           | 92             | 0.5                            | 4.9  | 0                                       | 0                                      |
| 1999                           | 93             | 0.4                            | 3.0  | 0                                       | 0                                      |
| 2000                           | 97             | 0.4                            | 2.4  | 0                                       | 0                                      |
| 2001                           | 96             | 0.3                            | 2.4  | 0                                       | 0                                      |
| 2002                           | 93             | 0.2                            | 1.8  | 0                                       | 0                                      |
| 2003                           | 98             | 0.2                            | 1.7  | 0                                       | 0                                      |

Table A2.2 NO<sub>2</sub> Results from Automatic Monitoring Sites 1992 – 2003

| Year  | Data Capture | Max Hourly Mean $\mu\text{g m}^{-3}$ | Annual Mean | No. of hourly means > 200 $\mu\text{g m}^{-3}$ | Is Annual Mean > 40 $\mu\text{g m}^{-3}$ |
|---|--------------|--------------------------------------|-------------|--|--|
| <b>Armagh Lonsdale Road (Roadside)</b>            |              |                                      |             |  |  |
| 2002  | 44           | 125                                  | 34          | 0  | No                                       |
| 2003  | 98           | 374                                  | 34          | 11   | No                                       |
| <b>Belfast Centre (Urban Centre)</b>              |              |                                      |             |  |  |
| 1992  | 61           | 249                                  | 44          | 3  | Yes                                      |
| 1993  | 97           | 356                                  | 42          | 6  | Yes                                      |
| 1994  | 95           | 191                                  | 40          | 0  | No                                       |
| 1995  | 95           | 381                                  | 40          | 15   | No                                       |
| 1996  | 97           | 251                                  | 38          | 3  | No                                       |
| 1997  | 96           | 164                                  | 38          | 0  | No                                       |
| 1998  | 93           | 163                                  | 34          | 0  | No                                       |
| 1999  | 97           | 142                                  | 34          | 0  | No                                       |
| 2000  | 81           | 124                                  | 31          | 0  | No                                       |
| 2001  | 86           | 335                                  | 32          | 3  | No                                       |
| 2002  | 95           | 258                                  | 30          | 3  | No                                       |
| 2003  | 95           | 170                                  | 32          | 0  | No                                       |
| <b>Belfast – Newtownards Road (Roadside)</b>      |              |                                      |             |  |  |
| 2002  | 66           | 212                                  | 50          | 2  | Yes                                      |
| 2003  | 96           | 179                                  | 45          | 0  | Yes                                      |
| <b>Belfast – Westlink (Roadside)</b>              |              |                                      |             |  |  |
| 2002  | 66           | 295                                  | 56          | 21   | Yes                                      |
| 2003  | 94           | 258                                  | 53          | 27   | Yes                                      |
| <b>Castlereagh Loughview Drive (Roadside)</b>     |              |                                      |             |  |  |
| 2002  | 50           | 132                                  | 28          | 0  | No                                       |
| 2003  | 63           | 149                                  | 34          | 0  | No                                       |
| <b>Craigavon – Castle Lane</b>                    |              |                                      |             |  |  |
| 2002  | 75           | 157                                  | 13          | 0  | No                                       |
| 2003  | 18           | 94                                   | 22          | 0  | No                                       |
| <b>Hollywood</b>                                  |              |                                      |             |  |  |
| 2003  | 70           | 111                                  | 25          | 0  | No                                       |
| <b>Lisburn – Lagan Valley Hospital (Roadside)</b> |              |                                      |             |  |  |
| 2002  | 45           | 221                                  | 54          | 1  | Yes                                      |
| 2003  | 78           | 172                                  | 28          | 0  | No                                       |
| <b>Londonderry Brook Park (Urban Background)</b>  |              |                                      |             |  |  |
| 1997  | 47           | 130                                  | 21          | 0  | -  |
| 1998  | 79           | 94                                   | 13          | 0  | No                                       |
| 1999  | 87           | 94                                   | 15          | 0  | No                                       |
| 2000  | 96           | 73                                   | 15          | 0  | No                                       |
| 2001  | 93           | 75                                   | 15          | 0  | No                                       |
| 2002  | 95           | 94                                   | 15          | 0  | No                                       |
| 2003  | 95           | 96                                   | 17          | 0  | No                                       |
| <b>Londonderry - Derry, Dale's Corner</b>         |              |                                      |             |  |  |
| 2003  | 11           | 166                                  | 48          | 0  | Yes                                      |

...Continued over...

Table A2.2 – *continued*: NO<sub>2</sub> Results from Automatic Monitoring Sites 1992 – 2003

| Year   | Data Capture | Max Hourly Mean $\mu\text{g m}^{-3}$ | Annual Mean | No. of hourly means > 200 $\mu\text{g m}^{-3}$ | Is Annual Mean > 40 $\mu\text{g m}^{-3}$ |
|--|--------------|--------------------------------------|-------------|--|--|
| <b>Newry - Monaghan Row (Urban Background)</b> |              |                                      |             |  |  |
| 2001   | 73           | 63                                   | 11          | 0  | No                                       |
| 2002   | 91           | 105                                  | 15          | 0  | No                                       |
| 2003   | 97           | 98                                   | 20          | 0  | No                                       |
| <b>Newry – Trevor Hill (Roadside)</b>          |              |                                      |             |  |  |
| 2001   | 61           | 103                                  | 19          | 0  | No                                       |
| 2002   | 98           | 208                                  | <b>44</b>   | 1  | <b>Yes</b>                               |
| 2003   | 91           | 189                                  | <b>50</b>   | 0  | <b>Yes</b>                               |
| <b>Newtownabbey – Sandyknowes</b>              |              |                                      |             |  |  |
| 2003   | 68           | 164                                  | 30          | 0  | No                                       |
| <b>Newtownabbey - Shore Road</b>               |              |                                      |             |  |  |
| 2003   | 70           | 132                                  | 29          | 0  | No                                       |

Table A2.3 SO<sub>2</sub> Results from Automatic Monitoring Sites 1992 - 2003

| Year                         | Data Capture % | Max 15-minute mean, $\mu\text{g m}^{-3}$ | No. of 15-minute means > 266 $\mu\text{g m}^{-3}$ | Max 1-hr mean $\mu\text{g m}^{-3}$ | No. of 1-hr means > 350 $\mu\text{g m}^{-3}$ | Max 24-hr mean $\mu\text{g m}^{-3}$ | No. of 24-hour means > 125 $\mu\text{g m}^{-3}$ | Annual Mean $\mu\text{g m}^{-3}$ |
|------------------------------|----------------|--|---|------------------------------------|--|-------------------------------------|---|----------------------------------|
| Ards *                       |                |  |   |                                    |  |                                     |   |                                  |
| 2002                         | 17             | 150                                      | 0   | 116                                | 0  | 48                                  | 0   | -                                |
| 2003                         | 93             | 221                                      | 0   | 192                                | 0  | 67                                  | 0   | 9                                |
| Armagh (Dobbin Street)       |                |  |   |                                    |  |                                     |   |                                  |
| 2003                         | 36             | 154                                      | 0   | 82                                 | 0  | 14                                  | 0   | 4                                |
| Ballymena (Ballykeel)        |                |  |   |                                    |  |                                     |   |                                  |
| 2002                         | 41             | 142                                      | 0   | 77                                 | 0  | 36                                  | 0   | 6                                |
| 2003                         | 49             | 98                                       | 0   | 51                                 | 0  | 28                                  | 0   | 6                                |
| Bangor                       |                |  |   |                                    |  |                                     |   |                                  |
| 2003                         | 80             | 168                                      | 0   | 144                                | 0  | 35                                  | 0   | 8                                |
| Belfast Centre               |                |  |   |                                    |  |                                     |   |                                  |
| 1992                         | 78             | 1256                                     | <b>316</b>  | 1024                               | <b>43</b>                                    | 307                                 | <b>12</b>                                       | 40                               |
| 1993                         | 97             | 867                                      | <b>436</b>  | 766                                | <b>53</b>                                    | 355                                 | <b>13</b>                                       | 48                               |
| 1994                         | 97             | 1046                                     | <b>388</b>  | 934                                | <b>52</b>                                    | 389                                 | <b>8</b>  | 45                               |
| 1995                         | 96             | 1317                                     | <b>346</b>  | 963                                | <b>54</b>                                    | 406                                 | <b>9</b>  | 40                               |
| 1996                         | 97             | 945                                      | <b>326</b>  | 740                                | <b>45</b>                                    | 299                                 | <b>10</b>                                       | 37                               |
| 1997                         | 96             | 607                                      | <b>141</b>  | 426                                | 8  | 171                                 | <b>4</b>  | 29                               |
| 1998                         | 89             | 471                                      | <b>47</b>   | 394                                | 3  | 136                                 | 2   | 21                               |
| 1999                         | 95             | 378                                      | 5   | 338                                | 0  | 89                                  | 0   | 16                               |
| 2000                         | 80             | 436                                      | 16  | 322                                | 0  | 67                                  | 0   | 13                               |
| 2001                         | 90             | 301                                      | 2   | 253                                | 0  | 70                                  | 0   | 11                               |
| 2002                         | 97             | 370                                      | 2   | 216                                | 0  | 63                                  | 0   | 7                                |
| 2003                         | 91             | 229                                      | 0   | 186                                | 0  | 69                                  | 0   | 8                                |
| Belfast East                 |                |  |   |                                    |  |                                     |   |                                  |
| 1992                         | 98             | 1650                                     | <b>1176</b>                                       | 1448                               | <b>179</b>                                   | 489                                 | <b>50</b>                                       | 69                               |
| 1993                         | 99             | 1267                                     | <b>824</b>  | 1150                               | <b>125</b>                                   | 412                                 | <b>35</b>                                       | 67                               |
| 1994                         | 99             | 1070                                     | <b>453</b>  | 958                                | <b>59</b>                                    | 545                                 | <b>18</b>                                       | 53                               |
| 1995                         | 92             | 1514                                     | <b>579</b>  | 1402                               | <b>106</b>                                   | 705                                 | <b>14</b>                                       | 56                               |
| 1996                         | 99             | 1176                                     | <b>656</b>  | 1070                               | <b>108</b>                                   | 362                                 | <b>22</b>                                       | 53                               |
| 1997                         | 99             | 774                                      | <b>500</b>  | 636                                | <b>58</b>                                    | 245                                 | <b>20</b>                                       | 45                               |
| 1998                         | 89             | 833                                      | <b>199</b>  | 636                                | 19   | 218                                 | <b>9</b>  | 35                               |
| 1999                         | 99             | 601                                      | <b>98</b>   | 487                                | 5  | 152                                 | <b>5</b>  | 29                               |
| 2000                         | 99             | 479                                      | <b>38</b>   | 466                                | 2  | 112                                 | 0   | 21                               |
| 2001                         | 94             | 450                                      | <b>139</b>  | 399                                | 13   | 226                                 | <b>5</b>  | 24                               |
| 2002                         | 97             | 365                                      | 5   | 314                                | 0  | 115                                 | 0   | 10                               |
| 2003                         | 97             | 213                                      | 0   | 194                                | 0  | 77                                  | 0   | 8                                |
| Carrickfergus                |                |  |   |                                    |  |                                     |   |                                  |
| 2002                         | 50             | 51                                       | 0   | 49                                 | 0  | 17                                  | 0   | 3.3                              |
| 2003                         | 97             | 226                                      | 0   | 176                                | 0  | 55                                  | 0   | 8                                |
| Castlereagh (Espie Way)      |                |  |   |                                    |  |                                     |   |                                  |
| 2002                         | NS             | 74                                       | 0   | 48                                 | 0  | 24                                  | 0   | NS                               |
| 2003                         | 96             | 112                                      | 0   | 93                                 | 0  | 44                                  | 0   | 4                                |
| Craigavon (Lord Lurgan Park) |                |  |   |                                    |  |                                     |   |                                  |
| 2002                         | 74             | 146                                      | 0   | 96                                 | 0  | 38                                  | 0   | 7                                |
| 2003                         | 17             | 80                                       | 0   | 67                                 | 0  | 30                                  | 0   | 10                               |

Table A2.3 *continued*: SO<sub>2</sub> Results from Automatic Monitoring Sites 1992 - 2003

| Year                          | Data Capture % | Max 15-minute mean, $\mu\text{g m}^{-3}$ | No. of 15-minute means > 266 $\mu\text{g m}^{-3}$ | Max 1-hr mean $\mu\text{g m}^{-3}$ | No. of 1-hr means > 350 $\mu\text{g m}^{-3}$ | Max 24-hr mean $\mu\text{g m}^{-3}$ | No. of 24-hour means > 125 $\mu\text{g m}^{-3}$ | Annual Mean $\mu\text{g m}^{-3}$ |
|-------------------------------|----------------|--|---|------------------------------------|--|-------------------------------------|---|----------------------------------|
| Dungannon (Lambfield)         |                |  |   |                                    |  |                                     |   |                                  |
| 2002                          | 18             | 94                                       | 0   | 38                                 | 0  | 24                                  | 0   | -                                |
| 2003                          | 96             | 141                                      | 0   | 78                                 | 0  | 35                                  | 0   | 2                                |
| Larne                         |                |  |   |                                    |  |                                     |   |                                  |
| 2003                          | 73             | 295                                      | 1   | 128                                | 0  | 58                                  | 0   | 4                                |
| Lisburn (Island Civic Centre) |                |  |   |                                    |  |                                     |   |                                  |
| 2002                          | 49             | 101                                      | 0   | 48                                 | 0  | 15                                  | 0   | 3.5                              |
| 2003                          | 79             | 120                                      | 0   | 88                                 | 0  | 42                                  | 0   | 5                                |
| Londonderry, Brook Park       |                |  |   |                                    |  |                                     |   |                                  |
| 1998                          | 54             | 1088                                     | 31  | 734                                | 3  | 130                                 | 1   | 13                               |
| 1999                          | 73             | 258                                      | 0   | 218                                | 0  | 46                                  | 0   | 11                               |
| 2000                          | 96             | 649                                      | 19  | 383                                | 1  | 73                                  | 0   | 11                               |
| 2001                          | 96             | 197                                      | 0   | 136                                | 0  | 44                                  | 0   | 11                               |
| 2002                          | 95             | 136                                      | 0   | 101                                | 0  | 35                                  | 0   | 11                               |
| 2003                          | 97             | 263                                      | 0   | 125                                | 0  | 49                                  | 0   | 11                               |
| Londonderry Brandywell        |                |  |   |                                    |  |                                     |   |                                  |
| 2002                          | 65             | 229                                      | 0   | 229                                | 0  | 74                                  | 0   | 16                               |
| 2003                          | 98             | 293                                      | 4   | 293                                | 0  | 98                                  | 0   | 15                               |
| Newry, Monaghan Row           |                |  |   |                                    |  |                                     |   |                                  |
| 2001                          | 73             | 506                                      | 1   | 138                                | 0  | 36                                  | 0   | 7                                |
| 2002                          | 95             | 146                                      | 0   | 114                                | 0  | 39                                  | 0   | 6                                |
| 2003                          | 96             | 154                                      | 0   | 109                                | 0  | 42                                  | 0   | 7                                |
| Newry, Trevor Hill            |                |  |   |                                    |  |                                     |   |                                  |
| 2001                          | 61             | 128                                      | 0   | 74                                 | 0  | 29                                  | 0   | 8                                |
| 2002                          | 97             | 577                                      | 4   | 306                                | 0  | 24                                  | 0   | 6                                |
| 2003                          | 97             | 96                                       | 0   | 59                                 | 0  | 31                                  | 0   | 8                                |
| Strabane (Springfield Park)   |                |  |   |                                    |  |                                     |   |                                  |
| 2002                          | 64             | 253                                      | 0   | 90                                 | 0  | 28                                  | 0   | 11                               |
| 2003                          | 94             | 168                                      | 0   | 69                                 | 0  | 32                                  | 0   | 8                                |



Table A2.4 PM<sub>10</sub> Results from Automatic Monitoring Sites 1992 – 2003

| Calendar Year  | Data Capture % | Annual Mean $\mu\text{g m}^{-3}$ | Max Daily Mean $\mu\text{g m}^{-3}$ | No. of Daily means > 50 $\mu\text{g m}^{-3}$ |
|--|----------------|----------------------------------|-------------------------------------|--|
| <b>Ards</b> (TEOM, converted to gravimetric equivalent)                        |                |                                  |                                     |  |
| 2002   | 17             | 30                               | 53                                  | 1  |
| 2003   | 82             | 24                               | 71                                  | 11   |
| <b>Armagh, Lonsdale Road</b> (TEOM, converted to gravimetric equivalent)       |                |                                  |                                     |  |
| 2002   | 38             | 30                               | 131                                 | 12   |
| 2003   | 100            | 33                               | 121                                 | 46   |
| <b>Bangor</b> (TEOM, converted to gravimetric equivalent)                      |                |                                  |                                     |  |
| 2003   | 57             | 27                               | 86                                  | 12   |
| <b>Belfast Centre</b> (TEOM, converted to gravimetric equivalent)              |                |                                  |                                     |  |
| 1992   | 79             | 35                               | 322                                 | <b>44</b>                                    |
| 1993   | 96             | <b>41</b>                        | 156                                 | <b>86</b>                                    |
| 1994   | 95             | 34                               | 248                                 | <b>38</b>                                    |
| 1995   | 95             | 32                               | 190                                 | 35   |
| 1996   | 95             | 31                               | 145                                 | <b>44</b>                                    |
| 1997   | 96             | 32                               | 110                                 | <b>41</b>                                    |
| 1998   | 94             | 27                               | 87                                  | 20   |
| 1999   | 97             | 26                               | 84                                  | 15   |
| 2000   | 81             | 25                               | 69                                  | 8  |
| 2001   | 81             | 25                               | 108                                 | 15   |
| 2002   | 98             | 23                               | 83                                  | 8  |
| 2003   | 97             | 24                               | 91                                  | 26   |
| <b>Belfast Clara Street</b> (Beta Attenuation Monitor)                         |                |                                  |                                     |  |
| 1999   | 95             | 22                               | 71                                  | 12   |
| 2000   | 93             | 16                               | 69                                  | 2  |
| 2001   | 92             | 19                               | 128                                 | 14   |
| 2002   | 94             | 17                               | 99                                  | 8  |
| 2003   | 95             | 22                               | 121                                 | 34   |
| <b>Belfast Westlink</b> (TEOM, converted to gravimetric equivalent)            |                |                                  |                                     |  |
| 2002   | 50             | 34                               | 108                                 | 32   |
| 2003   | 98             | 36                               | 105                                 | <b>63</b>                                    |
| <b>Carrickfergus</b> (TEOM, converted to gravimetric equivalent)               |                |                                  |                                     |  |
| 2002   | 50             | 17                               | 51                                  | 1  |
| 2003   | 76             | 25                               | 71                                  | 13   |
| <b>Castlereagh Loughview Drive</b> (TEOM, converted to gravimetric equivalent) |                |                                  |                                     |  |
| 2002   | 48             | 34                               | 112                                 | 8  |
| 2003   | 76             | 23                               | 61                                  | 9  |
| <b>Castlereagh Espie Way</b> (TEOM, converted to gravimetric equivalent)       |                |                                  |                                     |  |
| 2002   | 48             | 26                               | 74                                  | 3  |
| 2003   | 67             | 19                               | 53                                  | 4  |
| <b>Craigavon, Lord Lurgan Park</b> (TEOM, converted to gravimetric equivalent) |                |                                  |                                     |  |
| 2002   | 74             | 15                               | 78                                  | 2  |
| 2003   | 18             | 25                               | 70                                  | 3  |
| <b>Dungannon</b> (TEOM, converted to gravimetric equivalent)                   |                |                                  |                                     |  |
| 2002   | 19             | 15                               | 36                                  | 0  |
| 2003   | 88             | 28                               | 63                                  | 25   |

Table A2.4 *continued* - PM<sub>10</sub> Results from Automatic Monitoring Sites 1992 - 2003

| Calendar Year  | Data Capture % | Annual Mean $\mu\text{g m}^{-3}$ | Max Daily Mean $\mu\text{g m}^{-3}$ | No. of Daily means > 50 $\mu\text{g m}^{-3}$ |
|--|----------------|----------------------------------|-------------------------------------|--|
| <b>Holywood</b> (TEOM, converted to gravimetric equivalent)                    |                |                                  |                                     |  |
| 2003   | 71             | 27                               | 68                                  | 11   |
| <b>Larne</b> (TEOM, converted to gravimetric equivalent)                       |                |                                  |                                     |  |
| 2003   | 74             | 22                               | 189                                 | 18   |
| <b>Lisburn Dunmurry High School</b>  |                |                                  |                                     |  |
| 2003   | 16             | 28                               | 70                                  | 6  |
| <b>Lisburn Island Civic Centre</b> (TEOM, converted to gravimetric equivalent) |                |                                  |                                     |  |
| 2002   | 36             | 16                               | 37                                  | 0  |
| 2003   | 76             | 22                               | 77                                  | 7  |
| <b>Lisburn (LVH)</b> (TEOM, converted to gravimetric equivalent)               |                |                                  |                                     |  |
| 2002   | 50             | 14                               | 40                                  | 0  |
| 2003   | 63             | 26                               | 98                                  | 15   |
| <b>Londonderry Brook Park</b> (TEOM, converted to gravimetric equivalent)      |                |                                  |                                     |  |
| 1997   | 60             | 28                               | 90                                  | 13   |
| 1998   | 96             | 26                               | 157                                 | 18   |
| 1999   | 96             | 25                               | 111                                 | 11   |
| 2000   | 96             | 20                               | 84                                  | 6  |
| 2001   | 97             | 23                               | 130                                 | 15   |
| 2002   | 96             | 22                               | 80                                  | 9  |
| 2003   | 97             | 24                               | 90                                  | 20   |
| <b>Londonderry Brandywell</b> (TEOM, converted to gravimetric equivalent)      |                |                                  |                                     |  |
| 2002   | 73             | 25                               | 106                                 | 19   |
| 2003   | 99             | 29                               | 114                                 | 34   |
| <b>Lough Navar</b> (TEOM, converted to gravimetric equivalent)                 |                |                                  |                                     |  |
| 1996   | <50            | 13                               | 27                                  | 0  |
| 1997   | 96             | 13                               | 38                                  | 0  |
| 1998   | 98             | 12                               | 44                                  | 0  |
| 1999   | 96             | 12                               | 38                                  | 0  |
| 2000   | 99             | 12                               | 35                                  | 0  |
| 2001   | 96             | 13                               | 41                                  | 0  |
| 2002   | 96             | 15                               | 58                                  | 2  |
| 2003   | 99             | 15                               | 55                                  | 1  |
| <b>Newry, old site</b> (TEOM, converted to gravimetric equivalent)             |                |                                  |                                     |  |
| 1998   | 42             | 24                               | 90                                  | 9  |
| 1999   | 80             | 23                               | 76                                  | 8  |
| 2000   | 93             | 22                               | 114                                 | 5  |
| <b>Newry, Monaghan Row</b> (TEOM, converted to gravimetric equivalent)         |                |                                  |                                     |  |
| 2001   | 70             | 20                               | 68                                  | 4  |
| 2002   | 95             | 21                               | 78                                  | 8  |
| 2003   | 95             | 23                               | 79                                  | 22   |
| <b>Newry, Trevor Hill</b> (TEOM, converted to gravimetric equivalent)          |                |                                  |                                     |  |
| 2001   | 61             | 34                               | 86                                  | 26   |
| 2002   | 99             | 34                               | 89                                  | <b>38</b>                                    |
| 2003   | 97             | 37                               | 91                                  | <b>71</b>                                    |
| <b>Omagh Tamlaght</b> (TEOM, converted to gravimetric equivalent)              |                |                                  |                                     |  |
| 2003   | 26             | 23                               | 64                                  | 2  |
| <b>Strabane</b> (BAM)  |                |                                  |                                     |  |
| 2002   | 67             | 38                               | 147                                 | <b>48</b>                                    |
| 2003   | 97             | <b>43</b>                        | 164                                 | <b>101</b>                                   |

Table A2.5 Ozone Results from Automatic Monitoring Sites, 1990 - 2003

| Calendar Year                       | Data Capture, % | Max Daily 8 Hour Mean $\mu\text{g m}^{-3}$ | Days with max. daily 8hr mean > 100 $\mu\text{g m}^{-3}$ | Annual Mean $\mu\text{g m}^{-3}$ |
|-------------------------------------|-----------------|--|--|----------------------------------|
| <b>Belfast Centre</b>               |                 |  |  |                                  |
| 1992                                | 81              | 108  | 2  | 36                               |
| 1993                                | 97              | 88   | 0  | 32                               |
| 1994                                | 95              | 106  | 2  | 36                               |
| 1995                                | 96              | 136  | <b>11</b>  | 38                               |
| 1996                                | 96              | 130  | 5  | 34                               |
| 1997                                | 95              | 124  | 6  | 34                               |
| 1998                                | 94              | 112  | 3  | 42                               |
| 1999                                | 96              | 126  | 7  | 44                               |
| 2000                                | 81              | 130  | 2  | 42                               |
| 2001                                | 90              | 130  | 2  | 38                               |
| 2002                                | 96              | 98   | 0  | 37                               |
| 2003                                | 97              | 118  | 9  | 42                               |
| <b>Londonderry</b>                  |                 |  |  |                                  |
| 1997                                | 59              | 152  | 6  | 44                               |
| 1998                                | 90              | 108  | 2  | 52                               |
| 1999                                | 94              | 154  | 4  | 52                               |
| 2000                                | 97              | 120  | <b>11</b>  | 54                               |
| 2001                                | 94              | 104  | 2  | 46                               |
| 2002                                | 92              | 114  | <b>19</b>  | 58                               |
| 2003                                | 93              | 149  | <b>16</b>  | 52                               |
| <b>Lough Navar (1990 onwards) *</b> |                 |  |  |                                  |
| 1990                                | 96              | 170  | <b>21</b>  | 52                               |
| 1991                                | 99              | 158  | <b>14</b>  | 46                               |
| 1992                                | 87              | 160  | <b>19</b>  | 52                               |
| 1993                                | 98              | 112  | 5  | 48                               |
| 1994                                | 99              | 132  | 7  | 52                               |
| 1995                                | 93              | 148  | <b>20</b>  | 48                               |
| 1996                                | 97              | 118  | 6  | 46                               |
| 1997                                | 97              | 140  | 5  | 42                               |
| 1998                                | 95              | 112  | 3  | 46                               |
| 1999                                | 88              | 118  | 6  | 50                               |
| 2000                                | 90              | 124  | 7  | 48                               |
| 2001                                | 99              | 130  | 9  | 46                               |
| 2002                                | 88              | 102  | 1  | 42                               |
| 2003                                | 64              | 138  | 6  | 47                               |

\* Lough Navar has operated since 1987, but only data from 1990 onwards are shown here.

## Appendix 3

### Data from Smoke and SO<sub>2</sub> Sites

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#### CONTENTS

Table A3.1

Summary of Smoke and SO<sub>2</sub> Results for Northern Ireland,  
Calendar Year 2003

The following two tables contain smoke and SO<sub>2</sub> data from Smoke and SO<sub>2</sub> Network sites in Northern Ireland. These pollutants are monitored simultaneously on a daily basis, using the 8-port sampler apparatus. All the sites shown are part of the Smoke and SO<sub>2</sub> Network. Grid references are in 8-figure format, to the nearest 100m. There are a further three sites of this type, which are not part of the Network: annual mean smoke and SO<sub>2</sub> concentrations for these are presented in the main report.

**Table A3.1 Summary of Smoke and SO<sub>2</sub> Results for Northern Ireland, Calendar Year 2003. All concentrations in µg m<sup>-3</sup>.**

| Code                    | Site Name          | Authority              | Irish Grid Ref to 100m |       | Summary of Smoke Data 2003 |             |        |           |          | Summary of SO <sub>2</sub> Data 2003 |             |        |           |          |
|-------------------------|--------------------|------------------------|------------------------|-------|----------------------------|-------------|--------|-----------|----------|--------------------------------------|-------------|--------|-----------|----------|
|                         |                    |                        | East                   | North | Data Capt. %               | Arith. Mean | Median | 98th %ile | Max. Day | Data Capt. %                         | Arith. Mean | Median | 98th %ile | Max. Day |
| <b>NORTHERN IRELAND</b> |                    |                        |                        |       |                            |             |        |           |          |                                      |             |        |           |          |
| 68851                   | ANTRIM 1           | Antrim Borough Council | 3162                   | 3869  | 99                         | 13          | 8      | 57        | 124      | 99                                   | 23          | 24     | 43        | 79       |
| 69701                   | ARMAGH 1           | Armagh                 | 2877                   | 3450  | 61                         | 20          | 18     | 48        | 63       | 59                                   | 12          | 13     | 19        | 19       |
| 160005                  | BALLYMENA 5        | Ballymena              | 3109                   | 4053  | 96                         | 11          | 11     | 19        | 25       | 95                                   | 13          | 13     | 25        | 30       |
| 160006                  | BALLYMENA 6        | Ballymena              | 3120                   | 4026  | 95                         | 11          | 10     | 22        | 28       | 94                                   | 15          | 13     | 31        | 37       |
| 161504                  | BALLYMONEY 4       | Ballymoney             | 2954                   | 4259  | 100                        | 13          | 8      | 66        | 204      | 100                                  | 11          | 13     | 20        | 45       |
| 270012                  | BELFAST 12         | Belfast                | 3324                   | 3737  | 97                         | 9           | 5      | 42        | 70       | 97                                   | 18          | 18     | 36        | 66       |
| 270013                  | BELFAST 13         | Belfast                | 3357                   | 3740  | 100                        | 7           | 5      | 28        | 43       | 100                                  | 27          | 26     | 45        | 51       |
| 270033                  | BELFAST 33         | Belfast                | 3346                   | 3755  | 99                         | 8           | 5      | 27        | 52       | 99                                   | 29          | 32     | 45        | 51       |
| 270042                  | BELFAST 42         | Belfast                | 3322                   | 3748  | 98                         | 8           | 5      | 29        | 64       | 98                                   | 28          | 26     | 51        | 64       |
| 270044                  | BELFAST 44         | Belfast                | 3338                   | 3740  | 99                         | 5           | 4      | 14        | 25       | 99                                   | 25          | 26     | 38        | 45       |
| 270045                  | BELFAST 45         | Belfast                | 3335                   | 3723  | 100                        | 7           | 5      | 23        | 38       | 100                                  | 28          | 26     | 49        | 57       |
| 270046                  | BELFAST 46         | Belfast                | 3803                   | 3334  | 100                        | 4           | 3      | 14        | 25       | 98                                   | 21          | 19     | 38        | 45       |
| 768003                  | COLERAINE 3        | Coleraine              | 2861                   | 4328  | 82                         | 10          | 9      | 34        | 55       | 72                                   | 9           | 6      | 19        | 48       |
| 797501                  | COOKSTOWN 1        | Cookstown              | 2774                   | 3806  | 56                         | 13          | 10     | 56        | 98       | 42                                   | rejected    |        |           |          |
| 2551506                 | PORTADOWN 6        | Craigavon              | 3004                   | 3548  | 45                         | 6           | 4      | 23        | 58       | 52                                   | 10          | 12     | 30        | 36       |
| 1025001                 | DUNGANNON 1        | Dungannon              | 2802                   | 3629  | 80                         | 5           | 4      | 14        | 24       | 79                                   | 17          | 18     | 31        | 45       |
| 1757704                 | LARNE 4            | Larne                  | 3386                   | 4037  | 98                         | 6           | 5      | 18        | 51       | 96                                   | 17          | 18     | 30        | 36       |
| 1757705                 | LARNE 5            | Larne                  | 3401                   | 4033  | 100                        | 7           | 6      | 24        | 43       | 97                                   | 18          | 20     | 27        | 40       |
| 1032503                 | DUNMURRY 3         | Lisburn                | 3287                   | 3875  | 84                         | 8           | 5      | 24        | 82       | 84                                   | 21          | 20     | 36        | 48       |
| 1845003                 | LISBURN 3          | Lisburn                | 3263                   | 3636  | 85                         | 9           | 7      | 30        | 109      | 84                                   | 19          | 19     | 34        | 41       |
| 3325001                 | TWINBROOK 1        | Lisburn                | 3281                   | 3689  | 24                         | 7           | 5      | 16        | 17       | 24                                   | 20          | 18     | 29        | 29       |
| 2190014                 | LONDONDERRY 14     | Derry City Council     | 2443                   | 4174  | 47                         | 4           | 3      | 11        | 14       | 37                                   | 16          | 13     | 45        | 58       |
| 2233501                 | MAGHERAFELT 1      | Magherafelt            | 2896                   | 3901  | 99                         | 9           | 5      | 39        | 61       | 99                                   | 11          | 13     | 27        | 27       |
| 512601                  | BUSHMILLS 1        | Moyle District Council | 2941                   | 4409  | 56                         | 14          | 12     | 30        | 77       | 50                                   | 4           | 0      | 18        | 25       |
| 512602                  | BUSHMILLS 2        | Moyle District Council | 2941                   | 4407  | 22                         | 7           | 6      | 16        | 26       | 21                                   | 2           | 0      | 12        | 13       |
| 2410003                 | NEWRY 3            | Newry and Mourne       | 3078                   | 3268  | 98                         | 3           | 1      | 23        | 60       | 95                                   | 4           | 0      | 13        | 13       |
| 2412503                 | NEWTOWNABBEY 3     | Newtownabbey           | 3321                   | 3851  | 73                         | 8           | 6      | 24        | 88       | 55                                   | 4           | 0      | 13        | 14       |
| 2412504                 | NEWTOWNABBEY 4     | Newtownabbey           | 3283                   | 3907  | 99                         | 8           | 4      | 37        | 59       | 81                                   | 4           | 6      | 13        | 19       |
| 165005                  | BANGOR (CO DOWN) 5 | North Down             | 3497                   | 3810  | 85                         | 16          | 10     | 62        | 90       | 85                                   | 18          | 18     | 52        | 71       |
| 1517501                 | HOLYWOOD 1         | North Down             | 3397                   | 3784  | 62                         | 9           | 7      | 32        | 112      | 62                                   | 16          | 14     | 28        | 47       |
| 3111502                 | STRABANE 2         | Strabane               | 2351                   | 3972  | 96                         | 21          | 16     | 80        | 146      | 96                                   | 11          | 13     | 20        | 21       |

*Net acidity data from COOKSTOWN 1 rejected due to suspected alkaline interference.*