Air Quality Monitoring in Northern Ireland, 2002

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

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

Foreword

Air quality in Northern Ireland is improving. However, we cannot afford to be complacent. Whilst we do not experience today the typical smogs that were once commonplace during the 1950 and 1960's, we do face new challenges.

These challenges are reflected in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Meeting the health based air quality objectives of the Air Quality Strategy is a key objective for the Department of the Environment as part of its commitment to improve air quality and also to meet our obligations under the Investing for Health Strategy. Local air quality management is central to this and the Department has introduced the Environment (NI) Order 2002, air quality regulations, technical and policy guidance to enable Government Departments, District Councils and other stakeholders to deliver their contribution to meeting air quality targets and objectives.

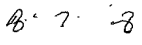
A great deal of work on local air quality management has already been done over the last two years and District Councils are in the final stages of completing the first round of review and assessments of local air quality. Where relevant air quality objectives are unlikely to be met, District Councils and other relevant authorities will be required to identify and implement measures to improve air quality. This process will provide a major opportunity for District Councils, Government Departments and their agencies to make a significant contribution towards the improvement of public health in Northern Ireland.

A key requirement is sound monitoring of the amount of pollution which is in the air. Monitoring increased substantially during 2002 mainly due to funding provided by the Department to support District Councils in their review and assessment of local air quality.

This report draws on all the results of this monitoring to provide a comprehensive view of air quality in 2002. The report has been drawn up in partnership with the Chief Environmental Health Officers Group (CEHOG). The Department and CEHOG view the continuance of this partnership as fundamental to providing the public with up to date accurate information on air quality.

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 in Northern Ireland over the calendar year 2002. It is intended to bring together in one report, results from all the District Councils who carried out air quality measurements 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 2002, and a summary of results for each pollutant.

A large number of new air quality monitoring sites were started up during 2002 as a consequence of funding provided by the Environment and Heritage Service. These included fifteen new automatic monitoring sites, as well as several active samplers and a large number of new passive diffusion tube sites. The new sites were, in most cases, located where high pollutant concentrations were expected. The results from several of these new sites have highlighted potential exceedences of Air Quality Strategy (AQS) objectives.

On the basis of results from 2002 and previous years, the following pollutants appear not to present a problem with respect to meeting air quality objectives in Northern Ireland: carbon monoxide, benzene, 1,3 butadiene and 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: sulphur dioxide, nitrogen dioxide, particulate matter as PM_{10}, ozone, and polyclic aromatic hydrocarbons.

Carbon monoxide was monitored using automatic techniques at two sites (Belfast and Londonderry). Both met the EC 2nd Daughter Directive limit value and UK Air Quality Strategy (AQS) objective for this pollutant in 2002.

Nitrogen dioxide was monitored using the automatic chemiluminescent technique at ten sites, six of which started operation during 2002. Results from some of the new sites have identified potential exceedences of AQS objectives. One site, Belfast Westlink, exceeded the 1st Daughter Directive limit and AQS objective of 200 μg m^{-3} for the hourly mean more than the permitted 18 times during 2002.

The EC 1st Daughter Directive limit value and AQS objective for the annual mean nitrogen dioxide (40 μg m^{-3}) was exceeded at four roadside sites, all by busy major roads: Belfast Westlink, Belfast Newtownards Road, Lisburn Lagan Valley Hospital, and Newry Trevor Hill. It is predicted that these four sites (and possibly other similar locations) may not meet the AQS objective for the annual mean by 2005. Two (Belfast Westlink and Belfast Newtownards Road) may not meet the EC Daughter Directive Limit Value in 2010.

Nitrogen dioxide was also monitored on a monthly basis using passive diffusion tube samplers at 257 sites in 2002. The number of diffusion tube sites has substantially increased since 2000; most of the new sites are at roadside. The EC 1st Daughter Directive limit value and AQS objective for the annual mean (40 μg m^{-3}) was exceeded at seven roadside sites in 2002. These sites were all in locations affected by traffic emissions – either in urban centres close to busy main roads, or near busy or congested roads in smaller towns. It is predicted that these seven sites will meet the AQS objective for the annual mean by 2005.

Sulphur Dioxide (SO_2) was monitored using automatic techniques at fourteen sites, of which nine began operation in 2002. All automatic sites met the 1st 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 2002, the first year in which it has done so. Where data were available for comparison, annual mean SO_2 concentrations were lower during 2002 than in 2001.

A further 39 urban sites monitored sulphur dioxide using the non-automatic net acidity method. No sites in Northern Ireland exceeded the 24-hour limit value for SO_2 (125 μg m^{-3}) on more than the permitted three days. Annual average levels of net acidity in Northern Ireland continue to decrease.

The number of sites monitoring suspended particulate matter as PM_{10} also increased substantially in 2002, from six to eighteen. All sites met the AQS objective of 40 μg m^{-3} for the annual mean PM_{10}, as gravimetric equivalent. However, two sites exceeded the AQS objective of 50 μg m^{-3} (gravimetric equivalent) for the 24-hour mean on more than the permitted 35 occasions. These were Newry Trevor Hill (a roadside site in a congested town centre), and Strabane Springfield Park (on a housing estate where solid fuel use is prevalent, and dispersion can be poor).

Suspended particulate matter was also measured using the older "black smoke" method, at 39 urban sites. The limits set for smoke by EC Directive 80/779/EEC (on sulphur dioxide and suspended particulates) remain in force until 2005, and require demonstration of compliance. No Northern Ireland sites have exceeded any of the limit values of Directive 80/779/EEC relating to smoke, since 1990. However, levels remain relatively high in residential areas where domestic solid fuel use is prevalent.

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. Most of these days occurred during a period of high ozone levels during spring 2002. This is the second time in three years that the Londonderry site has exceeded this objective. However, ozone is a transboundary pollutant and not easy to control by local action.

Benzene monitoring commenced at two sites, Belfast Centre and Belfast Roadside, in July 2002. Monitoring of 1,3-butadiene began in May 2003. The available data so far indicate that both pollutants are within AQS objectives. The results are consistent with those of the former Belfast South hydrocarbon site.

Polycyclic aromatic hydrocarbons were monitored at two sites: Lisburn Dunmurry and Belfast Clara Street. Annual mean benzo(a)pyrene (B(a)P) concentrations at both sites were considerably lower than the previous year's values. B(a)P concentrations at Belfast were, for the first time, comparable with those measured at other cities such as Birmingham and Manchester, having been substantially higher in previous years. The Belfast site met the new AQS objective (currently applicable only to England, Scotland and Wales) of 0.25 ngm^{-3}. However, B(a)P concentrations at Lisburn remained considerably higher than those measured at most urban sites in the network. The major source of PAH around Lisburn is the widespread use of domestic solid fuels.

No monitoring of metals was undertaken in 2002. A study in 1999-2000, discussed in the previous report in this series, established that even in industrial areas of Northern Ireland, these metallic pollutants are unlikely to constitute a serious problem.

Contents

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 2002. 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 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_{10}) and sulphur dioxide (SO_2), can be particularly high in parts of Northern Ireland. Oxides of nitrogen (NO and NO_2) are also pollutants of concern in some urban areas; the dominant source of these pollutants is likely to be motor vehicles. The exact nature and extent of the air quality problem will become clearer once District Councils complete their first round of Review and Assessment reports, due by December 2003.

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 continuous 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 2002. 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 2002, including the large number 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 2002.

2 Air Quality Developments in 2002

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'. These will supersede existing air quality legislation. It is envisaged that the structures established under the UK Air Quality Strategy and supporting legislation will provide the 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), covering sulphur dioxide (SO_2), oxides of nitrogen, particulate matter as PM_{10}, and lead, came into force on 19 July 1999. This Directive contains limit values for these pollutants, aimed at protection of human health and of ecosystems, 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. This Directive was transposed by The Air Quality Limit Values (Amendment) Regulations (Northern Ireland) 2002.
- The third Daughter Directive (or EC Ozone Directive, 2002/3/EC) came into force in 2002 and sets target values for protection of human health and vegetation. This Directive was transposed into legislation by The Air Quality (Ozone) Regulations (Northern Ireland) 2003.

The remaining pollutants listed in the Framework Directive are polycyclic aromatic hydrocarbons and the metallic elements cadmium, arsenic, nickel and mercury. The European Commission is still working on a proposal for a fourth Air Quality Daughter Directive covering these. In its present form, the proposal aims to set "assessment thresholds" (ambient concentrations above which mandatory monitoring would be necessary from 2008) for arsenic, cadmium, and nickel, together with a general monitoring requirement only, for mercury. A target value is proposed for polycyclic aromatic hydrocarbons. However, this proposal is not yet agreed and may change.

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_{10}) 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. Air Quality Strategy objectives are discussed in the subsequent sections of this report, which deal with the individual pollutants.

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 2nd Daughter Directive. In addition, further PM_{10} objectives have been set for 2010 and for the first time, an objective for polycyclic aromatic hydrocarbons (PAHs) has been added. At present no policy decision has yet been taken on the inclusion of an objective for PAH in Northern Ireland. Further modelling of PAH has been undertaken and the Department has issued a consultation document outlining the options for a Northern Ireland objective.

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) and after the first round of review and assessment involves a two-staged approach.

Updating and Screening Assessment 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 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.

At the time of writing, all District Councils in Northern Ireland are working towards the completion of the first round of review and assessments. A timetable for further rounds based on the revised two stage approach are detailed in the Local Air Quality Management Policy Guidance LAQM PGNI (03). The guidance also sets out the Departments proposals for District Councils to submit review and assessment progress reports. The Department will issue a consultation early in 2004 for guidance on the content of progress reports. The format of review and assessment progress report is likely to mirror the updating and screening assessment. It is intended to check if there have been any changes in respect to all seven pollutants. At the time of submission of the progress reports District Councils will be expected, where possible, to report any provisional monitoring data over the previous calendar year.

The Department believes that progress reports will;

- Make the three-yearly assessment work much easier;
- Provide regular and useful indicators for District Council benchmarking, quality of life or sustainability indicators (or equivalent);
- Help maintain the profile of local air quality management within the District Council;
- Provide for information needs in relation to planning and transport planning processes (i.e. transport plan annual reviews, development control);
- Help towards satisfying or perhaps for some District Councils justifying the expenditure on air quality modelling and monitoring.
- Provide an indication of the progress towards meeting the air quality objectives.
- Show the extent to which any air quality action plan is delivering improvements in air quality; and
- Provide some details of the impacts of any new road schemes or other developments.

2.4 MONITORING

Many new monitoring sites came into operation during 2002, with the objective of monitoring pollutants of concern in specific areas. These included fifteen automatic monitoring sites, more than doubling the number of automatic sites monitoring oxides of nitrogen, sulphur dioxide and particulate matter as PM_{10}. 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.

Monitoring of benzene (using active samplers) and 1,3-butadiene (using passive diffusion tubes) began at two sites in Belfast. This monitoring is funded by Defra. Six new active samplers for black smoke and SO_2 were set up, in residential areas where these pollutants are of particular concern.

Also, the number of diffusion tube monitoring sites increased substantially, in particular those monitoring NO_2 at roadside sites.

During 2002, 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 .

2.5 QUALITY ASSURANCE AND QUALITY CONTROL

The air quality monitoring results presented in this report are gathered from several sources, including large national networks and local monitoring carried out by District Councils for their own purposes. However, a documented programme of quality assurance and quality control (QA/QC) is essential for all air quality measurements if they are to be fit for purpose. The aims, objectives, and fundamental requirements of a QA/QC programme are set out in Part IV of the Environment Act 1995 Local Air Quality Management: Technical Guidance LAQM.TG(03) Appendix A1.7[1].

Some monitoring sites discussed in this report are part of the Automatic Urban and Rural Network (AURN), a national network of automatic monitoring sites operated on behalf of Defra and the Devolved Administrations. Site operators follow procedures documented in a Site Operator's Manual[2], available on the World Wide Web at http://www.aeat.co.uk/netcen/airqual/reports/lsoman/lsoman.html. Data from these sites are processed and ratified by experienced staff of the QA/QC contractor on a 3-monthly basis.

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, apart from supply of calibration gases. Data ratification is carried out on a 6-monthly basis).

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 specifications of the Technical Guidance[1] 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 (mgm^{-3}). To convert to parts per million, if necessary, the following relationship should be used:

1 ppm = 1.16 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	C 429 172	Urban Background	AURN

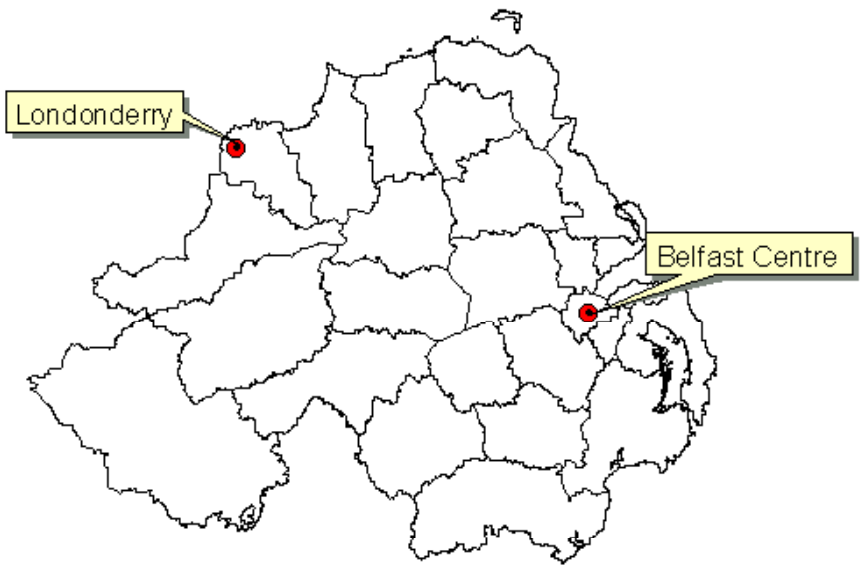


Figure 3.1 CO Monitoring Sites in Northern Ireland, 2002

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 2nd Daughter Directive). In the UK, the Air Quality Strategy contains an objective for CO, to be met by 31st December 2003.

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
WHO (non-mandatory)			
15-minute	100 mgm^{-3}	-	-
30-minute	60 mgm^{-3}	-	-
1-hour	30 mgm^{-3}	-	-
8-hour	10 mgm^{-3}	-	-
EC 2nd Daughter Directive (2000/69/EC)			
Max. Daily 8-hour Mean	10 mgm^{-3} (8.6 ppm)	-	1st January 2005
Air Quality Strategy (as currently adopted in Northern Ireland)			
Running 8-hour mean	10 mgm^{-3} (8.6 ppm)	-	31st 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.

Table 3.3 Results from Automatic CO Monitoring Sites

Calendar Year	Data Capture %	Annual Mean mg m^{-3}	Max 8-Hour Mean mg m^{-3}	Number of Exceedences of EC Limit Value	Number of Exceedences of AQS Objective
Belfast Centre					
1992	79	0.8	11.9	5	5
1993	97	0.8	12.3	1	1
1994	97	0.8	15.5	2	2
1995	95	0.7	16.2	4	4
1996	96	0.6	9.4	0	0
1997	96	0.8	8.1	0	0
1998	91	0.5	4.1	0	0
1999	94	0.5	4.3	0	0
2000	81	0.5	3.5	0	0
2001	60	0.5	5.5	0	0
2002	97	0.3	3.6	0	0
Londonderry					
1997	60	0.3	3.9	0	0
1998	92	0.5	4.9	0	0
1999	93	0.3	3.0	0	0
2000	97	0.3	2.3	0	0
2001	96	0.3	2.4	0	0
2002	93	0.2	1.7	0	0

Both sites currently meet the EC 2nd Daughter Directive limit value and the Air Quality Strategy objective for this pollutant, with maximum daily running 8-hour mean below 10 mg m^{-3} since 1996.

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 Belfast Centre. However, there are only five years' data from Londonderry, and as yet no significant downward trend can be identified.

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. Total UK emissions of carbon monoxide have reduced by 49% between 1990 and 2001, and the downward emission trend shows no sign of flattening off in recent years. An emission inventory study of Greater Belfast[3], 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[4], and less than 2% in Merseyside, Bristol and Southampton[3]) However, Belfast's total CO emissions are still dominated by road traffic (75%), and total UK emissions from this source are decreasing.

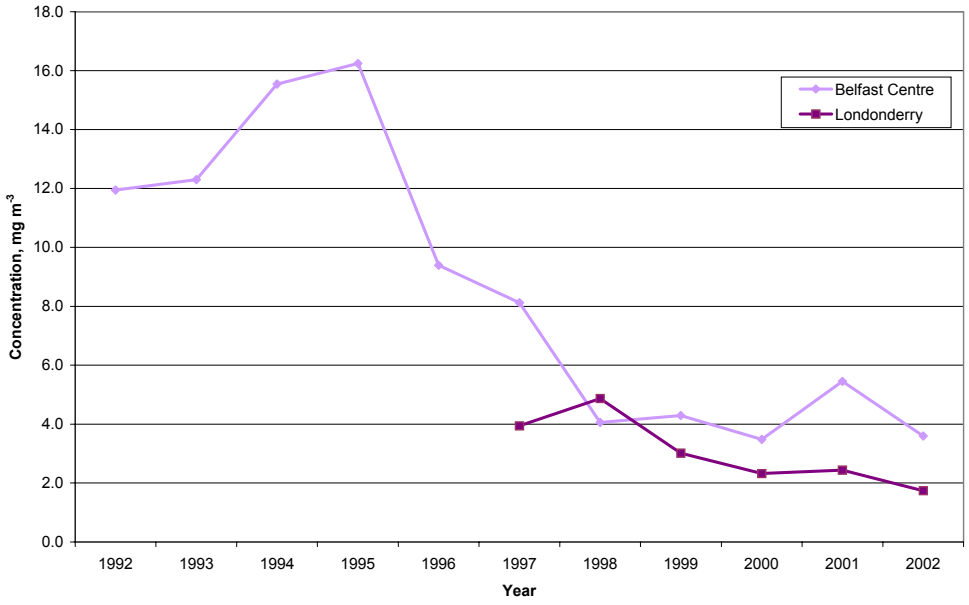


Figure 3.3 Maximum Running 8-hour Mean CO Concentration

Figure 3.4 Annual Mean CO Concentrations at Automatic Monitoring Sites

4 Nitrogen Dioxide

Combustion processes (including vehicle engines) emit a mixture of nitrogen dioxide (NO_2) and nitric oxide (NO). This mixture of oxides of nitrogen is collectively termed NO_x. NO is subsequently oxidised to NO_2 in the atmosphere. NO_2 is an irritant to the respiratory system, and can affect human health. Ambient concentrations of NO_2 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^{-6} grammes) per cubic metre ($\mu g\ m^{-3}$). To convert to parts per billion (ppb) if necessary, the following relationship should be used:

1 ppb = 1.91 $\mu g\ m^{-3}$ for nitrogen dioxide at 293K (20°C) and 1013mb.

4.1 MONITORING OF NITROGEN DIOXIDE

Monitoring of NO_2 is carried out by two methods; automatic NOx analysers and NO_2 diffusion tubes. Automatic analysers are based on the chemiluminescent method, and provide continuous monitoring of NO, NO_2 and total NO_x. 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 1st 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 concentrations of NO_2, which can then be targeted for monitoring using more sophisticated techniques.

The number of automatic NO_2 monitoring sites in Northern Ireland has increased substantially, from four in 2001 to ten in 2002. The new sites were mostly located at roadside locations, where levels of NO_2 were expected to be high. (A further three new sites then began operation in 2003). The sites are listed in Table 4.1, and their locations are shown in Figure 4.1.

Table 4.1 Automatic NO_2 Monitoring Sites

Site	Grid Ref.	Classification	Method	Network
Belfast Centre	J 339744	Urban Centre	Chemiluminescent	AURN
Londonderry	C 429172	Urban Background	Chemiluminescent	AURN
Armagh, Lonsdale Road	H876 458	Roadside	Chemiluminescent	Armagh
Belfast Westlink	J 330 737	Roadside	Chemiluminescent	Belfast
Belfast Upper Newtownards	J385 739	Roadside	Chemiluminescent	Belfast
Castlereagh, Loughview Drive	J357 707	Roadside	Chemiluminescent	Castlereagh
Craigavon Castle Lane	J082 584	Roadside	Chemiluminescent	Craigavon
Lisburn (Lagan Valley Hospital)	J265 637	Roadside	Chemiluminescent	Lisburn
Newry, Monaghan Row	J 078 268	Urban Background	Chemiluminescent	Newry & Mourne (CC)
Newry, Trevor Hill	J 088 266	Roadside	Chemiluminescent	Newry & Mourne (CC)

*CC = Calibration Club sites.

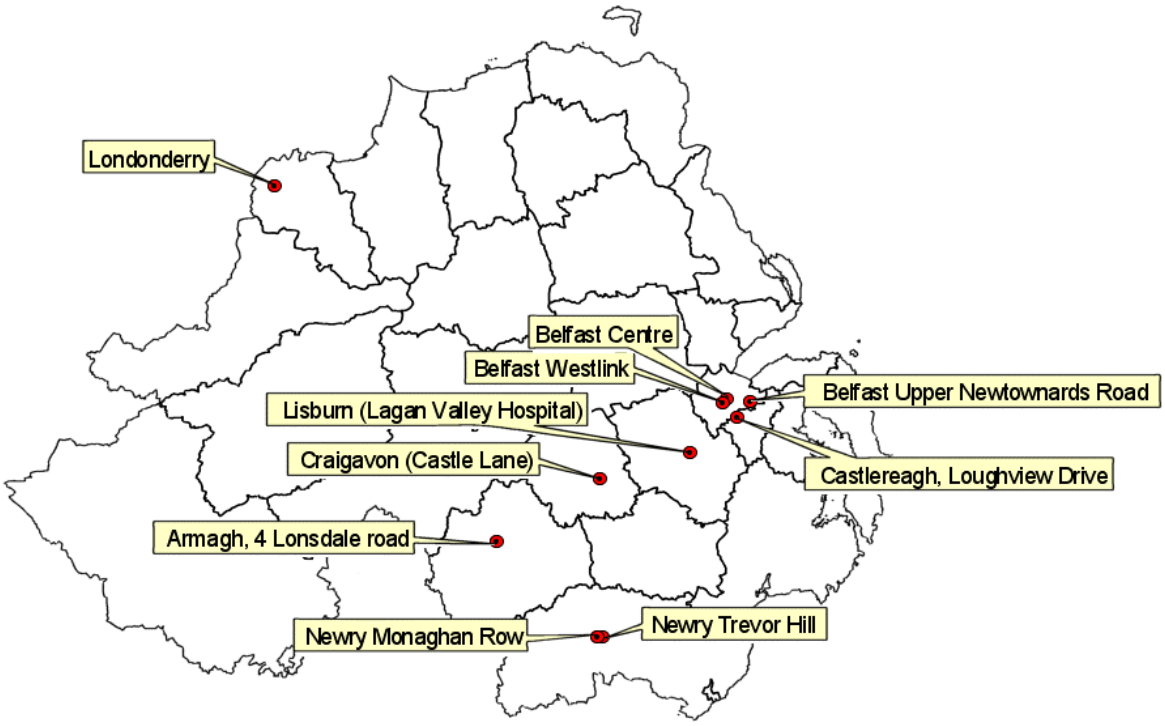


Figure 4.1 NO_2 Monitoring Sites 2002

One of the new automatic NO_2 monitoring sites which began operation in 2002 was the roadside site at Castlereagh, Loughview Drive by the Knock Dual Carriageway: this new site is shown in Figure 4.2.

Figure 4.2 New monitoring site for NO_x (and PM_{10}), Loughview Drive, Castlereagh

Many District Councils in Northern Ireland also carry out indicative monitoring of NO_2 using diffusion tubes, as pictured in Figure 4.3.

Figure 4.3 A Selection of Diffusion Tubes (from left to right, SO_2, BTX, NO_2)

The NO_2 diffusion tube is shown on the right hand side of Figure 4.3. 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. As there are so many, full site details are provided in Appendix 1, Table A1.1.

Table 4.2 Diffusion Tube NO_2 Monitoring Sites 2002

District Council	Number of sites	Number belonging to NO_2 Network (as of 2002)
Antrim	20	0
Ards	4	4
Armagh	8	4
Ballymena	13	4
Ballymoney	10	4
Banbridge	4	4
Belfast	18	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	4
Magherafelt	7	0
Moyle	8	0
Newry & Mourne	4	4
Newtownabbey	38	4
North Down	8	4
Omagh	11	4
Strabane	5	0
TOTAL	*257*	*66*

NO_2 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_2 diffusion tube monitoring sites in the Roadside category are shown in Figure 4.4, and NO_2 diffusion tube monitoring sites in other categories are shown in Figure 4.5. These Figures show the locations of sites operating in 2002.

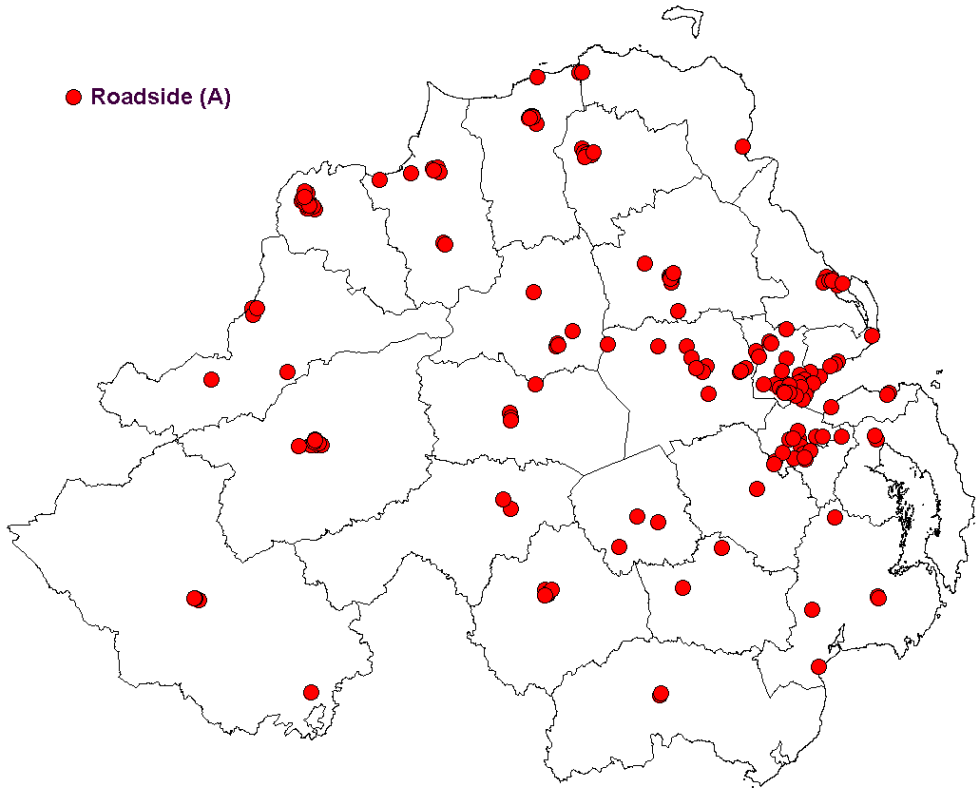


Figure 4.4 NO_2 Diffusion Tube Monitoring Sites 2002: Roadside

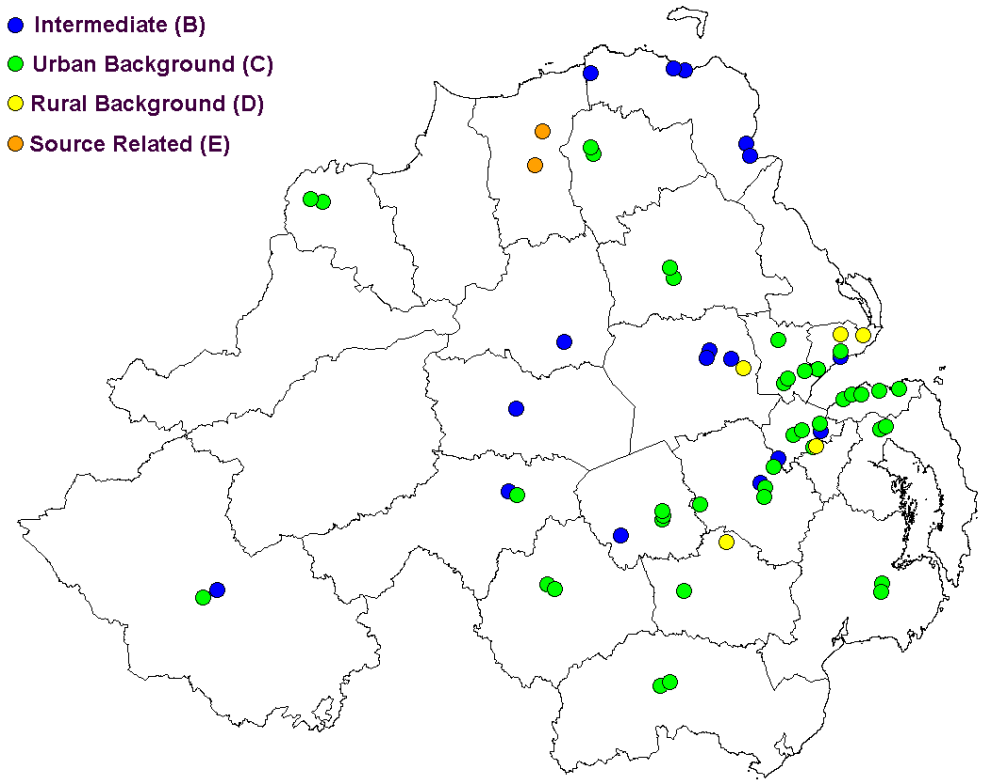


Figure 4.5 NO_2 Diffusion Tube Monitoring Sites 2002: Non-Roadside Categories

4.2 LIMIT VALUES AND OBJECTIVES FOR NITROGEN DIOXIDE

The World Health Organisation has set non-mandatory guide values for NO_2. Within Europe, NO_2 is covered by the 1st 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_2 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
WHO (non-mandatory)			
1 hour	200 μg m^{-3}	-	-
Annual Mean	40 μg m^{-3}	-	-
EC 1st Daughter Directive (1999/30/EC)			
1 hour	200 μg m^{-3}	18 per year	1st January 2010
Annual Mean	40 μg m^{-3}	-	1st January 2010
Annual Mean, for protection of vegetation	30 μg m^{-3} Total NOx	-	19th July 2001
Air Quality Strategy			
1 hour	200 μg m^{-3}	18 per year	31st December 2005
Annual Mean	40 μg m^{-3}	-	31st December 2005
Annual Mean, for protection of vegetation	30 μg m^{-3} Total NOx	-	31st December 2000

4.3 AUTOMATIC NITROGEN DIOXIDE RESULTS

Table 4.4 below shows NO_2 results from the automatic monitoring sites in Northern Ireland. To keep the table to a manageable size, only 2002 data are tabulated here: statistics for previous years are provided in Appendix 2. Table 4.4 shows the data capture, maximum hourly mean, the annual mean, and the number of hourly means greater than 200 μg m^{-3} (the hourly EC limit value and AQS objective).

Table 4.4 NO_2 Results from Automatic Monitoring Sites

Site	2002 Data Capture %	Max Hourly Mean μg m^{-3}	Annual Mean μg m^{-3}	No. of hourly means > 200 μg m^{-3}	Annual Mean > 40 μg m^{-3} ?
Belfast Centre	95	258	30	3	No
Londonderry	95	94	15	0	No
Armagh	44[1]	125	34	0	No
Belfast – Westlink	66[2]	295	**56**	**21**	**Yes**
Belfast – Newtownards Rd.	66[2]	212	**50**	2	**Yes**
Castlereagh (Loughview Dr.)	50[1]	132	28	0	No
Craigavon (Castle Lane) *	75	157	13	0	No
Lisburn – LVH	45[1]	221	**54**	1	**Yes**
Newry - Monaghan Row	91	105	15	0	No
Newry – Trevor Hill	98	208	**44**	1	**Yes**

Footnotes:
1 – New site, in operation from July 2002 (data capture July – December 2002 > 85%)
2 – New site in operation from May 2002 (data capture May – December 2002 > 98%)
* Craigavon data shown here are provisional and may be subject to further ratification.

Highest NO_2 concentrations were typically measured at roadside sites. There are a few exceptions: notably Craigavon Castle Lane had an annual mean of just 13 μg m^{-3} – lower than most other roadside sites. *(However, this value should be treated with caution as the data from this site have not been fully ratified.)*

Data from the monitoring sites have been compared with applicable AQS objectives. This is illustrated in Figure 4.6a, which shows the maximum hourly mean and annual mean (as bars) together with the AQS objectives (as horizontal lines).

The 2002 annual mean NO_2 concentration exceeded the AQS objective of 40 μg m^{-3} (to be met by 2005) at four roadside sites - Belfast Westlink, Belfast Newtownards Road, Lisburn Lagan Valley Hospital and Newry Trevor Hill.

Several sites recorded maximum hourly mean concentrations greater than the 1st Daughter Directive limit and AQS objective of 200 μg m^{-3} for the hourly mean. However, only one, the Belfast Westlink roadside site, which began operation in July 2002, exceeded this objective more than the permitted 18 times during 2002. Figure 4.6b shows the number of exceedences of the hourly mean AQS objective, compared with the permitted total of 18.

Data capture at all sites was at least 90%, with the exception of the six new sites that started up part way through 2002. Where data capture is less than 90% (as is the case for the five "new" sites), it is not valid to use the total number of exceedences of the 1-hour objective. Instead, according to the Technical Guidance[1] the 99.8th percentile of 1-hour means should be compared with the 1-hour NO_2 objective itself (200 μg m^{-3}). Belfast Westlink recorded 21 exceedences of the 1-hour NO_2 objective in just 8 months of operation, so clearly did not meet the objective regardless of data capture. In addition, two other sites had less than 90% data capture, and one or more 1-hour mean greater than 200 μg m^{-3}. These were Belfast Newtownards Road, and Lisburn Lagan Valley Hospital. The 99.8th percentile of hourly means was 156 μg m^{-3} at Newtownards Road; a 99.8th percentile value wasn't available for the Lisburn site, but the site had only 1 hourly mean over 200 μg m^{-3} in nearly six months of operation, so exceedence is very unlikely.

The 2002 annual mean NO_2 at four sites was greater than 40 μg m^{-3}; Belfast Westlink and Newtownards Road, Lisburn Lagan Valley Hospital and Newry Trevor Hill. However, three of these (the two Belfast sites and Lisburn LVH) were new sites, with less than 9 months data capture; therefore the 2002 averages for these sites were not truly representative of the annual means. Using the method set out in Box 6.5 of the Technical Guidance LAQM.TG(03)[1], together with 2001 data from the long-term urban background/urban centre monitoring sites at Belfast Centre and Londonderry, it was possible to estimate the annual mean 2002 concentrations for these three sites. This method gave estimated 2002 annual means as follows: Belfast Westlink 59 μg m^{-3}, Belfast Newtownards Road 53 μg m^{-3}, Lisburn Lagan Valley Hospital 52 μg m^{-3}. This confirms that these three new sites, (together with the fourth site Newry Trevor Hill), exceeded the annual mean objective of 40 μg m^{-3} in 2002.

It is also possible to predict annual mean NO_2 concentrations in future years at roadside sites, using the method set out in Box 6.6 of the Technical Guidance LAQM.TG(03). Using this approach, it is predicted that any roadside site with a 2002 annual mean NO_2 concentration greater than 43.5 μg m^{-3} is likely to exceed the AQS objective of 40 μg m^{-3} in 2005. This is the case for Belfast Westlink, Belfast Newtownards Road, Lisburn Lagan Valley Hospital and Newry Trevor Hill. Using the same method, any roadside site with a 2002 annual mean NO_2 concentration greater than 52.8 μg m^{-3} is likely to still have an annual mean NO_2 concentration greater than 40 μg m^{-3} in 2010. This is predicted to be the case for Belfast Westlink and Belfast Newtownards Road.

The EC and AQS vegetation protection limit of 30 μg m^{-3} total NO_x is not applicable to any of the above sites, as they are all in built up areas.

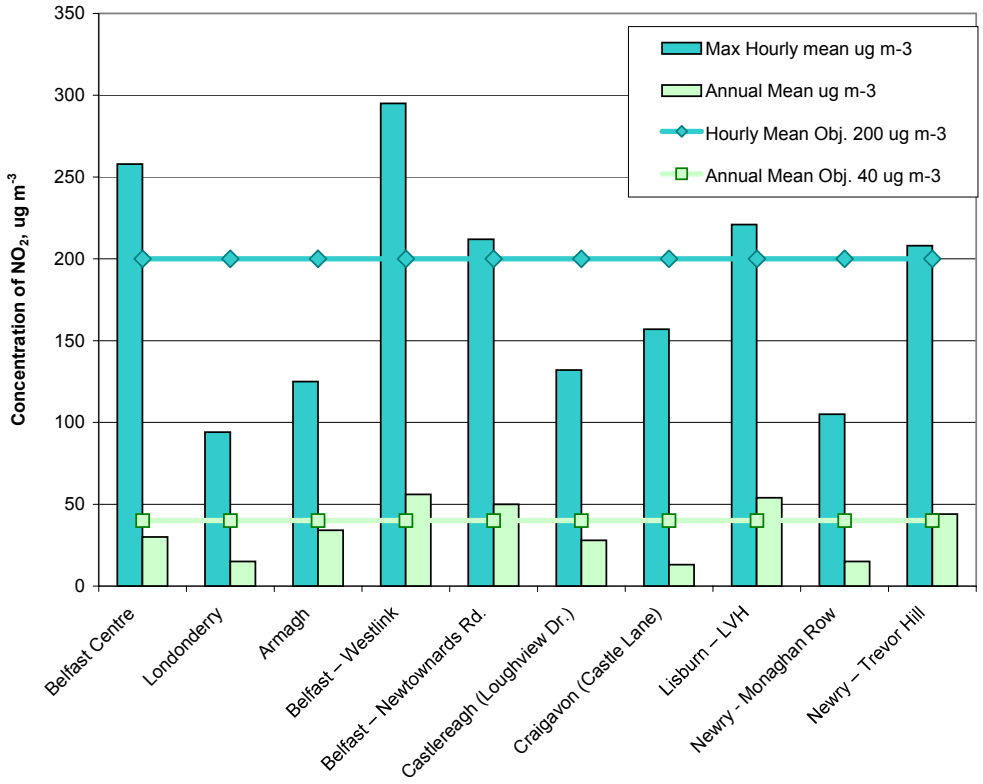


Figure 4.6a Comparison of NO_2 Results from Automatic Sites 2002 with AQS Objectives .

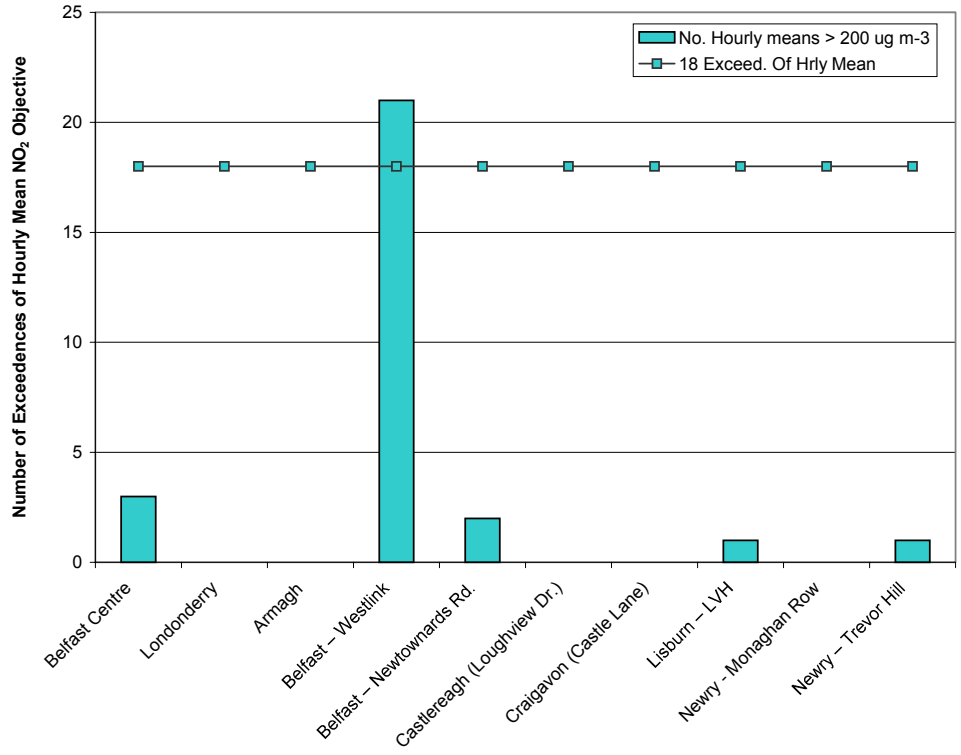


Figure 4.6b Number of Exceedences of Hourly Mean AQS Objective for NO_2 in 2002

4.4 DIFFUSION TUBE NITROGEN DIOXIDE RESULTS

Annual mean NO_2 concentrations, for 2002 from *all* NO_2 diffusion tube sites in Northern Ireland, are provided in Appendix 1. (No annual mean is shown where the site was in operation for less than 6 months of the year). Table 4.5 provides a summary of average NO_2 concentrations, for 2002, at the four site types. The average concentration for each site type is the arithmetic mean of all the individual site annual means. Of the total 257 sites, 237 provided an annual mean for 2002.

Table 4.5 Average NO_2 Concentrations in Northern Ireland Measured by Diffusion Tubes

Site Type	Number of sites with valid annual mean:			Average NO_2, 2002 $\mu g\ m^{-3}$		
	2000	2001	2002	2000	2001	2002
A (Roadside)	58	96	176	**26**	**27**	**24**
B (Intermediate)	25	15	11	**18**	**16**	**17**
C (Urban Background)	39	39	39	**12**	**14**	**15**
D (Rural Background)	6	5	5	**9**	**10**	**11**
E (Other: Source-related)	-	-	2	-	-	**7**

The averages in Table 4.5 are based upon *all* sites in Northern Ireland, whether or not they are part of the NO_2 Network. The data have not been corrected for diffusion tube bias. These annual averages are comparable with the averages reported by the NO_2 Network for the Northern Ireland region, which are as follows:

2002: Roadside 27 $\mu g\ m^{-3,}$ Urban Background 14 $\mu g\ m^{-3.}$

During 2002, seven sites had annual mean NO_2 concentrations greater than the EC Directive limit and AQS objective of 40 $\mu g\ m^{-3}$. All were Roadside (type A), and were as follows:

- Londonderry, Creggan Road; near the city centre, on a busy road with a steep incline.
- Belfast, Great George's Street, near an exit from the M3.
- Belfast, Upper Newtownards Road, Dundonald. This is on the major route linking Newtownards to Belfast, flanked by high buildings, and near traffic lights.
- Belfast, Upper Newtownards Road, Ballyhackamore. This is a major route for traffic in and out of the city.
- Belfast, Milner Street: this street is within a few metres of the Westlink junction, which links the M1 and M2 motorways.
- Limavady, Linenhall Street: this is a narrow single carriageway road, with buildings less than 2m from the kerb. It forms part of the town's one-way system. However, a bypass that opened in July 2003 appears to have substantially reduced traffic on Linenhall Street.
- Ballymena, George Street: this is a busy main street through the centre of Ballymena, with tall buildings on either side. There is a bus stop, and three sets of traffic lights on this section of road.

As observed previously in 2000 and 2001, exceedences of the annual mean limit for NO_2 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. The number of sites with annual means over 40 $\mu g\ m^{-3}$ has increased from four in 2001 to seven in 2002: however, rather than indicating that roadside NO_2 concentrations have increased, this probably simply reflects the increased number of roadside diffusion tube monitoring sites, particularly in suspected "hot spots".

Using the approach set out in (Box 6.6) of LAQM.TG(03) annual mean NO_2 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 $\mu g\ m^{-3}$ if the 2002 annual mean is greater than 43.5 $\mu g\ m^{-3}$. This is the case for four of the above sites: Londonderry Creggan Road, Belfast Great George's Street, and the two sites on Upper Newtownards Road. Similarly, the 2010 annual mean is predicted to exceed 40 $\mu g\ m^{-3}$ if the 2002 annual mean is greater than 52.8 $\mu g\ m^{-3}$. No sites fall into this category. (Note: these predictions are only approximate as the diffusion tube data have not been bias-corrected).

4.5 NITROGEN DIOXIDE TRENDS

Emission inventory data from the National Atmospheric Emissions Inventory at www.naei.org.uk show that total estimated UK emissions of NOx have decreased steadily by around 5.4% per year between 1990 and 2000. Emissions from road vehicles (which account for 60% of Greater Belfast's total NOx emissions[3]) have also decreased substantially. Hence, a downward trend in ambient NO_2 would be expected, and indeed the 2000-2001 report identified a significant downward trend in ambient concentrations of NO_2 at Belfast Centre.

4.5.1 Trends at Automatic Nitrogen Dioxide Sites

Figure 4.7 shows how annual mean NO_2 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). Only two sites have been in operation long enough to assess trends: the 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_2 concentration at Belfast Centre, but not at Londonderry. Annual mean NO_2 concentrations at the two sites in Newry (not all shown in Figure 4.7 as 2001 data capture was below 75%) were higher in 2002 than in 2001.

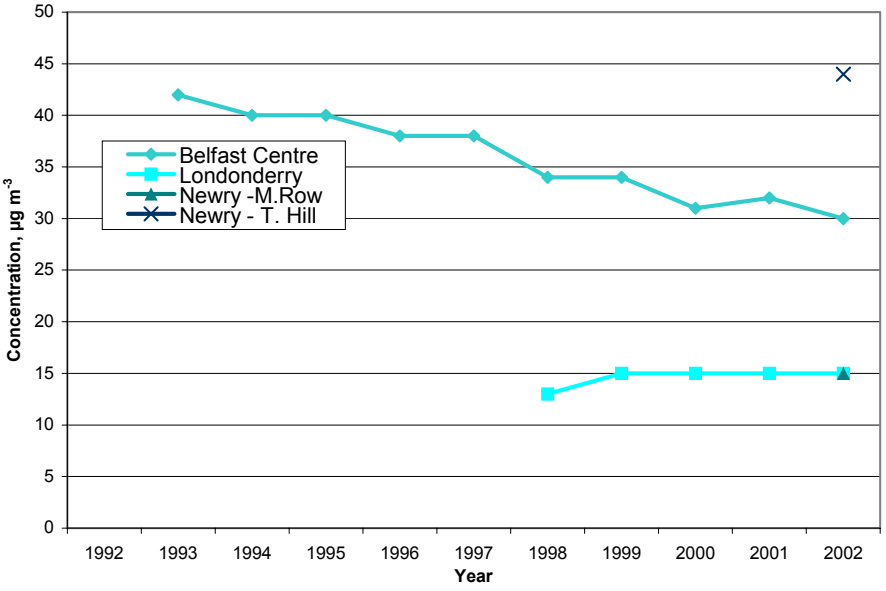


Figure 4.7 Annual Mean NO_2 Concentrations at Automatic Monitoring Sites (data capture at least 75%)

4.5.2 Trends at Diffusion Tube Nitrogen Dioxide Sites

Around 25% of the NO_2 diffusion tube sites operated by District Councils in Northern Ireland are also part of the NO_2 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. The Network has been in operation for ten years, thus it is possible to identify trends.

Table 4.6 shows annual mean NO_2 concentrations for Northern Ireland, based on data from the NO_2 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_2 is known or suspected to be high.

Table 4.6 Average NO_2 Concentrations, NO_2 Network Diffusion Tube Sites in Northern Ireland

Year	Average Roadside $\mu g\ m^{-3}$	Average Intermediate $\mu g\ m^{-3}$	Average Urban Background $\mu g\ m^{-3}$
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

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_2 concentration is significant (with 95% confidence limit) for all three site categories. However, average NO_2 concentrations in 2002 were the same as those measured the previous year.

5 Sulphur Dioxide

Sulphur dioxide (SO_2) 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_2. 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 (μg m^{-3}). To convert to parts per billion (ppb) if necessary, the following relationship should be used:

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

5.1 MONITORING OF SULPHUR DIOXIDE

Monitoring of SO_2 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 1st Daughter Directive, 1999/30/EC) provide continuous monitoring of SO_2, and the data can be compared with air quality limit values and objectives based on short-term and longer averaging periods. The number of automatic SO_2 monitoring sites in Northern Ireland has increased substantially, from five in 2001 to fourteen in 2002. These are listed in Table 5.1 and their locations are shown in Figure 5.1:

Table 5.1 Automatic SO_2 Monitoring Sites

Site	Grid Reference	Classification	Network
Belfast Centre (Lombard Street)	J339 744	Urban Centre	AURN
Belfast East (Templemore Ave)	J357 740	Urban Background	AURN
Londonderry (AURN)	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)
Ards	J487 747	Urban Background	Ards
Ballymena	D120 026	Urban Background	Ballymena
Carrickfergus	J411 882	Urban Background	Carrickfergus
Castlereagh, Espie Way	J373 720	Urban Background	Castlereagh
Dungannon	H802 635	Urban Background	Dungannon
Lisburn (Council Offices)	J274 643	Urban Background	Lisburn
Strabane, Springfield Park	H 351 972	Urban Background	Strabane (CC)
Craigavon, Lord Lurgan Park	J079 592	Urban Background	Craigavon

CC = Calibration Club member

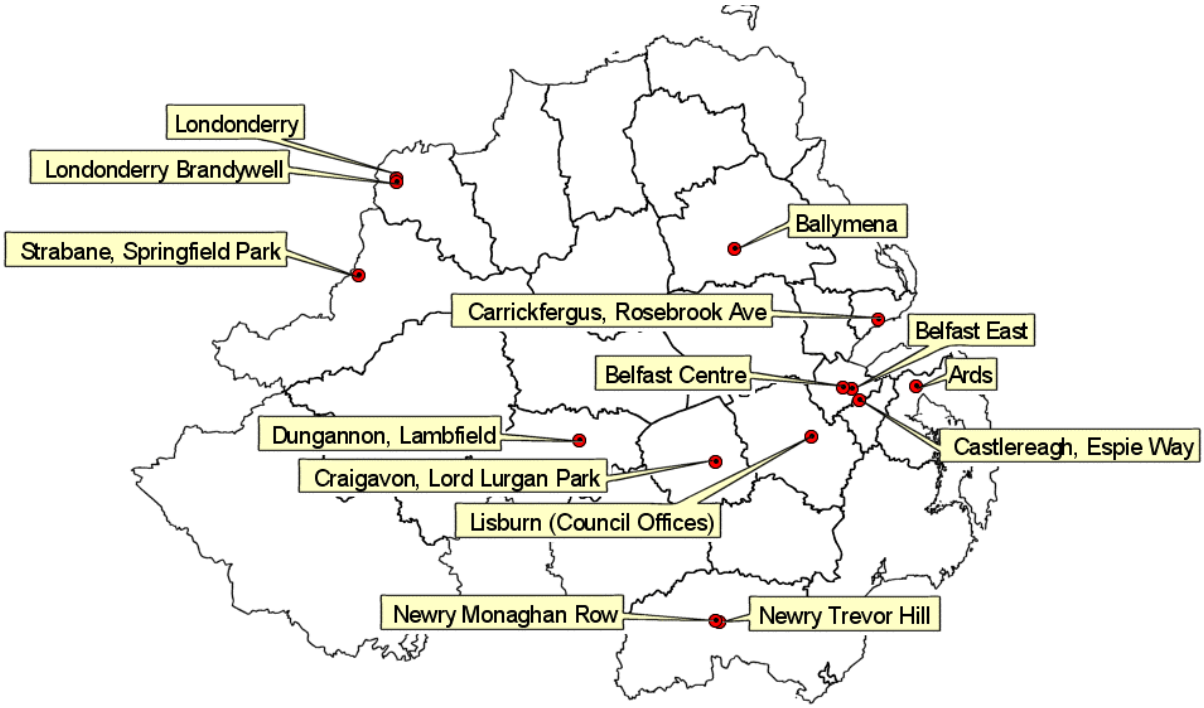


Figure 5.1 SO_2 Monitoring Sites

An example of one of the new automatic SO_2 monitoring sites which began operation in 2002 is at Lisburn City Council Offices, Lagan Valley Island. This site, which also monitors PM_{10}, is shown in Figure 5.2.

Figure 5.2 Lisburn Council Offices SO_2 and PM_{10} Monitoring Site

Despite the recent increase in the number of automatic monitoring sites, the most widespread method of measuring SO_2 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_2. However, it is widely used for low-cost indicative measurement of SO_2. A typical 8-port sampler is shown in Figure 5.3.

Figure 5.3 8-port Sampler for Smoke and SO_2

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 2002, there were 39 urban smoke and SO_2 monitoring sites operating in Northern Ireland, all but four belonging to the Smoke and SO_2 Network. A further two sites (Bentra and Fermoyle) were part of the Rural SO_2 Network, monitoring SO_2 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_2 Monitoring Sites

Site name	Grid Ref.	District Council	Network
ARMAGH 1	H 877 450	Armagh	Smoke & SO_2
KEADY 1	H 845 341	Armagh	Smoke & SO_2
BALLYMENA 5	D 109 053	Ballymena	Smoke & SO_2
BALLYMENA 6	D 120 026	Ballymena	Smoke & SO_2
BALLYMONEY 4	C 954 259	Ballymoney	Smoke & SO_2
BELFAST 12	J 324 737	Belfast CC	Smoke & SO_2
BELFAST 13	J 357 740	Belfast CC	Smoke & SO_2
BELFAST 33	J 346 755	Belfast CC	Smoke & SO_2
BELFAST 42	J 322 748	Belfast CC	Smoke & SO_2
BELFAST 44	J 338 740	Belfast CC	Smoke & SO_2
BELFAST 45	J 335 723	Belfast CC	Smoke & SO_2
BELFAST 46	J 803 334	Belfast CC	Smoke & SO_2
PORTADOWN 4	J 012 538	Craigavon	Smoke & SO_2
PORTADOWN 6	J 004 548	Craigavon	Smoke & SO_2
LONDONDERRY 12	C 438 200	Derry CC	Smoke & SO_2
LONDONDERRY 14	C 443 174	Derry CC	Smoke & SO_2
DUNGANNON 1	H 802 629	Dungannon	Smoke & SO_2
LARNE 3	D 400 029	Larne	Smoke & SO_2
LARNE 4	D 386 037	Larne	Smoke & SO_2
LARNE 5	D 401 033	Larne	Smoke & SO_2
DUNMURRY 3	J 287 875	Lisburn CC	Smoke & SO_2
LISBURN 3	J 263 636	Lisburn CC	Smoke & SO_2
TWINBROOK 1	J 281 689	Lisburn CC	Smoke & SO_2
MAGHERAFELT 1	H 896 901	Magherafelt	Smoke & SO_2
NEWRY 3	J 078 268	Newry and Mourne	Smoke & SO_2
NEWTOWNABBEY 2	J 318 825	Newtownabbey	Smoke & SO_2
NEWTOWNABBEY 3	J 321 851	Newtownabbey	Smoke & SO_2
NEWTOWNABBEY 4	J 283 907	Newtownabbey	Smoke & SO_2
BANGOR (CO DOWN) 5	J 497 810	North Down	Smoke & SO_2
HOLYWOOD 1	J 397 784	North Down	Smoke & SO_2
STRABANE 2	H 351 972	Strabane	Smoke & SO_2
COLERAINE 2	C 861 328	Coleraine	Smoke & SO_2
COOKSTOWN 1	H 774 806	Cookstown	Smoke & SO_2
BUSHMILLS 1	C 940 409	Moyle	Smoke & SO_2
ANTRIM 1	J 162 869	Antrim	Smoke & SO_2
NEWTOWNARDS	J 481 736	Ards	Local Auth.
COLERAINE (Pates Lane)	C 844 323	Coleraine	Local Auth.
DOWNPATRICK	J 490 459	Down	Local Auth.
NEWTOWNSTEWART	H 400 855	Strabane	Local Auth.
Bentra	J 458 923	Defra	Rural SO_2
Fermoyle	C 767 291	Defra	Rural SO_2

(Rural SO_2 sites monitor SO_2 only, not smoke.)

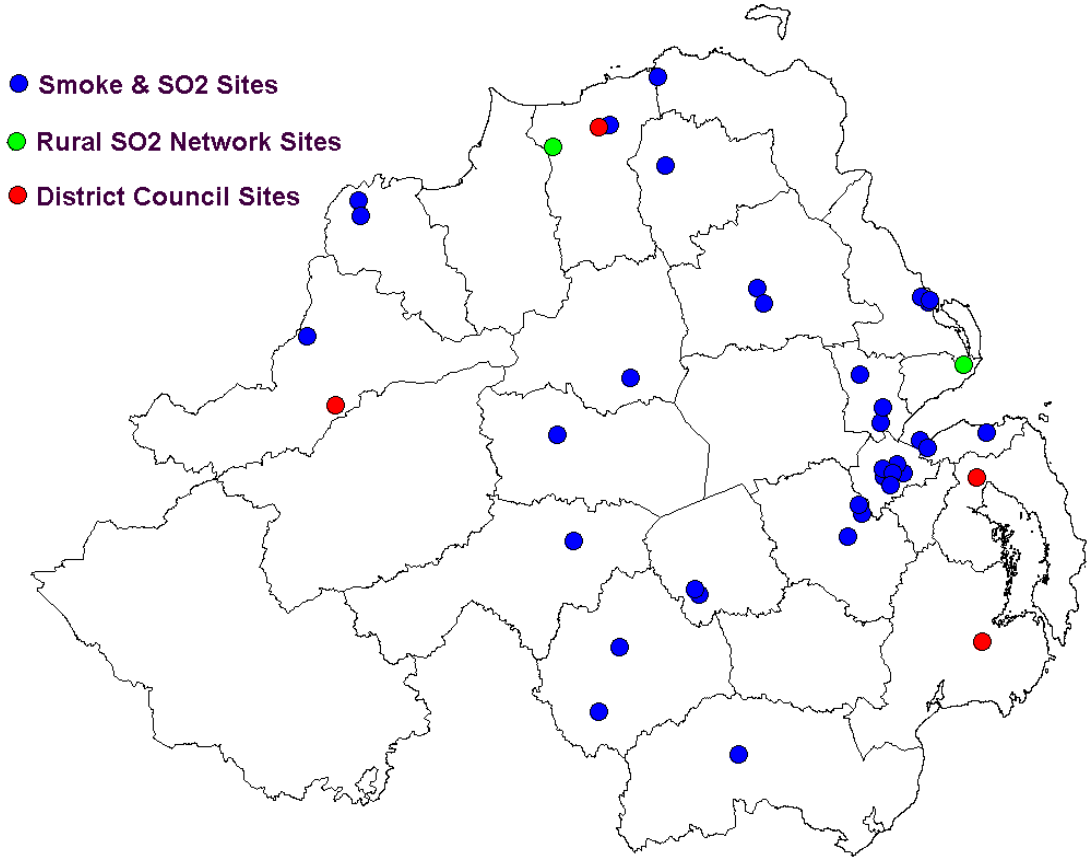


Figure 5.4 8-port Smoke and SO_2 Sampler Sites, 2002

Diffusion tubes are also used for indicative monitoring of SO_2. These passive samplers are similar to those used for NO_2 and described in Section 4. However, SO_2 diffusion tubes are generally less accurate than NO_2 diffusion tubes, and considered unsuitable for use for Review and Assessment purposes. Table 5.3 and Figure 5.5 show the SO_2 diffusion tube monitoring sites in 2002. Site details are given in Appendix 1.

Table 5.3 Diffusion Tube SO_2 Monitoring Sites

District Council	Number of sites, 2002
Antrim	10
Armagh	8
Ballymena	10
Ballymoney	8
Carrickfergus	2
Coleraine	5
Cookstown	4
Craigavon	8
Derry	13
Dungannon	5
Fermanagh	6
Larne	8
Limavady	3
Lisburn	12
Magherafelt	3
Moyle	8
Newry & Mourne	1
Newtownabbey	11
Omagh	5
Strabane	21

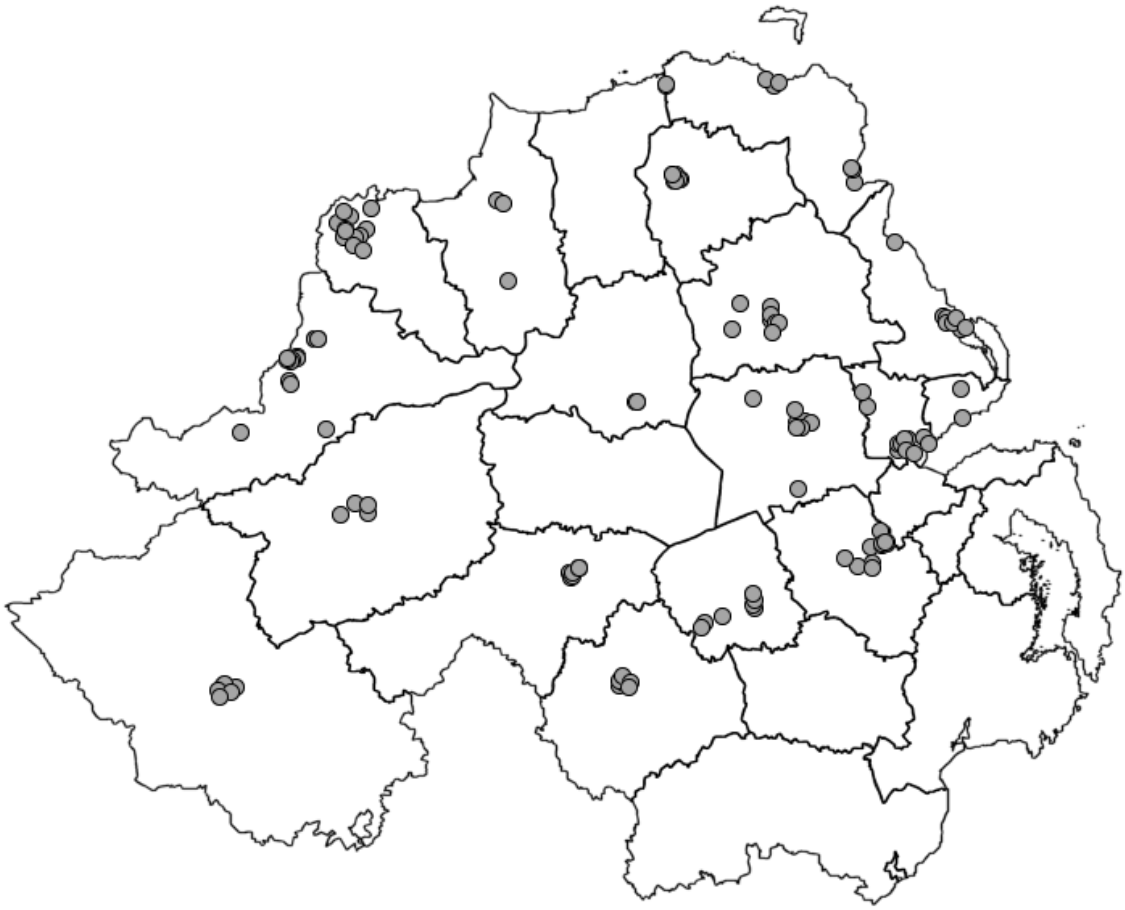


Figure 5.5 SO_2 Diffusion Tube Sites, 2002

5.2 LIMIT VALUES AND OBJECTIVES FOR SULPHUR DIOXIDE

Sulphur dioxide is covered by the following limit values and objectives as shown in Table 5.4. All these limits are for protection of human health except where stated.

Table 5.4 Limit Values and Objectives for Sulphur Dioxide

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

Before the 1st Daughter Directive came into force, SO_2 was covered by EC Directive 80/779/EEC on Sulphur Dioxide and Suspended Particulates. This Directive has been superseded by the 1st 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 1st Daughter Directive and have been fully met in Northern Ireland since the early 1990s. The current report therefore compares current SO_2 results with the limit values of the 1st Daughter Directive, rather than Directive 80/779/EEC.

5.3 AUTOMATIC SULPHUR DIOXIDE RESULTS

Table 5.5 shows results from the automatic SO_2 monitoring sites, for 2002. (Because of the larger number of sites in 2002, data for 2002 only are included here). Previous years' data are provided in Appendix 2. Figures in ***bold italics*** indicate more than the permitted number of exceedences of the relevant limit value.

Table 5.5 SO_2 Results from Automatic Monitoring Sites, 2002

Site	% Data Capture	Max 15-minute mean, μg m^{-3}	No. of 15-minute means > 266 μg m^{-3}	Max 1-hr mean μg m^{-3}	No. of 1-hr means > 350 μg m^{-3}	Max 24-hr mean μg m^{-3}	No. of 24-hour means > 125 μg m^{-3}	Annual mean, μg m^{-3}
Ards *	17	150	0	116	0	48	0	5
Ballymena (Ballykeel)	41	142	0	77	0	36	0	6
Belfast Centre AURN	97	370	2	216	0	63	0	7
Belfast East AURN	97	365	5	314	0	115	0	10
Carrickfergus	50	51	0	49	0	17	0	3.3
Castlereagh	NA	74	0	48	0	24	0	NA
Craigavon (Lord Lurgan Park)	74	146	0	96	0	38	0	7
Dungannon * (Lambfield)	18	94	0	38	0	24	0	NA
Lisburn (Council Offices)	49	101	0	48	0	15	0	3.5
Londonderry AURN	95	136	0	101	0	35	0	11
Londonderry Brandywell	65	229	0	229	0	74	0	16
Newry (Monaghan Row)	95	146	0	114	0	39	0	6
Newry (Trevor Hill)	97	577	4	306	0	24	0	6
Strabane	64	253	0	90	0	28	0	11

*Ards, Dungannon: November – December 2002 data only.
NA = information not available.
No QA/QC has been carried out on the data from Ards or Craigavon.

Twelve of the eighteen sites started operation part way through 2002, and so have less than 90% data capture for the year. However, on the basis of the available data, all sites in Northern Ireland met the requirements of the 1st Daughter Directive, and the objectives of the Air Quality Strategy during 2002.

This is illustrated in Figure 5.6, which shows the maximum 15-minute, 1-hour and 24-hour mean (as bars) compared with the relevant AQS objectives. Three sites, all with at least 90% data capture (Belfast Centre, Belfast East and Newry Trevor Hill) recorded maximum 15-minute means greater than the AQS objective of 266 μg m^{-3}. However, no sites had more than the permitted 35 exceedences of the 15-minute mean objective, and no sites recorded *any* exceedences of either the hourly or 24-hour mean objectives.

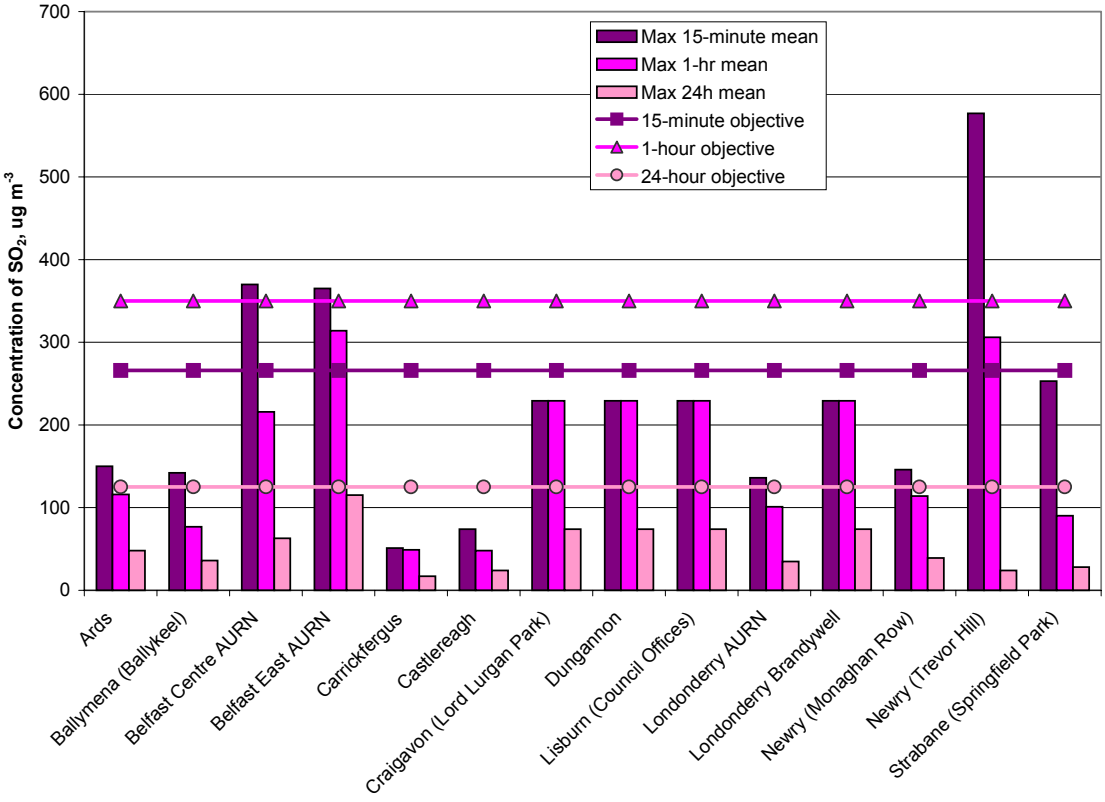


Figure 5.6 Comparison of Maximum 15-minute, Hourly and 24-hour Mean SO_2 Concentrations with AQS Objectives, 2002

2002 was the first year in which Belfast East met the objective for both the 15-minute and 24-hour average; in particular the number of 15-minute means greater than 266 μg m^{-3} decreased markedly in 2002. Concentrations of SO_2 at this site are lower in 2002 than in 2001 and previous years. A recent fuel use survey in the vicinity of the monitoring site has shown a high percentage of domestic properties have switched from solid fuel to natural gas. This is the most likely reason for the decrease in SO_2 in the area.

5.4 NON-AUTOMATIC SULPHUR DIOXIDE RESULTS

A summary of results from all Smoke and SO_2 Network sites in Northern Ireland is provided in Appendix 3, for year 2002. 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_2, particularly in residential areas. However, the average annual mean net acidity (as SO_2 equivalent) for all Smoke and SO_2 Network sites in Northern Ireland appears to be falling: from 27 μg m^{-3} in 2000, 20 μg m^{-3} in 2001, to 18 μg m^{-3} in 2002. (For comparison, the 2002 average for the whole UK was 14 μg m^{-3}).

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^{-3} for the 24-hour mean (not to be exceeded more than 3 times per calendar year) set by the EC 1st Daughter Directive, and the Air Quality Strategy.

The calendar year January to December 2002 was the first in which no sites in this Network (either in Northern Ireland or elsewhere) had more than three days where the 24-hour average net acidity was greater than the Daughter Directive Limit Value and AQS objective for SO_2 of 125 μg m^{-3}.

The annual mean net acidity (as SO_2) concentration at the non-network Downpatrick site was 13 μg m^{-3} in 2002. No annual means were supplied for Coleraine, Newtownards and Newtownstewart.

Annual and winter mean sulphur dioxide concentrations at the two Rural SO_2 Network sites (Bentra and Formoyle) were less than 5 μg m^{-3} : well within the limit of 20 μg m^{-3} set for protection of vegetation in rural areas.

5.5 DIFFUSION TUBE SULPHUR DIOXIDE RESULTS

As stated above, SO_2 diffusion tubes produce data of limited accuracy and are considered unsuitable for use for Review and Assessment purposes. However, SO_2 diffusion tubes are still widely used in Northern Ireland, and the number of sites increased substantially in 2002. Site locations are listed in Appendix 1. A summary of results is presented in Table 5.6 below.

The site categories used by the site operators are the same as for the NO_2 diffusion tubes in Northern Ireland (section 4). However, the main sources of SO_2 are domestic and industrial coal and oil combustion, rather than traffic emissions, so proximity to a road is far less relevant than in the case of NO_2. Highest concentrations are not necessarily expected at roadside (type A) sites but are more likely near to industrial sources, or in residential areas where coal use is widespread. The results in Table 5.6 reflect this; the overall average for roadside sites (8.2 μg m^{-3}) was slightly lower than that for urban background sites (10.0 μg m^{-3}).

Table 5.6 Annual Mean Sulphur Dioxide as Measured at Diffusion Tube Sites

Site Type	Total Number of sites	Number with valid reported annual mean	Average SO_2, 2002
A (Roadside)	49	45	8.2
B (Intermediate)	14	7	4.9
C (Urban Background)	76	66	10.0
D (Rural Background)	0	0	-
E (Other: Source-related)	11	9	9.7
All sites	**150**	**127**	**9.1**

The average SO_2 concentration from all diffusion tube sites was 9.1 μg m^{-3}: comparable with typical levels measured by the automatic monitoring sites, although considerably lower than the average result from the active sites (however, the latter monitor net acidity and therefore typically overestimate true SO_2 concentrations.)

5.6 SULPHUR DIOXIDE TRENDS

For reasons outlined in Sections 1.1 and 5.4, widespread reliance on solid fuels and oil for domestic heating has continued throughout the 1970s, 1980s and 1990s. Domestic combustion accounts for an estimated 28% of total annual SO_2 emission in the Belfast area, compared with 4% of total annual SO_2 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 shows two interesting features: (i) a decrease of almost 70% between 1990 and 2000, and (ii) a levelling-off of the downward trend in the most recent years 1999 and 2000.

New legislation on the sulphur content of solid fuel and fuel oils came into force on 15th October 1998 and 11th 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 1st 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_2.

5.6.1 Trends at Automatic Sulphur Dioxide Sites

Only three automatic sites have been in operation long enough to assess trends. Annual mean SO_2 concentrations from 1989 at these sites are shown in Figure 5.7. Regression analysis (Theil's non-parametric regression analysis) identified a significant downward trend (with 95% confidence limit) in the annual mean SO_2 concentrations at Belfast Centre and Belfast East, though not at Londonderry. After an apparent levelling-off of the downward trend at the two Belfast sites in 2000-2001, (highlighted in the previous report), the downward trend appears to have resumed in 2002.

Belfast East showed a marked decrease in annual mean SO_2 concentration between 2001 and 2002. The 2002 annual mean SO_2 concentration at this site is similar to that measured at the other two sites, whereas in previous years it has been consistently higher. However, future years' monitoring will be necessary to establish whether this apparent decrease continues.

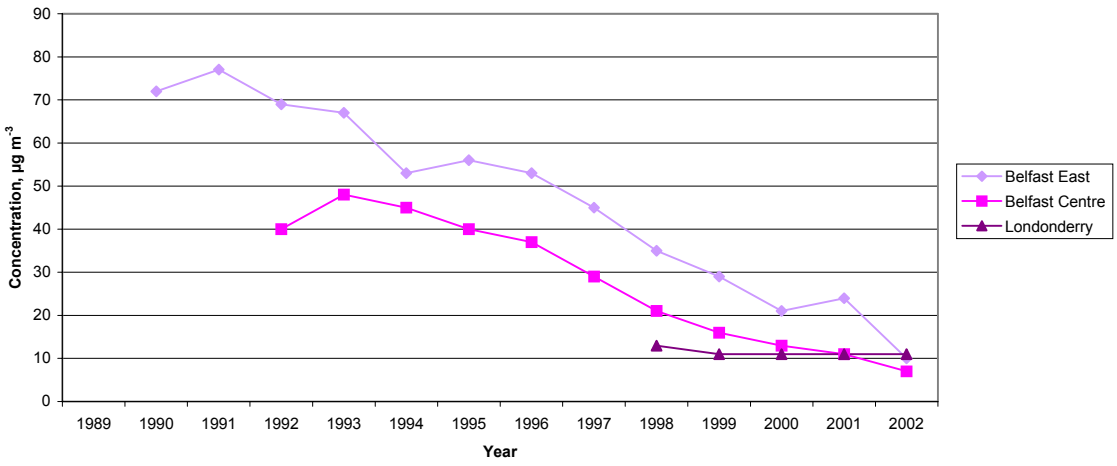


Figure 5.7 Annual Mean SO_2 concentration at Automatic Sites (data capture at least 75%)

5.6.2 Trends at Non-Automatic Sulphur Dioxide sites

Most of the non-automatic (8-port sampler) sites belong to the Smoke and SO_2 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 5.8, a graph of the average SO_2 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_2 has fallen, from over 80 μg m^{-3} in the 1960s to around 30 μg m^{-3} 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 5.8 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.

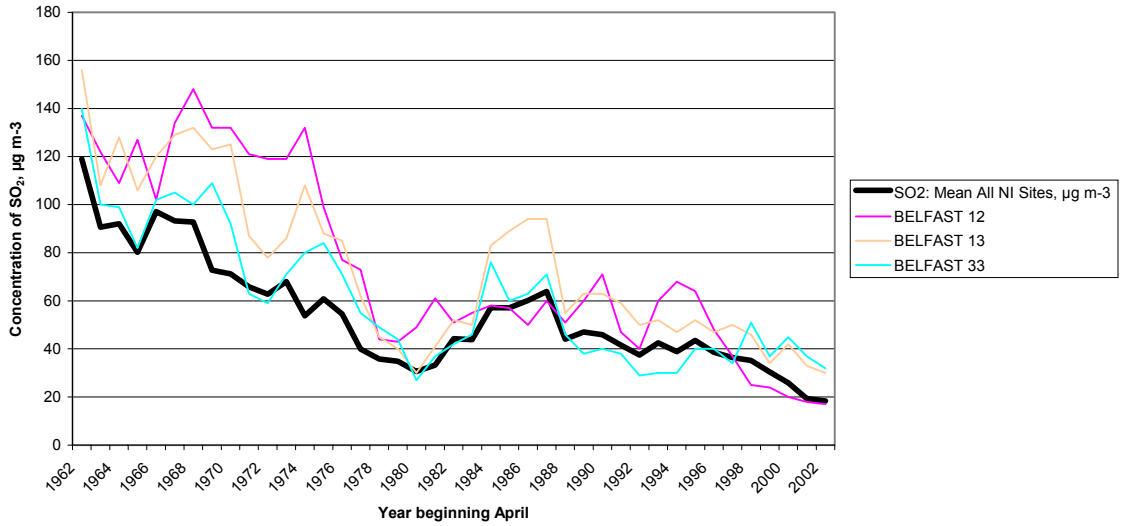


Figure 5.8 Annual Mean SO_2 Concentration at Smoke & SO_2 Sites in Northern Ireland. Network average and 3 long-running Belfast sites.

Although this network has provided a long-term historical dataset, it is also useful to examine trends for the most recent five years. Regression analysis for annual (pollution year) means 1998 to 2002 identified a downward trend, significant at the 95% confidence level, over this period. Therefore, it appears that on average, SO_2 concentrations in Northern Ireland, as measured by the non-automatic Smoke and SO_2 Network, are still decreasing. Further decrease is expected in the next few years, as natural gas becomes more readily available in the region, and as the sulphur content of other fuels is limited by regulation.

The estimated total annual UK emission of SO_2 is available from the NAEI, for years 1970-2001. The correlation was investigated between this parameter and the average annual SO_2 in Northern Ireland, as measured by the Smoke and SO_2 Network. The correlation between the two parameters can be expressed in terms of the correlation coefficient R. The closer this value is to 1, the stronger the correlation between them. In this case, correlation coefficient R = 0.66; for the sample of 32 paired values (for years 1970-2001) the correlation *is* significant, at the 99% confidence level. However, this should be compared with the much stronger correlation (R = 0.93) between the NAEI estimate of total annual UK emission of SO_2, and UK annual mean SO_2 concentrations, as measured by the same network. This is consistent with Northern Ireland's SO_2 emissions over the past 33 years having followed a different trend to those of the whole UK.

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_{10} and Black Smoke. The term "PM_{10}" refers to the mass fraction of particles collected by a sampler with a 50% cut-off at aerodynamic diameter 10 μm. PM_{10} 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 micrograms per cubic metre ($\mu g\ m^{-3}$).

6.1 MONITORING OF PARTICULATE MATTER

6.1.1 PM_{10} Monitoring

The number of automatic monitoring sites for particulate matter as PM_{10} in Northern Ireland increased substantially, from six sites in 2001 to eighteen in 2002. Site details and monitoring techniques are shown in Table 6.1 and Figure 6.1. The most widely used automatic PM_{10} monitoring technique is the Tapered Element Oscillating Microbalance (TEOM), but Beta Attenuation Monitors (BAM or Beta Gauge) are also in use, at Belfast Clara Street and Strabane.

The reference method for PM_{10} is the gravimetric technique, in which the ambient concentration of PM_{10} 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_{10} 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 such site is the AURN site in Londonderry - shown in Figure 6.2. This site is part of the AURN and also monitors a range of other pollutants.

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 μm; thus black smoke can be considered an approximation to dark PM_5.

During 2002, there were 39 sites in Northern Ireland measuring particulate as black smoke, 35 of which were part of the Smoke and SO_2 Network. Black smoke is monitored using the same 8-port sampler apparatus as non-automatic SO_2, 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_2) in Section 5.1, (with the exception of the Rural SO_2 Network sites, which monitor SO_2 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_{10} Monitoring Sites, 2002

Site	Grid Ref.	Classification	Technique	Network/ operator
Armagh, Lonsdale Road	H 876 458	Roadside	TEOM	Armagh
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
Londonderry (AURN)	C 429 172	Urban Background	TEOM	AURN
Londonderry (Brandywell)	C 428 163	Urban Background	TEOM	AURN Affiliated
Ards	J 487 747	Urban Background *	TEOM	Ards
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	H 802 635	Urban Background *	TEOM	Dungannon
Lisburn (Lagan Valley Hospital)	J 265 637	Roadside	TEOM	Lisburn
Lisburn (Council Offices)	J 274 643	Urban Background *	TEOM	Lisburn
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)
Strabane (Springfield Park)	H 351 972	Urban Background (Residential)	BAM	Strabane (CC)

CC = Calibration Club member.
* in a coal burning residential area.

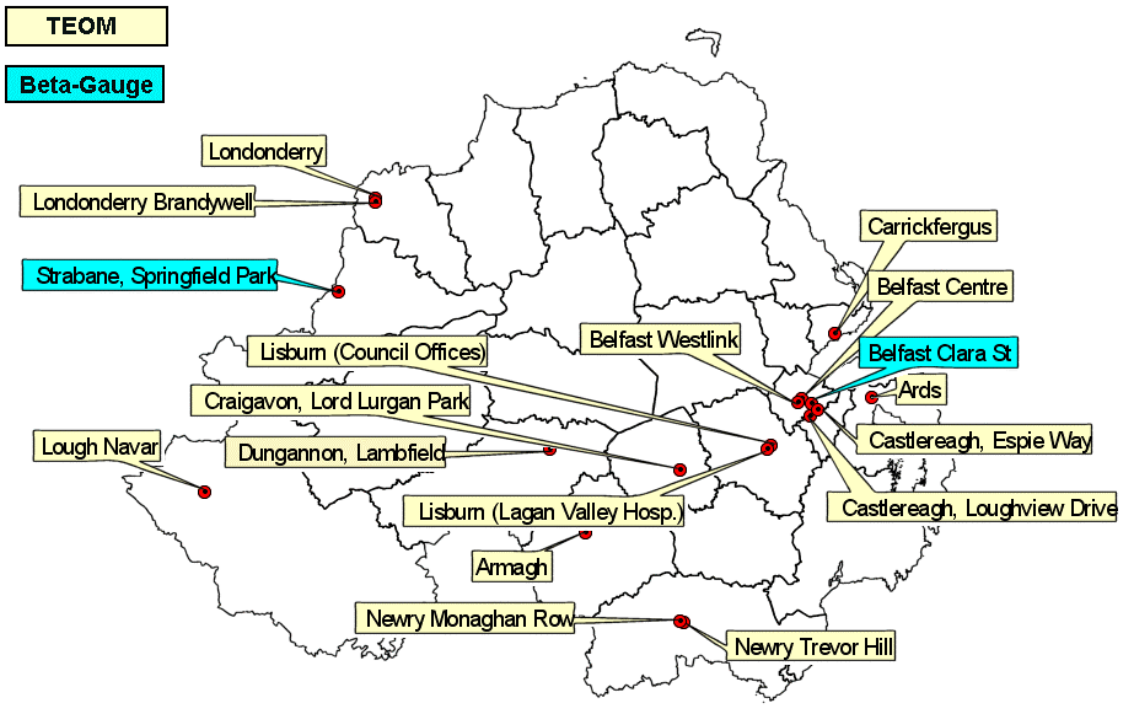


Figure 6.1 Locations of PM_{10} Monitoring Sites, 2002.

Figure 6.2 AURN Site in Londonderry, Monitoring PM_{10} and Other Pollutants

6.2 LIMIT VALUES AND OBJECTIVES FOR SUSPENDED PARTICULATE MATTER

6.2.1 Limit Values and Objectives for PM_{10}

Particulate matter, when measured as PM_{10}, is covered by the EC 1st Daughter Directive (1999/30/EC), which contains a two-stage set of limit values. The UK Air Quality Strategy sets objectives for PM_{10} 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_{10}

Averaging period	EC Limit or AQS Objective	Number of Permitted exceedences	To be achieved by
EC 1st Daughter Directive (1999/30/EC) Stage 1			
24 hour	50 μg m^{-3}	35 per year	1st January 2005
Annual Mean	40 μg m^{-3}	-	1st January 2005
EC 1st Daughter Directive (1999/30/EC) Stage 2 (to be confirmed)			
24 hour	50 μg m^{-3}	7 per year	1st January 2010
Annual Mean	20 μg m^{-3}	-	1st January 2010
Air Quality Strategy (as currently adopted in Northern Ireland)			
24 hour	50 μg m^{-3}	35 per year	31st December 2004
24 hour *	50 μg m^{-3}	7 per year	31st December 2010
Annual Mean	40 μg m^{-3}	-	31st December 2004
Annual Mean *	20 μg m^{-3}	-	31st 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 1st Daughter Directive and Air Quality Strategy set objectives for PM_{10}, smoke was covered by EC Directive 80/779/EEC on sulphur dioxide and suspended particulates. This Directive has been superseded by the 1st Daughter Directive; however, the limits relating to smoke remain in force until 2005, and the new Daughter Directive deals only with PM_{10}. The current report therefore compares 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 in 2005)

Limit Values (mandatory)	Smoke μg m^{-3} BS	Sulphur Dioxide μg m^{-3}
YEAR (median of daily values)	68	if smoke $\leq$ 34:120 if smoke > 34: 80
WINTER (median of daily values, October-March)	111	if smoke $\leq$ 51: 180 if smoke > 51: 130
YEAR (Peak, i.e. 98th Percentile of daily values)	213	if smoke $\leq$ 128: 350 if smoke > 128: 250
Guide Values (advisory only)		
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_{10} Results

Table 6.4 presents data from the automatic PM_{10} monitoring sites. TEOM data have been converted to gravimetric equivalent by multiplying by the appropriate factor of 1.3. Figures in ***bold italics*** indicate more than the permitted number of exceedences of the relevant limit or objective. To keep the table to a manageable size, only 2002 data are included: the full historical dataset is provided in Appendix 2.

Table 6.4 2002 PM_{10} Results from Automatic Monitoring Sites
(μg m^{-3} Gravimetric Equivalent)

Site	2002 Data Capture %	Annual Mean μg m^{-3}	Max Daily Mean μg m^{-3}	No. of Daily means > 50 μg m^{-3}	90th %ile of Daily Means (where DC < 90% and max day>50 μg m^{-3})
Armagh	38	30	131	12	45
Belfast Centre (AURN)	98	23	83	8	Not applicable
Belfast Clara Street	94	17	99	8	Not applicable
Londonderry (AURN)	96	22	80	9	Not applicable
Londonderry Brandywell)	73	25	106	19	41
Ards *	17	30	53	1	44
Belfast Westlink	66	34	108	32	***54***
Carrickfergus	50	17	51	1	37
Castlereagh (Loughview Drive)	48	34	112	8	*90th %ile not available*
Castlereagh (Espie Way)	48	26	74	3	*90th %ile not available*
Craigavon (Lord Lurgan Park) *	74	15	78	2	28
Dungannon	19	15	36	0	Not applicable
Lisburn (LVH)	50	14	40	0	Not applicable
Lisburn (Council Offices)	36	16	37	0	Not applicable
Lough Navar	96	15	58	2	Not applicable
Newry, Monaghan Row	95	21	78	8	Not applicable
Newry, Trevor Hill	99	34	89	***38***	Not applicable
Strabane	67	38	147	***48***	***65***

** No QA/QC has been carried out on the data supplied from Ards and Craigavon. These results should therefore be interpreted with caution.*

Twelve of the eighteen automatic PM_{10} monitoring sites began operation part way through 2002, and therefore have less than 90% data capture for the year. Annual statistics may not be representative in these cases.

Figures 6.3a and 6.3b illustrate how data from the monitoring sites compares with applicable AQS objectives. Figure 6.3a shows the maximum 24-hour mean and annual mean (as bars) together with the relevant AQS objectives (as horizontal lines). Figure 6.3b shows the number of exceedences of the 24-hour mean AQS objective for PM_{10}, compared with the permitted total of 35. On the basis of the available data, it appears that all sites meet the AQS objective of 40 μg m^{-3} for the annual mean PM_{10}, as gravimetric equivalent. Two sites exceeded the AQS objective of 50 μg m^{-3} (gravimetric equivalent) for the 24-hour mean, on more than the permitted 35 occasions: these were Newry Trevor Hill, and Strabane Springfield Park. Newry Trevor Hill is a roadside site close to a busy road through the centre of Newry. 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_{10} monitoring began.

Where data capture is less than 90% (as is the case for the 12 new sites), rather than simply checking for 35 exceedences of the 24-hour objective, the 90th percentile of 24-hour means should

be compared with the objective[1]. 90th percentile data are therefore included in Table 6.4, for sites where

(i) data capture was less than 90%, and

(ii) the maximum daily mean exceeded 50 μg m^{-3}.

At two of these sites, Belfast Westlink and Strabane, the 90th %ile of daily means for the period of operation during 2002 was greater than 50 μg m^{-3}. Strabane recorded over 35 exceedences of the 24-hour PM10 objective in 2002, so clearly did not meet the objective anyway, regardless of the data capture. (90th percentiles were not available for Castlereagh's two sites, Loughview Drive and Espie Way). None of the other new sites recorded any exceedences of the 24-hour PM_{10} objective. Three sites in total therefore did not meet the 24-hour objective for PM_{10} in 2002: Newry Trevor Hill, Belfast Westlink and Strabane Springfield Park.

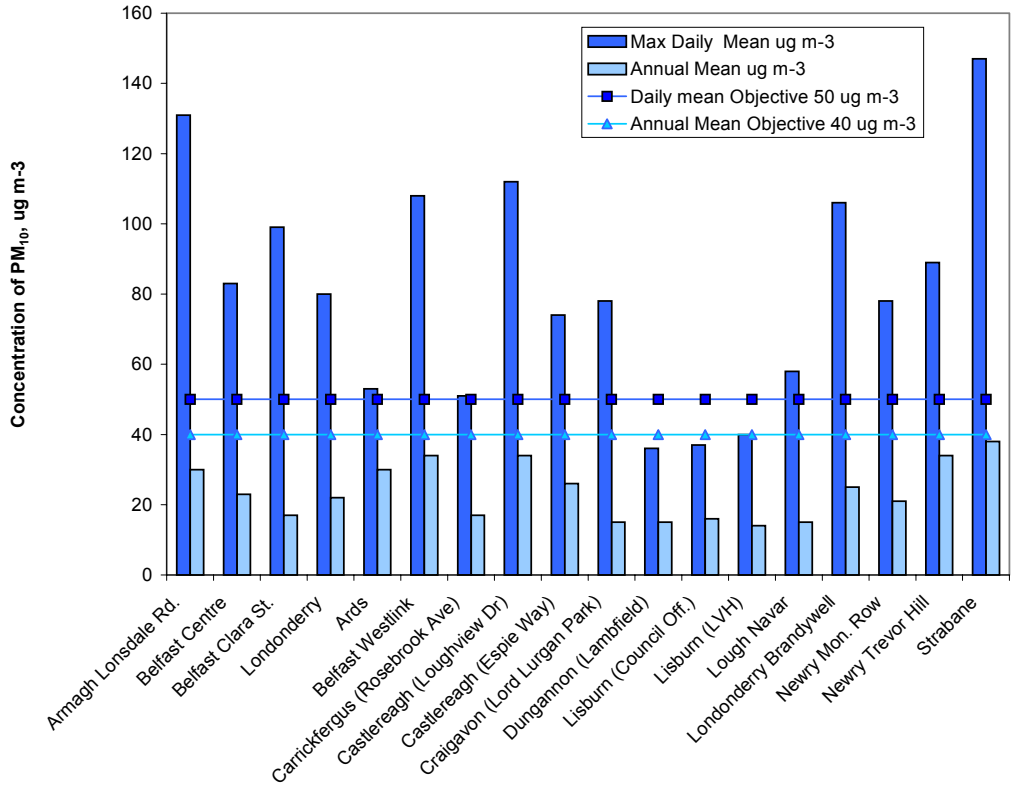


Figure 6.3a Comparison of 2002 PM_{10} Results from Automatic Sites with AQS Objectives .

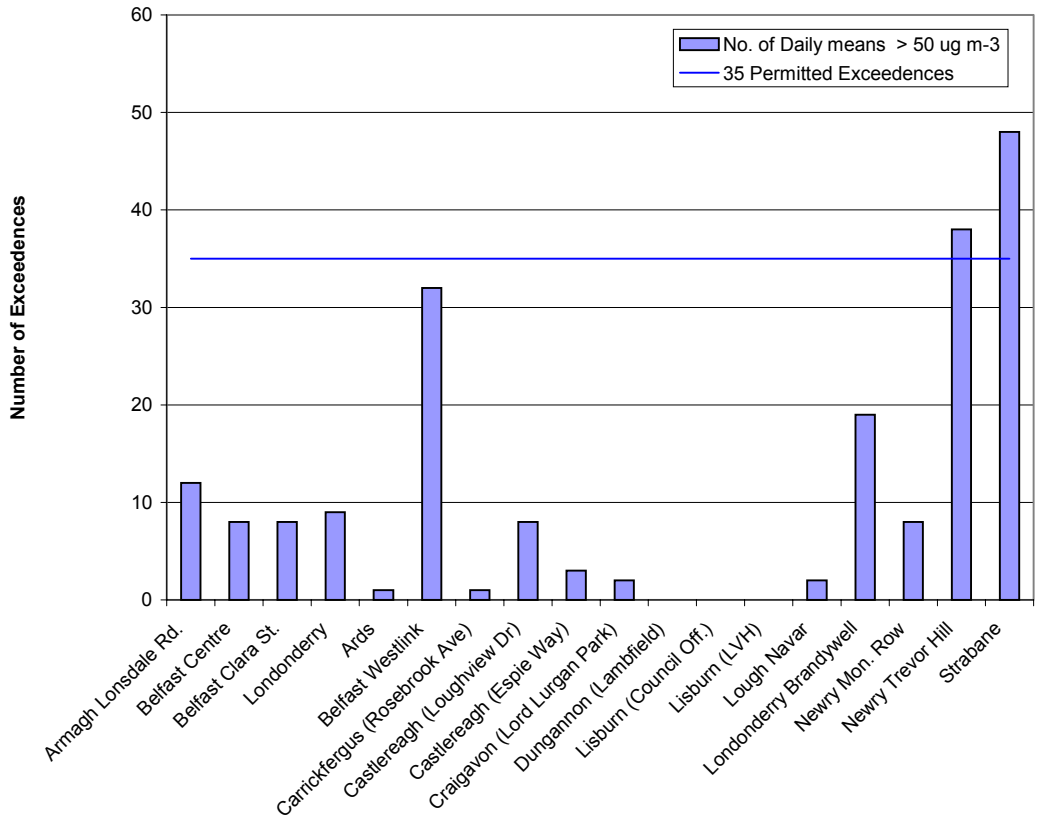


Figure 6.3b Number of Exceedences of 24-hour Mean AQS Objective for PM_{10}, 2002.

6.3.2 Black Smoke Results

A summary of smoke data for calendar year 2002 for all Smoke and SO_2 Network sites in Northern Ireland is shown in Appendix 3.

Smoke in 2002: Annual mean smoke concentrations in Northern Ireland (with one exception) ranged from 5 μg m^{-3} to 17 μg m^{-3}. The 2002 average for Northern Ireland was 9 μg m^{-3}; higher than the 2002 average of 6.9 μg m^{-3} obtained for the Network as a whole. The one exception was STRABANE 2, which recorded an annual mean smoke concentration of 27μg m^{-3}. This site is of particular interest as it is co-located with the automatic PM_{10} monitor at Springhill Park; unusually high smoke concentrations have been recorded ever since it started operation in 2000, and investigations indicated that the results were genuine. The automatic analyser was set up in 2002, and its results also show that levels of suspended particulate matter are high. The site is located on a housing estate with considerable domestic coal and oil burning, and local topography may impede dispersion. The only non-Network smoke site to report an annual mean smoke concentration was Downpatrick: the 2002 annual mean was 4 μg m^{-3}.

Smoke concentrations, historically, have been higher in Northern Ireland than in most other parts of the UK. This is because the limited availability of natural gas for domestic heating in Northern Ireland has necessitated greater use of coal and oil for this purpose.

All the sites in Northern Ireland meet the limit values of 80/779/EEC for smoke. The last occasion on which any of the limit values for smoke were exceeded in Northern Ireland was in 1990. During 2002, the annual arithmetic mean was well below the lower guide value of 34 μg m^{-3} 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 Belfast area, the contribution to primary PM_{10} emissions from domestic contribution is around 26%[3], a substantially higher proportion than in most UK cities. Therefore, trends in PM_{10} and black smoke emissions for Northern Ireland will not necessarily be the same as for other regions. However, NAEI data show a substantial decrease (of around 45%) in total UK PM_{10} emissions between 1990 and 2000, so it is not unreasonable to expect a decreasing trend for Northern Ireland.

6.4.1 PM_{10} Trends

Figure 6.4 shows annual mean PM_{10} concentrations for sites in Northern Ireland. (The data series for Newry Monaghan Row includes 1998-2000 data from a previous site very close to the present one: the two sites have been considered as one for the purpose of this trend plot). None of the sites which started operation in 2002 are illustrated, as none have 75% or more data for the year.

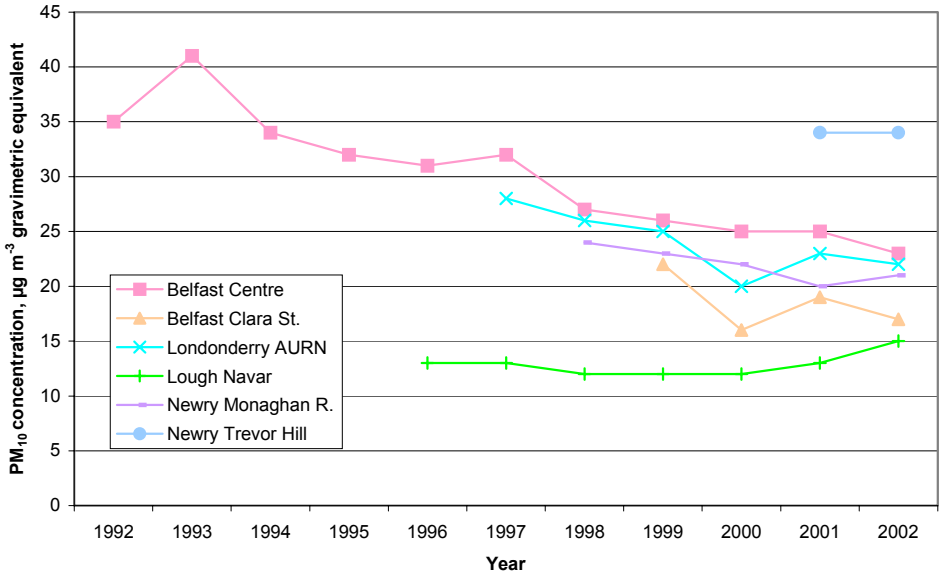


Figure 6.4 Annual Mean PM_{10}Concentrations at Automatic Monitoring Sites, Converted to Gravimetric Equivalent where applicable. (Data capture at least 75%).

The longest running site is Belfast Centre, which has been in operation since 1992. The annual mean PM_{10} concentration at this site has shown a steady decrease over this period. The urban sites at Londonderry (AURN) and Monaghan Row, Newry have operated for shorter periods, but also appear to show decreasing annual mean PM_{10} concentrations. At the rural Lough Navar site, annual mean PM_{10} concentrations have remained stable and below 15 μg m^{-3}, but appear to have increased during 2001-2002. Regression analysis (Theil's non-parametric regression analysis) identified a significant downward trend (with 95% confidence limit) in the annual mean PM_{10} concentrations at Belfast Centre and Londonderry (AURN), although not at Belfast Clara Street or Lough Navar. (At the two Newry sites, there is not enough data to assess trends).

6.4.2 Black Smoke Trends

The long-running historical dataset for the Smoke and SO_2 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 6.5, 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^{-3} in the early 1960s to less than 10 μg m^{-3} in 2002.

Figure 6.5 also 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.

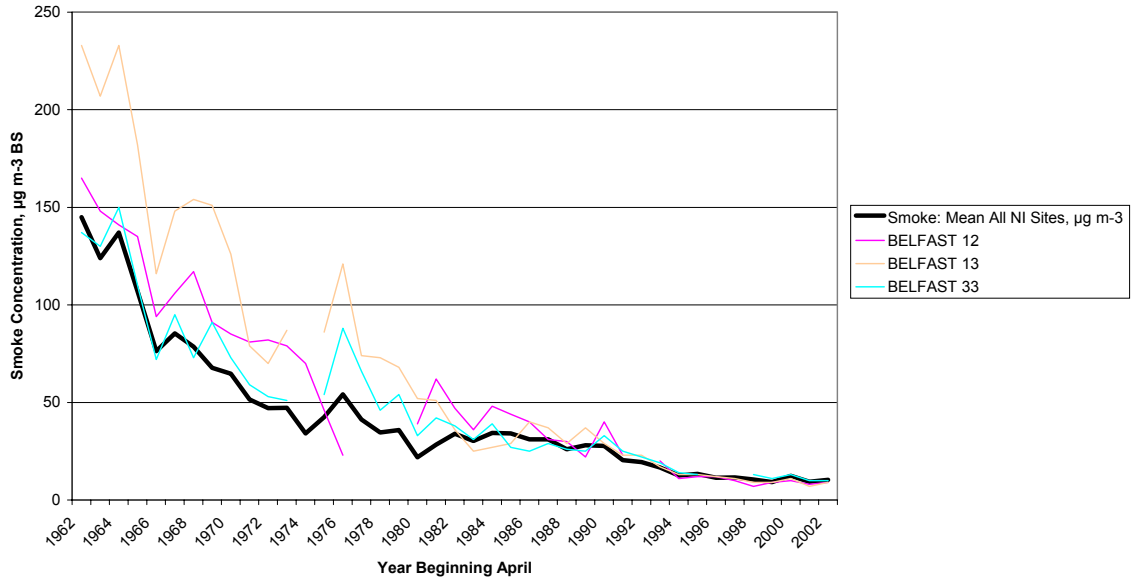


Figure 6.5 Trends in Black Smoke Concentration, Northern Ireland. Network average and 3 long-running Belfast sites.

As well as the long-term trends it is also interesting to investigate the trend over the past five years. Regression analysis of the average annual mean smoke concentration based on all sites in Northern Ireland shows that there is a small downward trend for the period 1997 – 2001, which is not significant at the 95% confidence limit. However, further decrease in smoke concentration in Northern Ireland is expected in the next few years, as natural gas becomes more readily available in the region, and domestic solid fuel use declines.

Estimated annual total UK emission data for black smoke are available from the NAEI, for years 1970 to 2001. The correlation was investigated between the total annual UK emission of black smoke, and the average annual smoke concentration in Northern Ireland, as measured by the Smoke and SO_2 Network. The correlation between the two parameters can be expressed in terms of the correlation coefficient R; the closer this value is to 1, the stronger the correlation between them. In this case, the correlation was found to be strong: R = 0.93. For the sample of 32 paired values (for years 1970-2001) this is significant at the 99% confidence level. The correlation is almost as strong as that found between total annual UK emission of smoke, and the average UK annual smoke concentration as measured by the Smoke and SO_2 Network (R = 0.95). This is consistent with black smoke emission trends for Northern Ireland over the past 32 years being similar to those calculated for the whole UK. This is in contrast to the findings for SO_2 (Section 5.6.2).

7 Ozone

Ozone (O_3) is a form of oxygen, with three atoms per molecule (unlike normal oxygen, O_2, 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_3 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_3 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.

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

1 ppb = 2.0 μg m^{-3} for ozone at 293K (20°C) and 1013mb.

7.1 MONITORING OF OZONE

Monitoring of O_3 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. A photograph of the rural Lough Navar site is shown in Figure 7.2.

Table 7.1 Automatic O_3 Monitoring Sites

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

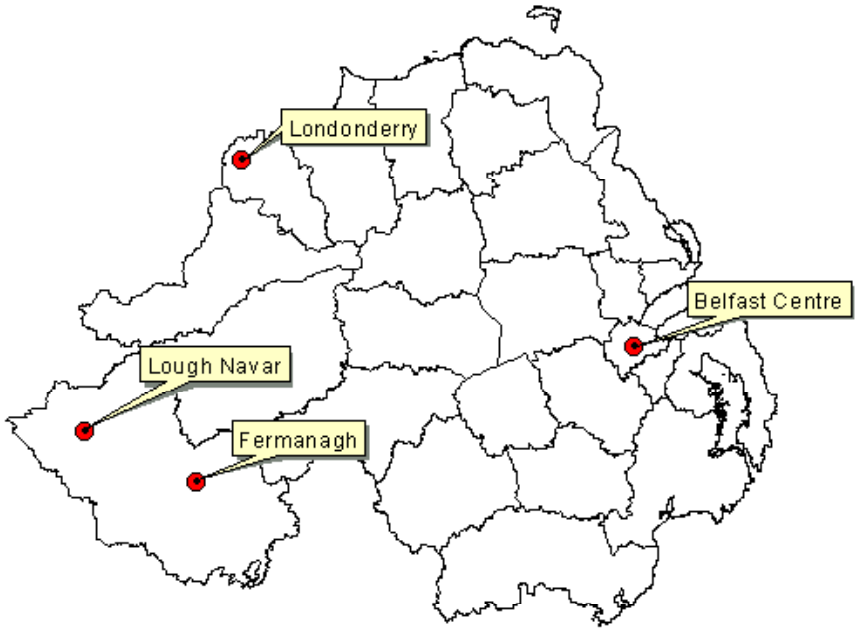


Figure 7.1 Location of Ozone Monitoring Sites

Figure 7.2 Lough Navar AURN Rural Site (analyser is inside building).

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 μg 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
WHO (non-mandatory guide)			
Day	O_3 concentrations not to exceed 120 μg m^{-3} for more than eight hours per day.		
EC Ozone Directive (2002/3/EC)			
Max. daily 8-hour mean. Compliance assessment to be based on the average number of days exceedence over 3 consecutive years.	120 μg m^{-3}	25 days per calendar year	Averaged over 3 years, beginning 2010.
AOT40[a], calculated from 1h values May- July. *For protection of vegetation.*	18,000 μg m^{-3} h	-	Averaged over 5 years, beginning 2010
Air Quality Strategy [b]			
Max. daily running 8-hour mean	100 μg m^{-3}	10 days per year	31 December 2005

a) AOT 40 is the sum of the differences between hourly concentrations greater than 80 µg m^{-3} (=40ppb) and 80 µg 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, and also the number of days per year on which this parameter exceeded 100 μg m^{-3}. Years in which the AQS objective was exceeded on more than 10 days are highlighted in ***bold italics.*** Annual mean ozone concentrations are included: although no limit values apply to this statistic, the annual mean may show long-term trends more clearly than short-term statistics.

Table 7.3 shows that:

- In earlier years, peak concentrations of ozone were typically higher at the rural Lough Navar site than at the two urban sites. However, since the mid 1990s all three sites have had similar maximum daily 8-hour running mean.
- The AQS objective for ozone has been met at Belfast Centre and Lough Navar since 1996.
- The AQS objective was exceeded on more than the permitted 10 days at Londonderry, in 2000 and 2002. However, the site did not exceed the less stringent EC 3rd Daughter Directive target.

Closer examination of the 2002 dataset for Londonderry revealed that the majority of days with maximum daily 8-hour running mean greater than 100 μg m^{-3} was exceeded occurred during the period March to May 2002. This objective is to be met by 31 December 2005.

The EC 3rd Daughter Directive also sets a target value for protection of vegetation, based on the AOT40 statistic. This is applicable in rural locations. Ozone data from the rural Lough Navar site, for the five years 1997 to 2002, were compared with this AOT40 target value for protection of vegetation. Lough Navar currently meets the target value.

The 2002 annual mean ozone concentration at the Fermanagh diffusion tube site was 91 μg m^{-3}. This is comparable with the annual mean of 80 μg m^{-3} recorded last year, but very high compared with the automatic analyser results.

Table 7.3 O_3 Results from Automatic Monitoring Sites

Calendar Year	Data Capture, %	Max Daily 8 Hour Mean μg m^{-3}	Days with max. daily 8hr mean > 100 μg m^{-3}	Annual Mean μg m^{-3}
Belfast Centre				
1992	81	108	2	36
1993	97	88	0	32
1994	95	106	2	36
1995	96	136	***11***	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
Londonderry				
1997	59	152	6	44
1998	90	108	2	52
1999	94	154	4	52
2000	97	120	***11***	54
2001	94	104	2	46
2002	92	114	***19***	58
Lough Navar (1990 onwards) *				
1990	96	170	***21***	52
1991	99	158	***14***	46
1992	87	160	***19***	52
1993	98	112	5	48
1994	99	132	7	52
1995	93	148	***20***	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

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

7.4 OZONE TRENDS

Figure 7.2 shows a time series plot of the annual maximum daily 8-hour running mean for ozone. All years of operation are included. There appear to be no clear trends, although at Lough Navar this statistic appears slightly lower in recent years than in the late 1980s and early 1990s. If ozone

concentrations remain at their current levels, occasional exceedences of the AQS objective may continue to occur, such as that observed at Londonderry in 2002.

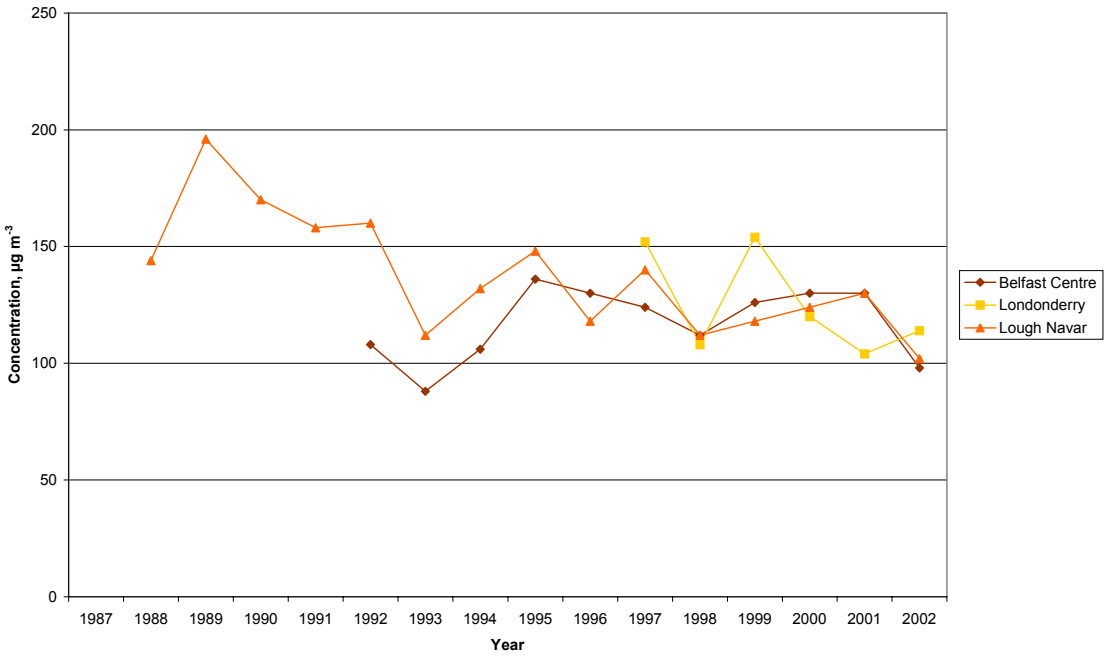


Figure 7.2 Maximum Daily 8-hour Running Mean Ozone Concentration, μg m^{-3}

Trends are sometimes more clearly identifiable in statistics based on longer sampling periods, such as the annual mean. Figure 7.3 shows a similar plot for the annual mean. The high annual mean measured at Londonderry in 2002 is clearly visible. Regression analysis (Theil's non-parametric analysis) of the annual means for all years of operation up to and including 2002, showed no statistically significant trends in the case of Belfast Centre, Londonderry or Lough Navar. (The previous report identified a small but statistically significant upward trend at Belfast Centre to 2001: however, with the inclusion of the 2002 data this is no longer the case.)

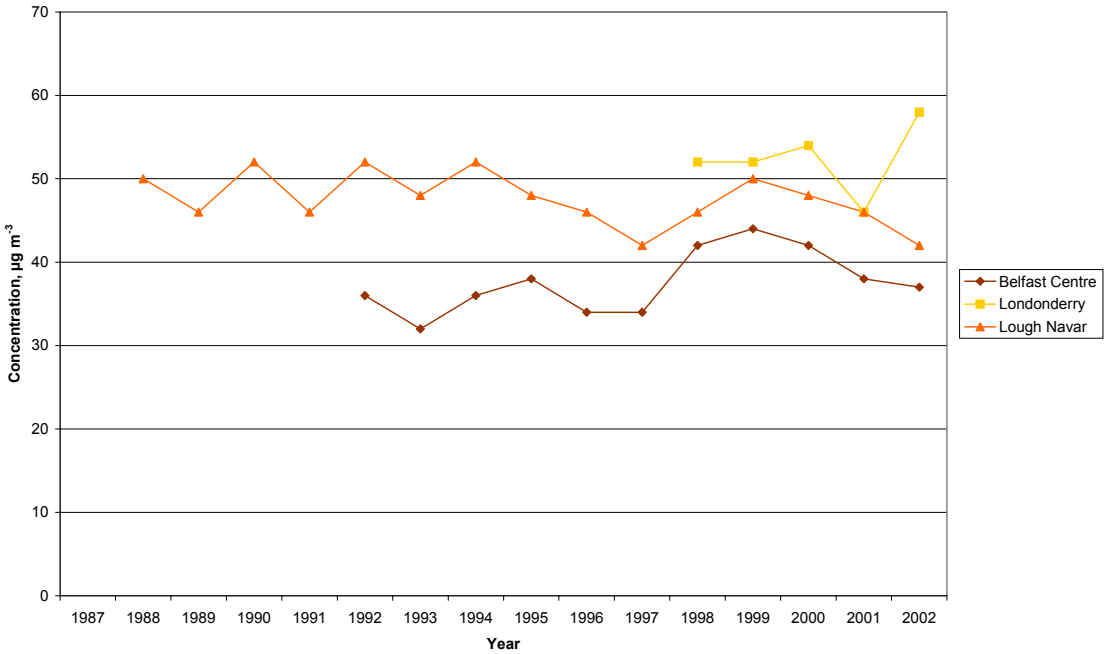


Figure 7.3 Annual Mean Ozone Concentrations (data capture at least 75%)

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 (μg m^{-3}). To convert to parts per billion (ppb) if necessary, the following relationships should be used:

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

1 ppb = 2.25 μg m^{-3} 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: Acenapthene, Acenapthylene, 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, Napthalene, 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 (ngm^{-3}).

According to the NAEI website (www.naei.org.uk), the largest source of PAHs in the UK at present is road transport, which in 2001 contributed 49% 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 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.

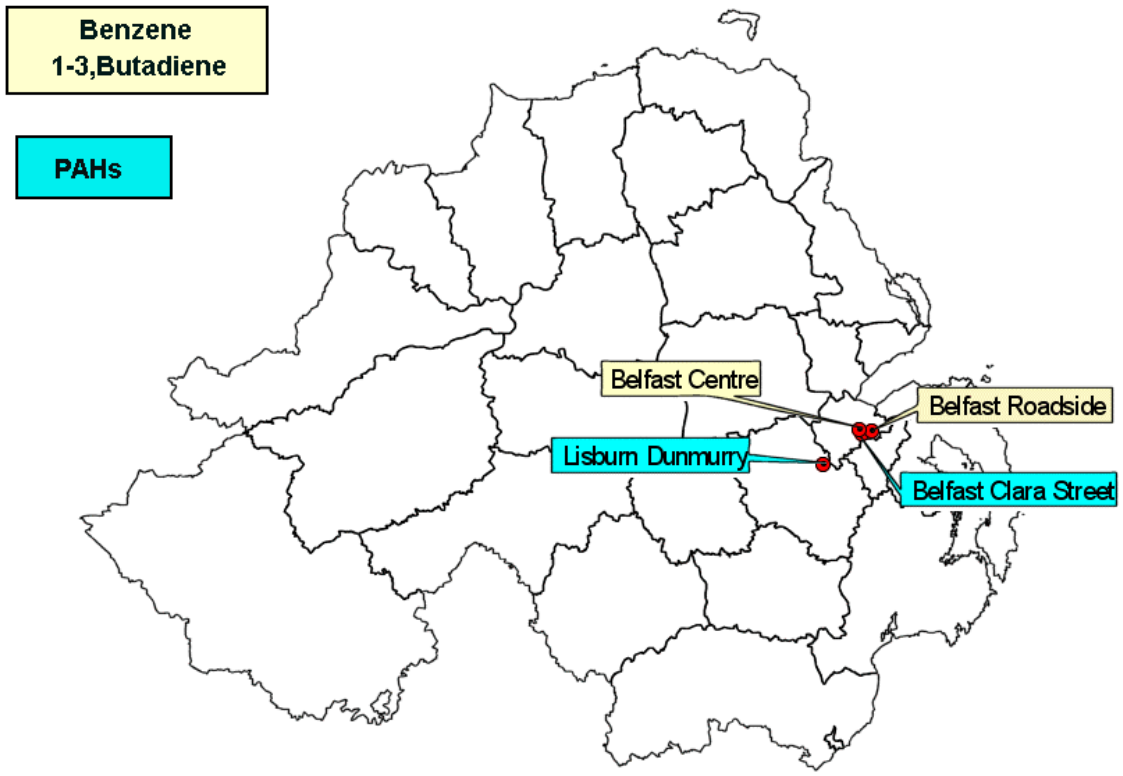


Table 8.1 Hydrocarbon Monitoring Sites

Site	Grid Ref.	Classification	Pollutants	Network
Belfast Centre	J 339 744	Urban Centre	Benzene, 1,3-butadiene	NPL Hydrocarbon
Belfast Roadside	J 379 739	Roadside	Benzene, 1,3-butadiene	NPL 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 2nd 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 2nd Daughter Directive. An objective was added for PAHs. Northern Ireland's policy on an objective for PAH is currently subject to consultation. However, the objective is discussed in this section because of its relevance to domestic solid fuel use. 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
EC 2nd Daughter Directive (2000/69/EC)		
BENZENE: **Calendar Year Mean**	5 μg m^{-3}	1st January 2010
Air Quality Strategy		
BENZENE: **Running annual mean** **Calendar Year Mean**	16.25 μg m^{-3} 3.25 μg m^{-3}	31st December 2003 31st December 2010
1,3 BUTADIENE: **Running annual mean**	2.25 μg m^{-3}	31st December 2003
Air Quality Strategy for PAH (Not at present adopted in Northern Ireland)		
PAHs * ***(using B(a)P as an indicator)*** **Calendar year mean**	0.25 ng m^{-3}	31st December 2010

** Footnote to Table 8.2: No policy decision has yet been taken on the inclusion of the PAH objective for Northern Ireland.*

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^{-3} for the annual mean total benzo(a)pyrene in the PM_{10} 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 2002.

Table 8.3 Concentrations of benzene, 2002

Site	Data Capture, %	Calendar Year Mean Concentration 2002, μg m^{-3}	Running Annual Mean Concentration 2002, μg m^{-3}
Belfast Centre	49%	1.04	-
Belfast Roadside	49%	2.47	-

As benzene monitoring only began in July 2002, data capture for 2002 is only 49% and there are as yet insufficient data to produce valid running annual means. However, the July – December 2002 means of 1.04 μg m^{-3} and 2.47 μg m^{-3} respectively are well within applicable Air Quality Strategy objective for the region (16.25 μg m^{-3}), and also within the EC 2nd Daughter Directive limit value of 5 μg m^{-3} for this pollutant. These initial results are consistent with those obtained by the former Belfast South hydrocarbon site, at which annual mean benzene concentration was consistently below 5 μg m^{-3} since 1994.

1,3-butadiene monitoring did not commence until 2003. However, data for 2003 so far, provided by NPL, indicate that levels of this pollutant at both sites are less than 0.2 μg m^{-3}, and therefore well within the applicable Air Quality Strategy objective of 2.25 μg m^{-3}. This is consistent with the findings from the former Belfast South hydrocarbon monitoring site. As reported in the previous report in this series, running annual mean concentrations of 1,3-butadiene at Belfast South were less than 2.25 μg m^{-3} throughout its operational period of 1994 - 2000.

8.3.2 Polycyclic Aromatic Hydrocarbons

The 2002 annual mean benzo(a)pyrene concentration was 0.65 ngm^{-3} at Lisburn Dunmurry, and 0.13 ngm^{-3} at Belfast Clara Street. Both sites are therefore within the proposed EC target value of 1.0 ngm^{-3} for this PAH. The new AQS objective of 0.25 ngm^{-3} for benzo(a)pyrene does not apply to Northern Ireland at the present time. However, Lisburn currently exceeds this value by a considerable margin. Modelling of PAH in Northern Ireland has been undertaken and the Department has issued a consultation document outlining the options for a Northern Ireland objective.

To put these values into context, they should be compared with results from other sites in the HAPS Network in England, Wales and Scotland – see Table 8.4 and Figure 8.2. The two sites in Northern Ireland are shown in ***bold italics***.

Table 8.4 Annual Mean Benzo(a)pyrene Concentrations at all HAPS Network Sites

Site	Type	Annual Mean 2000 ng m^{-3}	Annual Mean 2001 ng m^{-3}	Annual Mean 2002 ng m^{-3}
Ashington	Urban	0.17	0.20	0.15
Belfast	***Urban***	***-***	***0.37***	***0.13***
Birmingham	Urban	-	0.16	0.13
Bolsover	Urban	0.25	0.28	0.24
Bromley	Urban	-	-	0.25
Glasgow	Urban	0.12	0.12	0.12
Hazelrigg	Semi-Rural	0.06	0.08	0.04
High Muffles	Rural	0.04	0.05	0.04
Holyhead	Urban	0.11	0.15	0.25
Kinlochleven *	Urban	2.28	0.34	0.38
Leeds	Urban	-	0.16	0.18
Lisburn	Urban	***0.93***	***0.96***	***0.65***
London 2a	Urban	0.14	0.14	0.13
Manchester	Urban	0.24	0.34	0.12
Middlesbrough	Urban	0.28	0.37	0.15
Newcastle	Urban	-	0.11	0.12
Newport	Urban	0.35	0.36	0.19
Port Talbot	Urban	0.59	0.40	0.34
Scunthorpe	Urban	1.18	0.34	0.13
Speke	Urban	-	-	0.14
Stoke Ferry	Rural	0.09	0.09	0.08

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

Annual mean benzo(a)pyrene at rural sites (Hazelrigg, High Muffles, Stoke Ferry), ranged from 0.04 to 0.08 ngm^{-3}, well within the Air Quality Strategy's new 2010 objective of 0.25 ngm^{-3}. Urban sites (including Belfast Clara Street) typically had higher annual mean concentrations, ranging from 0.12 to 0.25 ngm^{-3}, but in 2002 only three of the 21 sites exceeded the AQS objective of 0.25 ngm^{-3}, compared with nine out of nineteen in 2001. In 2002, no sites approached or exceeded the proposed EC limit value for benzo(a)pyrene of 1.0 ngm^{-3} . Annual mean benzo(a)pyrene concentrations for 2002 were lower than those reported for 2000 and 2001 at the majority of HAPS network sites, including those in Northern Ireland.

Benzo(a)pyrene levels at Belfast Clara Street in 2002 were comparable with those at other city centre sites such as Birmingham, London and Manchester. However, mean benzo(a)pyrene levels

at the Lisburn site remain the highest in the HAPS network for the second year running. The Lisburn site 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 three years data for PAHs in Northern Ireland, it is not possible to assess trends. A study[5] 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 ngm^{-3} 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, as well as reducing ambient SO_2.

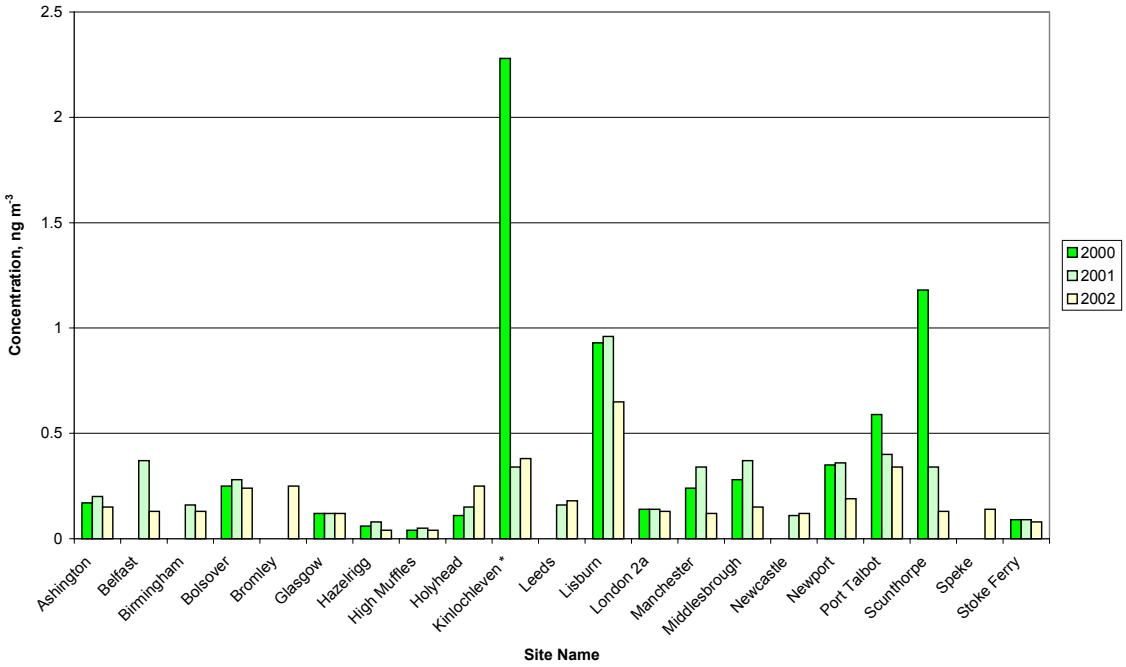


Figure 8.2 Annual Mean Benzo(a)pyrene Concentrations at HAPS Network sites, ng m^{-3} 2000 to 2002

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 the previous report, "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 Metals

The metallic elements lead (Pb), cadmium (Cd), arsenic (As), nickel (Ni) and mercury (Hg) have the potential to cause adverse health effects in humans. Cadmium, arsenic, and nickel occur as pollutant emissions from coal burning, heavy fuel oil burning, waste incineration and some industrial processes. Mercury is emitted from waste incineration, industrial processes using mercury cells, some non-ferrous metal processes and coal combustion. The major source of ambient lead is vehicles using lead-containing fuel. Emissions of cadmium, arsenic, nickel and mercury in the UK have all fallen by more than 80% since 1970, as a result of reduced coal and oil combustion, and better emission controls on industrial processes and waste incineration plant. Emissions of lead have been reduced by 93% since 1970, by a substantial reduction of the permitted lead content of petrol in 1986, followed by the phasing out of leaded petrol in 1999.

Concentrations of these metallic elements in ambient air are expressed in microgrammes (i.e. 10^{-6} grammes) per cubic metre (μg m^{-3}) or nanogrammes (i.e. 10^{-9} grammes) per cubic metre (ngm^{-3}).

9.1 MONITORING OF METALS

No monitoring of metallic air pollutants was undertaken in Northern Ireland during 2002. The most recent study in the region[6] (reported in the previous 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 twelve 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. Table 9.1 shows the locations of these monitoring sites. At these sites, particulate phase ambient concentrations were measured using gravimetric PM_{10} measurement apparatus. The duration of each sample period was one week. One site, Whitehead, also monitored the metal vanadium.

Table 9.1 Metals Monitoring Sites

Site	Grid reference	Description	Technique
Donnybrewer Road, Campsey	C 486 208	1km to the NE of Coolkeeragh Power station (oil fired)	Gravimetric PM_{10}
Bentra Road, Whitehead	J 450 911	1km to NE of Kilroot Power Station (oil fired)	Gravimetric PM_{10}
Victoria Park, Belfast	J 364 754	800m from Belfast Harbour Estate (mixed industrial area)	Gravimetric PM_{10}

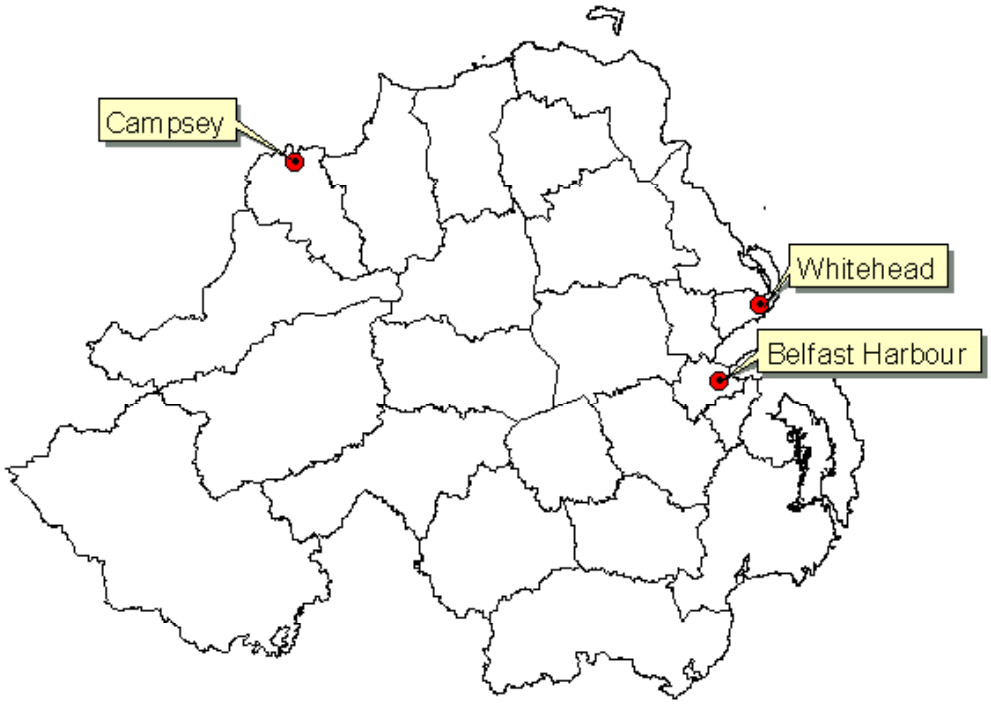


Figure 9.1 Monitoring Sites for Particulate Phase Metals, 2000

9.2 LIMIT VALUES AND OBJECTIVES FOR METALS

9.2.1 Lead

The 1st Daughter Directive, (1999/30/EC) and the Air Quality Strategy contain limit values and objectives for annual mean lead. These are shown in Table 9.2.

Table 9.2 Limit Values and Objectives for Lead

Averaging period	EC Limit or AQS Objective	To be achieved by
EC 1st Daughter Directive (1999/30/EC)		
Calendar Year Mean	0.5 μg m^{-3} (= 500 ng m^{-3})	1st January 2005, or 1st January 2010 in the immediate vicinity of industrial sources.
Air Quality Strategy		
Calendar Year Mean (1)	0.5 μg m^{-3} (= 500 ng m^{-3})	31st December 2004
Calendar Year Mean (2)	0.25 μg m^{-3} (= 250 ng m^{-3})	31st December 2008

At present, lead is the only metallic pollutant to be covered by the Air Quality Strategy.

9.2.2 Other Metals

The metals As, Cd, Hg and Ni in ambient air are to be covered by a fourth Daughter Directive, currently at the draft stage. In its present form, the proposed Directive aims to set "assessment thresholds" (ambient concentrations above which mandatory monitoring would be necessary from 2008) for arsenic, cadmium, and nickel, together with a general monitoring requirement only for

mercury. There would be no mandatory limits. Assessment thresholds for As, Cd and Ni are shown in Table 9.3; however, it should be noted that these have not been finalised and may change.

Table 9.3 *Proposed* EC Directive Assessment Thresholds for As, Cd and Ni.

Element	Averaging period	Target Value
As	Calendar year	6 ng m^{-3}
Cd	Calendar year	5 ng m^{-3}
Ni	Calendar year	20 ng m^{-3}

These assessment thresholds apply to the total As, Cd or Ni concentration in the PM_{10} fraction.

9.3 METALS RESULTS

Table 9.4 shows the metals monitoring results for all three sites in Northern Ireland, from the study[5] carried out by Casella Stanger, over the 12 months December 1999 to November 2000.

Annual mean Pb concentrations at all three sites were well within the EC Directive limit value 0.5 μg m^{-3} (500 ng m^{-3}). They were also well within the lower AQS objective of 0.25 μg m^{-3} (250 ng m^{-3}): thus all three sites already meet the AQS objective for this metal, set for the end of 2008. Annual means of As, Cd and Ni were well within the proposed EC Directive assessment thresholds at all three sites.

Table 9.4 Results of Metals Monitoring Study

	Annual mean ng m^{-3}	Min. weekly ng m^{-3}	Max weekly ng m^{-3}	Limit of detection ng m^{-3}
Lead				
Campsey	3	1	10	1
Whitehead	4	1	10	1
Belfast	12	3	40	1
Arsenic				
Campsey	0.72	0.06	14.92	0.06
Whitehead	0.47	0.06	1.48	0.06
Belfast	1.01	0.24	2.26	0.06
Cadmium				
Campsey	0.13	0.14	0.77	0.14
Whitehead	0.14	0.14	1.59	0.14
Belfast	0.14	0.14	0.45	0.14
Mercury				
Campsey	0.06	0.06	0.44	0.06
Whitehead	0.047	0.06	0.23	0.06
Belfast	0.08	0.06	0.63	0.06
Nickel				
Campsey	2.05	0.29	8.27	0.29
Whitehead	1.25	0.29	5.96	0.29
Belfast	3.59	0.29	11.38	0.29
Vanadium				
Whitehead	2.6	0.44	5.37	0.44

On the basis of this one-year study, it was concluded that levels of metallic pollutants at these three sites in Northern Ireland were low. As the duration of this study was just one year, it is not possible to assess trends. Overall UK trends for all these metals are decreasing.

10 Conclusions

1. Carbon Monoxide is measured at two sites: Belfast Centre and Londonderry. Both currently meet the EC limit value and the Air Quality Strategy objective for CO. There is a significant downward trend in the annual mean CO at Belfast Centre but not at Londonderry.

2. Nitrogen Dioxide is monitored at ten automatic sites, of which six were new in 2002. The new sites are located near busy roads, where NO_2 levels are expected to be high. Four automatic roadside sites (Belfast Westlink, Belfast Newtownards Road, Lisburn Lagan Valley Hospital and Newry Trevor Hill) had annual mean NO_2 concentrations greater than the EC Limit Value and the Air Quality Strategy objective of 40 μg m^{-3}. In addition, Belfast Westlink had more than the permitted 18 exceedences of the 1-hour mean objective of 200 μg m^{-3} during 2002. Some of the new sites had less than 90% data capture and therefore were assessed by comparing the 99.8th percentile of hourly means with the 1-hour mean objective, as specified by the Technical Guidance. However, none of the sites assessed in this way appeared to have exceeded this objective in 2002.

3. It is predicted, using the methods set out in the Technical Guidance[1], that the four roadside sites Belfast Westlink, Belfast Newtownards Road, Lisburn Lagan Valley Hospital and Newry Trevor Hill may not meet the AQS objective of 40 μg m^{-3} for the annual mean NO_2 concentration in 2005. Belfast Westlink and Belfast Newtownards Road may also fail to meet the EC Limit Value in 2010.

4. NO_2 was also monitored using diffusion tubes at 257 sites – a substantial increase from 155 sites in 2001. Most of the new sites are at roadside locations where concentrations of this pollutant are expected to be high. Seven diffusion tube sites (all roadside, near busy roads) had annual mean NO_2 concentrations greater than the EC Directive and AQS objective of 40 μg m^{-3}. All are predicted to meet the AQS objective by 2005.

5. Two automatic sites (Belfast Centre and Londonderry) have sufficient NO_2 data to assess trends: as identified last year (2001), there is a significant downward trend in annual mean NO_2 concentration at Belfast Centre only. Diffusion tube data show a significant downward trend for Roadside and Urban Background site types, for the period 1993 to 2002.

6. Sulphur Dioxide is monitored at fourteen automatic sites, of which nine were new in 2002. All automatic sites met the requirements of the 1st Daughter Directive and the objectives of the Air Quality Strategy in 2002. No sites recorded *any* exceedences of the 1-hour or 15-minute mean objectives for SO_2. Belfast East, a long-running site that has in the past recorded relatively high SO_2 concentrations, met the AQS objective for the 15-minute mean for the first time in 2002. Further years' monitoring will establish whether the site continues to consistently meet objectives.

7. Data from long-running sites indicate that SO_2 levels in Northern Ireland are decreasing. SO_2 concentrations were generally lower than those measured in 2001. Significant downward trends in annual mean SO_2 concentration were identified at Belfast Centre and Belfast East, but not Londonderry.

8. Net acidity data from the 39 urban non-automatic SO_2 (8-port sampler) sites also indicate that SO_2 levels in Northern Ireland are falling. In 2002, 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 first year for which this has been the case. The historical dataset from this network show a clear decrease in annual mean SO_2 concentrations since the 1960s, which remains evident in recent years' data.

9. The number of automatic sites monitoring particulate matter as PM_{10} increased from six to 18 during 2002. All sites met the AQS objective of 40 μg m^{-3} for the annual mean PM_{10}, as gravimetric equivalent. Two sites (Newry Trevor Hill and Strabane Springfield Park) exceeded the AQS objective of 50 μg m^{-3} for the 24-hour mean, on more than the permitted 35

occasions. Newry Trevor Hill is a roadside site in a busy town centre, Strabane Springfield Park is on a housing estate where coal and oil burning is prevalent.

10. Several of the new PM_{10} monitoring sites had less than 90% data capture for the year, and were therefore assessed by comparing the 90th percentile of 24-hour means with the 24-hour objective (as specified by the Technical Guidance). Of these sites, two (Belfast Westlink and Strabane) did not meet the 24-hour mean objective in 2002.

11. 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_{10} concentrations.

12. Particulate matter as black smoke is measured at 39 sites, of which 35 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_{10} monitor: this smoke sampler confirms that levels of suspended particulate are high at this location.

13. 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 3rd Daughter Directive target) was exceeded on more than the permitted 10 days in 2002 at Londonderry. The majority of these days occurred during the period March to May 2002. (This site exceeded the AQS objective for ozone in 2000 also).

14. Benzene monitoring began in July 2002 at Belfast Centre and Belfast Roadside. The 2002 6-month means of 2.47 μg m^{-3} at Belfast Roadside and 1.04 μg m^{-3} at Belfast Centre were well within the AQS objective for the running annual mean, and also within the EC 2nd Daughter Directive limit value. These initial results are also consistent those from the former Belfast South site.

15. 1,3-butadiene monitoring at Belfast Centre and Belfast Roadside did not commence until 2003. However, data for 2003 so far indicate that levels of this pollutant at both sites are well within the applicable Air Quality Strategy objective of 2.25 μg m^{-3}. This is consistent with the findings from the former Belfast South site.

16. Polycyclic aromatic hydrocarbons were monitored at two sites (Belfast Clara Street and Lisburn Dunmurry). Both sites showed a reduction in annual mean benzo(a)pyrene concentration in 2002. Belfast Clara Street now meets the proposed EC Target Value for B(a)P, but Lisburn remains significantly above the proposed Target Value.

11 Acknowledgements

Netcen would like to thank the District Councils and other organisations that carried out the air quality measurements detailed in this report, and CEHOG for collating their data.

12 References

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Appendices

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Appendix 1
Diffusion Tube Site Details and Data

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Table A1.1 NO_2 Diffusion Tube Data, 2002. Page 1 of 7

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*	Annual mean NO2, 2002, ug/m3
Antrim	Main Street, Templepatrick	3233	3858	NO		A		**31.0**
Antrim	Main St, Randalstown	3082	3904	NO		A		**35.0**
Antrim	Fountain Street, Antrim	3154	3865	NO		A		**23.0**
Antrim	M2/Ballyclare Road	3244	3864	NO		A	*9*	**25.0**
Antrim	Ballymena Road, north of Dunsilly	3135	3905	NO		A		**27.0**
Antrim	Belfast Road/Ballyclare Road	3235	3859	NO		A	*10*	**22.0**
Antrim	Ballycraigy Road/ Greystone Road	3171	3868	NO		A	*9*	**26.0**
Antrim	Oldstone Road/ A57	3175	3817	NO		A	*10*	**21.0**
Antrim	Belmont Road/ Belfast Road, (until Nov 2002)	3164	3858	NO		A	*10*	**17.0**
Antrim	Main St, Randalstown	3082	3904	NO		A		**35.0**
Antrim	Ballymena Road North of Dunsilly	3135	3905	NO		A	*11*	**26.0**
Antrim	Ballymena Road /Stiles Way	3144	3883	NO		A	*11*	**17.0**
Antrim	Fountain St, Antrim	3153	3865	NO		A	*11*	**29.0**
Antrim	Donegore Bridge, Antrim	3208	3874	NO		B		**18.0**
Antrim	M2 (until Nov 2002)	3169	3891	NO		B	*9*	**18.0**
Antrim	Stiles Way/ Fountain Hill, (until Nov 2002)	3163	3876	NO		B	*10*	**16.0**
Antrim	Background - Templepatrick	3232	3857	NO		D		**10.0**
Antrim	Main St, Crumlin (started Nov 2002)			NO				
Antrim	Tully Road, Crumlin (started Nov 2002)			NO				
Antrim	Ballymena Road/Oriel Road junction (started Nov 2002)			NO				
Ards	8 Court Street, Newtownards	3485	3735	YES	NEWTOWNARDS 1N	A		**24.9**
Ards	Rear of Town Hall opposite 18 Frances Street, Newtownards	3481	3741	YES	NEWTOWNARDS 7N	A		**25.2**
Ards	7 Ashgrove, Newtownards	3485	3745	YES	NEWTOWNARDS 3N	C		**6.9**
Ards	19 Islandmore Avenue, Newtownards	3495	3750	YES	NEWTOWNARDS 6N	C		**11.0**
Armagh	25 Railway Street, Armagh	2875	3458	YES	ARMAGH 5N	A		**37.1**
Armagh	Bridge House, Barrack Street, Armagh	2879	3450	YES	ARMAGH 3N	A		**16.1**
Armagh	St Patricks Fold, Scotch Street, Armagh	2877	3450	NO		A		**21.0**
Armagh	19 Victoria Street, Armagh	2882	3453	NO		A		**31.9**
Armagh	Portadown Road, Armagh	2887	3459	NO		A	*8*	**26.6**
Armagh	Lower Irish Street, Armagh	2874	3448	NO		A	*8*	**32.3**
Armagh	7 Desart Lane, Armagh	2868	3457	YES	ARMAGH 7N	C		**33.5**
Armagh	17 Folly Lane, Armagh	2882	3448	YES	ARMAGH 4N	C		**18.7**
Ballymena	29 Galgorm Road, Ballymena	3103	4032	YES	BALLYMENA 2N	A		**28.7**
Ballymena	Ballymoney Street, Ballymena	3108	4035	YES	BALLYMENA 5N	A		**28.7**
Ballymena	Queen Street, Ballymena	3107	4022	NO		A		**28.7**
Ballymena	Lisnevenagh Road, Ballymena	3119	3970	NO		A		**21.0**
Ballymena	Main Street, Cullybackey	3058	4056	NO		A		**21.0**
Ballymena	Cullybackey Road, Ballymena	3103	4034	NO		A		**23.0**

Table A1.1 NO_2 Diffusion Tube Data, 2002 – continued: page 2 of 7

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*	Annual mean NO2, 2002, ug/m3
Ballymena	North Road, Ballymena	3106	4030	NO		A		**28.7**
Ballymena	George Street, Ballymena	3105	4032	NO		A		**40.2**
Ballymena	Wellington Street, Ballymena	3108	4033	NO		A		**24.9**
Ballymena	Larne St, Ballymena	3106	4029	NO		A		**24.9**
Ballymena	Parkway, Ballymena	3110	4039	NO		A		**24.9**
Ballymena	Leighmore Avenue, Ballymena	3102	4025	YES	BALLYMENA 1N	C		**13.4**
Ballymena	8 Ballyloughan Avenue, Ballymena	3095	4044	YES	BALLYMENA 4N	C		**15.3**
Ballymoney	19 Linenhall Street, Ballymoney	2948	4259	YES	BALLYMONEY 1N	A		**25.7**
Ballymoney	Adajacent 8 Ballybogey Road, Ballymoney	2942	4269	YES	BALLYMONEY 5N	A	*6*	**19.2**
Ballymoney	6 Church Street, Ballymoney	2948	4258	NO		A		**18.6**
Ballymoney	31 Charles Street, Ballymoney	2946	4261	NO		A		**26.4**
Ballymoney	Opposite 51 Queen Street, Ballymoney	2952	4258	NO		A		**18.9**
Ballymoney	Ballymena Road, Ballymoney	2960	4257	NO		A		**11.3**
Ballymoney	Castle St,Gate End	2947	4253	NO		A		**17.9**
Ballymoney	Frosses Road / Kilraughts Road junction	2964	4261	NO		A		**14.4**
Ballymoney	Opposite 16 Armour Avenue, Ballymoney	2953	4256	YES	BALLYMONEY 3N	C		**10.7**
Ballymoney	2/4 Semicock Avenue, Ballymoney	2948	4268	YES	BALLYMONEY 4N	C		**12.0**
Banbridge	Dromore Street, Banbridge	3128	3462	NO		A		**33.8**
Banbridge	Fortfield, Dromore (fence beside dual carriageway)	3199	3536	NO		A		**30.0**
Banbridge	17 Springfields, Banbridge	3121	3444	NO		C		**17.4**
Banbridge	9 Fortfield, Dromore	3199	3535	NO		D		**16.0**
Belfast	Belfast City Hall, Donegall Square South	3338	3739	YES	BELFAST 1N	A		**36.0**
Belfast	Milner Street	3324	3734	YES	BELFAST 5N	A		**43.0**
Belfast	Black's Road	3297	3695	NO		A		**23.9**
Belfast	Cromac Street (A)	3341	3735	NO		A		**26.8**
Belfast	Upper Newtownards Road	3372	3740	NO		A		**21.8**
Belfast	Cromac Street (B), Southern approaches	3342	3737	NO		A		**33.9**
Belfast	301 Ormeau Road, Southern approaches	3345	3722	NO		A		**39.6**
Belfast	400 Ormeau Road, Southern approaches	3350	3709	NO		A		**33.1**
Belfast	Saintfield Road, Southern approaches	3353	3698	NO		A		**24.9**
Belfast	Great George's Street	3339	3750	NO		A		**45.3**
Belfast	Upper Malone Road	3332	3699	NO		A		**22.0**
Belfast	Stockman's Lane	3312	3710	NO		A		**36.2**
Belfast	Upper Newtownards Road (Ballyhackamore)	3385	3740	NO		A		**44.2**
Belfast	Westlink, near Grosvenor Road roundabout	3330	3737	NO		A		**39.8**
Belfast	Primary School, North Road	3375	3741	YES	BELFAST 4N	B	*6*	**19.7**
Belfast	Royal Victoria Hospital, 12 Grosvenor Road Belfast	3324	3735	YES	BELFAST 3N	C		**23.5**
Belfast	Station Road	3373	3755	NO		C		**23.9**
Belfast	Lombard Street	3339	3743	NO		C		**28.9**
Carrickfergus	27 Upper Road, Greenisland	3362	3857	NO		A		**12.2**
Carrickfergus	Islandmagee Road, Whitehead	3476	3923	NO		A		**7.6**
Carrickfergus	59 Shore Road, Greenisland	3379	3849	YES	CARRICKFERGUS 1N	A		**13.6**

Table A1.1 NO_2 Diffusion Tube Data, 2002 – continued: page 3 of 7

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*	Annual mean NO2, 2002, ug/m3
Carrickfergus	Railway Station, Fergus Avenue, Carrickfergus	3412	3878	NO		B		**7.5**
Carrickfergus	32 Mullaghmore Park, Greenisland	3369	3856	YES	CARRICKFERGUS 3N	C		**5.7**
Carrickfergus	College North Road, Carrickfergus	3411	3889	YES	CARRICKFERGUS 4N?	C		**9.1**
Carrickfergus	28 Bentra Road, Whitehead	3454	3919	NO		D		**6.3**
Carrickfergus	Lough Road, Loughmourne	3412	3921	NO		D		**13.8**
Carrickfergus	42 Albert Road Carrickfergus	3413	3876	NO			*6*	**4.6**
Carrickfergus	Model PS 4 Belfast Road Carrickfergus	3408	3871	NO			*6*	**13.9**
Carrickfergus	93 Belfast Road Carrickfergus	3399	3867	NO			*6*	**16.1**
Castlereagh	Council Offices, 368 Cregagh Road, BT6 9EZ	3362	3713	YES	CASTLEREAGH 1N	A	*12*	**13.0**
Castlereagh	985 Upper Newtownards Road, Dundonald	3420	3740	NO		A		**44.9**
Castlereagh	2 Newtownards Road	3352	3701	NO		A		**35.3**
Castlereagh	Lamp post, 17/19 Everton Drive, Castlereagh	3361	3712	YES	CASTLEREAGH 5N	C	*12*	**13.0**
Castlereagh	74 Downshire Park East	3365	3714	YES	CASTLEREAGH 6N	D	*12*	**10.0**
Coleraine	Lower Union Street / Minburn Road, Coleraine	2848	4328	NO		A	*4*	**22.0**
Coleraine	Upper Union Street, Railway Road, Coleraine	2851	4328	NO		A	*4*	**14.2**
Coleraine	Ring Road, Lodge Road Roundabout, Coleraine	2858	4314	NO		A	*4*	**14.2**
Coleraine	Railway Road, Coleraine	2852	4327	NO		A	*10*	**12.4**
Coleraine	Waterside traffic lights / Strand Road, Coleraine	2845	4325	NO		A	*10*	**12.2**
Coleraine	Dunnes car park / Coleraine Bridge, Coleraine	2846	4325	NO		A	*10*	**8.9**
Coleraine	Crocknamuck Road / Dunluce Ave, Portrush	2861	4400	NO		A	*10*	**15.1**
Coleraine	Spanboard, Coleraine	2859	4299	NO		E	*10*	**5.1**
Coleraine	University, Coleraine	2845	4235	NO		E	*10*	**7.9**
Cookstown	High Street, Moneymore	2857	3834	NO		A		**32.1**
Cookstown	James St, Cookstown	2810	3783	NO		A		**31.8**
Cookstown	Church St, Cookstown	2811	3775	NO		A		**31.6**
Cookstown	Killymoon St, Cookstown	2812	3769	NO		A		**25.8**
Cookstown	William St, Moneymore	2810	3784	NO		B		**33.3**
Craigavon	Castle Hardware, 7 Market Street, Portadown	3010	3538	YES	CRAIGAVON 9N	A		**31.0**
Craigavon	Town Hall, Union Street, Lurgan	3083	3583	YES	CRAIGAVON 5N	A		**24.0**
Craigavon	4 Cluandara, Derrymacash, Craigavon	3044	3593	NO		A		
Craigavon	Ashgrove community centre, Garvaghy Road, Portadown	3004	3548	NO		B		
Craigavon	36 Ardboe Drive, Lurgan	3080	3577	YES	CRAIGAVON 7N	C		**19.0**
Craigavon	21 Ballyhannon Road, Portadown	3081	3578	YES	CRAIGAVON 8N	C		**15.0**
Craigavon	Castle Lane (toilets), Lurgan	3082	3585	NO		C		
Craigavon	Lord Lurgan Park, Lurgan	3080	3593	NO		C		
Derry	3 Creggan Road, Derry	2428	4173	YES	LONDONDERRY 8N	A	*9*	**52.0**
Derry	3 Glendermot Road, Derry	2443	4167	YES	LONDONDERRY 9N	A	*8*	**32.7**
Derry	7 Harberton Park (Altnagelvin Lights)	2452	4156	NO		A	*9*	**24.1**
Derry	26 Rossdowney Park (Irish St Lights)	2449	4162	NO		A	*9*	**23.3**
Derry	Spencer Road / Victoria Road Flats	2438	4159	NO		A	*9*	**37.9**
Derry	6 Dacre Terrace	2436	4163	NO		A	*9*	**19.5**

Table A1.1 NO_2 Diffusion Tube Data, 2002 – continued: page 4 of 7

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*	Annual mean NO2, 2002, ug/m3
Derry	67 Clarendon Street	2432	4173	NO		A	*8*	**30.4**
Derry	54 William Street	2433	4169	NO		A	*8*	**19.9**
Derry	27 Park Avenue	2429	4177	NO		A	*8*	**22.2**
Derry	1 Simpson Brae, Derry	2442	4163	NO		A	*9*	**22.2**
Derry	123a Strand Road, Derry	2437	4182	NO		A		**0.0**
Derry	3 Farren park, Derry	2438	4187	NO		A	*8*	**24.9**
Derry	19 St Patricks Terrace, Derry	2434	4189	NO		A	*9*	**36.5**
Derry	34 Northland Terrace, Derry	2433	4179	NO		A	*9*	**25.1**
Derry	3 Silverbirch Crescent, Derry	2453	4167	YES	LONDONDERRY 11N	C	*9*	**15.9**
Derry	Brooke Park, Infirmary Road	2429	4173	YES	LONDONDERRY 10N	C	*11*	**14.2**
Derry	Brooke Park, Infirmary Road	2429	4173	YES	LONDONDERRY 10N	C	*9*	**15.3**
Derry	Brooke Park, Infirmary Road	2429	4173	YES	LONDONDERRY 10N	C	*9*	**14.2**
Down	5 St Patrick's Avenue, Downpatrick, BT30 6DW	3486	3445	NO		A	*9*	**19.4**
Down	9 Irish Street, Downpatrick, BT30 6BN	3487	3446	YES	DOWNPATRICK 1N	A		**25.0**
Down	19 Church Street, Ballynahinch BT24 8AF	3366	3422	YES	BALLYNAHINCH 9N	A	*11*	**18.5**
Down	Stream Street, Downpatrick BT30 6DD	3489	3442	NO		A	*9*	**17.5**
Down	Main Street, Saintfield BT24 7AA	3407	3591	NO		A	*9*	**15.0**
Down	4 Main Street, Newcastle	3378	3316	NO		A		**15.6**
Down	11 Orchard Way, Strangford Road, Downpatrick, BT30 6LD	3489	3459	YES	DOWNPATRICK 4N	C		**7.0**
Down	7 St Patrick's Drive, Downpatrick, BT30 6NR	3486	3442	YES	DOWNPATRICK 3N	C		**16.0**
Dungannon	Church St	2798	3624	NO		A		
Dungannon	Market Square	2798	3625	YES	DUNGANNON 1N	A		**22.0**
Dungannon	Howard Primary School, Moy Road	2812	3607	YES	DUNGANNON 5N	A		**17.5**
Dungannon	4 Ardgannon	2796	3630	YES	DUNGANNON 3N	B		**12.9**
Dungannon	11 Bushvale	2811	3623	YES	DUNGANNON 4N	C		**12.1**
Fermanagh DC	Town Hall, Enniskillen BT74 7BA	2235	3441	NO		A		**12.0**
Fermanagh DC	Belmore Street, Enniskillen	2239	3440	NO		A		**18.2**
Fermanagh DC	Westbridge House Anne St, Enniskillen	2233	3443	NO		A	*8*	**19.6**
Fermanagh DC	29 Henry St Enniskillen	2231	3443	NO		A	*8*	**22.7**
Fermanagh DC	Everglades, Tempo Road, Enniskillen	2256	3447	NO		B		**3.9**
Fermanagh DC	Rossole Road, Enniskillen	2230	3432	NO		C		**4.4**
Larne	Victoria Road/Agnew Street junction	3403	4029	NO		A	*8*	**31.0**
Larne	Upper Caimcastle Road	3392	4032	NO		A	*8*	**20.3**
Larne	Larne Harbour Roundabout	3412	4020	NO		A	*8*	**24.9**
Larne	Coastguard Road	3413	4017	NO		A	*8*	**15.7**
Larne	Antiville Road/A8 junction	3386	4021	NO		A	*8*	**23.7**
Larne	Riverdale	3397	4025	NO		A	*8*	**20.7**
Larne	Main St	3402	4026	NO		A	*8*	**24.9**
Larne	Ballylumford Road	3421	4020	NO			*7*	**16.3**
Limavady	Junction of Ballyquin Road / Main St, Dungiven	2688	4095	NO		A	*5*	**38.7**

Table A1.1 NO_2 Diffusion Tube Data, 2002 – continued: page 5 of 7

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*	Annual mean NO2, 2002, ug/m3
Limavady	Junction of Garvagh Road / Main St, Dungiven	2693	4092	NO		A	*6*	**34.4**
Limavady	Clooney Road, Greysteel	2571	4211	NO		A	*3*	**18.6**
Limavady	Main St, Ballykelly	2629	4223	NO		A	*6*	**29.1**
Limavady	Linenhall St, Limavady	2669	4231	NO		A	*6*	**41.0**
Limavady	Junction of Rathmore Road / Scroggy Road,Limavady	2678	4233	NO		A	*6*	**23.9**
Limavady	Greystone Road, Limavady	2682	4225	NO		A	*4*	**17.1**
Limavady	Irish Green St, Limavady	2672	4229	NO		A	*7*	**34.6**
Lisburn	Northern Bank, 62 Bow Street, Lisburn, BT28 1BN	3265	3644	YES	LISBURN 1N	A		**22.5**
Lisburn	18 Kingsway, Dunmurry	3295	3689	YES	LISBURN 7N	A		**17.2**
Lisburn	Antrim Road, Lisburn	3263	3646	NO		B		**14.8**
Lisburn	10 Beechlawn Park, Dunmurry	3296	3691	NO		B		**16.6**
Lisburn	75 Edgewater, Lisburn	3272	3637	YES	LISBURN 6N	C	*4*	
Lisburn	22 Ventnor Park, Lambeg	3269	3620	YES	LISBURN 3N	C		**7.6**
Lisburn	Main Street, Moira	3151	3606	NO		C		**20.0**
Lisburn	Dunmurry High School, River Road, Dunmurry	3287	3675	NO		C		**5.2**
Magherafelt	Queen Street, Magherafelt	2896	3905	NO		A		**32.0**
Magherafelt	Church Street, Magherafelt	2897	3909	NO		A		**34.0**
Magherafelt	Main Street, Maghera	2853	4004	NO		A		**38.0**
Magherafelt	Eel fishery, Toomebridge	2989	3908	NO		A	*10*	**17.0**
Magherafelt	Boyne Row, Castledawson	2925	3932	NO		A	*10*	**18.0**
Magherafelt	King St, Magherafelt	2898	3907	NO		A	*10*	**22.0**
Magherafelt	Wesleyan Mews, Magherafelt	2899	3907	NO		B		**24.0**
Moyle	Middle Park Road, Cushendall	3239	4272	NO		A	*4*	
Moyle	Light pole, Dunluce Road, Bushmills	2937	4408	NO		A	*4*	
Moyle	Bush/Dundarave estate entrance, Bushmills	2942	4409	NO		A	*4*	
Moyle	Elmwood car park, Bushmills	2947	4406	NO		B	*4*	
Moyle	Sheskburn House, 7 Mary St, Ballycastle	3122	4412	NO		B	*4*	
Moyle	Mill Street car park, Cushendall	3237	4275	NO		B	*4*	
Moyle	Leyland Road, Ballycastle	3101	4415	NO		B	*4*	
Moyle	St Patricks' PS, 244 Garron Road, Glenariff	3243	4252	NO		B	*4*	
Newry & Mourne	20a Water Street, Newry, Alexander Hanna	3086	3265	YES	NEWRY 6N	A		**38.3**
Newry & Mourne	St Colmans Parochial Hall, Trevor Hill, Newry	3088	3268	YES	NEWRY 10N	A		**32.5**
Newry & Mourne	Monaghan Row, Newry	3078	3268	YES	NEWRY 11N	C		**11.5**
Newry & Mourne	19 Balmoral Park, Newry	3094	3275	YES	NEWRY 9N	C		**15.3**
Newtownabbey	49 Main Street, Ballyclare	3288	3911	YES	NEWTOWNABBEY 1N	A		**33.0**

Table A1.1 NO_2 Diffusion Tube Data, 2002 – continued: page 6 of 7

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*	Annual mean NO2, 2002, ug/m3
Newtownabbey	690 Shore Road, Newtownabbey	3367	3837	YES	NEWTOWNABBEY 12N	A		**21.0**
Newtownabbey	O'Neill Road/Doagh Road roundabout, Newtownabbey	3355	3823	NO		A		**20.0**
Newtownabbey	A8 motorway Sandyknowles, Newtownabbey	3305	3832	NO		A		**35.0**
Newtownabbey	Doagh Village, Doagh Road, Doagh	3262	3895	NO		A		**19.0**
Newtownabbey	Braden Heights, Rathcoole, Newtownabbey	3339	3819	YES	NEWTOWNABBEY 13N	A		**14.0**
Newtownabbey	21 Ballyhenry Road, Newtownabbey	3305	3832	YES	NEWTOWNABBEY 11N	A		**35.0**
Newtownabbey	McMillan House, 323 Antrim Road, Glengormley	3318	3882	NO		A		**24.0**
Newtownabbey	174 Monkstown Road, Newtownabbey	3343	3852	NO		A		**23.0**
Newtownabbey	145 Jordanstown Road, Newtownabbey	3352	3844	NO		A		**20.0**
Newtownabbey	opposite 1A Jordanstown Road, Newtownabbey	3365	3836	NO		A		**22.0**
Newtownabbey	Prince Charles Way, Newtownabbey	3333	3819	NO		A	*4*	
Newtownabbey	Station Road, Newtownabbey	3355	3824	NO		A		**22.0**
Newtownabbey	74 Shore Road, Newtownabbey	3367	3837	NO		A	*4*	
Newtownabbey	Nortel, Doagh Road, Newtownabbey	3342	3838	NO		A	*8*	**18.0**
Newtownabbey	Ballyclare Road/Manse Road roundabout, Newtownabbey	3314	3838	NO		A		**24.0**
Newtownabbey	Junction at A8 Doagh Road, Newtownabbey	3310	3859	NO		A		**19.0**
Newtownabbey	Main Street, Ballynure,Ballyclare	3319	3936	NO		A		**23.0**
Newtownabbey	Longshot Road, Doagh, Newtownabbey	3268	3885	NO		A		**20.0**
Newtownabbey	North End, Ballyclare	3287	3913	NO		A		**22.0**
Newtownabbey	Roundabout @ bottom of Main St,Ballyclare	3291	3909	NO		A		**21.0**
Newtownabbey	Scullions Road, Mallusk, Newtownabbey	3304	3829	NO		A		**33.0**
Newtownabbey	Tudor Park, Newtownabbey	3298	3834	NO		A		**18.0**
Newtownabbey	44 Sandyknowes Av, Newtownabbey	3306	3827	NO		A		**30.0**
Newtownabbey	M5 @ Shore Road, Newtownabbey	3354	3815	NO		A		**30.0**
Newtownabbey	Merville Garden Village	3348	3807	NO		A		**23.0**
Newtownabbey	189 Doagh Road, Newtownabbey	3344	3829	NO		A		**19.0**
Newtownabbey	Valley Leisure centre, Newtownabbey	3336	3814	NO		A		**28.0**
Newtownabbey	Greenacres, Glebe Road, Newtownabbey	3324	3832	NO		A		**14.0**
Newtownabbey	Hightown Road/Mallusk Road, Newtownabbey	3314	3821	NO		A		**27.0**
Newtownabbey	St Bernards' Road School, Antrim Road, Newtownabbey	3323	3819	NO		A		**34.0**
Newtownabbey	Burnthill Road, Newtownabbey	3315	3819	NO		A		**23.0**
Newtownabbey	Hillhead Road/Mill Road junction	3291	3909	NO		A	*8*	**24.0**
Newtownabbey	Bernice Road/Mallusk Road	3277	3835	NO		A	*8*	**18.0**
Newtownabbey	Antrim Road, Sandyknowes, Newtownabbey	3306	3829	NO		C	*8*	**26.0**

Table A1.1 NO_2 Diffusion Tube Data, 2002 – continued: page 7 of 7.

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*	Annual mean NO2, 2002, ug/m3
Newtownabbey	Prince Charles Way/Manse Road	3314	3838	NO		C	*8*	**29.0**
Newtownabbey	Oaklands, Old Carrick Road, Newtownabbey	3344	3852	NO		C	*8*	**18.0**
Newtownabbey	Henryville Court, Ballyclare	3296	3910	NO		C	*8*	**17.0**
North Down	52 Bingham Street, Bangor	3507	3819	YES	BANGOR NI 7N	A		**18.0**
North Down	132 Main Street, Bangor	3504	3815	YES	BANGOR NI 6N	A		**18.0**
North Down	Marine Parade Holywood	3400	3793	NO		A		**20.2**
North Down	68 Groomsport Road, Bangor	3520	3819	YES	BANGOR NI 4N	C		**9.0**
North Down	1 Rathmore Road, Bangor	3483	3815	YES	BANGOR NI 8N	C		**11.0**
North Down	Station Road Cultra	3416	3800	NO		C		**16.5**
North Down	Bangor Road Seahill	3433	3808	NO		C		**22.3**
North Down	Bangor Road Ballyrobert	3450	3808	NO		C		**19.6**
Omagh	Campsie Road, Omagh	2457	3727	NO		A	7	**18.1**
Omagh	Hospital Road, Omagh	2465	3725	NO		A	7	**8.9**
Omagh	Swingbars Roundabout, Omagh	2460	3728	NO		A	7	**14.6**
Omagh	Dublin Road, Omagh	2456	3724	YES	OMAGH 1N?	A	7	**11.7**
Omagh	Great Northern Road, Omagh	2453	3735	NO		A	7	**24.8**
Omagh	Dromore Road, Omagh	2445	3270	NO		A	7	**9.9**
Omagh	Tamlaght Road, Omagh	2422	3722	YES	OMAGH 5N?	A	7	**10.8**
Omagh	McConnell Place, Omagh	2445	3725	YES	OMAGH 7N?	A	7	**13.0**
Omagh	Sedan Avenue, Omagh	2451	3729	NO		A	7	**14.1**
Omagh	Lisanelly Avenue, Omagh	2452	3733	NO		A	7	**13.0**
Omagh	Gortmore Gardens	2422	3722	YES	OMAGH 6N	A	7	
Strabane	Urney Road, Strabane	2337	3974	NO		A	7	**12.6**
Strabane	Melmount Road, Strabane	2339	3962	NO		A	7	**11.9**
Strabane	Main St, Newtownstewart	2402	3857	NO		A	7	**15.2**
Strabane	Main St, Castlederg	2262	3844	NO		A	7	**10.5**
Strabane	Main St, Strabane	2345	3975	NO		A	7	**14.5**

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.

Table A1.2 SO_2 Diffusion Tube Data, 2002 – page 1 of 2

Local Authority	Location of Sampler	Grid Reference Easting (to Nearest m)	Grid Reference Northing (to Nearest m)	Duration	Site Classification (if E, nature of source)	Height of sampler inlet above ground level	Monitoring & Reporting of results subject to any Quality Assurance/Quality Control or Accreditation systems YES/NO (if YES specify)
Antrim	Greystone Link	317200	386800	January-December	C	2m	NO
Antrim	Crumlin Community centre	315400	376200	February-December	C	2m	NO
Antrim	Railway Rd, (until Nov 2002)	315100	386800	january-September	C	2m	NO
Antrim	Stiles Community Centre	316200	387000	January-December	C	2m	NO
Antrim	Rathenraw Ind. Estate	317300	386900	January-December	C	2m	NO
Antrim	Moylena Road	315800	386000	January-December	C	2m	NO
Antrim	Durnish Road (ENVIRO)	314800	388800	January-July	C	2m	NO
Antrim	Randalstown Community Centre	308200	390700	January-December	C	2m	NO
Antrim	Cunningham Way	315100	386000	January-December	C	2m	NO
Antrim	Townparks North in Nov 2002				C		
Armagh	4 Lonsdale Rd, Armagh	287600	345800	March 2002-March 2003	A		NO
Armagh	Dobbin Street Community Centre	287700	345000	March 2002-March 2003	A		NO
Armagh	Filling station , Killylea Rd	286800	344900	March 2002-March 2003	A		NO
Armagh	Youth hostel, Callan St	287300	345300	March 2002-March 2003	A		NO
Armagh	7 Desart Lane, Armagh	286800	345700	March 2002-March 2003	A		NO
Armagh	St Patricks PS., Loughgall Rd	287300	346300	March 2002-March 2003	A		NO
Armagh	72 Drumadd Terrace	288500	345400	March 2002-March 2003	A		NO
Armagh	17 Folly Lane, Armagh	288200	344700	March 2002-March 2003	A		NO
Ballymena	Tobar Park	305980	405880	March - December	A	2.5m	NO
Ballymena	Chichester Park	311310	402390	March - December	A	2.5m	NO
Ballymena	Demense Estate	311030	403280	March - December	B	2.5m	NO
Ballymena	Brookfield Gardens	304610	401630	March - December	C	2.5m	NO
Ballymena	Dunclug (Cush Rd)	310990	405150	March - December	C	2.5m	NO
Ballymena	Dunclug (Grove Rd)	310830	405340	March - December	C	2.5m	NO
Ballymena	Rectory Estate	310840	404150	March - December	C	2.5m	NO
Ballymena	Ballykeel 1 (middle)	311660	402700	March - December	C	2.5m	NO
Ballymena	Ballykeel 2 (beside sign)	312230	402770	March - December	C	2.5m	NO
Ballymena	Drumtara	311050	401240	March - December	C	2.5m	NO
Ballymoney	Kirk Rd, Ballymoney	295640	426400	January - December	A	2.5m	NO
Ballymoney	Parkview Ballymoney	295120	426300	January - December	A	2.5m	NO
Ballymoney	Knocklayde Park, Ballymoney	295460	425960	January - December	B	2.5m	NO
Ballymoney	Carnany Drive, Ballymoney	296480	425740	January - December	C	2.5m	NO
Ballymoney	Carnany Gardens Ballymoney	296300	425640	January - December	C	2.5m	NO
Ballymoney	Raceview Road Ballymoney	295540	425300	January - December	C	2.5m	NO
Ballymoney	Stuart Park Ballymoney	295850	425410	January - December	C	2.5m	NO
Ballymoney	Alexandra Av, Ballymoney	295300	426350	January - December	C	2.5m	NO
Carrickfergus	Lough Road, Loughmourne	341200	392100	January - December	A	3m	
Carrickfergus	Town Hall, Carrickfergus	341500	387600	January - December	C	3m	
Coleraine	30 Dansehills Road, Coleraine	485600	233700	February - December	A	3.5M	NO
Coleraine	Pates Lane, Coleraine	484500	232300	March02- Feb 04	A	3.5m	NO
Coleraine	6/8 Ganimore Avenue, Portrush	485800	239400	February - December	C	3.5M	NO
Coleraine	Cuilrath St, Coleraine (Harpurs Hill)	488100	232800	March02- Feb 04	C	3.5m	NO
Coleraine	Castleton Park, Portstewart	482100	238100	March02- Feb 04	C	3.5m	NO
Cookstown	Edinburgh Drive, Cookstown				C		
Cookstown	Ratheen, Cookstown				C		
Cookstown	Millburn Park, Cookstown				C		
Cookstown	Stewart Ave, Cookstown				C		
Craigavon	Ashgrove Community Centre, Garvaghy Rd.	300360	354830		B	Approx 2m	No
Craigavon	Mourneview Community centre, Lurgan	308240	357210		B		No
Craigavon	36 Ardboe Drive, Lurgan	308050	357730		C	Approx 2m	No
Craigavon	Lord Lurgan Park, Lurgan	307980	359301		C		No
Craigavon	Castle lane (toilets), Lurgan	308230	358450		C	Approx 2.5m	No
Craigavon	38 Corcrain Ave	299940	354150		C	Approx 2m	No
Craigavon	12 Kernan Hill Manor, Kernan Hill Rd.	303140	355830		E	Approx 2m	No
Craigavon	67 Lake St, Lurgan	308200	359450		E	Approx 2m	No
Derry	4 Greenhaw Gardens	243800	419700	March - December	A	3.5m	NO
Derry	33 Bawnmore Place	247100	420900	March - December	A	3.5m	NO
Derry	Caw Community House, 65 Sperrin Park	246300	417700	March - December	A	3.5m	NO
Derry	70 Marianus Park	241700	418600	March - December	A	3.5m	NO
Derry	12 Dunaff Gardens	242700	416700	March - December	A	3.5m	NO
Derry	3 Silverbirch Crescent, Derry	245300	416700	March - December	A	3.5m	NO
Derry	27 Park Avenue	242900	417700	March - December	A	3.5m	NO
Derry	11 Violet Street	244500	416400	March - December	A	3.5m	NO
Derry	125 Galliagh park	242800	420400	March - December	A	3.5m	NO
Derry	Brandywell centre, Lecky Rd	242800	416300	March - December	A	3.5m	NO

Table A1.2 SO_2 Diffusion Tube Data, 2002 – page 2 of 2

Local Authority	Location of Sampler	Grid Reference Easting (to Nearest m)	Grid Reference Northing (to Nearest m)	Duration	Site Classification (if E, nature of source)	Height of sampler inlet above ground level	Monitoring & Reporting of results subject to any Quality Assurance/Quality Control or Accreditation systems YES/NO (if YES
Fermanagh DC	Everglades, Tempo Road, Enniskillen	225600	344700	January - December	B	2.6	YES - Analysing Laboratory S
Fermanagh DC	35 Derrin Rd Enniskillen	223330	344750	May - December	B	2.5	YES - Analysing Laboratory S
Fermanagh DC	20 Hillview Rd Enniskillen	223800	345100	May - December	B	2.9	YES - Analysing Laboratory S
Fermanagh DC	61 Windmill Hts Enniskillen	222750	344170	May - December	B	2.7	YES - Analysing Laboratory S
Fermanagh DC	28 Killynure Crescent Enniskillen	224770	343860	May - December	B	2.6	YES - Analysing Laboratory S
Fermanagh DC	Rossole Road, Enniskillen	223000	343100	January - December	C	2.8	YES - Analysing Laboratory S
Larne	Coastguard Rd	341310	401710	May02-Dec 03	A	Approx. 2m	YES
Larne	Dromaine Drive	338390	403890	June02-Dec03	C	Approx. 2m	YES
Larne	Green Way	339030	403530	June02-Dec03	C	Approx. 2m	YES
Larne	Loran Avenue	338960	402720	June02-Dec03	C	Approx. 2m	YES
Larne	St John's Place East	339920	402810	June02-Dec03	C	Approx. 2m	YES
Larne	Recreation Rd	340530	403650	June02-Dec03	C	Approx. 2m	YES
Larne	Channel Vista, Glenarm	342060	402030	June02-Dec03	C	Approx. 2m	YES
Larne	Ballylumford Rd	330660	415610	June02-Dec03	C	Approx. 2m	YES
Limavady	Station Rd/Holmlea Park, Dungiven	267100	422200	January - December	A	1.5m	NO
Limavady	143 Mount Eden, Limavady	268300	421700	January - December	A	1.5m	NO
Limavady	108 Roemill Gardens, Limavady	268900	409500	January - December	A	1.5m	NO
Lisburn	Barley Hill, Lisburn	327200	364400	January - December	C	2.5m	NO
Lisburn	Ballyknockan Park, knockmore	324800	363900		C	2.5m	NO
Lisburn	22 Ventor Park, Lisburn	326900	367000	January - December	C	2.5m	NO
Lisburn	22 Lawnbrook Drive, Low Road, Lisburn	322800	365300	January - December	C	2.5m	NO
Lisburn	75 Edgewater, Lisburn	327200	363700	January - December	C	2.5m	NO
Lisburn	36 Credenhill Park, Dunmurry	328500	369600	January - December	C	2.5m	NO
Lisburn	2 Beattie Park North, Dunmurry	329500	367500	January - December	C	2.5m	NO
Lisburn	25a Lilac Walk, Seymour Hill, Dunmurry	329200	367800	January - December	C	2.5m	NO
Lisburn	8 Pine Cross, Seymour Hill, Dunmurry	328600	367200	January - December	C	2.5m	NO
Lisburn	4 Hornbeam Road, Seymour Hill, Dunmurry	328600	367400	January - December	C	2.5m	NO
Lisburn	66 Larch Grove, Seymour Hill, Dunmurry	329300	367800	January - December	C	2.5m	NO
Lisburn	36/38 Elm Corner, Seymour Hill, Dunmurry	329100	367800	January - December	C	2.5m	NO
Magherafelt	Greenvale Leisure Centre, Magherafelt	289600	390160	January - December	A	N/A	YES - Lambeth Labs
Magherafelt	Westland Rd, Magherafelt	289330	390220	January - December	A	N/A	YES - Lambeth Labs
Magherafelt	Greenvale Park, Magherafelt	289630	390020	January - December	C	N/A	YES - Lambeth Labs
Moyle	Market St, Ballycastle	311400	440600	March 2002-June 2002	A	3m	
Moyle	Church/Main St, Ballycastle	294300	440600	March 2002-June 2002	A	3m	
Moyle	Lower Main St, Bushmills	294200	440800	March 2002-June 2002	A	3m	
Moyle	St Patricks' PS., 244 Garron Rd, Glenariff	324300	425200	March 2002-June 2002	B	3m	
Moyle	Middle Park Rd, Cushendall	323900	427200	March 2002-June 2002	B	3m	
Moyle	Mill St. car park, Cushendall	323700	427500	March 2002-June 2002	B	3m	
Moyle	Leyland Rd, Ballycastle	310100	441500	March 2002-June 2002	B	3m	
Moyle	Sheskburn House, 7 Mary St, Ballycastle	312200	441200	March 2002-June 2002	B	3m	
Newry & Mourne	Newry St, Warrenpoint			FEB03-	A	2.5m	YES
Newtownabbey	Anderson Park, Doagh, Ballyclare	326300	389500	01/12/2001 -	A	3.5m	YES - Lambeth Labs
Newtownabbey	2 Ravelston Avenue, Carnmoney	332800	384100	01/12/2001 -	A	3.1m	YES - Lambeth Labs
Newtownabbey	2 Mountainvale Crescent, Glengormley	331300	382300	01/12/2001 -	A	3.1m	YES - Lambeth Labs
Newtownabbey	15 Carwood Avenue, Glengormley	331300	383500	01/12/2001 -	A	3.2m	YES - Lambeth Labs
Newtownabbey	57 Burnthill Crescent, Carnmoney	331700	383400	01/12/2001 -	A	3.1m	YES - Lambeth Labs
Newtownabbey	13 Waverley Road, Newtownabbey	332200	384200	01/12/2001 -	A	3.1m	YES - Lambeth Labs
Newtownabbey	9 Mountpleasant Road, Jordanstown	335300	384500	01/12/2001 -	A	3.1m	YES - Lambeth Labs
Newtownabbey	7 Glenbroome Park, Jordanstown	336100	383500	01/12/2001 -	A	3.2m	YES - Lambeth Labs
Newtownabbey	15/16 Burnside Park, Ballyclare	325600	391800	01/12/2001 -	A	3.1m	YES - Lambeth Labs
Newtownabbey	22 Osterley Park, Newtownabbey	332400	382500	01/12/2001 -	A	3.1m	YES - Lambeth Labs
Newtownabbey	24 Braden Heights	333900	381900	01/04/2002 -	A	4.0m	YES - Lambeth Labs
Omagh	Meelmore Rd, Omagh	*244500*	*374000*	June-December	C	1.8m	YES-WASP,NIS
Omagh	Hospital Rd, Omagh	*246500*	*372500*	June-December	C	1.8m	YES-WASP,NIS
Omagh	Mullaghmore, Omagh	*246500*	*373800*	June-December	C	2.5m	YES-WASP,NIS
Omagh	Tamlaght Rd, Omagh	*242200*	*372200*	June-December	C	1.8m	YES-WASP,NIS
Omagh	Ashfields Gardens, Fintona			June-December	C	1.8m	YES-WASP,NIS
Strabane	Newtownkennedy St, Strabane	235200	397400	June-December	C	2.0m	YES-NAT INT SCHEME
Strabane	Springhill Park, Strabane	235200	397300	June-December	C	2.0m	YES-NAT INT SCHEME
Strabane	Ballycolman estate, Strabane	234750	397000	June-December	C	2.0m	YES-NAT INT SCHEME
Strabane	Innisfree Gardens, Strabane	235250	397000	June-December	C	2.0m	YES-NAT INT SCHEME
Strabane	Carlton Drive, Strabane	233600	396750	June-December	C	2.0m	YES-NAT INT SCHEME
Strabane	Hillview Park, Castlederg	226350	385250	June-December	C	2.0m	YES-NAT INT SCHEME
Strabane	Glennelly view, Plumbridge			June-December	C	2.0m	YES-NAT INT SCHEME
Strabane	Allen Park, Donemana			June-December	C	2.0m	YES-NAT INT SCHEME
Strabane	Mourne Park, Newtownstewart	239800	385700	June-December	C	2.0m	YES-NAT INT SCHEME
Strabane	Church Square, Sion Mills	*234000*	*393500*	June-December	C	2.0m	YES-NAT INT SCHEME
Strabane	The Willows, Sion Mills	234200	393100	June-December	C	2.0m	YES-NAT INT SCHEME
Strabane	Beechmount Ave, Strabane	234200	396900	June-December	E	2.0m	YES-NAT INT SCHEME
Strabane	Olympic Drive, Strabane	234400	396800	June-December	E	2.0m	YES-NAT INT SCHEME
Strabane	Ashgrove Park, Strabane	234200	396700	June-December	E	2.0m	YES-NAT INT SCHEME
Strabane	Melmount Gardens, Strabane	233800	396750	June-December	E	2.0m	YES-NAT INT SCHEME

Appendix 2
Historic Datasets for NO_2, SO_2 and PM_{10}

CONTENTS

Table A2.1 NO_2 Results from Automatic Monitoring Sites 1992 - 2002

Year	Data Capture %	Max Hourly Mean $\mu g\ m^{-3}$	Annual Mean $\mu g\ m^{-3}$	No. of hourly means > 200 $\mu g\ m^{-3}$	Annual Mean > 40 $\mu g\ m^{-3}$?
Belfast Centre (Urban Centre)					
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
Londonderry AURN (Urban Background)					
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
Armagh (Roadside)					
2002	44	125	34	0	No
Belfast – Westlink (Roadside)					
2002	66	295	**56**	**21**	**Yes**
Belfast – Newtownards Road (Roadside)					
2002	66	212	**50**	2	**Yes**
Castlereagh Loughview Drive (Roadside)					
2002	50	132	28	0	No
Craigavon – Castle Lane *Data not Ratified*					
2002	75	157	13	0	No
Lisburn – Lagan Valley Hospital (Roadside)					
2002	45	221	**54**	1	**Yes**
Newry - Monaghan Row (Urban Background)					
2001	73	63	11	0	No
2002	91	105	15	0	No
Newry – Trevor Hill (Roadside)					
2001	61	103	19	0	No
2002	98	208	**44**	1	**Yes**

Note: Belfast Westlink and Newtownards Road started up 1st May 2002, Armagh, Castlereagh and Lisburn LHV started up 1st July 2002.

Table A2.2 SO_2 Results from Automatic Monitoring Sites 1992 - 2002

Year	Data Capture %	Max 15-minute mean, µg m^{-3}	No. of 15-minute means > 266 µg m^{-3}	Max 1-hr mean µg m^{-3}	No. of 1-hr means > 350 µg m^{-3}	Max 24-hr mean µg m^{-3}	No. of 24-hour means > 125 µg m^{-3}	Annual Mean µg m^{-3}
Belfast Centre								
1992	78	1256	***316***	1024	***43***	307	***12***	40
1993	97	867	***436***	766	***53***	355	***13***	48
1994	97	1046	***388***	934	***52***	389	***8***	45
1995	96	1317	***346***	963	***54***	406	***9***	40
1996	97	945	***326***	740	***45***	299	***10***	37
1997	96	607	***141***	426	8	171	***4***	29
1998	89	471	***47***	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
Belfast East								
1992	98	1650	***1176***	1448	***179***	489	***50***	69
1993	99	1267	***824***	1150	***125***	412	***35***	67
1994	99	1070	***453***	958	***59***	545	***18***	53
1995	92	1514	***579***	1402	***106***	705	***14***	56
1996	99	1176	***656***	1070	***108***	362	***22***	53
1997	99	774	***500***	636	***58***	245	***20***	45
1998	89	833	***199***	636	19	218	***9***	35
1999	99	601	***98***	487	5	152	***5***	29
2000	99	479	***38***	466	2	112	0	21
2001	94	450	***139***	399	13	226	***5***	24
2002	97	365	5	314	0	115	0	10
Londonderry AURN								
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
Newry, Monaghan Row								
2001	73	506	1	138	0	36	0	7
2002	95	146	0	114	0	39	0	6
Newry, Trevor Hill								
2001	61	128	0	74	0	29	0	8
2002	97	577	4	306	0	24	0	6
Ards *								
2002	17	150	0	116	0	48	0	-
Ballymena (Ballykeel)								
2002	41	142	0	77	0	36	0	6
Carrickfergus								
2002	50	51	0	49	0	17	0	3.3
Castlereagh (Espie Way)								
2002	NS	74	0	48	0	24	0	NS

Table A2.2 *continued:* SO_2 Results from Automatic Monitoring Sites 1992 - 2002

Year	Data Capture %	Max 15-minute mean, µg m^{-3}	No. of 15-minute means > 266 µg m^{-3}	Max 1-hr mean µg m^{-3}	No. of 1-hr means > 350 µg m^{-3}	Max 24-hr mean µg m^{-3}	No. of 24-hour means > 125 µg m^{-3}	Annual Mean µg m^{-3}
Craigavon (Lord Lurgan Park)								
2002	74	146	0	96	0	38	0	7
Dungannon (Lambfield)								
2002	18	94	0	38	0	24	0	-
Londonderry Brandywell								
2002	65	229	0	229	0	74	0	16
Lisburn (Council Offices)								
2002	49	101	0	48	0	15	0	3.5
Strabane (Springfield Park)								
2002	64	253	0	90	0	28	0	11

* Ards: data capture low (Nov & Dec 2002 only), and no QA/QC carried out on data.
NS = Not specified.

Table A2.3 Results from Automatic PM_{10} Monitoring Sites 1992 - 2002

Calendar Year	Data Capture %	Annual Mean $\mu g\ m^{-3}$	Max Daily Mean $\mu g\ m^{-3}$	No. of Daily means > 50 $\mu g\ m^{-3}$
Belfast Centre (TEOM, converted to gravimetric equivalent)				
1992	79	35	322	***44***
1993	96	***41***	156	***86***
1994	95	34	248	***38***
1995	95	32	190	35
1996	95	31	145	***44***
1997	96	32	110	***41***
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
Belfast Clara Street (Beta Attenuation Monitor)				
1999	95	22	71	12
2000	93	16	69	2
2001	92	19	128	14
2002	94	17	99	8
Londonderry AURN (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
Lough Navar (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
Newry, old site (TEOM, converted to gravimetric equivalent)				
1998	42	24	90	9
1999	80	23	76	8
2000	93	22	114	5
Newry, Monaghan Row (TEOM, converted to gravimetric equivalent)				
2001	70	20	68	4
2002	95	21	78	8
Newry , Trevor Hill (TEOM, converted to gravimetric equivalent)				
2001	61	34	86	26
2002	99	34	89	***38***
Ards (TEOM, converted to gravimetric equivalent)				
2002	17	30	53	1
Armagh, Lonsdale Road (TEOM, converted to gravimetric equivalent)				
2002	38	30	131	12

Table A2.3 *continued* - Results from Automatic PM_{10} Monitoring Sites 1992 - 2002

Calendar Year	Data Capture %	Annual Mean $\mu g\ m^{-3}$	Max Daily Mean $\mu g\ m^{-3}$	No. of Daily means > 50 $\mu g\ m^{-3}$
Belfast Westlink (TEOM, converted to gravimetric equivalent)				
2002	50	34	108	32
Carrickfergus (TEOM, converted to gravimetric equivalent)				
2002	50	17	51	1
Castlereagh Loughview Drive (TEOM, converted to gravimetric equivalent)				
2002	48	34	112	8
Castlereagh Espie Way (TEOM, converted to gravimetric equivalent)				
2002	48	26	74	3
Craigavon, Lord Lurgan Park (TEOM, converted to gravimetric equivalent)				
2002	74	15	78	2
Dungannon (TEOM, converted to gravimetric equivalent)				
2002	19	15	36	0
Lisburn Council Offices (TEOM, converted to gravimetric equivalent)				
2002	36	16	37	0
Lisburn (LVH) (TEOM, converted to gravimetric equivalent)				
2002	50	14	40	0
Londonderry Brandywell (TEOM, converted to gravimetric equivalent)				
2002	73	25	106	19
Strabane (BAM)				
2002	67	38	147	**48**

Appendix 3
Data from Smoke and SO_2 Sites

CONTENTS

The following two tables contain smoke and SO_2 data from Smoke and SO_2 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_2 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_2 concentrations for these are presented in the main report.

Table A3.1 Summary of Smoke and SO_2 Results for Northern Ireland, Calendar Year 2002. All concentrations in $\mu g\ m^{-3}$.

Code	Site Name	Authority	Irish Grid Ref to 100m East	Irish Grid Ref to 100m North	Summary of Smoke Data in 2002 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Summary of SO_2 Data 2002 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	NORTHERN IRELAND													
68851	ANTRIM 1	Antrim BC	3162	3869	32	16	12	89	130	32	21	18	44	67
69701	ARMAGH 1	Armagh	2877	3450	90	13	13	36	57	87	13	13	20	20
1637001	KEADY 1	Armagh	0845	0341	25	16	14	32	43	25	1	0	13	13
160005	BALLYMENA 5	Ballymena	3109	4053	75	10	10	20	23	73	12	12	24	30
160006	BALLYMENA 6	Ballymena	3120	4026	93	10	9	25	39	89	12	12	28	55
161504	BALLYMONEY 4	Ballymoney	2954	4259	99	8	7	29	76	100	12	13	20	26
270012	BELFAST 12	Belfast	3324	3737	95	8	6	40	90	95	16	13	37	63
270013	BELFAST 13	Belfast	3357	3740	100	7	5	23	61	100	30	32	51	90
270033	BELFAST 33	Belfast	3346	3755	100	9	7	31	51	100	32	32	51	90
270042	BELFAST 42	Belfast	3322	3748	98	7	5	27	40	98	29	26	50	96
270044	BELFAST 44	Belfast	3338	3740	100	6	4	15	43	100	28	26	45	57
270045	BELFAST 45	Belfast	3335	3723	100	6	5	21	51	100	28	26	51	70
270046	BELFAST 46	Belfast	3803	3334	100	5	4	17	31	100	22	19	38	58
768003	COLERAINE 3	Coleraine	2861	4328	6	12	11	36	44	6	15	15	19	19
797501	COOKSTOWN 1	Cookstown	2774	3806	40	16	8	115	151	35	reject	reject	reject	reject
2551504	PORTADOWN 4	Craigavon	3012	3538	6	14	9	43	48	0	-	-	-	0
2551506	PORTADOWN 6	Craigavon	3004	3548	36	4	3	11	27	35	8	6	27	30
2190012	LONDONDERRY 12	Derry	2438	4200	2	18	16	32	34	2	30	35	52	54
2190014	LONDONDERRY 14	Derry	2443	4174	80	6	5	16	25	76	19	14	48	74
1025001	DUNGANNON 1	Dungannon	2802	3629	86	9	6	31	50	98	14	12	25	31
1757703	LARNE 3	Larne	3400	4029	15	9	7	34	45	15	18	19	26	26
1757704	LARNE 4	Larne	3386	4037	48	5	4	20	96	48	22	24	30	30
1757705	LARNE 5	Larne	3401	4033	48	6	4	27	45	48	24	26	33	33
1032503	DUNMURRY 3	Lisburn	3287	3875	65	10	7	43	95	64	19	18	34	41
1845003	LISBURN 3	Lisburn	3263	3636	93	10	7	45	138	92	14	13	26	54
3325001	TWINBROOK 1	Lisburn	3281	3689	77	7	4	29	46	75	16	14	28	35
2233501	MAGHERAFELT 1	Magherafelt	2896	3901	99	7	4	34	55	99	11	13	20	27
512601	BUSHMILLS 1	Moyle District Council	2941	4409	16	13	14	34	50	14	3	0	12	18
2410003	NEWRY 3	Newry and Mourne	3078	3268	89	8	5	28	68	83	7	6	18	19
2412502	NEWTOWNABBEY 2	Newtownabbey	3318	3825	10	9	5	34	40	10	13	13	19	19
2412503	NEWTOWNABBEY 3	Newtownabbey	3321	3851	96	6	5	25	44	96	reject	reject	reject	reject
2412504	NEWTOWNABBEY 4	Newtownabbey	3283	3907	79	7	4	34	54	78	reject	reject	reject	reject
165005	BANGOR (CO DOWN) 5	North Down	3497	3810	100	17	13	61	110	97	14	13	29	48
1517501	HOLYWOOD 1	North Down	3397	3784	93	6	4	22	35	92	12	13	26	33
3111502	STRABANE 2	Strabane	2351	3972	82	27	21	75	172	82	10	7	20	20

Net acidity (as SO_2) data from COOKSTOWN 2, NEWTOWNABBEY 3 & 4 were rejected due to alkaline interference.