AEAT/ENV/R/1025

Air Quality Review and Assessment - Stage 2

A report produced for:

Armagh City and District Council

and

Dungannon and South Tyrone District Council

March 2002

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Executive Summary

The UK Government published its strategic policy framework for air quality management in 1995 establishing national strategies and policies on air quality, which culminated in the Environment Act, 1995 in Great Britain. The National Air Quality Strategy provides a framework for air quality control through air quality management and air quality standards. New national air quality standards have been proposed by the Expert Panel on Air Quality Standards (EPAQS) for the UK. These and other air quality standards and their objectives have been enacted through the Air Quality Regulations in England, Wales and Scotland (2000). The GB Environment Act 1995 requires Local Authorities to undertake an air quality review. In areas where air quality objectives are not anticipated to be met by the specified date, Local Authorities are required to establish Air Quality Management Areas to improve air quality.

In Northern Ireland there are at present no equivalent Air Quality Regulations. However, there is a duty to meet the Air Quality limit values set within the European Commission Air Quality Framework Directive on which the UK national air quality objectives are based. Consequently, Councils in Northern Ireland have proceeded with the review and assessment process of air quality on a non-statutory basis.

The first step in this process is to undertake a review of current and potential future air quality in a three staged approach. Armagh City and District Council and Dungannon and South Tyrone Borough Council have completed a Stage 1 review and assessment which concluded that a Stage 2 review and assessment was required for the pollutants nitrogen dioxide and particulate matter from traffic sources.

This report is equivalent to a stage two air quality review as outlined in the Government's published guidance. The air quality review investigates current and potential future air quality through an examination of the location and size of principal emission sources, emissions modelling exercises and by reference to monitored air quality data.

The conclusions of the report are as follows:

Particulate matter (PM_{10})

- Armagh City and District Council
  It is recommended that there is no need for a Stage 3 Review and Assessment
- Dungannon and South Tyrone District Council
  It is recommended that there is no need for a Stage 3 Review and Assessment

Nitrogen Dioxide (NO_2)

- Armagh City and District Council
  It is recommended that the Council continues to monitor concentrations in Irish Street. There is no need to proceed to a stage 3 review and assessment at this time.
- Dungannon and South Tyrone District Council
  It is recommended that the Council carry out some diffusion tube monitoring in Church St. Following this, consideration should be given to completing a Stage 3 review and assessment.

Contents

Acronyms and definitions

AQS	Air Quality Strategy
AADTF	annual average daily traffic flow
APEG	Airborne Particles Expert Group
AQMA	Air Quality Management Area
AUN	Automatic Urban Network
CHP	Combined Heat and Power plant
CNS	central nervous system
CO	Carbon monoxide
CRI	Chemical Release Inventory (now the Pollution Inventory)
DEFRA	Department of the Environment, Food and Rural Affairs.
DMRB	Design Manual for Roads and Bridges
EA	Environment Agency
EPA	Environmental Protection Act
EPAQS	Expert Panel on Air Quality Standards
HA	Highways Agency
HFO	heavy fuel oil
HGV	heavy goods vehicle
IPPC	Integrated Pollution Prevention and Control
M	mega ($1x10^6$)
MoD	Ministry of Defence
NAEI	National Atmospheric Emission Inventory
NETCEN	National Environmental Technology Centre
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
PG	Process Guidance (notes)
PI	pollution inventory
ppb	parts per billion
ppm	parts per million
PSG	Pollutant Specific Guidance (see Reference section)
SO_2	Sulphur dioxide
SoS	Secretary of State
SSAQR	Second Stage Air Quality Review
TEOM	tapered element oscillating microbalance
VOC	volatile organic compound

1 Introduction to the air quality review

The UK Government published its strategic policy framework for air quality management in 1995 establishing national strategies and policies on air quality, which culminated in the Environment Act, 1995 in Great Britain. The National Air Quality Strategy provides a framework for air quality control through air quality management and air quality standards. New national air quality standards have been proposed by the Expert Panel on Air Quality Standards (EPAQS) for the UK. These and other air quality standards and their objectives have been enacted through the Air Quality Regulations in England, Wales and Scotland (2000). The GB Environment Act 1995 requires Local Authorities to undertake an air quality review. In areas where air quality objectives are not anticipated to be met by the specified date, Local Authorities are required to establish Air Quality Management Areas to improve air quality.

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1.1 PURPOSE OF THE STUDY

NETCEN was commissioned by Armagh City and District Council and Dungannon and South Tyrone Borough Council to complete a Second Stage Air Quality Review (SSAQR) within their areas for road vehicular sources of air pollution. The review:

- Investigates present and potential future air quality in the Armagh City and District Council and Dungannon and South Tyrone Borough Council areas.
- Identifies any actions that are likely to be required by Armagh City and District Council and Dungannon and South Tyrone Borough Council under Part IV of the GB Environment Act, 1995
- Recommends actions, if necessary, to control the subsequent air quality within the Armagh City and District Council and Dungannon and South Tyrone Borough Council areas.

1.2 APPROACH TAKEN

The approach taken in this study was to:

1. Identify the principal sources of pollutant emissions affecting air quality in the Armagh City and District Council and Dungannon and South Tyrone Borough Council areas.
2. Model expected present and potential future levels of pollutant concentrations in the Armagh City and District Council and Dungannon and South Tyrone Borough Council area and identify the areas of the district which are likely to experience the highest concentrations of pollutants.
3. Indicate whether present and predicted future air quality in the Borough is likely to comply with the requirements of the UK Air Quality Strategy.
4. Identify areas for further investigation.

In preparing this report the latest version of the GB Government Pollutant Specific Guidance has been used (LAQM TG4(00)).

1.3 STRUCTURE OF THIS REPORT

This report is structured in the following way: Chapter 1 introduces the UK Air Quality Strategy (AQS) and the local data used in this review and assessment. Chapter 2 provides more details on the local air quality management process. Chapters 3 to 4 consider the pollutants specified in the AQS and give an overview including the AQS objectives, the national perspective and the input required for this review. Data from national concentration maps, monitoring studies, road traffic, and local and distant point sources are then considered. Each chapter closes with an indication of whether the relevant AQS objective is expected to be met, or whether further work is required. Chapter 5 summarises all the findings and recommendations of the work.

1.4 INFORMATION PROVIDED BY THE COUNCILS TO SUPPORT THIS ASSESSMENT

The following information from Armagh City and District Council and Dungannon and South Tyrone Borough Council was used to complete this review and assessment:

- Local air quality monitoring data
- Proposed developments
- Traffic flow and speed data
- Transport strategy

1.4.1 Armagh City and District Council Borough and its environs

The Armagh City and District Council area covers approximately 260 sq. miles and has a population of approximately 57,000. The focus of the district is Armagh itself, which provides many of the services for the surrounding area and is therefore and important commercial centre. The smaller urban communities in the district also provide local services and employment. The majority of the district is rural varying in character from the relatively closely populated orchard country in the north of the district to the more sparsely populated upland forested areas of the Fews, rising to the over 1000ft above sea level in the south of the district.

1.4.2 Dungannon and South Tyrone District Council Borough and its environs

Dungannon and south Tyrone has a population of 46,900 in an area of 315 sq. miles. It is an area rich in history that stretches from the westward shores of Lough Neagh up through the Clogher Valley and northwards to the foothills of the Sperrins. There is a wide range of industrial, educational, health, cultural and leisure facilities on offer. The area whilst predominantly rural in nature has some significant urban areas.

1.4.3 Local air quality monitoring data

1.4.3.1 Extent of data available

Both Armagh City and District Council and Dungannon and South Tyrone Borough Council carry out monitoring of nitrogen dioxide using passive diffusion tube samplers. PM_{10} data was also available from Armagh City and District Council. Appendix 1 gives more information about the local air quality monitoring.

~~1.1.1.2~~1.4.3.2 Quality Assurance/Quality control of data

The diffusion tubes were analysed by laboratories, which participate in the laboratory intercomparison exercises for the UK National NO_2 Diffusion Tube Network. The results in this report have therefore been corrected for analyst bias as advised in the GB Government Pollutant Specific Guidance.

~~1.1.4~~1.4.4 Traffic data

Appendix 2 summarises the traffic information used in the assessment.

~~1.1.1.1~~1.4.4.1 Flow and speed

Traffic flow measurements and 2004/2005 predictions have been used as supplied by the relevant councils, as have average traffic speeds.

1.4.4.2 Traffic Growth

The national air quality objectives are targets for 2004 or 2005. Traffic growth forecasts were provided by the NI Roads Service Division.

~~1.1.1.3~~1.4.4.3 Fraction of HGVs

The model requires estimates of the fraction of HGVs on the roads to predict the pollutant concentrations. These data were available from the respective councils.
The model used to predict the roadside concentrations requires estimates of the fraction of HGVs on the roads. This data was used as supplied by the individual councils.

~~1.1.1.4~~1.4.4.4 Assumed distance from the centre of the road to the kerbside

The model used to predict the roadside concentrations requires estimates of the distance of the receptor and the kerbside from the centre of the road. This information was available from the councils supplied on maps on which the required measurements could be measured.

2 The updated Air Quality Strategy

The UK Government published its proposals for review of the National Air Quality Strategy in early 1999 (DETR, 1999). These proposals included revised objectives for many of the regulated pollutants. A key factor in the proposals to revise the objectives was the agreement in June 1998 at the European Union Environment Council of a Common Position on Air Quality Daughter Directives (AQDD).

Following consultation on the Review of the National Air Quality Strategy, the Government prepared the Air Quality Strategy for England, Scotland, Wales and Northern Ireland for consultation in August 1999. It was published in January 2000 (DETR, 2000).

Table 2.1 Major elements of the Environment Act 1995

Part IV Air Quality	Commentary
Section 80	Obliges the Secretary of State (SoS) to publish a National Air Quality Strategy as soon as possible.
Section 81	Obliges the Environment Agency to take account of the strategy.
Section 82	Requires local authorities, any unitary or district, to review air quality and to assess whether the air quality standards and objectives are being achieved. Areas where standards fall short must be identified.
Section 83	Requires a local authority, for any area where air quality standards are not being met, to issue an order designating it an air quality management area (AQMA).
Section 84	Imposes duties on a local authority with respect to AQMAs. The local authority must carry out further assessments and draw up an action plan specifying the measures to be carried out and the timescale to bring air quality in the area back within limits.
Section 85	Gives reserve powers to cause assessments to be made in any area and to give instructions to a local authority to take specified actions. Authorities have a duty to comply with these instructions.
Section 86	Provides for the role of County Councils to make recommendations to a district on the carrying out of an air quality assessment and the preparation of an action plan.
Section 87	Provides the SoS with wide ranging powers to make regulations concerning air quality. These include standards and objectives, the conferring of powers and duties, the prohibition and restriction of certain activities or vehicles, the obtaining of information, the levying of fines and penalties, the hearing of appeals and other criteria. The regulations must be approved by affirmative resolution of both Houses of Parliament.
Section 88	Provides powers to make guidance which local authorities must have regard to.

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

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

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

It is intended that the NAQS will provide a framework for the improvement of air quality that is both clear and workable. In order to achieve this, the Strategy is based on several principles that include:

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

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

2.1.1 National Air Quality Standards

At the centre of the AQS is the use of national air quality standards to enable air quality to be measured and assessed. These also provide the means by which objectives and timescales for the achievement of objectives can be set. Most of the proposed standards have been based on the available information concerning the health effects resulting from different ambient concentrations of selected pollutants and are the consensus view of medical experts on the Expert Panel on Air Quality Standards (EPAQS). These standards and associated specific objectives to be achieved between 2003 and 2008 are shown in Table 2.2. The table shows the standards in ppb and $\mu g\ m^{-3}$ with the number of exceedences that are permitted (where applicable) and the equivalent percentile.

Specific objectives relate either to achieving the full standard or, where use has been made of a short averaging period, objectives are sometimes expressed in terms of percentile compliance. The use of percentiles means that a limited number of exceedences of the air quality standard over a particular timescale, usually a year, are permitted. This is to account for unusual meteorological conditions or particular events such as November 5th. For example, if an objective is to be complied with at the 99.9th percentile, then 99.9% of measurements at each location must be at or below the level specified.

Table 2.2 Air Quality Objectives in the Air Quality Regulations (2000) for the purpose of Local Air Quality Management

Pollutant	Concentration limits		**Averaging period**	**Objective** [number of permitted exceedences a year and equivalent percentile]	
	($\mu g\ m^{-3}$)	(ppb)		($\mu g\ m^{-3}$)	date for objective
Benzene	16.25	5	**running annual** mean	**16.25**	by 31.12.2003
1,3-butadiene	2.25	1	**running annual** mean	**2.25**	by 31.12.2003
CO	11,600	10,000	**running 8-hour** mean	**11,600**	by 31.12.2003
Pb	0.5	-	**annual** mean	**0.5**	by 31.12.**2004**
	0.25	-	**annual** mean	**0.25**	by 31.12.**2008**
NO_2 (see note)	200	105	**1 hour** mean	**200** [maximum of 18 exceedences a year or equivalent to the 99.8th percentile]	by 31.12.2005
	40	21	**annual** mean	**40**	by 31.12.2005
PM_{10} (**gravimetric**) (see note)	50	–	**24-hour** mean	**50** [maximum of 35 exceedences a year or ~ equivalent to the 90th percentile]	by 31.12.2004
	40	–	**annual** mean	**40**	by 31.12.2004
	266	100	**15 minute** mean	**266** [maximum of 35 exceedences a year or equivalent to the 99.9th percentile]	by 31.12.2005
SO_2	350	132	**1 hour** mean	**350** [maximum of 24 exceedences a year or equivalent to the 99.7th percentile]	by 31.12.2004
	125	47	**24 hour** mean	**125** [maximum of 3 exceedences a year or equivalent to the 99th percentile]	by 31.12.2004

Notes

1. Conversions of ppb and ppm to ($\mu g\ m^{-3}$) correct at 20°C and 1013 mb.
2. The objectives for nitrogen dioxide are provisional.
3. PM_{10} measured using the European gravimetric transfer standard or equivalent. The Government and the devolved administrations see this new 24-hour mean objective for particles as a staging post rather than a final outcome. Work has been set in hand to assess the prospects of strengthening the new objective.

2.1.2 Policies in place to allow these objectives to be achieved

The policy framework to allow these objectives to be achieved is one that that takes a local air quality management approach. This is superimposed upon existing national and international regulations in order to effectively tackle local air quality issues as well as issues relating to wider spatial scales. National and EC policies that already exist provide a good basis for progress towards the air quality objectives set for 2003 to 2008. For example, the Environmental Protection Act 1990 allows for the monitoring and control of emissions from industrial processes and various EC Directives have ensured that road transport emission and fuel standards are in place. These policies are being developed to include more stringent controls. Recent developments in the UK include the announcement by the Environment Agency in January 2000 on controls on emissions of SO_2 from coal and oil fired power stations. This system of controls means that by the end of 2005 coal and oil fired power stations will meet the air quality standards set out in the AQS.

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

An important part of the Strategy is the requirement for local authorities to carry out air quality reviews and assessments of their area against which current and future compliance with air quality standards can be measured. Over the longer term, these will also enable the effects of policies to be studied and therefore help in the development of future policy. The Government has prepared guidance to help local authorities to use the most appropriate tools and methods for conducting a review and assessment of air quality in their District. This is part of a package of guidance being prepared to assist with the practicalities of implementing the AQS. Other guidance covers air quality and land use planning, air quality and traffic management and the development of local air quality action plans and strategies.

2.1.3 Timescales to achieve the objectives

In most local authorities in the UK, objectives will be met for most of the pollutants within the timescale of the objectives shown in Table 2.2. It is important to note that the objectives for NO_2 remain provisional. The Government has recognised the problems associated with achieving the standard for ozone and this will not therefore be a statutory requirement. Ozone is a secondary pollutant and transboundary in nature and it is recognised that local authorities themselves can exert little influence on concentrations when they are the result of regional primary emission patterns.

2.2 AIR QUALITY REVIEWS

A range of Technical Guidance has been issued to enable air quality to be monitored, modelled, reviewed and assessed in an appropriate and consistent fashion. This includes the Technical Guidance Note LAQM.TG4(98), and the latest version LAQM.TG4(00) May 2000, on 'Review and Assessment: Pollutant Specific Guidance'. This review and assessment has considered the procedures set out in the latest consultation draft.

The primary objective of undertaking a review of air quality is to identify any areas that are unlikely to meet national air quality objectives and ensure that air quality is considered in local authority decision making processes. The complexity and detail required in a review depends on the risk of failing to achieve air quality objectives and it has been proposed therefore that reviews should be carried out in three stages. All three stages of review and assessment may be necessary and every authority is expected to undertake at least a first stage review and assessment of air quality in their authority area. The Stages are briefly described in the following table, Table 2.3.

Table 2.3 Brief details of Stages in the Air Quality Review and Assessment process

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

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

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

Local authorities are expected to have completed review and assessment of air quality by December 2000. A further review will also need to be completed for the purposes of the Act before the target date of 2003.

2.3 LOCATIONS THAT THE REVIEW AND ASSESSMENT MUST CONCENTRATE ON

For the purpose of review and assessment, the authority should focus their work on locations where members of the public are likely to be exposed over the averaging period of the objective. Table 2.4 summarises the locations where the objectives should and should not apply.

Table 2.4 Typical locations where the objectives should and should not apply

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

Table 2.4 (contd.) Typical locations where the objectives should and should not apply

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

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

Key Points

- The GB Environment Act 1995 has required the development of a National Air Quality Strategy for the control of air quality.
- A central element in the Strategy is the use of air quality standards and associated objectives based on human health effects that have been included in the Air Quality Regulations.
- The Strategy uses a local air quality management approach in addition to existing national and international legislation. It promotes an integrated approach to air quality control by the various actors and agencies involved.
- Air quality objectives, with the exception of ozone, are to be achieved by specified dates up to the end of 2005 (2008 for one lead objective).
- A number of air quality reviews are required in order to assess compliance with air quality objectives. The number of reviews necessary depends on the likelihood of achieving the objectives.

3 Review and assessment of nitrogen dioxide

3.1 INTRODUCTION

Nitrogen oxides are formed during high temperature combustion processes from the oxidation of nitrogen in the air or fuel. The principal source of nitrogen oxides, nitric oxide (NO) and nitrogen dioxide (NO_2), collectively known as NO_x is road traffic, which is responsible for approximately half the emissions in Europe. NO and NO_2 concentrations are therefore greatest in urban areas where traffic is heaviest. Other important sources are power stations, heating plant and industrial processes.

Nitrogen oxides are released into the atmosphere mainly in the form of NO, which is then readily oxidised to NO_2 by reaction with ozone. Elevated levels of NO_x occur in urban environments under stable meteorological conditions, when the air mass is unable to disperse.

Nitrogen dioxide has a variety of environmental and health impacts. It is a respiratory irritant, may exacerbate asthma and possibly increase susceptibility to infections. In the presence of sunlight, it reacts with hydrocarbons to produce photochemical pollutants such as ozone. In addition, nitrogen oxides have a lifetime of approximately 1 day with respect to conversion to nitric acid. This nitric acid is in turn removed from the atmosphere by direct deposition to the ground, or transfer to aqueous droplets (e.g. cloud or rainwater), thereby contributing to acid deposition.

3.1.1 Standards and objectives for nitrogen dioxide

The national air quality objectives for NO_2 are:

- An annual average concentration of 40 μg m^{-3} (21 ppb); to be achieved 31st December 2005
- 200 μg m^{-3} (105 ppb) as an hourly average with a maximum of 18 exceedences in a year to be achieved 31st December 2005

Modelling studies suggest that in general achieving the annual mean of 40 μg m^{-3} is more demanding than achieving the hourly objective. If the annual mean is achieved, the modelling suggests the hourly objectives will also be achieved.

3.1.2 The National Perspective

All combustion processes produce some NO_x, but only NO_2 is associated with adverse effects on human health. The main sources of NO_x in the United Kingdom are road transport, which, in 1997 accounted for about half of the emissions, power generation (20%), and domestic sources (4%). In urban areas, the proportion of local emissions due to road transport sources is larger.

The results of the analysis set out in the National Air Quality Strategy suggest that for NO_2 a reduction in NO_x emissions over and above that achievable by national measures will be required to ensure that air quality objectives are achieved everywhere by the end of 2005. Local authorities with major roads, or highly congested roads, which have the potential to result in elevated levels of NO_2 in

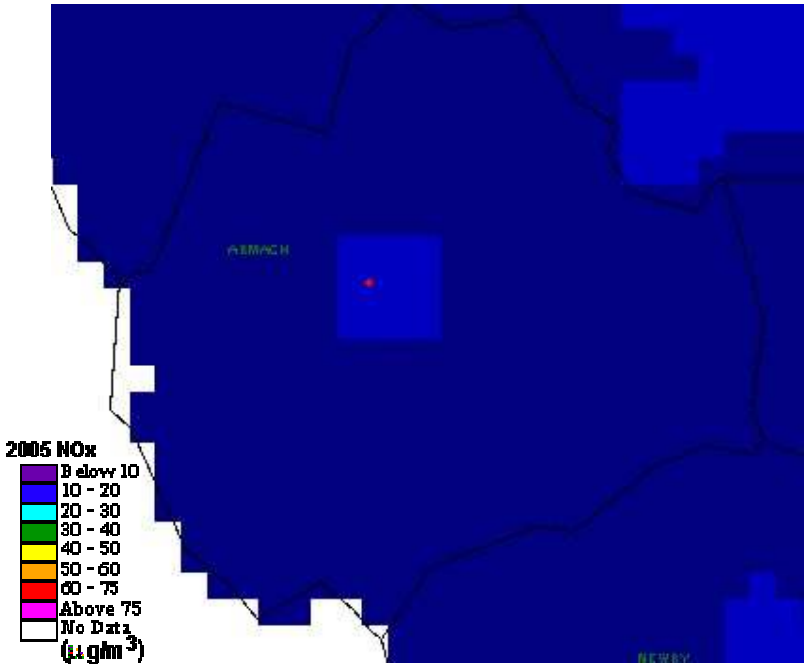
relevant locations, are expected to identify a need to progress to the second or third stage review and assessment for this pollutant.

3.2 ARMAGH CITY AND DISTRICT COUNCIL

3.2.1 Background concentrations of Nitrogen dioxide

Background concentrations were obtained for the Armagh City and District Council area using the maps on the UK National Air Quality Information Archive web site http://www.aeat.co.uk/netcen/airqual/home.html (Figure 3.1).

Figure 3.1. Background NO_x concentrations 2005



An estimated NOx background concentration has been taken from the highest value in the mapped dataset to provide a conservative estimate. A background NO_x estimate of 13.6µg/m^3 has been estimated for 2005 in the Armagh City and District Council region.

3.2.2 Monitoring of nitrogen dioxide in Armagh City and District Council

~~1.3~~

Monthly average concentrations of NO_2 have been measured with diffusion tubes at eight sites in Armagh City and District Council. The results for 2001 are summarised in Table 3.1. The data are presented in full in Appendix 1. The monitoring period of 11 months is considered to be representative of a full year and can be compared with the annual mean objective. Analysis of the

tubes was carried out by the Harwell Scientifics laboratory which was found to have a positive bias of 50.2% in 2001 relative to an automatic analyser (Intercomparison report still to be approved by DEFRA).

Table 3.1. Annual average concentrations measured at locations in the Armagh City and District Council area.

Location			Annual Average μg/m^3	Corrected for Lab Bias	Projected to 2005
25 Railway St	Site 1	k	33.6	16.7	15.2
Bridge House	Site 2	k	39.4	19.6	17.8
Desert Lane	Site 3	b	16.0	8.0	7.0
Folly Lane	Site 4	b	19.5	9.7	8.6
Scotch St	Site 5	k	17.6	8.8	8.0
Victoria St	Site 6	k	34.5	17.2	15.6
LWR Irish St	Site 7	k	32.6	16.2	14.7
Portadown Rd	Site 8	k	32.3	16.1	14.6

K=kerbside 1-5m from a busy road
I=Intermediate 20-30 m from the same or an equivalent road
B = background in a residential area more than 50 metres from a busy road.

The diffusion tubes placed at the kerbside and intermediate locations do not exceed the annual mean standard for nitrogen dioxide of 40 μg/m^3. The diffusion tube measurements suggest that it is likely that the NO_2 annual mean objective will be met at this location by 2005.

~~1.4~~3.2.3 Impact of Road traffic on concentrations of oxides of nitrogen in Armagh City and District Council

The Stage one Review and Assessment for Armagh City and District Council identified some road links as needing further study in a Stage two assessment. The concentrations at these kerbside locations were estimated using the Design Manual for Roads and Bridges (DMRB) using the traffic flow data provided by Armagh City and District Council. The effect of junctions has been taken into account in DMRB where traffic data have been provided. Traffic flow details are given in Appendix 2. The model has been used to predict nitrogen dioxide concentrations for 2005
Table 3.2 lists the annual average and 99.8th percentile of maximum hourly average kerbside concentrations (equivalent to 18 exceedences per year) of nitrogen dioxide predicted for 2005 in the Armagh City and District Council area. Following advice given in GB Government Guidance LAQM.TG4(00), the 99.8th percentile of hourly averages has been estimated as 3.5 times the annual mean for roadside locations.

Table 3.2. Nitrogen dioxide concentrations at roadside locations in the Armagh City and District Council using supplied HGV data

Description of Link	NO2 Annual mean ($\mu g/m^3$) 2005	NO2 99.8th percentile of hourly averages ($\mu g/m^3$) 2005
Portadown Rd	35.9	125.6
Drumadd Rd	38.5	134.9
Victoria St	38.4	134.4
Barrack St	38.4	134.4
Railway St	38.5	134.7
Lonsdale	41.2	144.2
Mall West	41.6	145.6
Irish st	48.3	168.9

For 2005, annual average concentrations of nitrogen dioxide are predicted to be 40 $\mu g\ m^{-3}$ or more at three locations within the town. However, concentrations recorded using diffusion tubes in Irish Street on the kerbside indicated the objective would be met (average 2001 concentration of 33 $\mu g\ m^{-3}$, uncorrected for lab bias, compared to the predicted concentration at the receptor 1.25 metres from the kerb of 48 $\mu g\ m^{-3}$). This does indicate that the DMRB model is over-predicting concentrations, which has been documented elsewhere. It is reasonable to assume that since measurements at the location of highest predicted concentrations do not indicate an exceedence, then no further review and assessment is needed at this time. It is, however, recommended that monitoring at this location continues.

~~1.4~~3.2.4 Conclusions for nitrogen dioxide concentrations in Armagh City and District Council

Emissions arising from road transport in Armagh City and District Council are predicted to cause an exceedence of the air quality objective at three locations within Armagh:

- Lonsdale
- Mall West
- Irish St

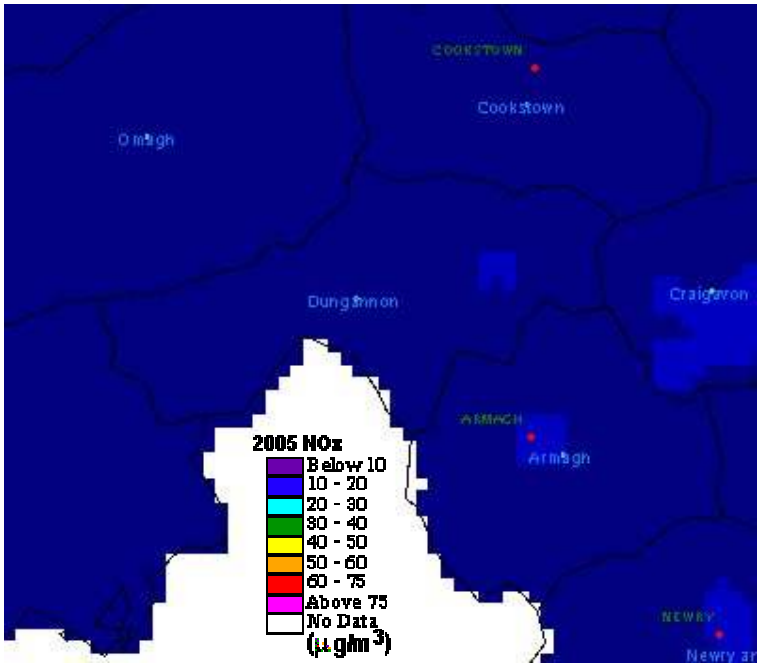
However, concentrations recorded using diffusion tubes in Irish Street on the kerbside indicated the objective would be met. It is reasonable to assume that since measurements at the location of highest predicted concentrations do not indicate an exceedence, then no further review and assessment is needed at this time. It is, however, recommended that monitoring at this location continues.

3.3 DUNGANNON AND SOUTH TYRONE DISTRICT COUNCIL

3.3.1 Background concentrations of Nitrogen dioxide

Background concentrations were obtained for the Dungannon and South Tyrone area using the maps on the UK National Air Quality Information Archive web site http://www.aeat.co.uk/netcen/airqual/home.html (Figure 3.2).

Figure 3.2. Background NO_x concentrations 2005



An estimated NOx background concentration has been taken from the highest value in the mapped dataset to provide a conservative estimate. A background NO_x estimate of 10.7µg/m^3 has been estimated for 2005 in the Dungannon and South Tyrone Borough Council region.

3.3.2 Monitoring of nitrogen dioxide In Dungannon and South Tyrone District Council

Monthly average concentrations of NO_2 have been measured with diffusion tubes at four sites in Dungannon and South Tyrone. The Results for 1998 to 2000 are summarised in Table 3.4. The data is presented in full in Appendix 1. The monitoring periods are representative of a full year and therefore the period average concentrations can be compared with the annual mean objective. Analysis of the tubes was carried out by the Lambeth Scientifics laboratory which was found to have the biases:

1998 12.8 %
1999 -30.7%
2000 1.2%
2001 9.8%
relative to an automatic analyser.

Table 3.4. Annual average concentrations measured at locations in the Dungannon and South Tyrone area.

µg/m^3				Annual Average	Corrected for lab bias	2005 projection
1998	Site 1	Market Square	k	22.5	19.6	16.5
	Site 2	4 Ardgannon, Quarry Lane	u	26.6	23.2	19.5
	Site 3	Howard Primary School	k	8.2	7.1	6.0
	Site 4	Bushvale	u	6.7	5.8	4.9
1999	Site 1	Market Square	k	19.5	25.5	21.9
	Site 2	4 Ardgannon, Quarry Lane	u	26.5	34.6	29.7
	Site 3	Howard Primary School	k	11.6	15.2	13.1
	Site 4	Bushvale	u	7.7	10.0	8.6
2000	Site 1	Market Square	k	17.8	17.5	15.4
	Site 2	4 Ardgannon, Quarry Lane	u	18.2	17.9	15.8
	Site 3	Howard Primary School	k	10.9	10.8	9.5
	Site 4	Bushvale	u	10.8	10.7	9.4
2001	Site 1	Market Square	k	20.4	22.4	20.3
	Site 2	4 Ardgannon, Quarry Lane	u	19.8	21.7	19.7
	Site 3	Howard Primary School	k	13.4	14.7	13.4
	Site 4	Bushvale	u	14.0	15.4	14.0

K=kerbside 1-5m from a busy road
I=Intermediate 20-30 m from the same or an equivalent road
B = background in a residential area more than 50 metres from a busy road.

The diffusion tubes placed at the kerbside and intermediate locations have not exceeded the annual mean standard for nitrogen dioxide of 40 µg/m^3. It is therefore unlikely that the NO_2 annual mean objective would be exceeded at these locations in 2005.

3.3.3 Impact of Road traffic on concentrations of oxides of nitrogen In Dungannon and South Tyrone District Council

The Stage one Review and Assessment for Dungannon and South Tyrone Borough Council identified some road links as needing further study in a Stage two assessment. The concentrations at these kerbside locations were estimated using the Design Manual for Roads and Bridges (DMRB) using the traffic flow data provided by Dungannon and South Tyrone Borough Council. The effect of junctions has been taken into account in DMRB where traffic data have been provided. Traffic flow details are given in Appendix 2. The model has been used to predict nitrogen dioxide concentrations for 2005.

Table 3.5 lists the annual average and 99.8th percentile of maximum hourly average kerbside concentrations (equivalent to 18 exceedences per year) of nitrogen dioxide predicted for 2005 in the Dungannon and South Tyrone Borough Council area. Following advice given in LAQM TG4(00), the 99.8th percentile of hourly averages has been estimated as 3.5 times the annual mean for roadside locations. An HGV percentage figure of 7.3% has been used in the modelling as this is (according to the Northern Ireland Roads Service survey of 114 roads) the average across Northern Ireland.

Table 3.5. Nitrogen dioxide concentrations at roadside locations in the Dungannon and South Tyrone District with 7.3% HGV, the Roads Service average.

Description of Link	NO2 Annual mean (µg/m^3) 2005	NO2 99.8th percentile of hourly averages (µg/m^3) 2005
Mullaghmore Rd	20.4	71
Moy Rd	29.6	104
Quarry Lane	20.6	72
Thomas St	29.7	104
Northland Rd	24.1	84
Circular Rd	26.9	94
Church St	40.2	141
Newell Rd	37.7	132
William St	31.2	109

For 2005, annual average concentrations of nitrogen dioxide are predicted to be 40 µg m^{-3}, the objective level, in Church St. It is therefore it is advised that a diffusion tube is located at Church St. to monitor the concentrations.

3.3.4 Conclusions for nitrogen dioxide concentrations In Dungannon and South Tyrone District Council

Existing monitoring of nitrogen dioxide using diffusion tubes show that an exceedance of the objective limits is unlikely at the monitored locations. Other roads have been modelled using the NI roads service average HGV%. This predicts that concentrations in 2005 in Church Street are on the objective level. It is therefore recommended that monitoring using diffusion tubes is carried out at this location to ascertain current concentration levels.

4 Review and assessment of PM_{10}

4.1 INTRODUCTION

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

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

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

~~1.3~~4.1.1 Standards and objectives for particulate matter

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

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

4.1.2 The National Perspective

National UK emissions of primary PM_{10} have been estimated as totalling 184,000 tonnes in 1997. Of this total, around 25% was derived from road transport sources. It should be noted that, in general, the emissions estimates for PM_{10} are less accurate than those for the other pollutants with prescribed objectives, especially for sources other than road transport.

The Government established the Airborne Particles Expert Group (APEG) to advise on sources of PM_{10} in the UK and current and future ambient concentrations. Their conclusions were published in January 1999 (APEG, 1999)[5]. APEG concluded that a significant proportion of the current annual average PM_{10} is due to the secondary formation of particulate sulphates and nitrates, resulting from the oxidation of sulphur and nitrogen oxides. These are regional scale pollutants and the annual concentrations do not vary greatly over a scale of tens of kilometres. There are also natural or semi-natural sources such as wind-blown dust and sea salt particles. The impact of local urban sources is

superimposed on this regional background. Such local sources are generally responsible for winter episodes of hourly mean concentrations of PM_{10} above 100 μg m^{-3} associated with poor dispersion. However, it is clear that many of the sources of PM_{10} are outside the control of individual local authorities and the estimation of future concentrations of PM_{10} are in part dependent on predictions of the secondary particle component.

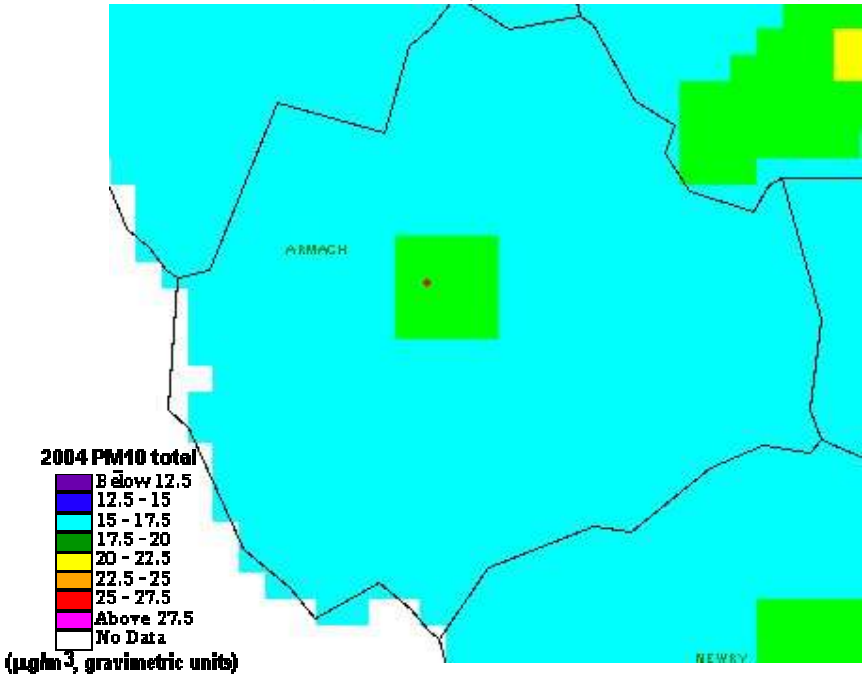
~~1.3~~4.2 ARMAGH CITY AND DISTRICT COUNCIL

4.2.1 Background concentrations of PM_{10}

~~1.1.2~~

Estimates of background concentrations of PM_{10} were obtained for the Armagh City and District Council area using the maps on the UK National Air Quality Information Archive web site http://www.aeat.co.uk/netcen/airqual/home.html. Figure 4.1 shows that the estimated annual average background concentration for 2004 in Armagh City and District Council was 20 μg/m^3 or lower.

Figure 4.1 Background PM_{10} concentrations 2004 (μg m^{-3})



4.2.2 Armagh City and District Council - impact of Road traffic on PM_{10}

As recommended in Government Guidance LAQM.TG4 (00) DMRB has been used to predict PM_{10} concentrations for 2004 from road traffic. An estimated maximum background concentration for 2004 of 18.7μg m^{-3} for Armagh City and District Council has then been used, taken from the highest value in the mapped dataset. Estimated traffic flows for 2005 have been used as that was the data supplied but this must be considered when deciding if the objective is likely to be met. As traffic

counts are likely to be higher in 2005 than in 2004 it can be assumed that if the objective is met with 2005 traffic data it would certainly have been met with 2004 data.

Guidance LAQM.TG4(00) states that the 24-hour objective is highly unlikely to be exceeded if the annual mean concentration is below 28 μg m^{-3}, gravimetric.

Table 4.1 shows the 2004 predictions that may be compared against the objectives. For 2004, the method predicts annual average concentrations of PM_{10} less than 28 μg m^{-3} at all of the locations modelled. Therefore it is predicted that there will be no exceedance of the objective.

Table 4.1. Predicted PM_{10} concentrations at roadside locations in the Armagh City and District Council region.

Description of Link	PM10 Annual mean (μg m-3) 2004
Portadown rd	21.1
Drumadd rd	21.4
Victoria st	21.4
Barrack st	21.4
Railway st	21.4
Lonsdale	21.9
Mall west	21.9
Irish st	22.9

4.2.3 Armagh City and District Council - PM_{10} Monitoring

PM_{10} concentrations have been measured using sophisticated automated analysers during 1999 at Shambles market, Armagh. The results are summarised in Table 4.2.

Table 4.2. PM_{10} Monitoring at Shambles Market , Armagh

Year	Annual Mean μg/m^3	Max 1 hour mean μg/m^3	Max 24 hour mean μg/m^3	Number of days exceeding EPAQS Standard
1999	19	168	61	8*

Exceedances are of AQS daily average standard of 50 μg/m^3 based on gravimetric equivalent (TEOM x 1.3)

This annual mean concentration can be used to predict forward to a concentration for 2004. Following the guide in the Pollutant Specific Guidance (Box 8.5), the results are summarised in Table 4.3.

Table 4.3. Determination of 2004 Background 2004 PM_{10} concentration

Calculated:	PSG Box 8.5 Ref	$\mu g/m^3$
Monitored annual mean	A	19.00
96 secondry PM_{10} concentration	B	8.00
Secondry PM $_{10}$ adjusted to year	C	7.49
Local primary PM_{10}	E	1.01
Adjusted for 2004	F	0.83
Secondry PM_{10} for 2004	G	6.63
Total PM_{10} for 2004	H	17.96

A 2004 annual mean prediction of 17.96$\mu g/m^3$ has been calculated and the Government Guidance (Chapter 8.11) recommends that to predict for the 90th percentile of the 24 hour mean the 2004 mean can be multiplied by 1.79. Therefore the 90th percentile for 2004 is 32 $\mu g/m^3$. This is well within the 50$\mu g/m^3$ limit and therefore exceedance is unlikely. The results from the monitor are also of the same order as those from the DMRB model predictions which confirms the low likelihood of an exceedance.

4.2.4 Conclusions for PM_{10} concentrations Armagh City and District Council

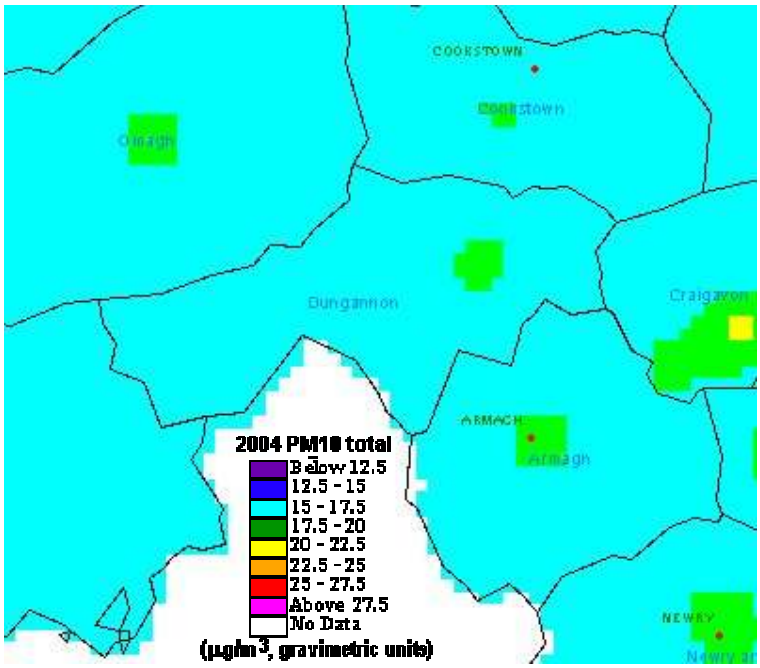
Emissions from traffic are not predicted by DMRB to lead to an exceedence of the PM_{10} objectives in 2004 and monitoring data supports this. Therefore it is recommended that it is not necessary for Armagh City and District Council to proceed to a Stage 3 Review and Assessment.

4.3 DUNGANNON AND SOUTH TYRONE DISTRICT COUNCIL

4.3.1 Background concentrations of PM_{10}

Estimates of background concentrations of PM_{10} were obtained for the Dungannon and South Tyrone Borough Council area using the maps on the UK National Air Quality Information Archive web site http://www.aeat.co.uk/netcen/airqual/home.html. Figure 4.2 shows that the estimated annual average background concentration for 2004 in Dungannon and South Tyrone was 20 μg/m^3 or lower.

Figure 4.2. Background PM_{10} concentrations 2004 (μg m^{-3})



4.3.2 Dungannon and South Tyrone District Council - impact of Road traffic on PM_{10}

As recommended in LAQM.TG4 (00) DMRB has been used to predict PM_{10} concentrations for 2004 from road traffic. An estimated maximum background concentration for 2004 of 18.1μg m^{-3} for Dungannon and South Tyrone has then been used, taken from the highest value in the mapped dataset. Estimated traffic flows for 2005 have been used as that was the data supplied but this must be considered when deciding if the objective is likely to be met. As traffic counts are likely to be higher in 2005 than in 2004 it can be assumed that if the objective is met with 2005 traffic data it would certainly have been met with 2004 data.

Guidance LAQM.TG4(00) states that the 24-hour objective is highly unlikely to be exceeded if the annual mean concentration is below 28 μg m^{-3}, gravimetric.

Table 4.4 shows the 2004 predictions that may be compared against the objectives. For 2004, the method predicts annual average concentrations of PM_{10} less than 28 μg m^{-3} at all of the locations modelled.

Table 4.4. Predicted PM_{10} concentrations at roadside locations in the Dungannon and South Tyrone Borough Council region.

Description of Link	PM10 Annual mean (μg/m^3) 2004
Mullaghmore Rd	19.0
Moy Rd	19.9
Quarry Lane	19.0
Thomas St	19.9
Northland Rd	19.4
Circular Rd	19.6
Church St	21.4
Newell Rd	21.0
William St	20.1

4.3.3 Conclusions for PM_{10} concentrations in Dungannon and South Tyrone District Council

Emissions from traffic and combustion sources are not predicted to lead to an exceedence of the PM_{10} objectives in 2004. Therefore it is concluded that there is no need to proceed to a Stage 3 Review and Assessment.

5 Conclusions and recommendations for each pollutant

5.1 NITROGEN DIOXIDE

- **Armagh City and District Council**
  Emissions arising from road transport in Armagh City and District Council are predicted to cause an exceedance of the objective at three locations within Armagh:
  - Lonsdale
  - Mall West
  - Irish St

However, concentrations recorded using diffusion tubes in Irish Street on the kerbside indicated the objective would be met (average 2001 concentration of 33 $\mu g\ m^{-3}$, uncorrected for lab bias, compared to the predicted concentration at the receptor 1.25 metres from the kerb of 48 $\mu g\ m^{-3}$). This does indicate that the DMRB model is over-predicting concentrations, which has been documented elsewhere. It is reasonable to assume that since measurements at the location of highest predicted concentrations do not indicate an exceedence, then no further review and assessment is needed at this time. It is, however, recommended that monitoring at this location should be continued.

- **Dungannon and South Tyrone District Council**
  Predictions indicate that concentrations are on the objective level for 2005 in Church Street in Dungannon. It is therefore recommended that monitoring is carried out at this location to ascertain the current concentration levels. Following this, consideration should be given to completing a Stage 3 review and assessment.

5.2 PARTICULATE MATTER (PM_{10})

- **Armagh City and District Council**
  Emissions from traffic sources are not predicted to lead to an exceedence of the PM_{10} objectives in 2004. it is recommended that there is no need for a Stage 3 Review and Assessment.

- **Dungannon and South Tyrone District Council**
  Emissions from traffic sources are not predicted to lead to an exceedence of the PM_{10} objectives in 2004. Therefore it is concluded that there is no need to proceed to a Stage 3 Review and Assessment.

6 References

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Appendices

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Appendix 1

CONTENTS

Armagh Diffusion tube results

μg/m^3			Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01
25 Railway St	Site 1	k	49.7	51.2	32.3	35.5	31.7	27.9	25.8	28.3	0.0	45.3	41.8
Bridge House	Site 2	k	50.4	43.2	41.4	39.5	45.1	34.8	29.6	34.2	32.3	36.1	46.4
Desert Lane	Site 3	b	27.1	20.2	20.8	14.7	16.6	11.3	9.0	11.7	13.2	14.7	16.6
Folly Lane	Site 4	b	30.6	25.6	23.5	19.1	20.2	13.0	11.8	14.7	17.4	16.4	22.5
Scotch St	Site 5	k	32.7	31.1	13.6	9.0	7.6	6.5	13.9	16.6	16.4	19.5	26.9
Victoria St	Site 6	k	36.9	42.8	36.9	36.5	35.0	30.2	23.9	28.1	31.9	35.5	41.8
LWR Irish St	Site 7	k	42.0	37.8	34.4	29.8	34.0	29.4	24.8	30.4	30.4	29.4	36.1
Portadown Rd	Site 8	k	35.1	36.9	27.3	37.4	39.3	30.0	24.3	28.1	34.2	26.2	37.1

Dungannon Diffusion Tubes Results

$\mu g/m^3$			Jan-98	Feb-98	Mar-98	Apr-98	May-98	Jun-98	Jul-98	Aug-98	Sep-98	Oct-98	Nov-98	Dec-98
Site 1	Market Square	k	23	20	45	13	15	21	22	28	17	20	17	29
Site 2	4 Ardgannon, Quarry Lane	ub	20	25	39	32	19	27	24	31	30	16	28	28
Site 3	Howard Primary School	k	8	5	16	5	6	6	2	11	13	8	3	15
Site 4	Bushvale	ub	7	7	12	9	4	6	3	0	0	0	7	25
			Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Site 1	Market Square	k	16	19	33	23	16	11	9	20	4	18	38	27
Site 2	4 Ardgannon, Quarry Lane	ub	27	35	37		9	16	20		26	22	44	29
Site 3	Howard Primary School	k	9	3	13	17	8	11	8		9	8	30	12
Site 4	Bushvale	ub	7	6	6	16	10	7	7	4	12	1	11	5
			Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00
Site 1	Market Square	k	12	36	17	17	25	9	6	27	12	20	30	2
Site 2	4 Ardgannon, Quarry Lane	ub	33	24	16	38	30	9	23	7	17	6	14	1
Site 3	Howard Primary School	k	20	14	6	9	9	5	8	12	8	14	11	15
Site 4	Bushvale	ub	18	14	3	10	10	7	6	13	8	17	15	9
			Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01
Site 1	Market Square	k	10	30	40	6	27	16	30	13	17	15		
Site 2	4 Ardgannon, Quarry Lane	ub	33	29	26	16	23	14	23	5	22	7		
Site 3	Howard Primary School	k	29	11	12	8	15	13	20	9	10	7		
Site 4	Bushvale	ub	21	12	13	19	15	8	22	7	19	4		

Appendix 2

CONTENTS

Armagh Traffic Data

Description of Link	distance to receptor (to centre of road) (m)	distance to receptor (to kerbside) (m)	annual average vehicle flow (veh/hr)	% HDV	average speed (km/hr)
Portadown rd	8.75	1.25	873	10	35
Drumadd rd	10	1.25	833	12	32
Victoria st	7.5	1.25	833	12	32
Barrack st	7.5	1.25	833	12	32
Railway st	10	1.25	832	12	32
Lonsdale	12.5	1.25	832	12	24
Mall west	8.75	1.25	832	12	24
Irish st	8.75	1.25	873	16	24

Dungannon Traffic Data

Description of Link	distance to receptor (to centre of road) (m)	distance to receptor (to kerbside) (m)	annual average vehicle flow (veh/hr)	% HDV	average speed (km/hr)
Mullaghmore Rd	10.00	7.50	478	12	64
Moy Rd	6.25	3.13	936	12	64
Quarry Lane	6.88	4.38	463	12	48
Thomas St	3.75	1.25	550	12	48
Northland Rd	7.50	3.75	626	12	48
Circular Rd	4.38	2.50	613	12	48
Church St	3.13	1.25	564	12	48
Newell Rd	3.13	1.25	495	12	48
William St	3.75	1.25	611	12	48