Perth & Kinross Council

August 2005

air quality report

PERTH & KINROSS COUNCIL

Environment Services

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Executive Foreword

Air Quality is one of the UK Government's key headline indicators of sustainable development which provide a scale for measuring everyday concerns. Moreover, clean air is an essential ingredient for a healthy environment supporting a high quality of life.

The population of Perth and Kinross have a right to expect that the air they breathe is safe and clean and will have no harmful effects upon their health or well being. This is why Perth & Kinross Council is committed to taking early action to minimise risks to health and the environment posed by air pollution, based on the best information available. With this in mind, Perth & Kinross Council is now publishing this report.

Perth & Kinross Council has been proactive in monitoring local air quality since 1990 although Review and Assessment of Air Quality has only been a statutory duty for all local authorities since 1997. Our local air quality is generally very good but there are a few locations in busy streets in Perth where emissions from traffic cause levels of nitrogen dioxide and particles slightly above current national objectives. Many other local authorities face similar challenges, particularly where relatively narrow streets, bounded by tall buildings, form 'street canyons' which restrict air movement and can cause pollution to increase from time to time.

The national air quality objectives have been progressively revised and strengthened since 1997 as knowledge of the health effects of the key pollutants has deepened. Perth meets all the objectives except those for the annual average for nitrogen dioxide and the annual average for particles set for 2010.

Today the primary cause of poor air quality in Perth and Kinross is emissions from road traffic, although some pollution is transported into the area by winds from elsewhere. In dealing with this problem which is limited to a very few areas within Perth city, we continue to preserve, and where possible improve upon, the high level of air quality enjoyed by residents and visitors to Perth & Kinross Council area.

My view is that sustained effort is necessary to protect our environment and public health. Most of us contribute to air pollution in some way and all of us suffer the consequences through the air we breathe. We can, collectively, make a difference to our local air quality by making small changes in the way we live and travel.

Therefore, based on the results within this report, a decision has been made to declare an Air Quality Management Area over Perth City and renewed efforts will be made to reach the national objective targets through the implementation of an action plan.

The declaration of an Air Quality Management Area gives us a strong starting position from which to tackle not only local air quality but also improve quality of life and achieve sustainable development throughout the community. We will work in partnership with local residents, industry and other relevant public, private and voluntary bodies in achieving this aim.

This proposal is an important and defining step towards establishing a strategic framework for tackling air pollution and demonstrates our commitment to the process of local air quality management. I hope that it will spark a serious debate about the importance of improving air quality, and in taking steps necessary to achieve this.

We want your views on our proposals, and your help to turn them into reality. We all have a responsibility to make a difference.

Bernadette Malone
Chief Executive
Perth & Kinross Council

Consultation Information

This report comprises consultation on 2 separate but related documents relating to the local air quality management regime installed by the Environment Act 1995. The documents incorporate:

1 ***A Detailed Assessment of air quality within Perth and Kinross***

2 ***A proposal for declaration of an Air Quality Management Area for particles and nitrogen dioxide to cover Perth***

You are invited to comment on each of these 2 documents.

The views and suggestions detailed in consultation responses will be analysed and used as part of the decision making process. We reserve the right to make responses publicly available, unless prior written notification to the contrary is received.

Comments are sought by 30 November 2005.

We would be grateful if you could clearly indicate in your response which parts of the consultation paper you are responding to as this will aid our analysis of the responses received.

A printed copy of this consultation document has been sent to the undernoted people/ organisations which are external to Perth & Kinross Council:

- *All MSPs, MPs and MEPs who have Perth & Kinross Council within their constituency boundaries.*
- *Neighbouring Local Authorities - Dundee City Council, Angus Council, Fife Council, Stirling Council and Highland Council.*
- *Scottish Executive.*
- *Scottish Environment Protection Agency.*
- *Perthshire Chamber of Commerce.*
- *Scottish National Heritage.*
- *Scottish Enterprise Tayside.*
- *Perth City Centre Management.*
- *Tayside Police, Western Division.*
- *VisitScotland, Perthshire.*

- *Tayside Health Board.*
- *Both National Park Authorities.*
- *All Community Councils within Perth & Kinross Council Area.*
- *All School Boards within Perth & Kinross Area.*

If you are aware of others with an interest who have not been notified, please either copy the consultation document to them or ask them to contact Perth & Kinross Council Environment Services on 01738 476476 and we will be happy to forward a copy.

Copies of this consultation document may be made available in large print on request and summaries may also be made available in other languages by contacting Perth & Kinross Council Environment Services on 01738 476476.

Comments, in writing or by email, on the consultation should be returned to:

Tom J Brydone
Environmental Health Manager
Environment Services
Pullar House
35 Kinnoull Street
PERTH
PH1 5GD

Tel 01738 476457
Email tjbrydone@pkc.gov.uk

If you have any issues that you wish to discuss further then contact:

Ross Edwards
Environmental Health Technical Officer
Environment Services
Pullar House
35 Kinnoull Street
PERTH
PH1 5GD

Tel 01738 476462
Email redwards@pkc.gov.uk

Dorothy Lewin
Environmental Health Officer
Environment Services
Pullar House
35 Kinnoull Street
PERTH
PH1 5GD

Tel 01738 476464
Email wdlewin@pkc.gov.uk

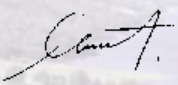
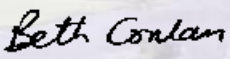
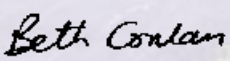
Tom J Brydone
Environmental Health Manager
Environment Services
Pullar House
35 Kinnoull Street
PERTH
PH1 5GD

Tel 01738 476457
Email tjbrydone@pkc.gov.uk

Detailed Assessment

Contract Page

Title	Air Quality Detailed Assessment
Customer	Perth & Kinross Council
Customer Reference	Detailed Assessment
Confidentiality, Copyright and Reproduction	Copyright AEA Technology plc All rights reserved. Enquiries about copyright and reproduction should be addressed to the Commercial Manager, AEA Technology plc.
File Reference	**netcen**/ED49248/Issue 1
Reference Number	AEAT/ENV/R1708/Issue 1
Address for Correspondence	**netcen** Culham Science Park Abingdon OXON OX14 3ED Tel 0870 190 6440 Fax 0870 190 6607 jeff.lampert@aeat.co.uk **netcen** is a operating division of AEA Technology plc **netcen** is certificated to ISO9001 & ISO14001

	Name	Signature	Date
Author	J Lampert		24 March 2004
Reviewed by	B. Conlan		24 March 2004
Approved by	B Conlan		24 March 2004

Executive Summary

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). This Strategy requires regular Reviews and Assessments of air quality by local authorities.

Perth & Kinross Council have commenced their second round of Review and Assessment of air quality, which is to be undertaken in two steps. The first step is an Updating and Screening Assessment, which was completed in April 2003. Where a significant risk of exceedence is identified for a pollutant it will be necessary for the local authority to proceed to a Detailed Assessment. Two pollutants were identified in Perth and Kinross, which were nitrogen dioxide and particulate matter. The major source of these emissions was road traffic in various potential hotspots within the centre of Perth.

This report represents a Detailed Assessment of air quality in Perth and Kinross.

The general approach taken to this Detailed Assessment was to:

- *collect and interpret additional data to that already used in the screening assessment, in order to support the detailed assessment, including more detailed traffic flow data around the areas outlined above;*
- *utilise the monitoring data from the Council's monitoring campaign to assess the ambient concentrations resulting from road traffic emissions, and to validate the output of the modelling studies;*
- *model the concentrations of NO_2 and PM_{10} around the selected roads, concentrating on the locations (receptors) where people might be exposed over the relevant averaging times of the air quality objectives;*
- *present the concentrations as contour plots of concentrations and assess the uncertainty in the predicted concentrations.*

This assessment has concluded that it is likely that the NO_2 objective for 2005 and the PM_{10} objective for 2010 will be exceeded in areas where personal exposure occurs. Consequently, Perth & Kinross Council need to declare an Air Quality Management Area to cover the area of exceedence in the Atholl Street/Barrack Street Junction and possibly other areas of Perth City. Following declaration a Further Assessment is required which needs to consider source apportionment modelling. This will support an Action Plan, which should then be prepared by the Council.

Acronyms and Definitions

AADT	Annual Average Daily Traffic Flow
ADMS	an atmospheric dispersion model
AQMA	Air Quality Management Area
AURN	Automatic Urban and Rural Network (nationally funded network)
CO	Carbon monoxide
DETR	Department of the Environment Transport and the Regions (now defra and the devolved administrations)
defra	Department for the Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges
EU	European Union
kerbside	0 to 1m from the kerb
LADS	Urban background model specifically developed for Stage 3 Review and Assessment work by NETCEN. This model allowed contributions of the urban background and road traffic emissions to be calculated.
Limit Value	An EU definition for an air quality standard of a pollutant listed in the air quality directives
NAEI	National Atmospheric Emission Inventory
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NRTF	National Road Traffic Forecast
PM_{10}	Particles
receptor	In the context of this study, the relevant location where air quality is assessed or predicted (for example, houses, hospitals and schools)
roadside	1 to 5m from the kerb
SO_2	Sulphur dioxide
TEMPRO	A piece of software produced for the Highways Agency used to forecast traffic flow increases

1 Introduction to the Detailed Assessment

This section outlines the purpose of this Detailed Assessment for Perth & Kinross Council, and the scope of the assessment.

1.1 Purpose of the Detailed Assessment

Perth & Kinross Council have commenced their second round of Review and Assessment of air quality, which is to be undertaken in two steps. The first step is an Updating and Screening Assessment, which was completed in April 2003. Where a significant risk of exceedence is identified for a pollutant it will be necessary for the local authority to proceed to a Detailed Assessment. Two pollutants were identified in Perth and Kinross, which were nitrogen dioxide and particulate matter. The major source of these emissions was road traffic in various potential hotspots within the centre of Perth which include:

- *Atholl Street - Barrack Street*
- *Main Street - Perth Bridge*
- *Tay Street - Queens Bridge*
- *County Place - South Street*
- *Kinnoull Street - High Street*

This report is the Detailed Assessment of both of these pollutants where a more robust assessment was carried out to determine if the objectives are likely to be exceeded.

1.2 Overview of Approach Taken

The general approach taken to this Detailed Assessment was to:

- *collect and interpret additional data to that already used in the screening assessment, in order to support the detailed assessment, including more detailed traffic flow data around the areas outlined above.*
- *utilise the monitoring data from the Council's monitoring campaign to assess the ambient concentrations resulting from road traffic emissions, and to validate the output of the modelling studies.*
- *model the concentrations of NO_2 and PM_{10} around the selected roads, concentrating on the locations (receptors) where people might be exposed over the relevant averaging times of the air quality objectives.*
- *present the concentrations as contour plots of concentrations and assess the uncertainty in the predicted concentrations.*

1.3 Relevant Scottish Executive Documentation Used

This report takes into account the guidance in LAQM.TG(03)[1], published January 2003.

1.4 Pollutants Considered in This Report

Pollutants included in the Air Quality Regulations[2] and considered in this report are listed in Table 1.1.

Table 1.1 Objectives included in the Air Quality Regulations 2000 and (Amendment) Regulations 2002 for the purpose of Local Air Quality Management

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Nitrogen dioxide[b]	200 µg/m^3 not to be exceeded more than 18 times a year	1 hour mean	31/12/2005
	40 µg/m^3	annual mean	31/12/2005
Particles (PM_{10}) (gravimetric)[c] All authorities	50 µg/m^3 not to be exceeded more than 35 times a year	24 hour mean	31/12/2004
	40 µg/m^3	annual mean	31/12/2004
Authorities in Scotland only[d]	50 µg/m^3 not to be exceeded more than 7 times a year	24 hour mean	31/12/2010
	18 µg/m^3	annual mean	31/12/2010

[b] *The objectives for nitrogen dioxide are provisional.*
[c] *Measured using the European gravimetric transfer sampler or equivalent.*
[d] *These 2010 Air Quality Objectives for PM_{10} apply in Scotland only, as set out in the Air Quality (Scotland) Amendment Regulations 2002[2].*

2 The UK 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)[3].

2.1 National Air Quality Standards

At the centre of the Air Quality Strategy 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. These standards and associated specific objectives to be achieved between 2003 and 2010 are shown in Table 1.1.

2.2 Air Quality Reviews – The Approaches and Expected Outcomes

Technical Guidance has been issued in 'Review and Assessment: Technical Guidance' LAQM.TG (03)[1] to enable air quality to be monitored, modelled, reviewed and assessed in an appropriate and consistent fashion. This Detailed Assessment has considered the procedures set out in this technical guidance.

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 two steps. Both steps 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 steps are briefly described in the following table, Table 2.1.

Table 2.1 Brief details of steps in the second Round of the Air Quality Review and Assessment process

Level of Assessment	Objective	Approach
Updating and Screening	To identify those matters that have changed since the last review and assessment, which might lead to a risk of an air quality objective being exceeded.	Use a checklist to identify significant changes that require further consideration. Where such changes are identified, then apply simple screening tools to decide whether there is sufficient risk of an exceedence of an objective to justify a Detailed Assessment
Detailed Assessment	To provide an accurate assessment of the likelihood of an air quality objective being exceeded at locations with relevant exposure. This should be sufficiently detailed to allow the designation or amendment of any necessary AQMAs.	Use quality-assured monitoring and validated modelling methods to determine current and future pollutant concentrations in areas where there is a significant risk of exceeding an air quality objective.
Annual Progress Reports	Local authorities should prepare annual air quality Progress Reports between subsequent rounds of reviews and assessments. The concept is that this will ensure continuity in the LAQM process.	Advice on progress reports has been provided in Guidance LAQM.TG(03)[1].

The current deadline for completion of detailed assessments is April 2004.

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 2.2 summarises the locations where the objectives should and should not apply.

Table 2.2 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	Nitrogen dioxide Particulate Matter (PM_{10})	All background locations where members of the public might be regularly exposed.	Building facades of offices or other places of work where members of the public do not have regular access.
		Building facades of residential properties, schools, hospitals, libraries etc.	Gardens of residential properties.
			Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.
24 Hour Mean	Particulate Matter (PM_{10})	All locations where the annual mean objective would apply. Gardens of residential properties.	Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.

Table 2.2 (continued)

Averaging Period	Pollutants	Objectives *should* apply at:	Objectives should *not* generally apply at:
1 Hour Mean	Nitrogen dioxide	All locations where the annual mean and 24 hour mean objectives apply.	Kerbside sites where the public would not be expected to have regular access.
		Kerbside sites (eg 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 be expected to have access.	

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

3 Information Used to Support This Assessment

This section lists the key information used in this review and assessment.

3.1 Conclusions From The First Round of Review and Assessment of Air Quality for Perth & Kinross Council

Perth & Kinross Council has completed the following review and assessments of air quality to date:

- *Stage 1 (March 1999)*[4]
- *Stage 1 (revised) and Stage 2 (September 2002)*[5]
- *Updating and Screening Assessment (2003)*[6]

The Updating and Screening Assessment report concluded that Perth & Kinross Council are required to carry out a Detailed Assessment for nitrogen dioxide and PM_{10}.

3.2 Maps and Distances of Receptors from Roads

Perth & Kinross Council provided electronic OS LandLine™ which was used in the Geographical Information System (GIS) for this assessment. Individual buildings or groups of buildings (receptors) were identified from the electronic OS LandLine™ maps of the areas. The distances of these receptors from the road, and the widths of the roads, were accurately determined from the maps.

3.3 Road Traffic Data

This section summarises the information used in this report; more detailed information is given in Appendix 2. Appendix 2 lists the locations of the traffic flow and speed measurement points, flow and speed data and other relevant traffic statistics.

3.3.1 Summary of Traffic Data Provided

Data were collated from data provided by Perth & Kinross Council for the Perth City area:

- *Manual count data*
- *Automatic (SCOOT) traffic count data (Figure 3.1)*

Scoot traffic count data were used to calculate traffic flows at the most relevant locations for assessment of air quality impacts.

Figure 3.1 SCOOT Traffic Count Points in Perth

3.3.2 Fraction of HGVs

Percentages of cars, LGVs, HGVs and buses were available from the 12-hour manual count data for Perth City.

3.3.3 Base Year for Traffic

The base year for the traffic flows was 2003.

3.3.4 Traffic Growth

Traffic growth figures were calculated from the TEMPRO database[8] using the methodology described in the Air Quality Review and Assessment web site[10].

3.3.5 Distance From the Centre of the Road to the Kerbside and to the Receptors

Road widths and the distances of receptors from the road were taken from the electronic OS LandLine™ of the Council area.

3.3.6 Traffic Speeds

Traffic speeds used for the model were 24 km/hr along Atholl Street and Barrack Street and 16 km/hr at the junction of the two roads. In other locations similar speeds were applied where there was evidence of prolonged congestion, otherwise speed limits were applied.

3.4 Ambient Monitoring

Perth & Kinross Council have undertaken monitoring of the following pollutants in their area:

- *Nitrogen dioxide - Automatic monitor + NO_2 Diffusion Tubes*
- *Particles (PM_{10}) - Automatic monitor*

Details of locations of, and concentrations recorded by, the diffusion tube monitors are given in Appendix 1.

3.4.1 Diffusion Tubes

Perth & Kinross Council carry out monitoring of NO_2 by diffusion tubes at a wide range of locations. The tubes are analysed by Dundee City Council Scientific Services.

3.4.2 Continuous Monitoring

Concentrations of NO_2, and PM_{10} are recorded using a continuous monitoring station located at 176 High Street Perth (OS grid reference 311700 923600). Figure 3.2 shows the automatic monitoring station.

Figure 3.2 Perth Automatic Monitoring Station

NOx Analyser
An API model M200 Chemiluminescent Nitrogen Oxides analyser was used for this study. This analyser provides continuous data for concentrations of both NO_X and NO. Given that $NO_X = NO + NO_2$ it can be seen that concentrations of

NO_2 are easily derived from this method. This analyser is typical of those employed within the Department for Environment, Food and Rural Affairs' (defra) Automatic Urban and Rural Network (AURN) of national air monitoring stations.

The NO_X analyser was calibrated regularly throughout the monitoring period. Chemical scrubbers were used to provide a clean air sample, and a standard gas cylinder to provide span gas. Data from the instruments were scaled according to the instrument responses from these two point calibrations. The calibration gas cylinder used was calibrated at the **netcen** Gas Standards Calibration Laboratory (GSCL). **netcen**'s GSCL holds UKAS accreditation (lab. no. 0401) for the calibration of NO, NO_2, SO_2 and CO gas mixtures. Using this cylinder to calibrate the analyser at the Perth monitoring site ensures that the data are traceable to national metrology standards.

Particulate Analyser
The analyser used to measure PM_{10} concentration is a Rupprecht & Patashnick (R&P) Tapered Element Oscillating Microbalance (TEOM). It provides measurements in real time which are recorded on the datalogger. The system measures PM_{10} concentration by continuously determining the particle mass deposited on a filter. The filter is attached to a hollow tapered element that vibrates at its natural frequency of oscillation. As particles collect on the filter, the frequency changes by an amount inversely proportional to the square root of the mass deposited. This analyser is typical of the type used in the AURN.

4 Detailed Assessment for Nitrogen Dioxide

4.1 The National Perspective

The principal source of NO_X emissions is road transport, which accounted for about 49% of total UK emissions in 2000 [1]. Major roads carrying large volumes of high-speed traffic (such as motorways and other primary routes) are a predominant source, as are conurbations and city centres with congested traffic. Within most urban areas, the contribution of road transport to local emissions will be much greater than for the national picture[1].

Meeting the annual mean objective in 2005 is expected to be considerably more demanding than achieving the 1-hour objective. National studies have indicated that the annual mean objective is likely to be achieved at all urban background locations outside of London by 2005, but that the objective may be exceeded more widely at roadside sites throughout the UK in close proximity to busy road links.

4.2 Standards and Objectives for Nitrogen Dioxide

The Scottish Executive have adopted two Air Quality Objectives for nitrogen dioxide - an annual mean concentration of 40 µg m^{-3}, and a 1-hour mean concentration of 200 µg m^{-3} not to be exceeded more than 18 times per year. The objectives are to be achieved by the end of 2005.

4.3 Conclusions of the Updating and Screening Assessment for Nitrogen Dioxide

The following conclusions were given for nitrogen oxides in the Updating and Screening Assessment report for Perth and Kinross[6] :

"Nitrogen dioxide predicted concentrations indicate that the annual average objective is likely to be exceeded in 2005 near busy junctions and in street canyons. This has been confirmed from the diffusion tube measurements. There are no significant industrial sources of nitrogen dioxide in Perth and Kinross.

Perth & Kinross Council is required to carry out a Detailed Assessment for nitrogen dioxide".

4.4 Background Concentrations for Nitrogen Dioxide

The estimated average background nitrogen dioxide concentration for 2001 was 5.0 µg m^{-3} in Perth and Kinross with a maximum concentration of 18.1 µg m^{-3} in Perth City[7].

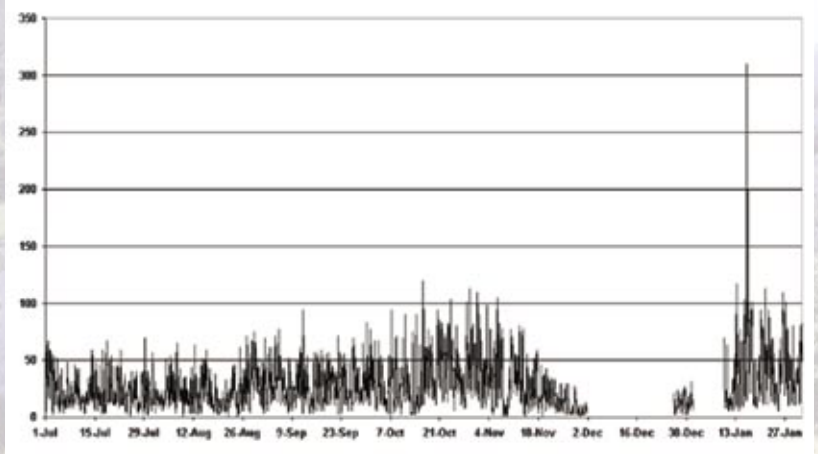
4.4.1 Diffusion Tube Monitoring

Nitrogen dioxide is measured in Perth at four sites operated as part of the UK national survey and at additional sites also operated by Perth & Kinross Council (Appendix 1, Table A1.1).

4.4.2 Automatic Monitoring

Monitoring for nitrogen dioxide is undertaken using an automatic monitoring station at an urban centre location in Perth City - in the pedestrian precinct, adjacent to 176 High Street. Nitrogen dioxide concentrations are measured using a chemiluminescent oxides of nitrogen analyser operated and calibrated by **netcen**. Figure 4.1 shows the time series of hourly average data for the period 1 July 2003 to 31 January 2004.

Figure 4.1 Nitrogen Dioxide Concentrations July 2003 – January 2004 (µg m^{-3})



There was a data loss of 48 days over the period due to an instrumental fault. There was one hourly average concentration above the 200 µg m^{-3} objective level (310 µg m^{-3} on 16 January). The 1-hour mean NO_2 objective allows up to 18 exceedences per year.

4.4.3 Diffusion Tube Analysis

The tubes analysed by Dundee Scientific Services are prepared by using 10% or 20% v/v TEA in water methodology. In the UK NO_2 Network Field Intercomparison Exercise 2001 the results of Dundee Scientific Services showed a bias of + 23% relative to the reference value as determined by an automatic chemiluminesence method. The period of the intercomparison was 5 September - 31 October 2001.

4.4.4 Bias Correction of Diffusion Tube Data

Diffusion tubes were exposed in triplicate alongside the automatic monitor located in High Street, Perth. For the period 1 July 2003 to 31 January 2004 the average concentrations measured were:

- *Chemiluminescent analyser* *29.0 µg m^{-3}*
- *Diffusion tubes* *35.7 µg m^{-3}*

These results have been combined with data from other intercomparisons using tubes from the same analyst (from the defra review and assessment helpdesk) to obtain an overall bias adjustment factor (Table 4.1).

Table 4.1 Diffusion Tube Bias Adjustment Factor

Local Authority	Length of Study (months)	Diffusion Tube Mean Conc (Dm) (µg m^{-3})	Automatic Monitor Mean Conc (Cm) (µg m^{-3})	Bias (B)	Bias Adjustment Factor (A) (Cm/Dm)
Dundee CC	12	52.1	42.6	22.3%	0.82
Fife Council	11	46.3	37.0	25.1%	0.79
Perth	7	35.7	29.0	23.4%	0.81
				Overall Factor	0.80

Diffusion tube data presented in this report have been multiplied by the factor 0.80.

4.5 Assessment of Road Traffic Sources

Traffic flow data were taken from manual and automatic SCOOT traffic count data taken in 2003 for local roads in Perth City supplied by the Council (Appendix 2).

4.5.1 LADS Urban Modelling

Estimated NO_2 concentrations around receptors in Perth were estimated using the LADS Urban model (see Appendix 3 for details). Meteorological data used in the model were recorded at Leuchars in 2001. This was the closest meteorological station to Perth and the most recent dataset available at the time of modelling was 2001. The model outputs have been plotted as a series of contour lines showing concentrations in µg m^{-3} around the roads studied.

The annual average NO_2 concentration measured in the period 1 July 2003 to 31 January 2004 using the automatic chemiluminescent monitor located in Perth High Street was 29 µg m^{-3}.

The measurements at the High Street site were adjusted to provide estimates of annual mean concentrations during 2003 by reference to measurements made over the same periods at the Glasgow City Chambers, Dumfries and Inverness sites following Technical Guidance LAQM.TG(03)[1]. The missing data in the Perth measurements were eliminated for the relevant period from the other data sets before comparison. Table 4.2 provides details of the adjustment factors calculated.

Table 4.2 Adjustment Factors Used to Scale Part Year Monitoring Data

Site	Pollutant	Part Year Average Concentration µg m^{-3}	Annual Concentration µg m^{-3}	Factor
Dumfries	NO_2	37.3	36.9	0.99
Glasgow City Chambers		48.3	48.6	1.01
Inverness		20.7	22.1	1.07
				1.023

The measured value needs to be multiplied by the factor of 1.023 to give an estimated annual mean of 29.7 µg m^{-3}.

4.5.2 Validation and Verification of the Model

In simple terms, model validation is where the model is tested at a range of locations and is judged suitable to use for a given application. The modelling approach used in this assessment has been validated, and used in numerous **netcen** air quality review and assessments.

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. Table 4.3 compares modelled predictions, using LADS Urban with Leuchars 2001 weather data, of oxides of nitrogen and nitrogen dioxide concentrations with measured values at the High Street monitoring site for 2003.

Table 4.3 Comparison of Modelled and Measured Concentrations

	Oxides of Nitrogen Concentration, $\mu g\ m^{-3}$		Nitrogen Dioxide Concentration, $\mu g\ m^{-3}$	
	Modelled	Measured	Modelled	Measured
High Street	57.1	66.1	26.4	29.7

The comparison indicates that the model is slightly underestimating nitrogen dioxide concentrations.

4.5.3 Bias Adjustment of the Model

Bias adjustment is the process where the concentrations of the model are adjusted to agree with local air quality monitoring data. In this case, the modelled nitrogen dioxide concentrations require adjustment and need to be increased by 3.3 µg m^{-3} for 2003.

4.6 Model Results

4.6.1 Predicted Concentrations Atholl Street – Barrack Street

Table 4.4 shows the bias corrected annual mean NO_2 concentration measured in 2003 at locations in Barrack Street and Atholl Street. Concentrations have been estimated for 2005 using a factor of 0.948 as detailed in LAQM.TG(03)[1].

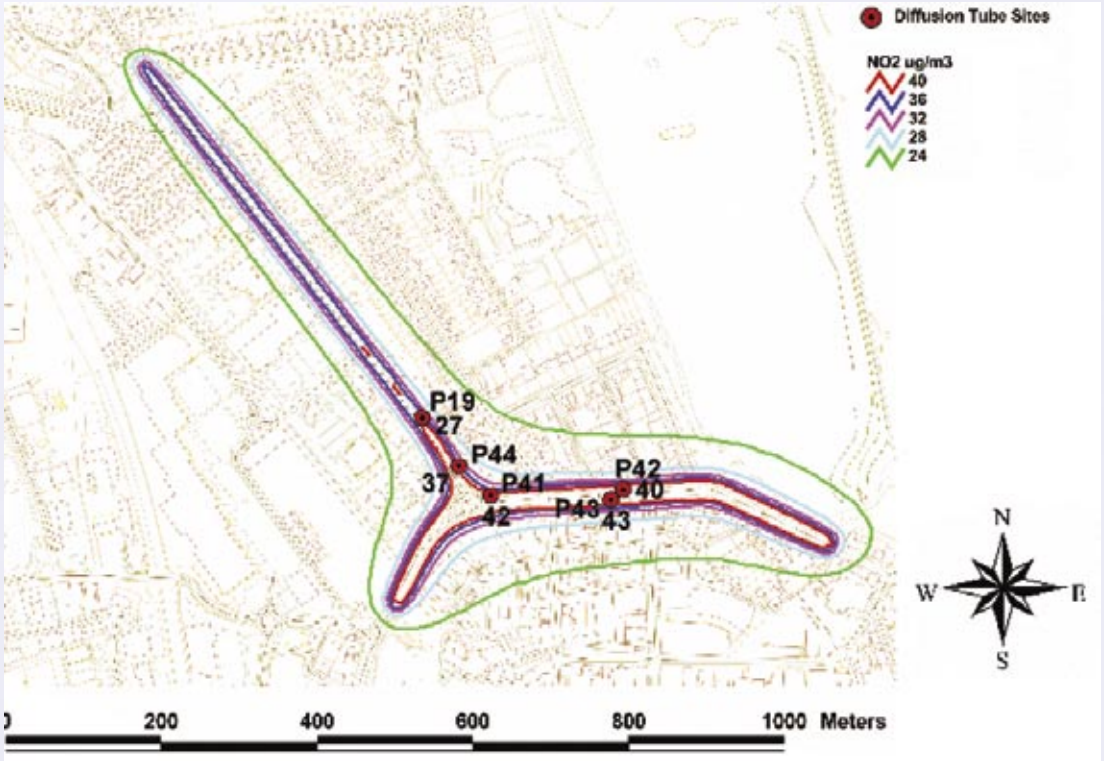
Table 4.4 Annual NO_2 Diffusion Tube Concentrations 2003 and 2005 ($\mu g\ m^{-3}$)

No	Type	Location	NO_2 in 2003	NO_2 in 2005
P19	R	St Ninians School	28	27
P41	R	76 Atholl Street, Perth PH1 5NL	43	41
P42	K	26-28 Atholl Street, Perth PH1 6NP	42	40
P43	R	17 Atholl Street, Perth PH1 5NH	44	42
P44	K	22 Barrack Street, Perth PH1 5RD	38	36

The diffusion tube concentrations indicate that the annual mean objective was exceeded in 2003 in Atholl Street and is likely to be exceeded in 2005 in Atholl Street.

Figure 4.2 shows contour plots of NO_2 concentrations around receptors near Barrack Street and Atholl Street in Perth 2005.

Figure 4.2 Nitrogen Dioxide Concentrations Barrack Street – Atholl Street 2005 [µg m^{-3}]



NO_2 concentrations for 2005 estimated from the 2003 diffusion tube measurements have been marked on the plot. Facades of properties near the samplers at 17, 26-28 and 76 Atholl Street will be within the area exceeding the annual NO_2 objective in 2005 and this is consistent with the diffusion tube results. The annual average objective value is likely to be exceeded at most properties close to Atholl Street. Exceedences are possible at properties close to the sampler at 22 Barrack Street but are less likely further away from the Atholl Street - Barrack Street junction in Barrack Street/Dunkeld Road.

4.6.2 Predicted Concentrations Main Street – Perth Bridge

Table 4.5 shows the bias corrected annual mean NO_2 concentration measured in 2003 at locations in Main Street. Concentrations have been estimated for 2005 using a factor of 0.948 as detailed in LAQM.TG(03)[1].

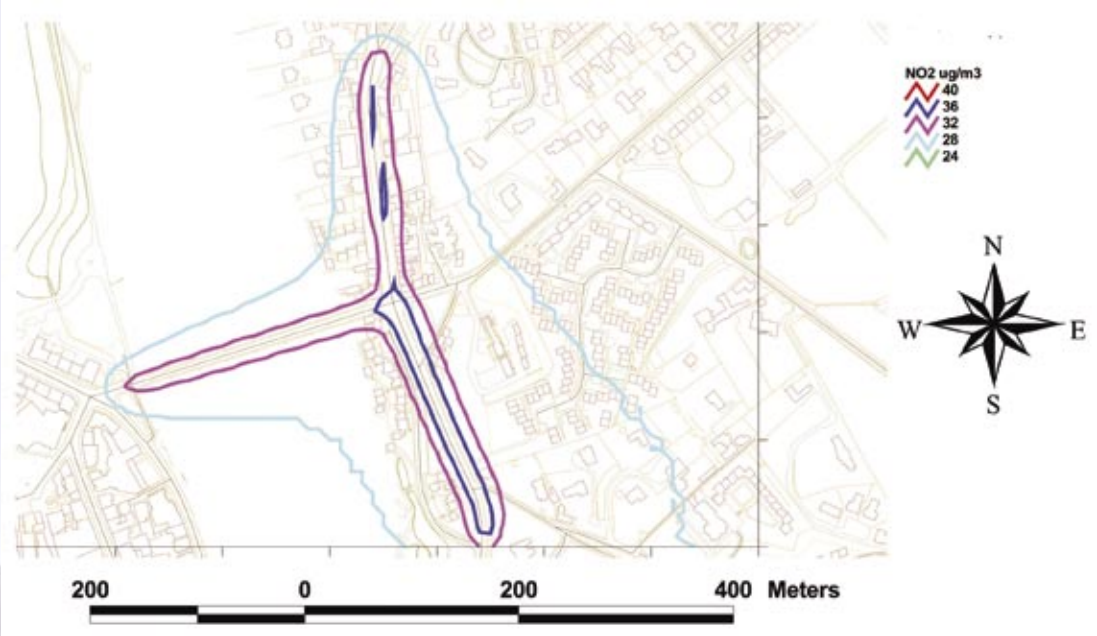
Table 4.5 Annual NO_2 Diffusion Tube Concentrations 2003 and 2005 (µg m^{-3})

Tube Number	Location	NO_2 in 2003	NO_2 in 2005
P14	9 Main Street, Bridgend, Perth PH2 7HD	36	35
P39	39 Main Street, Bridgend, Perth PH2 7HD	40	38
P40	18 Main Street, Bridgend, Perth PH2 7HB	36	34
P38	93-109 Main Street, Bridgend, Perth PH2 7HE	28	27

The diffusion tube concentrations indicate that the annual mean objective was exceeded in 2003 in Main Street but is unlikely to be exceeded in 2005.

Figure 4.3 shows contour plots of NO_2 concentrations around receptors near Main Street and Perth Bridge in Perth in 2005.

Figure 4.3 Nitrogen Dioxide Concentrations Main Street – Perth Bridge 2005 µg m^{-3}



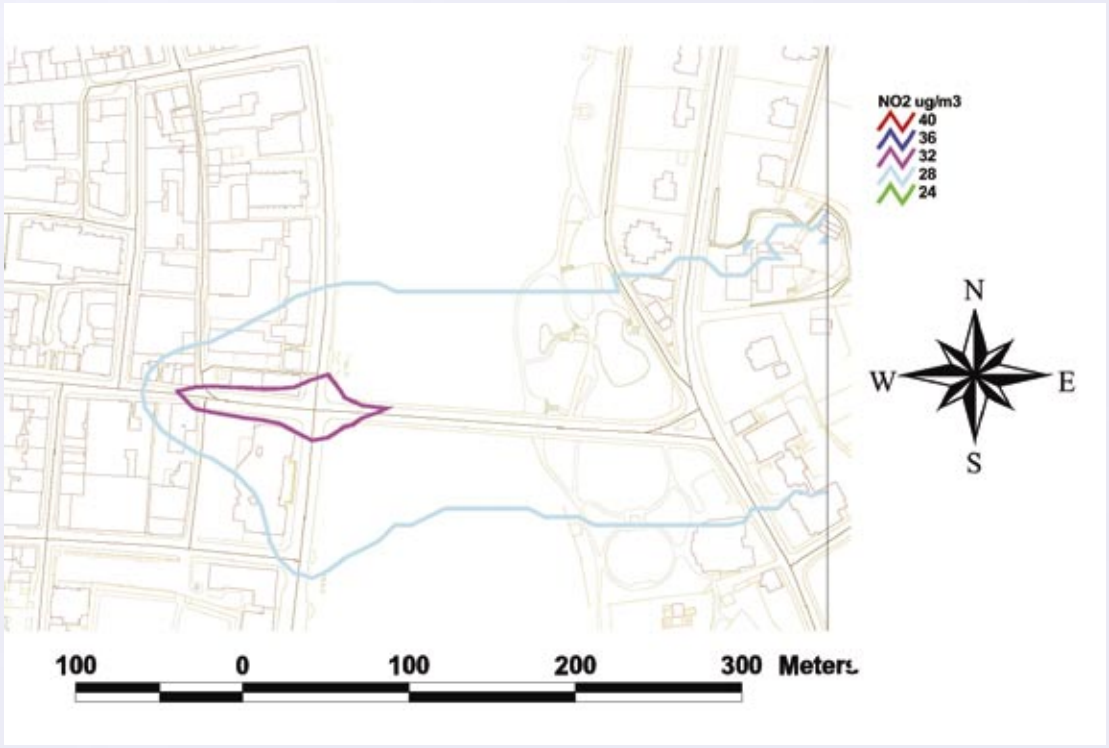
The maximum modelled concentration is 36 µg m^{-3}. The plots indicate that the 40 µg m^{-3} annual average objective is unlikely to be exceeded in 2005 at receptors close to Main Street, and this is consistent with the diffusion tube results.

4.6.3 Predicted Concentrations Tay Street – Queens Bridge

No diffusion tube data are available for this area.

Figure 4.4 shows contour plots of NO_2 concentrations around receptors near Tay Street and Queens Bridge in Perth in 2005.

Figure 4.4 Nitrogen Dioxide Concentrations Tay Street – Queens Bridge 2005 [µg m^{-3}]



The maximum modelled concentration is 32 µg m^{-3}. The plot indicates that the 40 µg m^{-3} annual average objective is unlikely to be exceeded in 2005.

4.6.4 Predicted Concentrations County Place – South Street

Table 4.5 shows the bias corrected annual mean NO_2 concentration measured in 2003 at locations in South Street, Scott Street and County Place. Concentrations have been estimated for 2005 using a factor of 0.948 as detailed in LAQM.TG(03)[1].

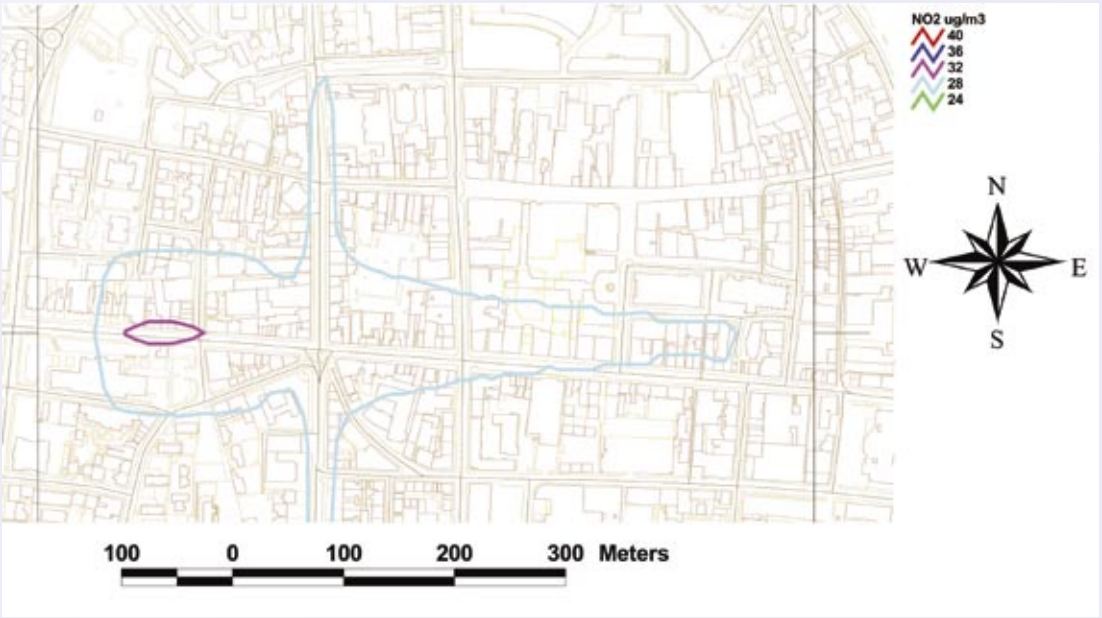
Table 4.5 Annual NO_2 Diffusion Tube Concentrations 2003 and 2005 (µg m^{-3})

Tube Number	Location	NO_2 in 2003	NO_2 in 2005
P30	104 South Street, Perth PH2 8PA	35	33
P31	45-47 South Street, Perth PH2 8PD	30	28
P32	135 South Street, Perth PH2 8PA	32	30
P33	216 South Street, Perth PH2 8EE	34	32
P34	10 County Place, Perth PH2 8EE	40	38

The diffusion tube concentrations indicate that the annual mean objective was exceeded in 2003 in County Place but is not likely to be exceeded in 2005.

Figure 4.5 shows contour plots of NO_2 concentrations around receptors near County Place, King Street and South Street in Perth in 2005.

Figure 4.5 Nitrogen Dioxide Concentrations County Place – South Street 2005 (µg m^{-3})



The maximum modelled concentration is 32 µg m^{-3}. This modelled concentration is slightly lower than the concentrations measured using diffusion tubes at 10 County Place, 42 Scott Street and 104 South Street. This may be due to the specific circumstances at these locations not accounted for in the model eg excessive queue lengths. However both the model results and the diffusion tube measurements indicate that the 40 µg m^{-3} annual average objective is unlikely to be exceeded in 2005.

4.6.5 Predicted Concentrations Kinnoull Street – High Street

Table 4.6 shows the bias corrected annual mean NO_2 concentration measured in 2003 at locations in the High Street. Diffusion tubes were co-located in triplicate with the automatic analyser. Concentrations have been estimated for 2005 using a factor of 0.948 as detailed in LAQM.TG(03)[1].

Table 4.6 Annual NO_2 Diffusion Tube Concentrations 2003 and 2005 (µg m^{-3})

Tube Number	Location	NO_2 in 2003	NO_2 in 2005
P54	Real Time Monitor adjacent to 176 High Street, Perth PH1 5EW	28	27
P1	42 Scott Street, Perth PH1 5PH	37	35

The diffusion tube concentrations indicate that the 40 µg m^{-3} annual average objective is unlikely to be exceeded in 2005.

Figure 4.6 shows contour plots of NO_2 concentrations around receptors near Kinnoull Street and High Street in Perth in 2005.

Figure 4.6 Nitrogen Dioxide Concentrations Kinnoull Street – High Street 2005

** Location of continuous monitor*

The real time monitor (marked on the plot) lies in the contour region 28-32 µg m^{-3} which is consistent with the measured average for 2003 of 29.7 µg m^{-3}.

The plot indicates that the 40 µg m^{-3} annual average objective is unlikely to be exceeded in 2005.

The maximum modelled concentration is 32 µg m^{-3}. This modelled concentration is slightly lower than the concentration measured using diffusion tubes at 42 Scott Street. This may be due to the specific circumstances at that location not accounted for in the model eg excessive queue lengths. However both the model results and the diffusion tube measurements indicate that the 40 µg m^{-3} annual average objective is unlikely to be exceeded in 2005.

4.7 Conclusions for NO_2 Concentrations in Perth & Kinross Council Area

Exceedences of the 40 µg m^{-3} annual mean objective for 2005 are likely in Perth at properties close to Atholl Street and possible at properties in Barrack Street close to the junction with Atholl Street. Concentrations in Main Street in Bridgend and County Place are predicted to be lower than, but close to, the 40 µg m^{-3} objective.

5 Detailed Assessment for PM_{10}

5.1 The National Perspective

National UK emissions of primary PM_{10} have been estimated as totalling 184,000 tonnes in 1997[3]. 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)[9]. 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.

5.2 Standard and Objective for PM_{10}

The Scottish Executive have adopted two Air Quality Objectives for fine particles (PM_{10}) which are equivalent to the EU Stage 1 limit values in the first Air Quality Daughter Directive[11]. The objectives are 40 μgm^{-3} as the annual mean, and 50 μgm^{-3} as the fixed 24-hour mean to be exceeded on no more than 35 days per year, to be achieved by the end of 2004. In addition there are objectives of 50 μgm^{-3} as the fixed 24-hour mean to be exceeded on no more than 7 days per year, and 18 μgm^{-3} as the annual mean to be achieved by the end of 2010 which applies to Scottish Authorities only. The objectives are based upon measurements carried out using the European gravimetric transfer reference sampler or equivalent.

5.3 Conclusions of the Updating and Screening Assessment for PM_{10}

The following conclusions were given for PM_{10} in the Updating and Screening Report for Perth and Kinross:

"The DMRB screening model indicates that the annual mean objective of 40 μgm^{-3} for PM_{10} will be met in 2004. The annual mean objective of 18 μgm^{-3} may be exceeded at relevant locations close to A roads, busy roads and junctions in Perth and Kinross in 2010. The 24 hour mean objective of 50 μgm^{-3} may be exceeded more than 35 times a year in 2004 and 7 times a year in 2010 close to busy road junctions in Perth.

Perth & Kinross Council is required to carry out a Detailed Assessment for PM_{10}".

5.4 Detailed Assessment of PM_{10}

5.4.1 Background Concentrations for PM_{10}

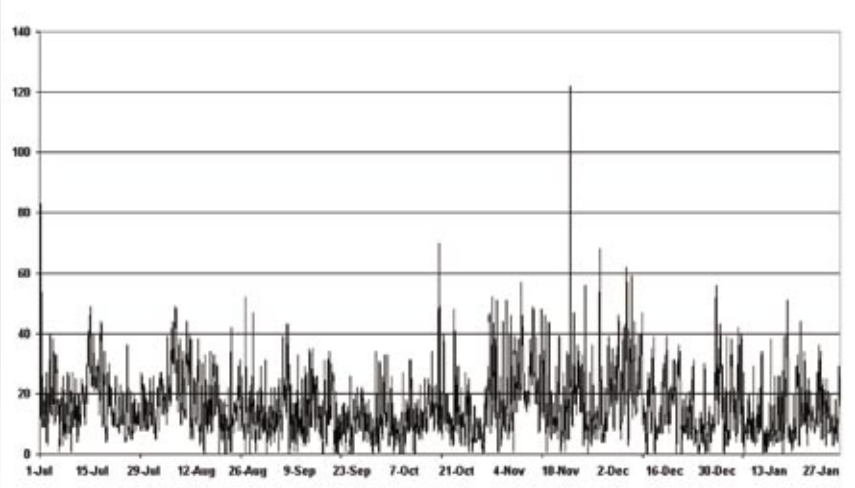
The estimated average background PM_{10} concentration for 2001 was 12.7 µg m^{-3} in Perth and Kinross with maximum concentration of 15.8 µg m^{-3} in Perth City[7].

5.4.2 Assessment of Monitoring Data

Monitoring for PM_{10} has been undertaken at an automatic monitoring station located at 176 High Street, Perth (Figure 3.2). Measurements are made using a TEOM automatic particulate analyser. Measured concentrations presented in this report have been multiplied by a factor of 1.3 to approximate the gravimetric equivalent value according to the guidance[1].

Figure 5.1 shows the hourly average PM_{10} concentrations measured over the period July 2003 to January 2004.

Figure 5.1 Hourly Average PM_{10} (Gravimetric) Concentrations in Perth July 2003 to January 2004 (µg m^{-3})



The maximum daily average concentration recorded in July to December 2003 was 35.4 µg m^{-3} and the average was 16.0 µg m^{-3}.

5.4.3 Assessment of Road Traffic Sources

Traffic flow data were taken from manual and automatic SCOOT traffic count data taken in 2003 for local roads in Perth City supplied by the Council (Appendix 2, Tables A2.1 and A2.2).

5.4.4 LADS Urban Modelling

Estimated PM_{10} concentrations around receptors in Perth were estimated using the LADS Urban model. The model outputs have been plotted as a series of contour lines showing concentrations in µg m^{-3} around the roads studied. Traffic speeds used for the model were 24 km/hr along Atholl Street and Barrack Street and 16 km/hr at the junction of the two roads.

The measurements at the High Street site were adjusted to provide estimates of annual mean concentrations during 2003 by reference to measurements made over the same periods at the Glasgow Centre and Aberdeen sites following Technical Guidance LAQM.TG(03)[1]. Table 5.1 provides details of the adjustment factors applied and the estimated full year concentrations.

Table 5.1 Adjustment Factors Used to Scale Part Year Monitoring Data

Site	Pollutant	Part Year Average Concentration µg m^{-3}	Annual Concentration µg m^{-3}	Factor (annual mean/period mean
Glasgow Centre	PM_{10}	19.0	21.4	1.13
Aberdeen		20.0	22.4	1.12
Average				1.125

The average PM_{10} concentration measured in July to December 2003 using the automatic chemiluminescent monitor located in Perth High Street was 16.0 µg m^{-3}. Using the correction factor calculated in Table 5.1, the estimated annual average concentration in 2003 was 18.0 µg m^{-3}.

5.4.5 Validation and Verification of the Model

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. Table 5.2 compares modelled predictions of PM_{10} concentrations with measured values at the High Street monitoring site for 2003.

Table 5.2 Comparison of Modelled and Measured Concentrations

	PM_{10} Concentration, µg m^{-3}	
	Modelled	Measured
High Street	15.5	18.0

This shows that the model tends to under read slightly.

5.4.6 Bias Adjustment of the Model

Bias adjustment is the process where the concentrations of the model are adjusted to agree with local air quality monitoring data. In this case, the modelled values have been increased by 2.5 µg m^{-3}.

5.4.7 Predicted Concentrations Atholl Street – Barrack Street

Figures 5.2 and 5.3 show contour plots of PM_{10} concentrations around receptors near Barrack Street and Atholl Street in Perth in 2004 and 2010.

Figure 5.2 PM_{10} Concentrations Barrack Street – Atholl Street 2004 (µg m^{-3})

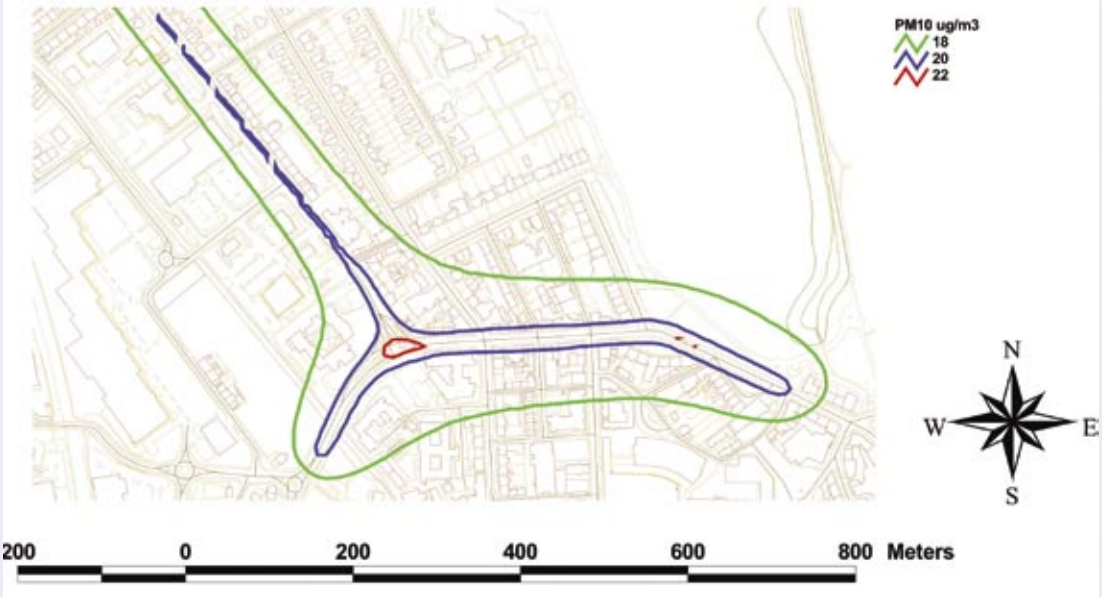


Figure 5.3 PM_{10} Concentrations Barrack Street – Atholl Street 2010 (µg m^{-3})

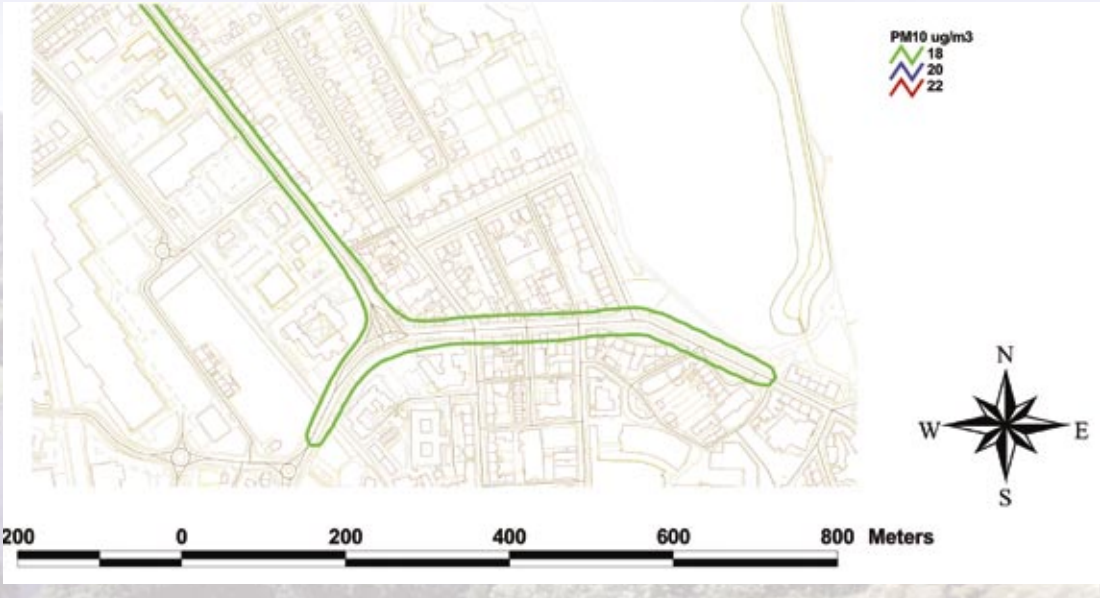


Figure 5.2 indicates that the 40 µg m^{-3} annual mean objective is unlikely to be exceeded at receptors near Atholl Street and Barrack Street in 2004.

Figure 5.3 indicates that the 18 µg m^{-3} annual mean objective may not be met at receptors near Atholl Street, Atholl Street/Barrack Street Junction and Barrack Street/ Dunkeld Road in 2010 (buildings facing on to Atholl Street lie within the 18 µg m^{-3} lines).

Concentrations were also modelled at the following locations:

- *Main Street - Queens Bridge*
- *Kinnoull Street - High Street*

Maximum modelled concentration contours were less than 18 µg m^{-3} for 2004 and the results are not presented here.

Of the objectives set with the target date of 2004, the 24-hour averaging period objective is more stringent than the annual period objective. To exceed the 24-hour objective the annual means should be greater than 32 µg m^{-3}. As concentrations modelled were below this threshold, it is unlikely that the 24-hour objective is exceeded in 2004. In contrast, of the PM_{10} objectives set for the target date of 2010, the annual average period objective is more stringent than the 24-hour period objective.

5.5 Conclusions for PM_{10} Concentrations in Perth & Kinross Council Area

The 40 µg m^{-3} annual mean objective is unlikely to be exceeded at receptors in Perth City in 2004.

The 50 µg m^{-3} 24-hour mean, not to be exceeded more than 35 times a year, objective is unlikely to be exceeded at receptors in Perth City in 2004.

The 18 µg m^{-3} annual mean objective may not be met at receptors near Atholl Street and Barrack Street/Dunkeld Road in 2010.

The 50 µg m^{-3} 24-hour mean, not to be exceeded more than 7 times a year, objective is unlikely to be exceeded at receptors in Perth City in 2010.

6 Declaring an Air Quality Management Area

6.1 Issues to Consider in Declaring Air Quality Management Areas

The review and assessment results indicate that an AQMA needs to be declared in Perth City incorporating the residential areas in Atholl and Barrack Street where exceedences of the objectives have been determined. In deciding where the boundary of the AQMA lies the Council needs to consider the following:

- *Model uncertainty - Computer models used to determine the likely air quality in the future are uncertain due partly to:*
  - *inherent uncertainty within the model.*
  - *the year to year variability in the air quality.*
  - *to the predicted future road traffic volume and characteristics such as queue lengths.*
  - *the likely reduction in the background air quality concentrations (see appendix 3 for technical details of model validation).*
- *The Council may find that where areas are currently close to the objective, or indeed, just over the objective then there is chance that future predictions may give rise to varying conclusions.*
- *It may be administratively much simpler to designate a wider area, based on existing boundaries and natural features.*
- *The action plan area will need to cover a wider area than the exceedence area as the traffic impacts on attempts to reduce emissions in Atholl/Barrack Street/ Dunkeld Road may affect surrounding streets.*

The Council may wish to declare the whole of the centre of Perth an AQMA or just those areas of most concern. The main area of Perth in which the objectives for nitrogen dioxide and PM_{10} are unlikely to be met is Atholl Street and Barrack Street/Dunkeld Road and this area should be covered by an AQMA. However, there are other areas including Main Street, Bridgend and County Place, Perth where elevated nitrogen dioxide levels are being experienced. While levels are currently above the objectives, it is predicted by the model that these will be sufficiently low to be under the objective by the target year. While there is no statutory duty to declare these areas as AQMAs, given the high diffusion tube concentrations recorded at these locations and the uncertainty in the modelling, they could be considered and therefore covered by the Air Quality Action Plan. The Council may either declare each of these smaller areas AQMAs or declare a wider area in the wider area of Perth.

6.2 Action Planning

The Council will also have to draw up an action plan stating what powers the Council has that it intends to exercise in order to improve air quality in the AQMA. Consultation is important to ensure action plans have public support.

7 Conclusions and Recommendations

This assessment has concluded that it is likely that the NO_2 objective for 2005 and the PM_{10} objective for 2010 will be exceeded in areas of Perth where personal exposure occurs. Consequently, Perth & Kinross Council need to declare an Air Quality Management Area to cover the area of exceedence at Atholl Street, the Atholl Street/Barrack Street Junction,

Barrack Street/Dunkeld Road and possibly other areas of Perth City. Within 12 months following declaration a Further Assessment is required which needs to consider source apportionment modelling. This will support an Action Plan, which must also be produced by the Council within 12-18 months from designation of the AQMA.

8 References

1. Part IV of the Environment Act 1995. Local Air Quality Management. LAQM.TG(03) January 2003.

2. The Air Quality (Scotland) Amendment Regulations 2002, ISBN 0 11061468 2.

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

4. Perth & Kinross Council (1999) First Stage Air Quality Review & Assessment Perth & Kinross Council, March 1999

5. Perth & Kinross Council (2002) First and Second Stage Air Quality Review & Assessment Perth & Kinross Council, September 2002

6. Updating and Screening Assessment, **netcen**, April 2003

7. Maps of Estimated Ambient Air Pollution in 2001 and Projections for Other Years www.airquality.co.uk/archive/laqm/tools.php

8. Department for Transport 2003 www.tempro.org.uk/

9. Source Apportionment of Airborne Particulate Matter in the United Kingdom Report of the Airborne Particles Expert Group January 1999

10. Air Quality Review & Assessment Website www.uwe.ac.uk/aqm/review/index.html

11. European Commission Directive 1999/30/EC

Appendices

Contents

Appendix 1 – Monitoring Data

Table A1.1 Bias Adjusted NO_2 Diffusion Tube Data ($\mu g\ m^{-3}$)

Site No	Address	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03	Aug 03	Sep 03	Oct 03	Nov 03	Dec 03	Mean 03
Perth 1 L	42 Scott Street, Perth PH1 5PH	35	46	40	46	33	33	33	35	33	36	40	33	37
Perth 1 R	42 Scott Street, Perth PH1 5PH	36	43	44	47	31	30	34	32	33	38	40	33	37
Perth 1 C	42 Scott Street, Perth PH1 5PH	35	45	40	45	32	34	34	35	31	38	40	32	37
Perth 2	17 Speygate, Perth PH2 8PJ	25	30	29	23	17	18	18	18	23	22	24	19	22
Perth 3 L	15 Murray Crescent, Perth PH2 0HU	23	31	23	17	12	11	12	13	18	20	26	21	19
Perth 3 R	15 Murray Crescent, Perth PH2 0HU	22	30	22	16	13	11	11	10	17	21	26	21	18
Perth 5 L	8 Stormont Street, Perth PH1 5NW	27	30	27	17	16	16	14	15	21	19	20	16	20
Perth 5 R	8 Stormont Street, Perth PH1 5NW	25	28	28	16	18	20	17	15	17	19	18	15	20
Perth 6	41 Mull Place, Perth PH1 3DP	17	24	17	10	8	7	8	6	12	12	12	10	12
Perth 7	257 Rannoch Road/Newhouse Road Roundabout, Perth PH2 DW	19	29	22	18	12	11	12	11	15	18	25	21	18
Perth 13 L	86/88 South Street Perth PH2 8PD	36	41	45	37	35	34	31	29	36	34	32	26	35
Perth 13 R	86/88 South Street Perth PH2 8PD	37	39	48	38	36	34	33	27	35	32	33	27	35
Perth 14 L	9 Main Street, Bridgend, Perth PH2 7HD	30	39	39	46	34	34	35	36	32	36	39	32	36
Perth 14 R	9 Main Street, Bridgend, Perth PH2 7HD	32	40	38	45	33	34	33	34	29	32	41	33	35
Perth 14 C	9 Main Street, Bridgend, Perth PH2 7HD	31	44	38	40	32	35	33	35	29	36	43	35	36
Perth 19	St Ninian's School, Dunkeld Road, Perth PH1 5RF	30	37	38	26	24	25	26	27	23	30	27	22	28
Perth 20	2 Crieff Road, Perth PH1 5RT	23	32	26	27	20	20	21	21	19	26	29	24	24
P28	28 York Place, Perth PH2 8EH	30	49		41	35	36	36	35	26	38	39	32	36
P29	37 York Place, Perth PH2 8EH	34		35	40	26	25	25	24	20	35	36	30	30
P30 L	104 South Street, Perth PH2 8PA	35	40	46	38	37	35	30	29	26	36	33	27	34
P30 C	104 South Street, Perth PH2 8PA	35	44	48	38	37	33	31	32	23	37	32	26	35
P30 R	104 South Street, Perth PH2 8PA	43	43	49	36	34	34	33	32	25	36	34	28	35
P31	45-47 South Street, Perth PH2 8PD	29	40	32	37	25	25	24	25	17	31	38	31	30
P32	135 South Street, Perth PH2 8PA	35	43	34	37	28	28	27	23	19	37	38	31	32
P33	216 South Street, Perth PH2 8NY	32	44	39	38	29	31	29	40	22	34	40	33	34
P34 L	10 County Place, Perth PH2 8EE	36	44	46	47	42	43	40	39	33	40	40	33	40
P34 R	10 County Place, Perth PH2 8EE	37	47	49	45	44	43	40	31	30	40	39	32	40
P35	17 Princes Street, Perth PH2 8NG	35	36	38	31	25	24	23	26	21	31	28	23	28
P36	51 Glasgow Rd, Perth PH2 0PE	36	45	38	31	25	21	22	23		33	40	33	31
P37	Riggs Rd, Perth PH1 1PR	28	36	35	27	22	22	21	22	19	30	30	24	26
P38	93-109 Main Street, Bridgend, Perth PH2 7HE	28	38	33	35	27	21	25	26	16	27	32	26	28
P39 L	39 Main Street, Bridgend, Perth PH2 7HD	35	46	47	47	40	38	33	41	25	39	42	34	39
P39 R	39 Main Street, Bridgend, Perth PH2 7HD	36	53	47	51	40	35	36	37	27	41	48	39	41
P40 L	18 Main Street, Bridgend, Perth PH2 7HB	36	43	46	33	35	34	33	35	28	40	33	27	35
P40 R	18 Main Street, Bridgend, Perth PH2 7HB	34	43	44	38	38	40	34	37	29	40	37	31	37

Table A1.1 (continued)

Site No	Address	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03	Aug 03	Sep 03	Oct 03	Nov 03	Dec 03	Mean 03
P41 L	76 Atholl Street, Perth PH1 5NL	40	45	48	55	37	38	34	41	37	39	52	43	42
P41 R	76 Atholl Street, Perth PH1 5NL	45	56	47	54	39	41	35	35	42	42	50	41	44
P42	26-28 Atholl Street, Perth PH1 6NP	37	50	46	49	37	39	37	40	42	45	44	36	42
P43 L	17 Atholl Street, Perth PH1 5NH	40	54	49	48	43	46	43	40	45	41	43	35	44
P43 C	17 Atholl Street, Perth PH1 5NH	42	53	51	48	44	46	41	40	46	42	45	37	45
P43 R	17 Atholl Street, Perth PH1 5NH	43	53	53	46	45	45	42	41	46	38	39	32	44
P44 L	22 Barrack Street, Perth PH1 5RD	37	54	41	43	31	34	30	28	35	37	48	39	38
P44 R	22 Barrack Street, Perth PH1 5RD	40	48	42	44	29	29	30	32	33	38	51	42	38
P45	Ballantine Place, Perth PH1 5RR	26	33	30	23	16	15	15	18	19		25	21	22
P46	204 A Crieff Road, Perth PH1 2PE	25	34	28	26	22	23	21	21	24	28	30	25	26
P47	5 East Huntingtower, Perth PH1 3JJ	14	35	26	22	18	17	21	19	19	24	31	25	23
P48	30 Edinburgh Road, Perth PH2 8BX	20	36	28	25	17	17	19	17	21	22	34	28	24
P49	Opp Wood'n Garden, Glencarse PH2 7LX	18	36	27	28	21	22	21	17	21	18	31	25	24
P50	Linden Garden Centre, Glencarse PH2 7LX	17	36	28	30	20	23	21	20	21		30	25	25
P51	2 West Bridge Street, Bridgend, Perth PH2 7HA	26	34	31	29	22	26	19	22	25	28	30	24	26
P54L	Real Time Monitor adjacent to 176 High Street, Perth PH1 5EW							19	24		29	32	32	27
P54C	Real Time Monitor adjacent to 176 High Street, Perth PH1 5EW							20	21	23	29	34	32	26
P54R	Real Time Monitor adjacent to 176 High Street, Perth PH1 5EW							21	22		28	34	33	28
P55	7 West High Street, Crieff											40	34	37
P56	39 High Street, Crieff											34	28	31
P57	The Highland Trading Company, 62 High Street, Crieff											28	30	29
P58 L	9 East High Street, Crieff											38	32	35
P58R	9 East High Street, Crieff											38	34	36

Appendix 2 – Traffic Data

Table A2.1 Manual Traffic Counts in Perth City

	1-9 April 2003		1-9 October 2003	
	AADT	%HDV	AADT	%HDV
Perth Bridge between Charlotte Street and Main Street	13286	4.3	12473	3.8
Queen's Bridge between Tay Street and A85	14693	6.8	13424	7.7
Shore Road between A989 and Harbour Road	4567	12.9	6588	13.1
Edinburgh Road between A989 and South Inch View	9778	5.5	10296	6.8
St Leonards Bank between A989 and Abbot Street	5080	5.3	4898	5.1
Glasgow Road between Earls Dyke and Whitefriars Crescent	14649	8.1	14186	8.9
Long Causeway between Caledonian Road and St Catherines Road	13360	2.4	12655	2.7
Barrack Street between Atholl Street and Low Street	19763	7.0	19354	6.9
Balhousie Street between Barossa Place and Hay Street	6425	4.9	6406	4.5

Table A2.2 AADT Flows Derived from Scoot Traffic Counts in Perth City

Street	AADT
Gowrie Street	9781
Main Street	21148
Barrack Street	22411
Atholl Street	29576
South Street to Tay Street	12010
Queens Bridge	14579
Perth Bridge	12480

Appendix 3 – Model Validation

Introduction

The dispersion model ADMS-3 was used to predict nitrogen dioxide and PM_{10} concentrations at roadside locations. ADMS-3 is a PC-based model that includes an up-to-date representation of the atmospheric processes that contribute to pollutant dispersion.

The model was used to predict:

- *the local contribution to pollutant concentrations from roads.*
- *the contribution from urban background sources.*

The contribution from urban background sources was calculated from the ADMS-3 output using the NETCEN Local Area Dispersion System (LADS) model. The LADS model provides efficient algorithms for applying the results of the dispersion model over large areas. The model was verified by comparison with monitoring data obtained at a number of roadside, kerbside or near-road monitoring sites in London.

Nitrogen Dioxide Model Errors

The error in the modelled annual average at each site was calculated as a percentage of the modelled value. The standard deviation of the errors was then calculated: it was 12% with five degrees of freedom.

In practical terms:

- *there is less than 1: 5 chance (ie 100 - 80 = 20%) that the 40 µg m^{-3} objective will be exceeded if the modelled annual average concentration in 2005 is less than 34 µg m^{-3} (ie 40/1.19).*
- *there is less than 1: 20 (ie 100 - 5 = 5%) chance that the objective will be exceeded if the modelled roadside concentration is less than 28 µg m^{-3} (ie 40/1.44).*

Similarly:

- *there is less than 1: 5 chance that the 200 µg m^{-3} 99.8th percentile concentration will be exceeded if the modelled concentration for 2005 is less than 157 µg m^{-3}.*
- *there is less than 1: 20 chance that the objective will be exceeded if the modelled concentration in 2005 is less than 117 µg m^{-3}.*

PM_{10} Model Errors

The difference between the modelled and measured values was calculated. The standard deviation of the difference was then determined.

The estimated standard error was 2.0 µg m^{-3} and 4.3 µg m^{-3} (gravimetric) for the annual mean and 90th percentile concentrations respectively with 5 degrees of freedom.

In practical terms:

- *there is less than 1: 5 chance that the 50 µg m^{-3} objective will be exceeded in 2004 if the modelled 90th percentile 24 hour average concentration is less than 43.5 µg m^{-3}.*
- *there is less than 1: 20 chance that the objective will be exceeded if the modelled roadside concentration is less than 36 µg m^{-3}.*

Similarly:

- *there is less than 1: 5 chance that the 18 µg m^{-3} objective will be exceeded in 2010 if the modelled average concentration is less than 14.7 µg m^{-3}.*
- *there is less than 1: 20 chance that the objective will be exceeded if the modelled roadside concentration is less than 11 µg m^{-3}.*

Appendix 4 – Descriptions of Selected Models and Tools

ADMS V3.1 (Atmospheric Dispersion Modelling System)

This is a new generation multi-source dispersion model using an up-to-date representation of atmospheric dispersion. Specific features include the ability to treat both wet and dry deposition, building wake effects, complex terrain and coastal influences. ADMS-3 can model releases from point, area, volume and line sources and can predict long-term and short-term concentrations. Urban and rural dispersion co-efficients are included and calculations of percentile concentrations are possible.

DfT's TEMPRO Traffic Forecast Model

TEMPRO V3.1 was made available by DfT in November 1997. It is based on the 1997 National Road Traffic Forecasts, ie the most recent version of the NRTF used for the national Atmospheric Emissions Inventory forecasts.

According to the supporting documentation, TEMPRO is linked to the National Trip End Model forecasts of growth in car traffic and underlying car ownership within specified areas in an average weekday. The trip ends are not constrained by the capacity of the network, but the trip distance does seem to take account of capacity constraints and congestion at district level.

In summary, it seems that TEMPRO is based on a 'demand to travel' and car ownership basis on a district level, with actual traffic flow constrained by current road capacity in the area. It is primarily designed as a tool for local planners to use for evaluating land use changes and traffic redistribution schemes.

Proposal for Declaration of an Air Quality Management Area

Perth & Kinross Council has a statutory duty to periodically review air quality in its area and where exceedence of specified objectives is predicted, to declare an Air Quality Management Area (AQMA). The accompanying Detailed Assessment of Air Quality concludes that certain objectives are not likely to be met in areas of Perth where traffic is regularly congested and that it is therefore necessary for an AQMA to be declared.

Legal Background

In 1997, the Government published a National Air Quality Strategy and introduced a statutory process of local air quality management (LAQM) under the Environment Act 1995. Part IV of the Act requires each local authority to periodically review air quality in its area.

Local authorities must review and assess air quality according to prescribed guidance. This involves considering present and future air quality in their area to determine if the objectives are likely to be achieved by the relevant deadlines. If the objective for any pollutant is predicted to be exceeded in areas where there is relevant public exposure, local authorities have a duty to declare an Air Quality Management Area (AQMA), following a process of consultation. As a consequence of declaring an AQMA, further assessment of the air quality must be completed and reported on and an Air Quality Action Plan defined within 12 months and 18 months, respectively, from the date of declaration.

Section 84(2)(b) of the Environment Act 1995 makes clear that local authorities are required to act 'in pursuance of the achievement of air quality... objectives in the designated area'. Local authorities are not under a legal obligation to achieve the objectives, although they are required to show that they are doing all that they reasonably can to work towards meeting them.

The Air Quality (Scotland) Amendment Regulations 2002 prescribe air quality objectives and the date by which they must be achieved (table 1.1 in the accompanying Detailed Assessment document). National objectives are derived from health-based standards which have been set, purely on the basis of medical and scientific evidence of how each pollutant affects human health, at appropriate levels for protection of the most sensitive members of the population. The Scottish Parliament transposed recent European Union Directives into national legislation. With regard to particles (PM_{10}) they set more stringent objectives than those currently specified for the rest of the UK.

The accompanying Detailed Assessment of Air Quality in Perth and Kinross, which was completed in March 2004 and undertaken by **netcen** acting as consultants on behalf of the Council, concluded that:

> *It is likely that the Nitrogen Dioxide objective for 2005 and the Particles (PM_{10}) objective for 2010 will be exceeded in areas of Perth where personal exposure occurs. Consequently, it is necessary to declare an AQMA to cover the projected areas of exceedence in Atholl Street, the Atholl Street/Barrack Street junction, Barrack Street/Dunkeld Road and possibly other areas of Perth City.*

It confirmed emissions from congested traffic to be the source of elevated levels of nitrogen dioxide and particles (PM_{10}) at these locations in Perth, and that elevated concentrations of nitrogen dioxide which were close to the objectives were also being experienced at County Place/York Place and Bridgend. Additional monitoring undertaken since 2003 and assessed in 2005 indicates that levels of nitrogen dioxide continue to show significant potential to exceed the objectives at these locations.

General Information

Road traffic emissions are the predominant source of nitrogen dioxide and a major local source of particles throughout the UK. Slow moving and queuing vehicles in narrow streets bounded by tall buildings produce raised levels of these pollutants in city centres and small market towns. Across the UK, 152 local authorities, including Edinburgh, Glasgow and Aberdeen, are known to have declared AQMA's since 1997. In over 95% of AQMA's, road traffic emissions were the main cause of exceedance, and problem areas have included narrow congested streets in smaller towns, motorway corridors in rural locations, as well as large urban conurbations.

Details of recent individual Reviews and Assessments have not yet been released, however, it is anticipated that at least nine AQMA's will now be required in Scotland as a result of the current round of review and assessment, with the three major cities understood to be considering whether their current AQMA boundaries may need to be revised.

Deciding the Boundary

The Scottish Executive does not prescribe how local authorities are to decide the boundaries of an AQMA, however the following considerations are recommended:

- *The traffic impacts from reduction of emissions in the immediate area of exceedence may affect other areas and therefore the Action Plan should cover a wider area than the exceedence area.*
- *Where areas are currently close to an objective there is a possibility that future predictions may give rise to exceedence.*
- *Mathematical modelling of the area of exceedence is inherently uncertain - such models are influenced by year to year variability in air quality, variability in local traffic volume and vehicle characteristics, changes in background air quality concentrations etc.*
- *Designation of a wider area based on existing boundaries may be administratively simpler and more cost effective than subsequent amendment of a small area if further or future assessment shows the location of exceedence to be greater than originally estimated.*
- *Designation of a larger area rather than specified streets or wards can help to avoid local concerns about perceived possibility of blighting individual property values.*

It is therefore proposed that Perth & Kinross Council designate Perth as an AQMA for both nitrogen dioxide and particles (PM_{10}). The AQMA is defined as being within the following boundary line description:

> *from a point mid–stream of the River Tay directly under the Friarton Bridge, follow the M90 road back to Broxden roundabout continuing down the A9 towards Inveralmond roundabout until the ward 25 (Hillyland) boundary line crosses it; follow this ward boundary to the River Almond and then the mid-stream line of the River Almond till it meets the River Tay; follow the mid-stream line of the River Tay until the Annaty Burn junction; follow the Annaty Burn until it crosses under the mid-point of the A94 road; from this point take a straight line through the mid point of the eastern junction on the A90(T) road to Walnut Grove to the mid-stream of the River Tay; from this point return up the River Tay to the start point under the Friarton Bridge, all as shown on Map 1.*

This proposal fulfils all the above considerations.

It will facilitate an holistic approach to the action planning process by the Council, and its partners, allowing development of appropriate sustainable measures.

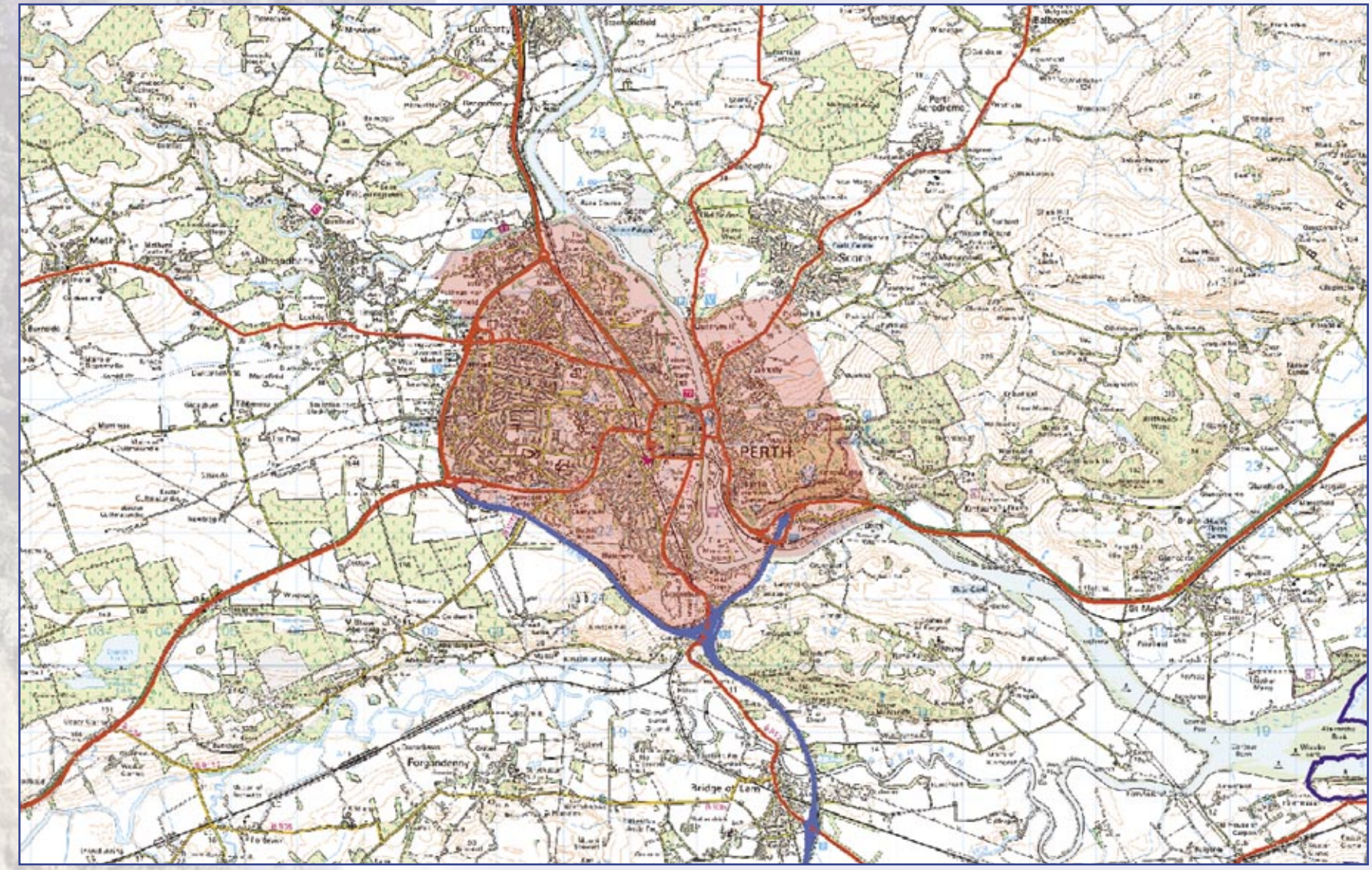
It demonstrates Perth & Kinross Council's pro-active and responsible commitment to local environmental management and protection through inclusion, not only of the current areas of exceedence for each pollutant, but also of those areas which are close to, and at times may exceed, the objectives.

The Air Quality Action Plan (AQAP) which has to be developed for the AQMA must consider, and assess the sustainability of, all options available to the council for alleviation of elevated air pollution in the areas of exceedence. Designation of the whole of Perth will facilitate implementation of the AQAP through integration with other Council policies and strategies to ensure that air quality is not addressed in isolation but included as a material consideration in other decision making processes.

Future Actions

Designation of the AQMA for nitrogen dioxide and particles (PM_{10}) will be by Order of the Council on conclusion of the statutory consultation process. This is to be followed by both a statutory Further Assessment to identify and clarify the significance of each source of these pollutants within Perth and Kinross, and by development of the statutory AQAP. Council officers will continue to liaise with the Scottish Executive and SEPA, as statutory consultees, throughout the process.

Map 1. Air Pollution Overview Scale 1:50,000



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Consultation Reminder

Comments are sought by 30 November 2005.

We would be grateful if you could clearly indicate in your response which parts of the consultation paper you are responding to as this will aid our analysis of the responses received.

Comments, in writing or by email, on the consultation should be returned to:

Tom J Brydone
Environmental Health Manager
Environment Services
Pullar House
35 Kinnoull Street
PERTH
PH1 5GD

Tel 01738 476457
Email tjbrydone@pkc.gov.uk

If you have any issues that you wish to discuss further then contact:

Ross Edwards
Environmental Health Technical Officer
Environment Services
Pullar House
35 Kinnoull Street
PERTH
PH1 5GD

Tel 01738 476462
Email redwards@pkc.gov.uk

Dorothy Lewin
Environmental Health Officer
Environment Services
Pullar House
35 Kinnoull Street
PERTH
PH1 5GD

Tel 01738 476464
Email wdlewin@pkc.gov.uk

Tom J Brydone
Environmental Health Manager
Environment Services
Pullar House
35 Kinnoull Street
PERTH
PH1 5GD

Tel 01738 476457
Email tjbrydone@pkc.gov.uk

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