Updating & Screening Assessment of Air Quality in Aberdeen

July 2006

ABERDEEN
CITY COUNCIL

Executive Summary

Part IV of the Environment Act 1995 requires local authorities to periodically review and assess the current and likely future air quality in their areas. The purpose of this Updating and Screening report is to update the findings of previous reviews and assessments and predict whether any of the air quality objectives specified in the Air Quality (Scotland) Regulations 2000, as amended are at risk of being exceeded in Aberdeen.

Part of Aberdeen City Centre, centering on Union Street and Market Street has been declared an Air Quality Management Area (AQMA) due to current and likely future exceedances of the air quality objectives for nitrogen dioxide (NO_2) and particulates (PM_{10}). Recent monitoring results confirm NO_2 levels continue to exceed the annual mean objective across the AQMA. The 1 hour objective is met at the Union Street continuous monitoring station, but exceedances were recorded at the Market Street station in 2001, 2002 and 2003. Compliance with the annual mean and 24 hour objectives for PM_{10} to be met by 2004 was achieved at the Union Street continuous monitoring station, however both objectives were exceeded at Market Street in 2005. The more stringent 2010 objectives for PM_{10} are currently exceeded at both sites and predicted to continue to do so in 2010.

The Council's Air Quality Action Plan was finalised in July 2006 and details the measures that are to be implemented to improve the air quality in the designated area. The implementation of all the measures will enable compliance with the objectives for NO_2, however exceedances of the annual mean PM_{10} objective is still predicted at some areas, particularly around the Holburn Street/Union Street junction.

Outwith the AQMA there have been no exceedances of the annual mean or 1 hour objectives for NO_2 at the Anderson Drive or Errol Place continuous monitoring stations. Diffusion tubes located at the roadside, however, indicated levels close to or above the annual mean at locations of relevant population exposure along several arterial roads, particularly the Anderson Drive/Great Northern Road corridor.

PM_{10} levels at the Anderson Drive and Errol Place continuous monitors comply with the 2004 annual mean and 1-hour objective and exceedances at locations outwith the AQMA are unlikely. With the application of a 1.3 factor to correct TEOM readings to gravitational equivalent there is potential for the 2010 annual mean value to be exceeded at both locations, however exceedance is unlikely with the less stringent 1.14 correction factor. There were no exceedances of the 2010 24-hour objective at Anderson Drive, however the objective was exceeded at Errol Place in 2004 and 2005 indicating a potential for exceedance in 2010.

Approval has been granted for the construction of a Western Peripheral Route around Aberdeen and the partial pedestrianisation of Union Street with associated road infrastructure improvements. Both developments are due for completion by 2010/2011 and will significantly improve air quality across the city.

Detailed modelling of NO_2 and PM_{10} concentrations within the city centre was carried out in 2005 as part of the development of the Air Quality Action Plan. Further modelling associated with the pedestrianisation of Union Street and construction of the Western Peripheral Route is ongoing. In view of this work no Detailed Assessment of NO_2 or PM_{10} is proposed at this time. The current monitoring will continue, particularly to determine appropriate correction factors to apply to diffusion tube and TEOM readings to enable a more accurate indication of the potential for exceedance of the objectives in future years. Further monitoring associated with the Union Street pedestrianisation and WPR will be considered in response to conclusions from ongoing modelling.

No exceedances of the air quality objectives for carbon monoxide, benzene, 1,3-butadiene, lead or sulphur dioxide were predicted and no further action is required for these pollutants.

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1. Introduction

The purpose of this Updating and Screening report is to update the findings of previous review and assessments of air quality in Aberdeen. The report describes recent monitoring and modelling results and identifies those matters that have changed and which may now require further assessment. Results of the study are used to determine the risk of exceedance of the national air quality objectives set out in the Air Quality (Scotland) Regulations 2000, as amended in 2002 and whether a Detailed Assessment of any of the prescribed pollutants is required.

1.1 Review and Assessment Framework

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2000 and 2003 addendum set out the government's framework for air quality management. Part IV of the Environment Act 1995 requires local authorities to periodically review air quality in their areas to assess compliance with the air quality objectives detailed in the Air Quality (Scotland) Regulations 2000, as amended in 2002. The objectives set out in the regulations are shown in Table 1.1

Table 1.1 Objectives included in the Air Quality (Scotland) Regulations 2000, and Amendment Regulations 2002

Column 1 *Substance*	**Column 2** *Air Quality Objectives*		**Column 3** *Prescribed Date*
	Concentration	*Measured As*	
Benzene	16.25ugm^{-3}	Running annual mean	31 December 2003
Benzene	3.25ugm^{-3}	Running annual mean	31 December 2010
1,3-Butadiene	2.25ugm^{-3}	Running annual mean	31 December 2003
Carbon monoxide	10.0 mgm^{-3}	Running 8-hour mean	31 December 2003
Lead	0.5 ugm^{-3}	Annual mean	31 December 2004
Lead	0.25 ugm^{-3}	Annual mean	31 December 2008
Nitrogen dioxide	200 ugm^{-3} not to be exceeded more than 18 times a year	1-hour mean	31 December 2005
Nitrogen dioxide	40 ugm^{-3}	Annual mean	31 December 2005
PM_{10}	50 ugm^{-3} not to be exceeded more than 35 times a year	24-hour mean	31 December 2004
PM_{10}	40 ugm^{-3}	Annual mean	31 December 2004

PM_{10}	50 ugm^{-3} not to be exceeded more than 7 times a year	24-hour mean	31 December 2010
PM_{10}	18 ugm^{-3}	Annual mean	31 December 2010
Sulphur dioxide	350 ugm^{-3} not to be exceeded more than 24 times a year	1-hour mean	31 December 2004
Sulphur dioxide	125 ugm^{-3} not to be exceeded more than 3 times a year	24-hour mean	31 December 2004
Sulphur dioxide	266 ugm^{-3} not to be exceeded more than 35 times a year	15-minute mean	31 December 2005

The local air quality management (LAQM) framework sets out a timetable for local authorities that requires reviews and assessments to be carried out every three years. Authorities should have already completed two rounds of this process. Round 3 requires authorities to complete an Updating and Screening assessment (USA) by the end of April 2006. This report has been produced to fulfil the authority's duty under the LAQM framework.

Where the Updating and Screening report identifies a risk of an exceedance of an air quality objective at a location of relevant public exposure then a Detailed Assessment must be carried out. The Detailed Assessment considers any risk of exceedance of an objective in greater depth and whether it is necessary to declare an Air Quality Management Area (AQMA) or amend an existing AQMA. If required the next round of Detailed Assessments should be completed by April 2007.

The LAQM framework also requires local authorities to submit Progress Reports at regular periods in years when Updating and Screening and Detailed Assessment reports are not required.

2. Summary of Review and Assessments in Aberdeen

2.1 Round One Review and Assessment

The first round of the review and assessment process concluded levels of carbon monoxide (CO), benzene, 1,3-butadiene, lead (Pb), sulphur dioxide (SO_2), and particulates (PM_{10}) in Aberdeen were unlikely exceed national air quality objectives and no further assessment of these pollutants was required. Exceedances of the annual mean NO_2 objective and potential exceedances of the 1 hour objective were predicted in parts of the city centre leading to the declaration of an AQMA in June 2001. Following subsequent detailed studies of Nitrogen dioxide (NO_2) levels in 2001 and 2002 the AQMA was slightly amended in March 2003 to include adjoining areas. The amended AQMA covered Market Street, Union Street, King Street (Castle Street – Roslin Terrace), Virginia Street (Market Street – Marischal Street), and Holburn Street (Union Street – Great Southern Road).

2.2 Round Two Review and Assessment

The USA of the second round of review and assessment was completed in August 2003 and concluded it was not necessary to proceed to a Detailed Assessment for CO, benzene, 1,3-butadiene, lead and SO_2. A Detailed Assessment for NO_2 and PM_{10} was undertaken to consider

a) road traffic emissions in the city centre
b) road traffic emissions along 9 arterial roads identified as having the potential to exceed national air quality objectives and
c) emissions from shipping activities at Aberdeen Harbour

The Detailed Assessment predicted continued exceedances of the annual mean NO_2 objective within the existing AQMA and also at areas of relevant population exposure on Virginia Street, Commerce Street and East North Street. The AQMA was subsequently amended in January 2005 to include these areas. Exceedances of the 2010 annual mean PM_{10} objective, introduced in the Air Quality (Scotland) (Amendment) Regulations 2002, were also predicted in the city centre. An AQMA for PM_{10} was declared in January 2005 covering the same footprint as the 2005 AQMA for NO_2. A map of the 2005 AQMAs for NO_2 and PM_{10} is shown in Appendix 2.

Predicted concentrations at relevant receptors on the peripheral routes were below the air quality objectives and no AQMA was required. However, the Detailed Assessment did predict annual mean levels close to the objective and potential exceedances of the objective at a number of locations, particularly Haudigan Roundabout on Great Northern Road/Anderson Drive (A96).

The Detailed Assessment also considered emissions of SO_2, NO_2 and PM_{10} associated with shipping movements at Aberdeen Harbour. Emissions of NO_2 were not predicted to give rise to an exceedance of air quality objectives in isolation, but may combine with emissions from other sources such as road traffic, to cause exceedances of the annual mean objective on Market Street and Virginia Street. Predicted SO_2 and PM_{10} concentrations at areas of relevant population exposure were insignificant in comparison with the air quality objectives.

2.3 Progress Report

Aberdeen City Council completed a progress report describing recent monitoring data and new developments in September 2005. Levels of NO_2 and PM_{10} at the locations of continuous monitors did not vary significantly over the period 2000-2004.

The Progress Report also summarised the outcome of vehicle emission testing undertaken in March 2005 and progress on the completed of the Air Quality Action Plan.

2.4 Round Three Review and Assessment

This Updating and Screening report has been carried out following LAQM.TG(03) and 2006 Update using the pollution specific checklist boxes detailed in the guidance. Continuous monitoring data is provided in the relevant section text for the pollutants monitored by Aberdeen City Council (NO_2, CO, PM_{10} and SO_2) and summarised in the checklist box. NO_2 diffusion tube values are shown in Appendix 3. Quality control procedures are detailed in Appendix 4.

2.5 New and Changed Developments

Part A and Part B Industrial Process

Information from SEPA indicates there have been no new or amended authorised processes since the last round of the review and assessment process likely to result in exceedance of any of the air quality objectives.

Guild Street/Union Square Development

Planning approval was granted in 2000 for a retail and leisure development on the existing railyard between Market Street and Guild Street adjacent to the existing AQMA. The development will increase traffic flows and, without mitigation measures, will have a negative impact on air quality. The development was considered in detailed modelling carried out in the preparation of the Air Quality Action Plan. Proposed mitigation measures include a number of junction changes on Market Street and Guild Street and discussions with developers/operators to investigate if further measures could be put in place to limit the effects of the development on air quality.

Road Traffic

The Scottish Executive has agreed to promote the construction of a Western Peripheral Route around Aberdeen to allow Trunk Road traffic to by-pass Aberdeen and provide a distributor road for local traffic. The finalised route of the WPR was confirmed by the Scottish Parliament in March 2006. A Management Agent Team has been formed to supervise the project and a consultant appointed to carry out the detailed design of the scheme. Although not due for completion until 2010/2011, initial modelling has shown completion will result in at least a 5% reduction in traffic volumes.

Approval has also been given for the partial pedestrianisation of Union Street (Market Street to Union Terrace) with associated road infrastructure improvements. The road layout and traffic modelling concerning the Guild Street/Union Square development and pedestrianisation of Union Street are being progressed jointly. As detailed in section 7.7, the changes to the road network will significantly reduce levels of NO_2 in the city centre. Work is programmed for completion by 2010.

Information on the impact of these major developments on air quality are discussed in greater detail within the pollutant specific sections of this report.

Air Quality Action Plan

The final draft of the Council's Air Quality Action Plan was approved by SEPA and the Scottish Executive in July 2006. The Plan details short, medium and long term actions that, if implemented, should together enable compliance with the air quality objectives by 2010. Detailed modelling was undertaken in 2005 to assess the impact of the various Actions. Short term Actions such as increased public awareness of air quality issues, improved public transport, the promotion of green travel plans and further controlled parking should result in a gradual improvement in air quality. However, the pedestrianisation of Union Street and associated road infrastructure improvements are the key measures to significantly improve city centre air quality.

Aberdeen Airport

Planning permission was granted in May 2004 for the 24 hour opening of Aberdeen airport. Previous permission restricted the opening hours from 0600-2330. It is anticipated that a maximum of 6-8 flights will take off/land during the night. The new opening hours will therefore have no impact on local air quality management. There has been a gradual year on year increase in the number of flights taking off and landing at Aberdeen airport. The increase is not considered sufficient to result in potential exceedances of the air quality objectives. Further comments on emissions from activities associated with Aberdeen airport are reported in the relevant pollution specific sections of this report.

Aberdeen Harbour

As part of an assessment of the impact of Aberdeen Harbour on the local environment, Aberdeen Harbour Board commissioned Aberdeen University to undertake a study of the impact of activities at the Harbour, including shipping movements, on air quality. Monitoring and analysis of NO_2, PM_{10} and SO_2 was undertaken over various timescales and using alternative techniques. Several of these varied from those adopted for LAQM purposes. The report concluded that shipping movements were unlikely to result in any exceedance of the air quality objectives and that road traffic was the dominant pollution source in the area.

Modelling of emissions from Aberdeen Harbour was also undertaken as part of the Detailed Assessment during round 2 of the Review and Assessment process. Further comments on emissions from both studies are reported in the relevant pollutant specific sections of this report.

3. Review and Assessment for Carbon Monoxide

3.1 Introduction

The main source of carbon monoxide (CO) in the UK is road transport. Annual emissions have been falling steadily since the 1970s and are expected to continue to do so. Studies at a national level, based on both measured and modelled data, suggest that there is little likelihood of the objective for CO being exceeded.

3.2 Health Effects of Carbon Monoxide

Exposure to very high concentrations of carbon monoxide may promote the formation of carboxyhaemogloblin in the blood, which reduces the capacity to carry oxygen. Effects are most pronounced in people suffering from an existing disease which affects the delivery of oxygen to the brain, for example angina.

3.3 Air Quality Standards and Objectives of Carbon Monoxide

The air quality objective for CO has been set at a level of $10mgm^{-3}$ as a maximum running 8-hour mean concentration to be achieved by the end of 2003.

3.4 The Updating and Screening Assessment for Carbon Monoxide

Both the first and second rounds of the review and assessment process concluded that the air quality standard for CO was being met and that there was negligible risk of the objective being exceeded in Aberdeen. Road traffic was identified as the main source of CO.

Technical guidance LAQM.TG(03) recommends that local authorities should collate information on

- Monitoring data
- Very busy roads

This information is detailed in the checklist in Section 3.5.

3.4.1 Monitoring Data

There is one continuous monitoring station located at Errol Place, an urban background site close to Aberdeen city centre. This site is representative of relevant population exposure and is part of the UK national monitoring network. Data has been scaled and ratified by NETCEN/AEA technology, an independent agency responsible for the management of the network.

Table 3.1 summarises the annual mean and maximum 8-hour running average concentration for the period 1999-2005 at Errol Place.

Table 3.1 Annual Mean CO Level and Maximum 8-hour running mean at Continuous Monitoring Station

Year	Annual mean (mgm^{-3})	Max running 8-hour mean (mgm^{-3})	Exeedances of running 8-hour mean	% Data capture
1999	0.5	1.9	0	93
2000	0.2	1.1	0	87
2001	0.3	2.3	0	98
2002	0.2	2.0	0	94
2003	0.4	1.6	0	97
2004	0.3	1.7	0	93
2005	0.3	1.2	0	99

Current measurements are well below the maximum 8-hour running mean of 10 mgm^{-3} to be achieved by 2003. Monitoring data suggests the CO objective is unlikely to be exceeded at any location.

3.5 Updating and Screening Assessment Checklist

The USA Checklist within LAQM.TG(03) (Jan 06) was used to assess the likelihood of exceedance of the air quality objective for CO and whether a 'Detailed Assessment' is required. The outcome of the assessment is summarised in Table 3.2.

Table 3.2 Updating and Screening Checklist: Carbon Monoxide

Checklist item	Updating and Screening Assessment
Monitoring data	This authority currently has one CO continuous monitor at Errol Place, an urban background site close to the city centre. Appendix 1 shows the site location. The site is representative of relevant population exposure. Annual mean and maximum 8-hour running mean values from 1999-2005 are shown in Table 3.1. There were no exceedances of annual mean or maximum daily 8-hour objectives. It is considered unlikely that the CO objectives will be exceeded at this location.
Very busy roads or junctions in built up areas	There are no 'very busy' roads or junctions in areas where the current year background concentration is expected to be above 1 mgm^{-3}.
Conclusion	There has been no significant change with regards to CO emissions in this authority and as such a Detailed Assessment will not be required.

4. Review and Assessment of Benzene

4.1 Introduction

The main sources of benzene emissions in the UK are petrol-engined vehicles, petrol refining and the uncontrolled emissions from petrol station forecourts without vapour recovery systems.

EU and UK policy measures in place, or planned for future years, will reduce emissions of benzene. For example EU legislation has reduced the maximum benzene content of petrol from 5% to 1%. The European Auto-Oil programme will further reduce emissions for cars and light-duty vehicles and emissions of benzene from the storage and distribution of petrol are controlled by vapour recovery systems.

4.2 Health effects of Benzene

Benzene is a recognised human carcinogen. Exposure to elevated levels is associated with increased risk of leukaemia. There is no absolutely safe level of benzene, however the adopted air quality standard is considered to represent an exceedingly small risk.

4.3 Air Quality Standards and Objectives for Benzene

The air quality objective for benzene has been set at a level of 16.25 ugm^{-3} as a running annual mean to be achieved by the end of 2003 and a level of 3.25 ugm^{-3} as a running annual mean which has to be achieved by the end of 2010.

4.4 The Updating and Screening Assessment for Benzene

The first and second rounds of the review and assessment concluded that the risk of benzene objective being exceeded in Aberdeen was minimal.

The technical guidance LAQM.TG(03) recommends that Local Authorities should collate information on:

Monitoring data
Very busy roads or junctions in built up areas
Industrial sources
Petrol stations
Major fuel storage depots

4.5 Updating and Screening Checklist

The USA Checklist within LAQM.TG(03) (Jan 06) was used to assess the likelihood of exceedance of the air quality objective for benzene and whether a 'Detailed Assessment' is required. The outcome of the assessment is summarised in Table 4.1

Table 4.1 Updating and Screening Checklist: Benzene

Checklist Item	Updating and Screening Assessment
Monitoring data	This authority is not currently monitoring for benzene.
Road Traffic	There are no 'very busy' roads or junctions in Aberdeen where the background level is expected to be above 2ugm^{-3}.
New industrial sources Industrial processes with substantially increased emissions, or new relevant exposure	There are no new industrial processes or industrial processes with substantially increased emissions, or new relevant exposure of relevance for benzene in Aberdeen, or any neighbouring authority.
Petrol stations	No petrol stations with an annual throughput of more than 2000 m^3 of petrol and with a busy road nearby and relevant population exposure where identified in the 2003 USA. There has been no change in this position.
Major fuel storage depots (benzene only)	There are no major fuel storage depots of relevance for benzene in Aberdeen, or any neighbouring authority. There has been no change in this position.
Conclusions	There has been no significant change with regards to benzene emissions in this authority and as such a Detailed Assessment will not be required.

5. Review and Assessment of 1,3-butadiene

5.1 Introduction

Emissions of 1,3-butadiene arise as a by-product of the combustion of petroleum. The main source of 1,3-butadiene is from vehicle exhausts, although significant contributions are made from carbon industrial processes.

Emissions of 1,3-butadiene have decreased significantly since 1990. The introduction of catalytic convertors and improvements to fuel technology led to a 61% reduction in emissions between 1990 and 2000. However, contributions from certain industrial processes may significantly impact on local air quality.

Monitoring from national network sites and modelling data has shown there is little likelihood of the objective being exceeded.

5.2 Health Effects of 1,3-butadiene

Like benzene, 1,3-butradiene is a human carcinogen. Exposure to elevated levels is linked to cancers of the lymphoid system and blood forming tissues, lymphomas and leukaemia.

5.3 Air Quality Standard and Objective for 1,3-butadiene

The air quality objective for 1,3-butadiene has been set as a maximum running annual mean concentration of 2.25ugm^{-3} to be achieved by December 2003.

5.4 Updating and Screening Assessment of 1,3-butadiene

The first and second rounds of the review and assessment concluded that the risk of the air quality objective for 1,3-butadiene being exceeded in Aberdeen was minimal.

The Technical Guidance LAQM.TG(03) recommends that Local Authorities should collate information on:

- Monitoring data
- New industrial sources
- Existing industrial sources with significantly increased emissions

5.5 Updating and Screening Checklist

The USA Checklist within LAQM.TG(03) (Jan 06) was used to assess the likelihood of exceedance of the air quality objective for benzene and whether a ‘Detailed Assessment’ is required. The outcome of the assessment is summarised in Table 5.1

Table 5.1 Updating and Screening Checklist: 1,3-butadiene

Checklist item	Updating and Screening Assessment
Monitoring data	This authority is not currently monitoring for 1,3-butadiene.
New industrial sources	There are no new industrial processes or industrial processes with substantially increased emissions, or new relevant exposure of relevance for 1,3-butadiene in Aberdeen, or any neighbouring authority.
Industrial processes with substantially increased emissions, or new relevant exposure	
Conclusions	There has been no significant change with regards to 1,3-butadiene emissions in this authority and as such a Detailed Assessment will not be required.

6. Review and Assessment of Lead

6.1 Introduction

Historically, the largest source of lead was from vehicle exhaust emissions as it was used as an additive in petrol. However, in recent years, this source has been subject to the greatest reduction in emissions. Leaded petrol was phased out at the end of 1999 with the implementation of the Directive on the Quality of Petrol and Diesel Fuels.

Emissions of lead are now limited to a variety of industrial activities including battery manufacture, pigments in paint and glazes, alloys, radiation shielding, tank lining and piping.

6.2 Health Effects of Lead

Exposure to very high levels of lead may result in toxic biochemical effects, causing problems in the synthesis of haemoglobin and the possible inhibition of intellectual development, particularly in children. High levels of lead may also affect the kidneys, gastrointestinal tract, joints and reproductive system, and cause acute or chronic damage to the nervous system.

6.3 Air Quality Standards and Objectives for Lead

Two air quality objectives have been set for lead. The first objective has been set at 0.5 ugm^{-3} as a running annual mean to be achieved by December 2004. A lower objective of 0.25 ugm^{-3} as a running annual mean to be achieved by the end of 2008 has also been set.

6.4 The Updating and Screening Assessment for Lead

The first and second rounds of the review and assessment process concluded that the risk of the air quality objective for lead being exceeded in Aberdeen was minimal.

The Technical Guidance LAQM.TG(03) recommends that Local Authorities should collate information on:

- Monitoring data
- New industrial sources
- Industrial sources with substantially increased emissions

6.5 Updating and Screening Checklist

The USA Checklist within LAQM.TG(03) (Jan 06) was used to assess the likelihood of exceedance of the air quality objective for lead and whether a ‘Detailed Assessment’ is required. The outcome of the assessment is summarised in Table 6.1

Table 6.1 Updating and Screening Checklist: Lead

Checklist item	Updating and Screening Assessment
Monitoring data	This authority is not currently monitoring for lead.
New industrial sources	There are no new industrial processes or industrial processes with substantially increased emissions, or new relevant exposure of relevance for lead in Aberdeen, or any neighbouring authority.
Industrial processes with substantially increased emissions, or new relevant exposure	
Conclusions	There has been no significant change with regards to lead emissions in this authority and as such a Detailed Assessment will not be required

7. Review and Assessment of Nitrogen Dioxide

7.1 Introduction

Nitrogen dioxide (NO_2) and nitric oxide (NO) are both oxides of nitrogen, and are collectively referred to as nitrogen oxides (NOx). All combustion processes produce NOx emissions, largely in the form of nitric oxide, which is then converted to nitrogen dioxide, mainly as a result of reaction with ozone in the atmosphere.

The principal source of nitrogen oxide emissions is road transport, which accounted for about 49% of total UK emissions in 2000. 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 such as Aberdeen, the contribution of road transport to local emissions will be much higher. The contribution of road transport to nitrogen oxide emissions has declined significantly in recent years as a result of various policy measures, and further reductions are expected up until 2010 and beyond.

Other significant sources of nitrogen oxide emissions include the electricity supply industry and other industrial and commercial sectors. Emissions from both sources have also declined dramatically due to the fitting of low oxide burners and the increased use of natural gas plant.

On a national level, the annual mean objective is widely exceeded at roadside sites throughout the UK. Exceedances of the 1-hour objective are dependent on meteorological conditions and so vary from year to year.

7.2 Health Effects on Nitrogen Dioxide

NO_2 is associated with adverse effects on human health. Short-term exposure to high concentrations may cause inflammation of respiratory airways. Long-term exposure may affect lung function and enhance responses to allergens in sensitised individuals. Asthmatics are particularly at risk.

7.3 Air Quality Standards and Objectives for Nitrogen Dioxide

Two air quality objectives have been set for nitrogen dioxide, an annual mean concentration of 40 ugm^{-3} and a 1-hour mean concentration of 200ugm^{-3} not to be exceeded more than 18 times a year. These objectives were to be achieved by the end of 2005.

7.4 The Updating and Screening Assessment for Nitrogen Dioxide

The Stage 3 review and assessment undertaken during the first round of the review and assessment process predicted exceedances of the annual mean NO_2 objective in parts of the city centre. An Air Quality Management Area (AQMA) covering Market Street, Union Street, King Street (Castle Street-Roslin Terrace), and Virginia Street (Market Street-Marischal Street) was declared in June 2001. Potential exceedances of the 1-hour objective of 200ugm^{-3} (18 exceedances permitted per year) were also predicted on Market Street.

A Stage 4 assessment of the AQMA completed in March 2003 found that NO_2 levels had increased slightly since the completion of the Stage 3 assessment. This assessment also predicted exceedances of the annual mean objective on Holburn Street. The AQMA was subsequently amended to include the section of Holburn Street between Great Southern Road and Union Street.

A Detailed Assessment was carried out as part of the second round of the review and assessment process. This assessment confirmed continued exceedances of the NO_2 annual mean objective in the city centre. The assessment also identified exceedances of the objective on Commerce Street, Virginia Street and East North Street following the renovation of derelict properties to flats. The AQMA was subsequently amended in January 2005 to include Commerce Street and Virginia Street. Appendix 1 shows the 2005 AQMA for NO_2.

In order to complete the Updating and Screening Assessment, authorities should collate information on the following

- Monitoring data outside an AQMA
- Monitoring data within an AQMA
- Narrow congested streets with residential properties close to the kerb.
- Junctions
- Busy streets where people may spend 1 hour or more close to traffic
- Roads with high flows of buses and HGV's
- New roads constructed or proposed since the last round of review and assessment
- Roads with significantly changed traffic flows
- Bus stations
- New industrial sources
- Industrial sources with substantially increased emissions
- Aircraft

This information is detailed in the Checklist in Section 7.10. Section 7.5-7.9 discuss monitoring data and emissions from new roads, aircraft and shipping in more detail.

7.5 Monitoring Data Outside an AQMA

7.5.1 Continuous monitoring

The following 2 continuous chemiluminescent analysers are located outside the AQMA.

Errol Place: an urban background site close to Aberdeen City Centre.
Anderson Drive: a roadside site between Headland Court and Broomhill Road.

The Errol Place site is at a location of relevant population exposure. Anderson Drive is approximately 10-20m closer to the kerbside than would normal for population exposure in this area.

Table 7.1 shows annual mean NO_2 concentrations between 2000 and 2005 and predicted values. Anderson Drive was commissioned in February 2004. The Year Adjustment Calculator spreadsheet downloaded from the internet was used to project the 2005 measured concentrations to 2010. The results are also shown in Table 7.1. QA/QC information is included in Appendix 4.

Table 7.1 Annual Mean NO_2 Concentration and Exceedances of the 1 Hour Objective at Continuous Stations Outside AQMA

Station	Year	Annual Mean (ugm^{-3})	Exceedances of 1hr objective	Data Capture (%)
Errol Place	2000	22	0	93
	2001	23	0	94
	2002	24	0	89
	2003	31	0	88
	2004	26	0	90
	2005	24	0	97
	2010 (predicted)	21		
Anderson Drive Commissioned March 2004	2004 (Feb-Dec)	30	0	96
	2005	24	0	73
	2010 (predicted)	20		

NO_2 concentrations at Errol Place and Anderson Drive are below the 2005 annual mean objective and there have been no exceedances of the 1-hour objective.

7.5.2 **Diffusion Tubes**

Nitrogen dioxide levels are also measured outwith the AQMA using diffusion tubes located at 17 sites across the city. Table A.3.1 in Appendix 3 provides information on site locations and annual mean concentrations between 1999 and 2004. The diffusion tube survey ceased temporarily in 2005 (only 3 months data available) and consequently there is no 2005 data.

Bias adjusted values and projections to building façade where appropriate are shown in Table A.3.3 and A.3.4 in Appendix 3. Procedures to bias adjust data is described in the QA/QC information in Appendix 4. As reported, there is substantial uncertainty regarding the application of appropriate bias adjustment factors and therefore the diffusion tube results should be treated with caution.

With the application of the Errol Place bias factor, exceedances of the annual mean objective were apparent at the building façade, 885 Great Northern Road in 2002, 2003 and 2004 (2002 factor applied to 2003 and 2004 data). Exceedances were also apparent in 2004 (2002 bias factor) at St Mary's Church, King Street, 86 Victoria Road, Torry, Wellington Road/Kerloch Place and 107 Anderson Drive and reached the objective level at these sites in 2002.

The application of the mean bias factor of the 3 continuous stations, resulted in higher bias corrected diffusion tube values and additional exceedances in 2004 adjacent to Bucksburn Primary School, Inverurie Road and 38 Ellon Road.

The traffic flow and the site environment at the Anderson Drive continuous monitoring station is similar to the diffusion tubes located adjacent to 107 Anderson Drive and 549 North Anderson Drive, although the diffusion tubes are 3-4m closer to kerbside in both cases. Although there is no comparative same year data, the 10 month continuous monitoring value of 30ugm^{-3} in 2004 and annual mean value of 24ugm^{-3} in 2005 are substantially lower than the bias adjusted diffusion tube values at both sites for 2002-2004. This is particularly evident at 107 Anderson Drive where the bias adjustment value ranged from 50-56ugm^{-3} in 2002-04 (Errol Pl factor) and 51-63ugm^{-3} (mean factor from 3 monitoring stations). Based on these observations, it would appear that diffusion tube data for 2002-2004 is over-reading compared to continuous monitoring data and thus predicted concentrations using the Errol Place and mean bias factors are likely to be 'worst case'.

The city wide diffusion tube survey recommenced in February 2006. Triplicate diffusion tubes are now also co-located at the Anderson Drive continuous monitoring station. Information from the monitoring will assist in the identification of appropriate bias adjustment factors and trends in NO_2 outwith the AQMA in future years.

7.6 Monitoring Data within the AQMA

7.6.1 Continuous monitoring

The following 2 continuous chemiluminescent analysers are located within the AQMA.

Market Street: a city centre roadside site
Union Street: a city centre roadside site

These monitoring sites are at locations of relevant population exposure for both the 1 hour and annual mean objectives.

Table 7.2 summarises NO_2 concentrations between 2000 and 2005. The Year Adjustment Calculator spreadsheet downloaded from the internet was used to project the Market Street 2005 measured annual mean concentration to 2010. The 2004 annual mean was used at Union Street to project to 2010 due to the uncertainty regarding the validity of the 2005 value. QA/QC information is included in Appendix 4.

Table 7.2 Annual Mean NO_2 Concentration and Exceedances of the 1 Hour Objective from Continuous Stations Inside AQMA

Station	Year	Annual Mean (ugm^{-3})	Exceedances of 1hr objective	Data Capture (%)
Union Street	2000	51	0	87
	2001	55	0	96
	2002	53	0	94
	2003	50	1	95
	2004*	52	10	
	2005*	64	100	90
	2010 (predicted)	42		
Market Street	2000	57	11	89
	2001	60	27	97
	2002	69	43	94
	2003	56	23	95
	2004	67	15	84
	2005	55	6	91
	2010 (predicted)	46		

*Data for the period September 2004 - May 2005 showed significantly raised NO_2 concentrations at Union Street. There was only 1 exceedance of the 1 hour objective in 2004 prior to September, but 9 exceedances between September and December with a further 100 between January and May 2005. There was no change in traffic flows or activity at the site and no explanation can be offered for the high readings. Equipment fault may be responsible, however records do not indicate any analyser breakdown likely to result in overreadings and all service and audit reports were satisfactory. AEA Technology ratified the data and as no equipment problem or other explanation could be provided for the readings, the recommendation was to treat the data as valid, but to be viewed as suspect.

Annual mean levels at both Union Street and Market Street clearly exceeded the 2005 air quality objective and are predicted to do so in 2010.

7.6.2 **Diffusion Tube Monitoring Data**

There is also a network of diffusion tube monitoring within the AQMA. Table A.3.1 in Appendix 3 provides information on site locations and annual mean concentrations between 1999 and 2004. Bias adjusted values are shown in Tables A.3.2 in Appendix 3. All monitoring sites are at building façade and at locations of relevant population exposure. As stated in section 7.5.2, there is substantial uncertainty regarding the application of appropriate bias adjustment factors and therefore the diffusion tube results should be treated with caution.

Exceedences of the annual mean objective were apparent at all sites within the AQMA. Bias adjusted values are higher across the AQMA than the Market Street and Union Street continuous monitoring values for the period 2002-2004. This is particularly the case for the 2004 values (2002 bias factor) and suggests the application of the 2002 factor is resulting in an over-reading of NO_2 diffusion tube results. Highest levels were consistently measured at 184-192 Market Street (68-89ugm^{-3} between 2000-2003), 105 King Street (63-77ugm^{-3}), 40 Union Street (58-83ugm^{-3}) and 469 Union Street (68-82ugm^{-3}).

Information from diffusion tubes co-located with the Market Street and Union Street continuous monitors will assist in the identification of appropriate bias factors in future years. It can be concluded from existing data that high levels of NO_2 exist across the AQMA.

7.7 **New Roads**

As reported in 2.5.3, the construction of the Western Peripheral Route (WPR) will significantly reduce road traffic on radial roads across the city. The greatest flow reduction will be along the Anderson Drive/Auchmill Road/Inverurie Road corridor. Modelling has predicted at least a 5-10% flow reduction on this route with a 20-30% reduction in HGVs. A 12% reduction in HGVs is predicted on Great Northern Road and a 23% reduction on King Street. The WPR will therefore significantly reduce NO_2 levels across the city. Further modelling of the air quality impact of the WPR is ongoing.

7.8 **Aircraft**

Aberdeen airport is located at the perimeter of the city approximately 7 miles from the city centre. There are residential properties to the east of the airport. Passenger throughput in 2005 was 2,876,722 passengers with 1,637 tonnes of freight transported. The equivalent passenger throughput as calculated using LAQM.TG(03) is below 5 million person per year. The airport is unique in the UK in that there are a large number of helicopter movements. Monitoring of emissions via diffusion tubes was undertaken by a consultant on behalf of BAA over 6 months between November 2003 and May 2004. Tubes were exposed for 4-week periods. Levels at all sites were well below the annual mean objective. Exceedances of the NO_2 objectives due to emissions from aircraft, including take-off and landing, ground movements and associated activities are not predicted.

7.9 **Shipping**

Aberdeen Harbour has been included within this USA report due to its city centre location in close proximity to residential accommodation and the AQMA.

Modelling of emissions from the harbour was undertaken as part of the Detailed Assessment in Round 2 of the Review and Assessment process. The maximum NO_2 concentration at areas of relevant population exposure attributable to emissions from the harbour was predicted to be 10ugm^{-3} at the southern end of Market Street. Although emissions from the harbour are unlikely to result in exceedances of the objective in isolation, they may contribute to the exceedances of the annual mean objective on Market Street and areas surrounding Virginia Street.

Aberdeen Harbour Board commissioned Aberdeen University to undertake long term and short term monitoring of NO_2 emissions within the harbour area during 2003/04. Monitoring and analysis techniques varied from those recommended for LAQM purposes, although diffusion tubes were used for long term monitoring over a 14 month period. Comparisons were made with continuous monitoring undertaken by this authority and appropriate bias adjustment made to diffusion tube results. In summer the average NO_2 concentration for all harbour sites was significantly lower than concentrations typical of the city centre, though in winter the harbour levels were much closer to city centre levels. Although the annual mean objective was exceeded at most sites with highest levels close to Market Street, the report concluded that shipping movements were unlikely to result in exceedances of the objectives and that road traffic was the dominant pollution source.

As there have been two recent assessments of NO_2 emissions from Aberdeen Harbour no further Detailed Assessment is proposed at this time. Diffusion tube monitoring of NO_2 within the harbour area is being undertaken by this authority and will be reported in future review and assessments.

7.10 **Updating and Screening Checklist**

The USA Checklist within LAQM.TG(03)(Jan06) was used to assess the likelihood of exceedance of the air quality objective for NO_2 and whether a Detailed Assessment is required. The outcome of the assessment is summarised in Table 7.3

Table 7.3 Updating and Screening Checklist: Nitrogen Dioxide

Checklist item	Updating and Screening Assessment
Monitoring data outside an AQMA	There are two continuous monitors at Errol Place and Anderson Drive and a network of diffusion tubes outside the AQMA. Appendix 1 shows the site locations. Monitoring data is detailed in sections 7.5. QA/QC information is included in Appendix 4. The annual mean value at Errol Place between 2000-05 ranged from 22-31ugm^{-3}. At Anderson Drive the 2005 annual mean was 24ugm^{-3}. There have been no exceedances of the 1-hour objective at either site. Bias adjusted diffusion tube values indicate potential exceedances of the annual mean objective at several sites along main arterial roads although there is some uncertainty regarding the bias factors applied. The highest level was adjacent to 885 Great Northern Road which is close to Haudigan roundabout.

Monitoring data within an AQMA	There are two continuous monitors at Union Street and Market Street and a network of diffusion tubes within the AQMA. Appendix 1 shows the site locations. Monitoring data is detailed in section 7.6. QA/QC information is included in Appendix 4. The annual mean objective at the Union Street continuous monitor was 50-64 ugm^{-3} between 2000 and 2005 and 55-69 ugm^{-3} at the Market Street monitor. Levels are well above the annual mean objective at both sites. There were more than 18 exceedances of the 1-hour objective at Market Street in 2001, 2002 and 2003. Although more than 18 exceedances were recorded at Union Street in 2005, the validity of the data is questionable. Results from the diffusion tube survey indicate exceedances of the annual mean objective at sites across the AQMA.
Narrow congested streets with residential properties close to the kerb	This was examined in the 2003 USA and there is no change in this position
Junctions	This was examined in the 2003 USA and there is no change in this position
Busy streets where people may spend 1-hour or more close to traffic	This was examined in the 2003 USA and there is no change in this position
Roads with high flows of buses and/or cars	This was examined in the 2003 USA and there is no change in this position

New roads constructed or proposed since the previous round of review and assessment	A proposal to construct a Western Peripheral Route (WPR) around Aberdeen was identified in the 2003 USA. Funding from the Scottish Executive was confirmed in 2005 and a final route identified in 2006. Completion is programmed for 2011. The impact of the WPR on air quality along roads within the city was undertaken as part of a traffic impact assessment, however further detailed modelling and assessment of the route is ongoing. A Detailed Assessment in terms of LAQM is only proposed if modelling indicates potential exceedances of the objectives at locations along the route. The WPR is predicted to reduce traffic flows on the Anderson Dr/Auchmill Rd corridor by 5-10% with an HGV reduction of 20-30%. City centre flows will also be reduced by at least 5% with a 15% reduction on Market Street. Its construction will assist in the reduction of NO_2 levels on existing roads throughout the city.
Roads with significantly changed traffic flows, or new relevant exposure	There are currently no roads with significantly changed traffic flows or new relevant exposure, however approval has been granted for the partial pedestrianisation of Union Street (Market Street to Union Terrace) and development of a retail and leisure park at Guild Street/Union Square with associated road infrastructure changes. Completion is programmed for 2010. The impact on air quality of these changes was the subject of detailed modelling in 2005 as part of an assessment of the Actions detailed in the draft Air Quality Action Plan. Further detailed traffic modelling associated with the Union Street pedestrianisation and Guild Street/Union Square developments are ongoing. As a result of the current and recent air quality and traffic modelling no Detailed Assessment of traffic flow changes is proposed.

Bus stations	The bus station at Guild St, adjacent to the AQMA, is being redeveloped as part of the Guild St/Union Square development with associated road infrastructure changes. The development is subject to detailed traffic and air quality modelling. No Detailed Assessment is therefore proposed at this time.
New industrial sources Industrial processes with substantially increased emissions, or new relevant exposure	There are no new industrial processes or industrial processes with substantially increased emissions, or new exposure of relevance for nitrogen dioxide in Aberdeen, or any neighbouring authority.
Aircraft	Emissions associated with aircraft movements are discussed in section 7.8. The predicted total equivalent passenger throughput at Aberdeen airport is less than 5 mppa. Diffusion tubes around the airport indicated there is little risk of exceedances of the objectives due to emissions from aircraft.
Shipping	Aberdeen Harbour is situated within the city centre with relevant population exposure within 500m. Modelling and monitoring of emissions are discussed in section 7.9 and are estimated to be approximately 10ugm^{-3} at the nearest point of population exposure. Emissions from Aberdeen Harbour will not give rise to exceedances of the objectives in isolation, but may combine with road traffic to cause exceedances of the annual mean objective on Market Street and surrounding areas.

Conclusions	Emissions within the AQMA continue to exceed the annual mean objective and are predicted to do so until the completion of the Guild Street/Union Square development, the pedestrianisation of Union Street and associated infrastructure changes. The annual mean concentrations at the 2 continuous monitors outwith the AQMA are well below the objective, however diffusion tube monitoring at roadside sites indicates potential exceedances at several locations of relevant population exposure. Air quality at roadside locations across the city will be significantly improved by the pedestrianisation of Union Street and construction of the Western Peripheral Route. As a result of the recent and ongoing modelling of these developments a Detailed Assessment of nitrogen dioxide is not proposed at this time. Additional monitoring will be considered following the outcome of the modelling. The outcome of ongoing monitoring and progress on the Guild St/Union St and WPR developments will be reported in the 2007 Progress Report.

8. Review and Assessment of Sulphur Dioxide

8.1 Introduction

Power stations are the main source of sulphur dioxide (SO_2) emissions in the UK, accounting for over 70% of sulphur dioxide emissions in 2000. There are also significant emissions from other industrial combustion sources. Domestic sources now only account for 4% of emissions, but can be locally much more significant. Road transport is a relatively unimportant source and accounts for less than 1% of total sulphur dioxide emissions.

A small number of AQMA's were declared following the first and second rounds of Review and Assessment. These relate to emissions from coal-fired boilers, domestic coal burning and shipping at a major port.

8.2 Health Effects of Sulphur Dioxide

Sulphur dioxide causes constriction of the airways by stimulating nerves in the lining of the nose, throat and airways of the lung. The latter effect is particularly likely to occur in those suffering from asthma and chronic lung disease.

8.3 Air Quality Standards and Objectives for Sulphur Dioxide

Several air quality objectives have been set for sulphur dioxide. The most stringent is a 15 minute mean of 260 ugm^{-3} to be exceeded no more than 35 times in a year, to be achieved by December 2005. There are also additional objectives set in order to achieve the requirements specified in the first EU daughter directive. These are a 1-hour mean objective of 350 ugm^{-3} to be exceeded no more than 24 times per year and a 24-hour objective of 125 ugm^{-3} to be exceeded no more than 3 time per year, both to be achieved by the end of 2004.

8.4 The Updating and Screening Assessment for Sulphur Dioxide

The first round of the review and assessment process identified potential for exceedances of the short-term SO_2 objectives due to emissions from three Part A industrial combustion processes that may run on heavy fuel oil when supplies of natural gas are interrupted. No other significant sources of SO_2 were identified. Further investigation of the industrial processes, only one of which is now operational confirmed the use of heavy fuel oil was minimal and exceedances of the objectives were unlikely.

No exceedances of the air quality objectives for SO_2 were predicted in the second round of the review and assessment process.

Technical Guidance LAQM.TG(03) recommends authorities should collate information on:

- Monitoring data outside an AQMA
- Monitoring data within an AQMA
- New industrial sources
- Industrial sources with substantially increased emissions
- Areas of domestic coal burning
- Small boilers >5MW $_{(thermal)}$ burning coal or oil
- Shipping
- Railway locomotives

This information is detailed in the Checklist in Section 8.7. Section 8.4.1 and 8.5 discuss continuous monitoring data and emissions from shipping in more detail.

8.4.1 **Monitoring Data**

Continuous Monitoring Station

There is one continuous SO_2 monitoring station located at Errol Place, an urban background site close to the city centre. This site is representative of relevant population exposure. Table 8.1 summarises the annual mean concentration and number of exceedances of the 24-hour, 1-hour and 15-minute objectives for the period 2001-2005. Data for 15-minute concentrations is only available from 2003.

Table 8.1 Annual Mean SO_2 Concentration and Number of Exceedances of Objectives at Continuous Monitoring Station

Year	Annual mean (ugm^{-3})	Exceedances of 24-hour objective	Exceedances of 1-hour objective	Exceedances of 15-minute objective	% Data capture
2001	5	0	0	N/A	91
2002	5	0	0	N/A	98
2003	7	0	0	0	95
2004	4	0	0	2	92
2005	3	0	0	0	96

There were 2 exceedances of the 15-minute objective in 2004 (35 permitted per year) and no exceedances in the other years over which data is available. Monitoring data suggests the SO_2 objective is unlikely to be exceeded at any urban background location.

8.5 **Shipping**

Emissions from shipping in Aberdeen Harbour were considered in the 2004 Detailed Assessment. The report estimated that approximately 600 tonnes of SO_2 are emitted from the harbour annually, the majority being generated by the ship's auxillary engines while at berth. Dispersion modelling identified that peak concentrations occur within the main harbour area, away from relevant population exposure. The predicted SO_2 concentrations at areas of relevant population exposure were insignificant in comparison to the air quality objectives.

Monitoring of SO_2 via diffusion tubes within the harbour area was undertaken by Aberdeen University as part of a study commissioned by Aberdeen Harbour Board to assess the impact of the harbour on air quality. Tubes were exposed for 2-week periods from July 2003 to July 2004. The average concentration of SO_2 around the harbour, averaged over all sites, was 37ugm^{-3}. At many of the sites the samples were around or even below the limit of qualification of the analytical method. Although measurements were obtained as means of 15 days, the report concluded that the 24-hour objective would not be exceeded.

8.6 Updating and Screening Checklist

The USA Checklist within LAQM.TG(03)(Jan06) was used to assess the likelihood of exceedance of the air quality objective for SO_2 and whether a Detailed Assessment is required. The outcome of the assessment is summarised in Table 8.2

Table 8.2 Updating and Screening Checklist: Sulphur Dioxide

Checklist item	Updating and Screening Assessment
Monitoring data outside an AQMA	This authority has one SO_2 continuous monitor at Errol Place, an urban background site (location map included in Appendix 1). This site is representative of relevant population exposure. Annual mean concentrations and number of exceedances of the 24-hour, 1-hour and 15min objectives from 2001-05 are shown in Table 8.1 There were 2 exceedances of the 15-min objective in 2004 (35 permitted per year). All objectives were met in other years. It is considered unlikely that the SO_2 objective will be exceeded at this location.
Monitoring data within an AQMA	Not applicable as there is no AQMA for SO_2 (NO_2 and PM_{10} only)
New industrial sources	There are no new industrial processes or industrial processes with substantially increased emissions, or new relevant exposure of relevance for sulphur dioxide in Aberdeen, or any neighbouring authority. Two Part A processes that run on heavy fuel oil when the natural gas supply is interrupted have ceased trading since the first round of Review and Assessment.
Industrial processes with substantially increased emissions, or new relevant exposure	
Domestic Sources	This was examined in the 2003 USA. No areas of domestic coal burning were identified and there has been no change in this position.

Small Boilers >5MW(thermal)	This was examined in the 2003 USA. No small boilers >5MW burning coal or heavy fuel oil were identified as likely to result in exceedances of the objectives. There has been no change in this position.
Shipping	Aberdeen Harbour is located in the city centre. There is relevant population exposure within 500m of the Harbour. In 2004 8334 vessels arrived in Aberdeen and 8335 in 2005. Modelling of SO_2 emissions from shipping was carried out as part of the 2004 Detailed Assessment and is discussed on section 8.6. An assessment of emissions due to shipping undertaken by Aberdeen University on behalf of Aberdeen Harbour Board is also discussed. Both reports concluded there is little likelihood of exceedances of the any of the objectives. There are no other significant sources of SO_2 that may affect the area. As there have been two recent studies of SO_2 emissions from shipping the authority does not intend to proceed to a Detailed Assessment to further assess emissions from shipping.
Railway locomotives	This was examined in the 2003 USA. The railway station and freight depot were not identified as likely to result in exceedances of the objectives. There has been no change in this position. The proposal for the Guild Street/Union Square development includes the relocation of the freight depot to a site on the periphery of Aberdeen. There will be no areas of relevant population exposure within close proximity to the new location.
Conclusions	There has been no significant change with regards to sulphur dioxide emissions in this authority and as such a Detailed Assessment will not be required.

9. Review and Assessment of PM_{10} (fine particles)

9.1 Introduction

There are a wide range of emission sources that contribute to PM_{10} concentrations in the UK. Primary particle emissions are derived directly from combustion sources, including road traffic, power generation, industrial processes etc. Secondary particles are formed by chemical reactions in the atmosphere, and comprise principally of sulphates and nitrates. Coarse particles comprise of emissions from a range of sources, including re-suspended dusts from road traffic, construction works, mineral extraction processes, wind-blown dusts and soils, sea salt and biological particles.

9.2 Health Effects of PM_{10}

Long-term exposure to particulate matter is associated with a range of effects on health including effects on the respiratory and cardiovascular systems, asthma and mortality. Short-term exposure to high levels of particulates can result in deaths in susceptible individuals with pre-existing lung and heart disease.

9.3 Air Quality Standards and Objectives for PM_{10}

Various air quality objectives have been set for PM_{10}. There is an annual mean of 40 ugm^{-3} and a fixed 24 hour mean of 50 ugm^{-3} to be exceeded on no more than 35 days per year, both to be achieved by the end of 2004. The Air Quality (Scotland)(Amendment) Regulations also introduced a 24-hour mean objective of 50 ugm^{-3} not to be exceeded more than 7 times per year, and an annual mean of 18 ugm^{-3} to be achieved by the end of 2010. This annual mean objective is unique to Scotland and more onerous than the objectives applicable in the rest of the UK. The objectives are based upon measurements carried out using the European gravitational transfer reference sampler or equivalent.

9.4 The Updating and Screening Assessment for PM_{10}

The first round of the review and assessment process identified potential for exceedances of the objectives in Aberdeen due to emissions from road traffic. Further investigation via continuous monitoring and modelling confirmed the objectives were not likely to be exceeded.

A Detailed Assessment of PM_{10} was carried out during the second round of the Review and Assessment process. Modelling and monitoring results indicated potential exceedances of the 2010 annual mean objective in Aberdeen City Centre leading to the declaration of an Air Quality Management Area in January 2005. The AQMA covers the same footprint as the AQMA for NO_2. PM_{10} emissions from Aberdeen Harbour were also considered in the Detailed Assessment. Modelling predicted PM_{10} concentrations at areas of relevant population exposure due to shipping movement were insignificant in comparison to the air quality objectives.

The Technical Guidance LAQM.TG(03) recommends the authority should collate information on:

- Monitoring data outside the AQMA
- Monitoring data within the AQMA
- Busy roads and junctions
- Roads with high flow of buses and/or HGVs
- New roads constructed or proposed since the last round of the review and assessment
- Roads close to the objective during the first round of the review and assessment
- Roads with significantly changed traffic flows
- New industrial sources
- Industrial sources with substantially increased emissions
- Areas with domestic solid fuel burning
- Quarries, landfill sites, opencast coal, handling of dusty cargo at ports etc
- Aircraft

This information is detailed in the USA Checklist in Section 9.7. Sections 9.4.1 and 9.4.2 discuss monitoring data in more detail.

9.4.1 **Monitoring Data Outside the AQMA**

The following 2 TEOM continuous monitors are located outside the AQMA:

Errol Place: an urban background site close to the city centre
Anderson Drive: a roadside site between Headland Court and Broomhill Road.

The Errol Place site is at a location of relevant population exposure. Anderson Drive is approximately 10-20m closer to the kerbside than would be normal for population in this area.

Table 9.1 shows the annual mean values and the number of exceedances of the 24-hour objective at the two stations between 1999 and 2005. Data is reported with a multiplication factor of 1.3 and 1.14 to estimate gravimetric values as recommended in LAQM.TG(03) (Jan 06). The 1.3 correction factor has been used to assess exceedances of the 24-hour objective.

Table 9.1: Annual Mean PM_{10} Concentration and Exceedances of 24 Hour Objective at Continuous Monitoring Stations Outside AQMA

Station	Year	Measured Annual Mean (ugm^{-3})	Corrected Annual Mean (1.3 factor)	Corrected Annual Mean (1.14 factor)	Exceedances of 24 hour objective	Data Capture (%)
Errol Place (commissioned Dec 1998)	1999	14	18	16	6	79
	2000	14	18	16	3	94
	2001	12	15	14	1	97
	2002	14	18	16	3	76
	2003	17	22	19	14	98
	2004	15	19	17	9	93
	2005	15	19	17	4	92
	2010*		18			
Anderson Dr (commissioned March 04)	2004	15	19	17	5	96
	2005	14	18	16	5	100
	2010*		18			

*predicted concentration

Concentrations at both Anderson Drive and Errol Place are well below both the 2004 annual mean and 24 hour objectives with the application of a 1.3 multiplication factor to correct TEOM readings to gravitational equivalent i.e. worst case scenario. With the 1.3 factor levels at Errol Place in 2003 and 2004 exceeded the annual mean value of $18ugm^{-3}$ to be achieved by 2010. Compliance would be achieved with the lower 1.14 correction factor. The 2004 background maps and the year adjustment calculator downloaded from the internet were used to predict 2010 concentrations. At Errol Place the predicted annual mean in 2010 value just complied with the 2010 objective with the 1.3 factor, however with the application of the 1.14 factor exceedances would be unlikely.

A further TEOM monitor, co-located with a Partisol gravitational sampler was installed within Aberdeen Harbour in 2006. Readings from monitoring at this site will assist in the development of an appropriate factor to correct TEOM readings to gravitational equivalent in future years and additionally provide useful data on PM_{10} levels within the Harbour.

Although there is limited data for Anderson Drive, the annual mean values in 2004 and 2005 are similar to Errol Place. This is unexpected as Anderson Drive is a roadside site while Errol Place is an urban background site. Errol Place is within 1km from the sea, Anderson Drive is over 5km from the sea. Sea salts may be a contributing factor to the raised PM_{10} levels at Errol Place.

Compliance with the 24 hour objective to be achieved by 2010 was achieved in all years at Errol Place except for 2003 and 2004 when there were 14 and 9 exceedances respectively (7 permitted). Compliance was achieved at Anderson Drive.

9.4.2 **Monitoring Data Within the AQMA**

The following 2 TEOM continuous monitors are located within the AQMA:

Union Street: a roadside site within the city centre
Market Street: a roadside site within the city centre

Both sites are 1-2m from building facades.

Table 9.2 shows the annual mean values and the number of exceedances of the 24-hour objective at the two stations between 1999 and 2005. Data is reported as the annual mean value with the 1.3 and 1.14 correction factors. The 1.3 correction factor has been used to assess exceedances of the 24-hour objective.

Table 9.2 Annual Mean PM_{10} Concentration and Exceedances of 24 Hour Objective at Continuous Monitoring Stations Inside AQMA

Station	Year	Measured Annual Mean (ugm^{-3})	Corrected Annual Mean (1.3 factor)	Corrected Annual Mean (1.14 factor)	Exceedances of 24 hour objective	Data Capture (%)
Union St (Commissioned April 2000)	2000	18	23	20	2	91
	2001	19	25	22	10	87
	2002	19	24	21	6	82
	2003	20	26	23	20	96
	2004	18	24	21	7	96
	2005	19	25	22	6	94
Market St (Commissioned 2004)	2005	40	52	46	84	65

The annual mean concentrations is well below the 2004 objective at Union Street with the application of the 1.3 multiplication factor to correct to gravitational equivalent i.e. worst case scenario. Compliance with the 2004 24 hour objective is also achieved. The 2004 annual mean and 24 hour objective were exceeded at Market Street in 2005.

Levels at both sites currently exceed the 2010 annual mean objective with the less stringent 1.14 correction factor and are predicted to do so in 2010. As there were more than 7 exceedances of the 24 hour objective at Union Street in 2001 and 2003, compliance with the 2010 annual mean objective may be achieved in most years, however compliance at Market Street is very unlikely.

9.5 **Updating and Screening Checklist**

The USA Checklist within LAQM.TG(03)(Jan06) was used to assess the likelihood of exceedance of the air quality objective for PM_{10} and whether a Detailed Assessment is required. The outcome of the assessment is summarised in Table 9.3.

Table 9.3: Updating and Screening Checklist: PM_{10}

Checklist item	Updating and Screening Assessment
Monitoring data outside an AQMA	There are two continuous monitors at Errol Place and Anderson Drive outside the AQMA. Appendix 1 shows the site locations. Monitoring data is detailed in sections 9.4.1 and 9.4.2. QA/QC information is included in Appendix 4. The annual mean value between 1998 and 2005 at Errol ranged from 18-25 ugm^{-3} (gravitational equivalent 1.3 correction factor). The 2005 value at Anderson Drive (A90) was 17 ugm^{-3} (gravitational equivalent with 1.3 correction factor). There were no exceedances of the 2004 annual mean or 1-hour objective at either site, however the 2010 annual mean is currently exceeded at Errol Place and there were more than 7 exceedances of the 24-hour objective in 2003 and 2004. The Errol Place site is within 1000m of the sea and may be influenced by sea salts. These issues and the potential for exceedances of the 2010 objectives at urban background sites will require further investigation.
Monitoring data within an AQMA	There are two continuous monitors at Union Street and Market Street within the AQMA. Appendix 1 shows the site locations. Monitoring data is detailed in section 9.4.2. QA/QC information is included in Appendix 4. The annual mean objective at Union Street ranged from 23-26ugm^{-3} between 2000 and 2005. The 2005 value at Market Street was 52ugm^{-3} (gravitational equivalent 1.3 correction factor). The 2004 24 hour objective was met at Union Street, however the objective was exceeded at Market Street in 2005 when there were 84 exceedances. The 2010 annual mean is currently exceeded at both sites and there were more than 7 exceedances of the 24-hour objective at Market Street in 2005 and at Union Street in 2001 and 2003. Monitoring results indicate a continued likelihood for exceedance of the 2010 objectives in the AQMA.
Busy roads and junctions	This was examined in the 2003 USA and there is no change in this position

Junctions	This was examined in the 2003 USA and there is no change in this position
Roads with high flows of buses and/or HGVs	This was examined in the 2003 USA and there is no change in this position
New roads constructed or proposed since the previous round of review and assessment	A proposal to construct a Western Peripheral Route (WPR) around Aberdeen was identified in the 2003 USA. Approval was confirmed in 2005 and a final route identified in 2006. Completion is programmed for 2011. An air quality assessment of the impact of the new road will be required as part of the detailed modelling and assessment of the route. A Detailed Assessment in terms of LAQM is only proposed if modelling indicates potential exceedances of the objectives at locations along the route. The WPR is predicted to reduce city centre traffic by at least 5% with a 15% HGV reduction on Market Street. Its construction will assist in the reduction of city centre PM_{10} levels..
Roads with significantly changed traffic flows, or new relevant exposure	There are currently no roads with significantly changed traffic flows or new relevant exposure, however approval has been granted for the partial pedestrianisation of Union Street (Market Street to Union Terrace) and development of a retail and leisure park at Guild Street/Union Square with associated road infrastructure changes. Completion is programmed for 2010. These changes were the subject of detailed modelling in 2005 as part of an assessment of the predicted air quality improvements with the implementation of the Actions detailed in the draft Air Quality Action Plan. Even with the completion of the development the modelling indicated potential exceedances of the 2010 annual mean objective at limited locations, particularly around the Union Street/Holburn Street junction. As a result of the recent modelling no further Detailed Assessment of the traffic flow changes are proposed.

Roads close to the objective during the second round of Review and Assessment	There were no roads outwith the AQMA close to the 2004 objectives, however potential exceedances of the 2010 objectives were identified at residential properties on Auchmill Road and the A90/A96 Haudigan roundabout in the Detailed Assessment. The completion of the Western Peripheral will reduce traffic flows, with associated predicted improvements in air quality at these sites. The Anderson Drive (A90) continuous monitoring site, while not at a junction, has a similar traffic flows to North Anderson Drive approaching Haudigan roundabout. The flow at Auchmill Road is slightly greater than at Anderson Drive. Further data from the Anderson Dr monitor and ongoing modelling of the WPR will indicate the likelihood of exceedances of the 2010 objective outwith the AQMA.
New industrial sources Industrial processes with substantially increased emissions, or new relevant exposure	There are no new industrial processes or industrial processes with substantially increased emissions, or new exposure of relevance for PM_{10} in Aberdeen, or any neighbouring authority.
Areas of domestic solid fuel burning	This was examined in the 2003 USA. No areas of domestic solid fuel burning were identified and there has been no change in this position.
Quarries/landfill sites/opencast coal/handling of dusty cargo at ports etc.	This was examined in the 2003 USA and there has been no change in this position. There have been no complaints regarding dust from cargo loading/unloading or storage operations at Aberdeen Harbour. Additionally, emissions from the Harbour were included in the 2004 Detailed Assessment and the 2004 study of the Harbour air quality undertaken by Aberdeen University. Both reports concluded there is little likelihood of exceedances of the PM_{10} objectives due to emissions from the Harbour.

Conclusions	Emissions within the AQMA currently exceed the annual mean 2010 objective and are predicted to continue to do so at limited locations even with the completion of the Guild Street/Union Square development including the pedestrianisation of Union Street and associated infrastructure changes. The objectives are currently not exceeded outwith the AQMA, however modelling and monitoring indicate potential exceedances of the 2010 annual mean objectives adjacent to several peripheral roads, particularly around Haudigan roundabout. As a result of the ongoing modelling of the Guild St/Union Square and the propose Western Peripheral Route, and the implementation of the Air Quality Action Plan the authority does not propose to undertake a Detailed Assessment of PM_{10} emissions at this time. Additional monitoring will be considered following the completion of the modelling. The outcome of ongoing monitoring and progress on the Guild St/Union St and WPR developments will be reported in the 2007 Progress Report.

10. **Conclusions**

Monitoring results from continuous analysers and diffusion tubes show NO_2 levels within the AQMA continue to exceed the annual mean objective. At the Union Street continuous analyser the annual mean over the period 2000-2004 was relatively consistent, ranging from 50-55ugm^{-3}. The 2005 value of 64ugm^{-3} is significantly higher, however there is some uncertainty regarding the validity of this data. The annual mean at Market Street was variable over the period 2000-2005, ranging from 55-69 ugm^{-3}. The 2005 value was 55 ugm^{-3}. There have been no exceedances of the 1 hour objective at Union Street, however the objective was exceeded at Market Street in 2001, 2002 and 2003.

Diffusion tube results across the AQMA were higher than at the continuous monitoring stations over the period 2002-2004, however there is some uncertainty regarding the application of appropriate bias adjustment factors. Highest levels were consistently measured at 184-192 Market Street, 105 King Street, 40 Union Street, 469 Union Street.

Compliance with the 2004 annual mean and 24 hour objectives for PM_{10} was achieved at the Union Street continuous monitoring station, however both objectives were exceeded at Market Street in 2005. The annual mean value at Union Street in 2005 of 25 ugm^{-3} (1.3 correction factor to gravitational equivalent) or 22 (1.14 factor) is similar to values over the period 2000-2004 which ranged from 23-26 ugm^{-3} (1.3 factor) or 20-23 (1.14 factor). The annual mean at Market Street in 2005 was 52ugm^{-3} (1.3 factor) or 46ugm^{-3} (1.14 factor). Exceedance of the 2010 annual mean is predicted at both sites. The 2010 24 hour objective was exceeded at Union Street in 2001 and 2003 indicating potential for exceedance in 2010. Exceedance of the 2010 24 hour objective is predicted at Market Street.

Outwith the AQMA the annual mean NO_2 concentration at both Errol Place and Anderson Drive in 2005 was 24ugm^{-3}. The level over the period 2000-2004 at Errol Place ranged from 22-31ugm^{-3}. There have been no exceedances of the 1 hour objective at either site. Exceedances of the NO_2 objective at these locations in future years is unlikely.

Bias adjusted diffusion tube values at roadside locations, projected to locations of relevant population exposure, exceeded the annual mean NO_2 objective adjacent to 885 Great Northern Road in 2002, 2003 and 2004 and adjacent to St Mary's Church, King Street, 86 Victoria Road, Torry, 107 Anderson Drive and Wellington Road/Kerloch Place in 2004. The objective value was also reached at these locations in 2002. Diffusion tube values throughout the city in 2002, 2003 and 2004 are substantially higher then in 2000 and 2001 and there is uncertainty regarding the application of appropriate correction factors. Further co-located continuous and diffusion tube monitoring is required to determine an appropriate bias factor that will enable the prediction of exceedances of the annual mean NO_2 objective at locations outwith the AQMA.

The annual mean PM_{10} concentration at both Errol Place and Anderson Drive was 19ugm^{-3} (1.3 factor to correct to gravitational equivalent) or 17ugm^{-3} (1.14 factor) in 2005. There have been no exceedances of the 2004 annual mean or 24 hour objective at either continuous monitor and exceedance of the 2004 objectives at locations outwith the AQMA in future years is unlikely. With the application of a 1.3 factor to correct TEOM readings to gravitational equaivalent there is potential for the 2010 annual mean value to be exceeded at both locations, however exceedance is unlikely with the less stringent 1.14 correction factor. There were no exceedances of the 2010 24-hour objective at Anderson Drive, however the objective was exceeded at Errol Place in 2004 and 2005 indicating a potential for exceedance in 2010.

The construction of a Western Peripheral Route around Aberdeen and the partial pedestrianisation of Union Street with associated road infrastructure improvements will significantly improve air quality. Modelling of both developments was carried out as part of a traffic impact assessment and further modelling is ongoing. Detailed modelling of NO_2 and PM_{10} within the city centre was also carried out in 2005 during the development of the Council's Air Quality Action Plan.

In view of the recent and ongoing modelling no Detailed Assessment of NO_2 or PM_{10} is proposed at this time. The co-location of diffusion tubes at all continuous analysers and a TEOM and Partisol gravitation sampler at Aberdeen Harbour will assist in determining appropriate factors to correct diffusion tube and TEOM readings. Any additional monitoring requirements will be considered following the completion of the modelling.

No exceedances of the air quality objectives for carbon monoxide, benzene, 1,3-butadiene, lead or sulphur dioxide were predicted and no further action is required for these pollutants.

Results from the ongoing air quality monitoring and progress in the construction of the Western Peripheral Route and pedestrianisation of Union Street with any associated modelling results will be reported in the 2007 Progress Report.

References

1 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, DETR January 2000.

2 Addendum to the Air Quality Strategy for England, Scotland, Wales and Northern Ireland, DEFRA, February 2003.

3 Environment Act 1995.

4 The Air Quality (Scotland) Regulations 2000.

5 The Air Quality (Scotland)(Amendment) Regulations 2001.

6 Local Air Quality Management Technical Guidance LAQM, TG(03), DEFRA, February 2003.

7 Local Air Quality Management Technical Guidance LAQM, TG(03) Update – January 2006, DEFRA

8 Aberdeen City Council Stage 3 Review and Assessment of Air Quality March 2001.

9 Aberdeen City Council Stage 4 Review and Assessment of Air Quality, March 2003.

10 Aberdeen City Council Updating and Screening Report August 2003.

11 Aberdeen City Council Detailed Assessment of Air Quality, August 2004.

12 Aberdeen City Council Air Quality Action Plan July 2006.

Appendices

Appendix 1: Location Map of Continuous Monitoring Station and Diffusion Tubes

Appendix 2: Map of AQMA (NO_2 and PM_{10})

Appendix 3: Diffusion Tube Data

Appendix 4: QA/QC Procedures

Appendix 3

Table A.3.1 Diffusion Tube Measurements 1999 – 2004 (ugm^{-3})

Site Number	Site	1999	2000	2001	2002	2003	2004
	Outside AQMA						
1	Bucksburn Primary Sch, Inverurie Rd	25.6	23.1	24	33	37	36
2	885 Gt Northern Road	27.7	28.5	33	48	48	51
3	549 North Anderson Dr	25.8	24.1	27	38	37	38
4	38 Ellon Road	27.3	23.9	25	34	37	40
5	St Marys Church King St	29.2	28.7	33	44	45	47
6	86 Victoria Road Torry	26.2	27.1	31	40	40	41
7	Wellington Rd/ Kerloch Pl	38.8	25.0	27	39	39	48
8	107 Anderson Drive	29.4	30.2	36	53	54	55
9	481 Gt Western Rd (RSMcColl)	26.2	25.2	25	34	33	36
10	Lang Stracht/ Westray Rd	14.9	15.5	17	22	21	23
11	Dyce Primary, Gordon Terr	9.6	9.7	13	14	15	15
12	Collie Sports Centre, Scotstown Rd	10.9	12.2	12	14	16	17
13	Northfield swimming pool, Kettleshill Cres	12.0	16.8	13	18	18	19
14	Day Nursery ARI	10.1	13.4	13	18	18	20
15	785 Gt Northern Road			25	35	36	42
16	40 Auchmill Road			29	38	38	46
	Inside AQMA						
17	31 Market St	39.7	39.0	43	58	58	53
18	184/192 Market St	49.3	48.9	56	75	73	77
19	105 King Street	47.0	45.3	49	65	74	73
20	40 Union St	43.7	43.0	47	68	73	62
21	Music Hall Union St	31.5	33.2	36	51	51	53
22	St Nicholas Square	23.1	13.6	23	39	39	51
23	Guild St/ Market Street			44	60	58	57
24	43/45 Union St (Poundstretcher)			42	55	58	56
25	14 Holburn St (Polo Club)			42	55	55	58
26	468 Union St (Shish Mahal)			42	58	61	60
27	215 King Street (Safeways)			28	40	42	42
28	26 King Street			32	47	48	49
29	104 King St (Gala Bingo)			40	53	55	52
30	21 Holburn St (Kings Fabrics)				60	56	53
31	147 Holburn Street				39	39	37
32	82 Holburn St (Malt Mill)				51	53	52
33	61 Holburn Street				47	47	47
34	469 Union Street				67	71	65
35	209 Union St (British Airways)				58	62	56
36	249 Holburn Street					40	42

Table A.3.2 Bias Adjusted Diffusion Tube Values Inside AQMA (ugm^{-3})

Site	2000 Bias Adj	2001 Bias Adj	2002 Bias Adj	2003 Bias Adj	2003 Bias Adj (2002 factor)	2004 Bias Adj (2002 factor)
31 Market Street	53	56	71	56	66	63
184 / 192 Market Street	68	75	89	70	85	94
105 King Street	63	66	77	71	85	87
40 Union Street	58	61	83	70	85	76
Music Hall, Union Street	45	47	62	49	60	65
St Nicholas Square	18	30	48	37	46	62
Guild Street / Market Street		59	71	56	66	68
43 / 45 Union Street		55	67	56	68	68
14 Holburn Street		55	67	53	64	71
468 Union Street		55	71	59	71	73
215 King Street		38	48	40	48	50
26 King Street		42	57	46	56	60
104 King Street		54	63	53	63	62
21 Holburn Street			73	54	66	65
147 Holburn Street			48	37	46	45
82 Holburn Street			62	51	62	63
61 Holburn Street			57	45	55	57
469 Union Street			82	68	83	79
209 Union Street			71	60	73	68
249 Holburn Street				38	47	51

Table A.3.3 Bias Adjusted Diffusion Tube Values Outside AQMA Applying Errol Place Factor (ugm-3)

Site	2000 Bias Corrected	2000 Facade	2001 Bias Corrected	2001 Facade	2002 Bias Corrected	2002 Facade	2003 Bias Corrected	2003 Bias Corrected (2002 factor)	2003 Facade	2003 Facade (2002 factor)	2004 Bias Corrected (2002 factor)	2004 Facade (2002 factor)
Outside AQMA												
Bucksburn Primary Sch, Inverurie Road	21	21	26	26	33	33	34	35	34	35	36	36
885 Great Northern Road	26	23	36	32	48	44	45	45	40	41	52	46
549 North Anderson Drive	22	16	29	22	38	29	34	35	26	26	38	29
38 Ellon Road	22	21	27	26	34	33	34	35	33	33	40	38
St Mary's Church, King Street	26	24	36	32	44	40	42	42	38	38	47	43
86 Victoria Road, Torry	25	25	34	34	40	40	37	38	37	38	41	41
Wellington Road / Kerloch Place	23	23	29	29	39	39	36	37	36	37	48	48
107 Anderson Drive	27	21	39	29	54	40	50	51	38	38	56	42
481Great Western Road	23	22	27	26	34	33	31	31	29	29	36	35
Lang Stracht / Westray Road	14	11	19	14	22	17	20	20	15	15	23	17
Dyce Primary, Gordon Terrace	9	9	14	14	14	14	14	14	14	14	15	15
Collie Sports Centre, Scotstown Road	11	11	13	13	14	14	15	15	15	15	17	17
Northfield Swimming Pool, Kettleshill Cres	15	15	14	14	18	18	17	17	17	17	19	19
Day Nursery ARI	12	12	14	14	18	18	17	17	17	17	20	20
785 Great Northern Road			27	20	35	27	33	34	25	25	42	32
40 Auchmill Road			32	24	38	29	35	36	27	27	46	35

Table A.3.4 Bias Adjusted Diffusion Tube Values Applying Mean of 3 Continuous Monitoring Sites (ugm^{-3})

Site	2000 Bias Corrected	2000 Facade	2001 Bias Corrected	2001 Facade	2002 Bias Corrected	2002 Facade	2003 Bias Corrected	2003 Bias Corrected (2002 factor)	2003 Facade	2003 Facade (2002 factor)	2004 Bias Corrected (2002 factor)	2004 Facade (2002 factor)
Outside AQMA												
Bucksburn Primary Sch, Inverurie Road	28	28	30	30	38	38	35	42	35	36	41	41
885 Great Northern Road	35	31	41	37	55	49	46	55	41	51	58	52
549 North Anderson Drive	29	22	33	25	43	32	35	42	26	38	43	32
38 Ellon Road	29	28	31	29	39	37	35	42	33	40	46	43
St Mary's Church, King Street	35	32	41	37	50	45	43	51	38	47	54	48
86 Victoria Road, Torry	33	27	38	38	46	46	38	46	38	41	47	47
Wellington Road / Kerloch Place	31	25	33	33	44	44	37	44	37	48	55	55
107 Anderson Drive	37	28	45	33	60	45	51	62	38	55	63	63
481Great Western Road	31	29	31	29	39	37	31	38	30	36	41	39
Lang Stracht / Westray Road	19	14	21	16	25	19	20	24	15	23	26	20
Dyce Primary, Gordon Terrace	12	12	16	16	16	16	14	17	14	15	17	17
Collie Sports Centre, Scotstown Road	15	15	15	15	16	16	15	18	15	17	19	19
Northfield Swimming Pool, Kettleshill Cres	20	20	16	16	21	21	17	21	17	19	22	22
Day Nursery ARI	16	16	16	16	21	21	17	21	17	20	23	23
785 Great Northern Road			31	23	40	30	34	41	26	42	48	36
40 Auchmill Road			36	27	43	32	36	43	27	46	52	39

Table A.3.5 Errol Place Continuous Monitoring and Diffusion Tube Co-located Values (ugm^{-3})

From	To	Tube 1	Tube 2	Tube 3	Mean	AUMN	% Difference
27/07/2000	24/08/2000	14	15	17	15.3	16.9	1.13
24/08/2000	21/09/2000	17	19	21	19.0	19.4	1.02
21/09/2000	19/10/2000	28	28	18	24.7	22.6	0.90
19/10/2000	15/11/2000	28	35	38	33.7	27.8	0.82
15/11/2000	14/12/2000	29	35	41	35.0	30.2	0.86
14/12/2000	04/01/2001	39	36	36	37.0	32.3	0.87
04/01/2001	01/02/2001	22	25	32	26.3	37.2	1.43
01/02/2001	01/03/2001	39	31	41	37.0	33.3	0.90
01/03/2001	29/03/2001	23	23	26	24.0	22.9	0.95
29/03/2001	26/04/2001	18	15	15	16.0	16.2	1.01
26/04/2001	24/05/2001	16	20	18	18.0	19.2	1.07
24/05/2001	21/06/2001	11	14	17	14.0	15.5	1.11
21/06/2001	19/07/2001	16	10	13	13.0	14.2	1.09
19/07/2001	16/08/2001	19	19	18	18.7	18.7	0.98
16/08/2001	13/09/2001	16	17	19	17.3	16.9	0.99
13/09/2001	11/10/2001	17	22	16	18.3	19.2	1.07
11/10/2001	08/11/2001	22	22	27	23.7	25.9	1.08
08/11/2001	06/12/2001	30	33	30	31.0	38.6	1.25
06/12/2001	03/01/2002	29	29	24	27.3	32.3	1.18
03/01/2002	31/01/2002	33	35	29	32.3	34.2	1.06
31/01/2002	28/02/2002	37	34	34	35.0	32.3	0.92
28/02/2002	28/03/2002	28	24	23	25.0	30.3	1.21
28/03/2002	25/04/2002	21	21	29	23.7	25.5	1.07
25/04/2002	23/05/2002	17	19	21	19.0	21.2	1.12
23/05/2002	20/06/2002	17	22	16	18.3	19.0	1.04
20/06/2002	18/07/2002	11	15	17	14.3	15.7	1.10
18/07/2002	15/08/2002	17	19	19	18.3	16.8	0.92
15/08/2002	12/09/2002	16	22	20	19.3	21.8	1.13
12/09/2002	10/10/2002	23	27	23	24.3	25.1	1.03
10/10/2002	07/11/2002	40	40	41	40.3	25.2	0.63
07/11/2002	06/12/2002	28	27	25	26.6	30.5	1.15
06/12/2002	06/01/2003	21	21	21	21.0	21.9	1.04
06/01/2003	31/01/2003	28	26	26	26.6	34.6	1.30
31/01/2003	26/02/2003	24	25	25	24.7	38.4	1.55
22/05/2003	19/06/2003	35	36	35	35.3	23.6	0.66
19/06/2003	17/07/2003	21	19	19	19.7	14.6	0.74
17/07/2003	14/08/2003	21	26	25	24.0	21.8	0.91
14/08/2003	26/09/2003	25	26	26	25.7	20.5	0.80
26/09/2003	30/10/2003	36	36		36.0	26.6	0.74
30/10/2003	02/12/2003	40	40		40.0	36.2	0.91
02/12/2003	19/01/2004	39	42		40.5	36.6	0.90
MEAN					**25.3**	**25.2**	**1.02**

Table A.3.6 Union Street Continuous Monitoring and Diffusion Tube Co-located Values (ugm^{-3})

From	To	Tube 1	Tube 2	Tube 3	Mean	AUMN	% Difference
03/07/2000	28/07/2000	39	41	37	39.0	47.9	1.23
28/07/2000	25/08/2000	37	40	34	37.0	47.5	1.28
25/08/2000	21/09/2000	35	29	34	32.7	44.7	1.35
21/09/2000	23/10/2000	30	41	37	36.0	45.6	1.27
23/10/2000	17/11/2000	47	40	45	44.0	62.7	1.43
17/11/2000	15/12/2000	40	30	44	38.0	50.4	1.33
15/12/2000	19/01/2001	39	40	41	40.0	63.7	1.59
19/01/2001	02/02/2001	40	40	42	40.7	53.2	1.30
02/02/2001	02/03/2001	50	43	45	46.0	61.1	1.33
02/03/2001	30/03/2001	52	48	44	48.0	61.1	1.27
30/03/2001	27/04/2001	41	43	38	40.7	53.2	1.30
27/04/2001	25/05/2001	39	46	49	44.7	58.9	1.31
25/05/2001	22/06/2001	36	41	44	40.3	49.4	1.24
22/06/2001	20/07/2001	30	40	45	38.3	48.0	1.26
20/07/2001	17/08/2001	31	30	37	32.7	44.0	1.33
17/08/2001	14/09/2001	40	37	43	40.0	49.9	1.25
14/09/2001	12/10/2001	38	35	42	38.3	49.9	1.31
12/10/2001	12/11/2001	32	44	38	38.0	51.8	1.36
12/11/2001	07/12/2001	42	45	48	45.0	61.4	1.36
07/12/2001	04/01/2002	51	48	44	47.7	62.9	1.32
04/01/2002	05/02/2002	44	40	43	42.3	55.3	1.31
05/02/2002	01/03/2002	39	44	46	43.0	61.2	1.42
01/03/2002	28/03/2002	34	46	41	40.3	51.9	1.29
28/03/2002	29/04/2002	30	30	36	32.0	44.7	1.40
29/04/2002	24/05/2002	40	37	33	36.7	42.5	1.15
24/05/2002	21/06/2002	32	30	30	30.7	42.10	1.37
21/06/2002	19/07/2002	37	34	35	35.3	46.8	1.33
19/07/2002	16/08/2002	45	42	39	42.0	51.9	1.24
16/08/2002	19/09/2002	40	36	37	37.7	49	1.30
19/09/2002	11/10/2002	52	47	52	48.6	59.9	1.23
11/10/2002	08/11/2002	50	49	43	47.3	58.9	1.25
08/11/2002	06/12/2002	55	52	50	52.3	47.3	0.90
06/12/2002	06/01/2003	56	54	54	54.7	52.7	0.97
06/01/2003	14/02/2003	50	48	46	48.0	61.8	1.28
23/05/2003	24/06/2003	72	61	63	65.3	41.7	0.64
24/06/2003	18/07/2003	50	50	54	51.3	44.2	0.86
18/07/2003	22/08/2003	43	44	54	47.0	38.4	0.82
22/08/2003	29/09/2003	49	57	45	50.3	46.6	0.93
29/09/2003	03/11/2003	52	52	60	54.7	60.3	1.10
03/11/2003	01/12/2003	55	53	54	54.0	54.9	1.02
				MEAN	**43.01**	**51.99**	**1.23**

Table A.3.7 Market Street Continuous Monitoring and Diffusion Tube Co-located Values (ugm^{-3})

From	To	Tube 1	Tube 2	Tube 3	Mean	AUMN	% Difference
03/07/2000	28/07/2000	49	45	48	47.3	60.8	1.29
28/07/2000	25/08/2000	45	40	47	44.0	64.9	1.48
25/08/2000	21/09/2000	39	44	49	44.0	57.3	1.30
21/09/2000	23/10/2000	40	40	45	41.7	55.4	1.32
23/10/2000	17/11/2000	42	45	48	45.0	57.3	1.27
17/11/2000	15/12/2000	43	40	42	41.7	55.4	1.32
15/12/2000	19/01/2001	30	41	32	34.3	63.0	1.85
19/01/2001	02/02/2001	51	49	47	49.0	57.3	1.17
02/02/2001	02/03/2001	45	48	51	48.0	61.1	1.27
02/03/2001	30/03/2001	55	50	48	51.0	74.5	1.46
30/03/2001	27/04/2001	47	50	51	49.3	64.9	1.32
27/04/2001	25/05/2001	55	50	50	51.7	74.5	1.43
25/05/2001	22/06/2001	43	45	49	45.7	57.3	1.25
22/06/2001	20/07/2001	43	50	45	46.0	63.4	1.38
20/07/2001	17/08/2001	41	38	42	40.3	51.8	1.30
17/08/2001	14/09/2001	40	30	44	38.0	53.8	1.42
14/09/2001	12/10/2001	40	43	38	40.3	54.7	1.37
12/10/2001	12/11/2001	46	38	45	43.0	59.7	1.39
12/11/2001	07/12/2001	42	45	52	46.3	60.3	1.31
07/12/2001	04/01/2002	39	40	45	41.3	54.5	1.32
04/01/2002	05/02/2002	40	34	39	37.7	53.5	1.42
05/02/2002	01/03/2002	51	47	42	46.7	63.8	1.36
01/03/2002	28/03/2002	47	39	41	42.3	59.7	1.41
28/03/2002	29/04/2002	37	39	47	41.0	54.7	1.33
29/04/2002	24/05/2002	39	46	49	44.7	57.0	1.28
24/05/2002	21/06/2002	57	54	58	56.3	79.8	1.41
21/06/2002	19/07/2002	64	62	59	61.7	83.5	1.36
19/07/2002	16/08/2002	69	66	60	65.0	84.6	1.30
16/08/2002	19/09/2002	45	51	46	47.3	61.4	1.29
19/09/2002	11/10/2002	65	60	64	63.0	57.9	0.92
11/10/2002	08/11/2002	57	85	55	65.6	59.9	0.91
08/11/2002	06/12/2002	71	67	66	68.0	61.6	0.91
06/12/2002	06/01/2003	79	70	64	71.0	64.9	0.91
06/01/2003	14/02/2003	60	58	62	60.0	79.6	1.33
23/05/2003	24/06/2003	72	61	63	65.3	41.7	0.64
24/06/2003	18/07/2003	50	50	54	51.3	44.2	0.86
18/07/2003	22/08/2003	43	44	54	51.3	44.2	0.86
22/08/2003	29/09/2003	49	57	45	50.3	46.6	0.93
29/09/2003	03/11/2003	52	52	60	54.7	60.3	1.10
01/12/2003	21/01/2004						
MEAN					**49.52**	**60.53**	**1.25**

Appendix 4 QA/QC Procedures

Continuous Analysers

The continuous analysers are serviced by the equipment supplier at 6 monthly intervals. The contract includes call outs to sites for repairs and the routine replacement of consumables.

The Errol Place monitoring station is part of the UK's Automated Urban Network (AUN). All AUN sites are subject to an independent audit and stringent QA/QC procedures undertaken by AEA Technology on behalf of Department of Environment, Food and Rural Affairs (DEFRA). Data validation and ratification for this site is performed by AEA Technology. The authority also has a separate contract with AEA Technology to audit the Market Street, Union Street and Anderson Drive analysers at 6 monthly intervals for QA/QC purposes.

The analysers perform daily automatic calibrations which are used to assess the routine performance of the analysers and any long term response drift. Manual calibrations are performed by trained officers every two weeks using a calibration mixture traceable to national standards. These calibrations act as a check on the operation of the analysers and enable determination of the instrument response factors used to calculate the concentration of NO_2. The calibrations enable data to be scaled for any analyser drift.

All data is scrutinised on a daily basis (Monday-Friday). Should a problem be identified, the site is visited immediately and, if necessary, a further manual calibration is performed. Any data considered suspect is deleted. Records are kept of instrument breakdowns, services and audits and any local activities or weather conditions that may influence readings.

It should be noted that during 2005 normal operator quality control procedures, including the regular checking of data and fortnightly calibrations, were performed erratically at all sites except Errol Place due to unforeseen staffing issues within the Council's Environmental Health Service. To ensure, as far as possible, that only valid data is reported AEA Technology was contracted to ratify the 2005 data for Market Street, Union Street and Anderson Drive. The 2005 NO_2 data, particularly for Union Street and Market Street has greater uncertainty than for other years reported.

NO_2 data for Union Street for the period September 2004-May 2005 showed significantly raised levels with over 100 exceedances of the 1-hour objective when there had only been 1 in the previous 4 years. There has been no change in traffic flow or other environmental factors at the site that could explain these readings. All service and audit reports were satisfactory and records do not show any analyser breakdown likely to result in the over reading of data. As no explanation could be provided for the abnormal readings AEA Technology recommended that the data should be treated as valid, but with a caveat explaining the uncertainty.

It should also be noted that over the period August 2004 – November 2005 the NO calibration gas cylinder at Market Street appeared to be a different concentration than reported on the manufacturer certification. (reported concentration of 450ppb compared to a measured concentration of 303ppb). A potential issue with this cylinder was highlighted at the March 2005 audit, however the recommendation was to monitor until the next audit. The September 2005 audit recommended the replacement of the cylinder which was implemented. AEA Technology advised that the cylinder concentration

identified during the audit should be used in the ratification of data rather than the manufacturer certification. Reports of ratified data run for the period January – July 2004 i.e. prior to the suspect cylinder showed similar values to the period August 2004 – December 2004 indicating the cylinder concentration used in the data ratification process is appropriate.

Passive Diffusion Tubes

Passive diffusion tube monitoring is carried out in accordance with procedures contained in the UK NO_2 Survey Instruction Manual and LAQM.TG(03). All diffusion tubes, other than those co-located at the continuous analysers are attached to lampposts/downpipes at a height of 2m above ground level. Co-located tubes are located in triplicate close to the analyser air intake. All exposure times are recorded and copies provided to the laboratory with the exposed tubes. Three unexposed tubes are also submitted with each batch of exposed tubes to check contamination did not occur during tube preparation.

The diffusion tubes are supplied by Gradko International and analysed by Aberdeen City Council's Public Analyst. The laboratory is UKAS accredited for this task and participates in the Workshop Analysis Scheme for Proficiency (WASP) inter laboratory QA/QC. The laboratory has always performed well in the scheme.

Diffusion tube measurements within and outside the AQMA and co-located measurements are reported in Appendix 3. The 2003 USA reported difficulties in the application of appropriate bias adjustment factors due to a significant difference in the co-located diffusion tube and continuous monitoring data, particularly at Union Street and Market Street. Data for 2002 showed a slight over-reading of diffusion tube measurements compared to a large under-reading in the previous years. The 2003 report suggested this may have been associated with a change to the laboratory tube preparation method or a slight change to the location of the co-located tubes within the analyser enclosure.

It was anticipated that monitoring results in subsequent years would assist in the establishment of more consistent and robust bias adjustment factors, however the application of bias factors remains a concern. Unfortunately no diffusion tube monitoring was undertaken in 2005. Monitoring data for 2004 is available for the city wide diffusion tube survey, however no co-located sampling was performed. Furthermore, 2003 co-located data is limited resulting in a higher uncertainty.

The Public Analyst does not analyse diffusion tubes co-located at a monitoring site for any other local authority or organisation thus no mulit-survey results could be applied. The use of the national data base to apply factors from elsewhere in the UK was not considered appropriate.

Spreadsheets produced by NETCEN and downloaded from the internet were used to calculate bias adjustment factors and the precision and accuracy of the co-located tubes. Precision and accuracy was good for all years except 2003. Co-located Values at the Errol Place, Union Street and Market Street continuous are shown in Tables A.3.5, A.3.6 and A.3.7 in Appendix 3. Table A.4.1 summarises the calculated bias adjustment factors.

Table A.4.1 Bias Factors Co-located Diffusion Tube and Continuous Monitoring Data

Bias Factor A									
Site	**Type**	**2000**	*(n)*	**2001**	*(n)*	**2002**	*(n)*	**2003***	*(n)*
Errol Place	UB	0.91	*6*	1.09	*13*	1.01	*13*	0.93	*9*
Market Street	Rd	1.39	*7*	1.34	*7*	1.19	*13*	0.96	*6*
Union Street	Rd	1.36	*7*	1.3	*13*	1.22	*13*	0.96	*5*

* *Uncertainty higher than 50%*

It is evident that the 2000 and 2001 bias factors for Market Street and Union Street are significantly higher than 2002 and 2003. The following procedures were applied to bias correct diffusion tubes inside and outside the AQMA for the period 2000-2004.

Diffusion Tubes Inside AQMA

Market Street and Union Street bias factors are consistently similar over the 4 year period. The mean of the two sites for the relevant year was used to correct all other diffusion tubes within the AQMA. As the 2003 factor has an uncertainty greater than 50% the 2003 data is also reported using the 2002 factor. The 2002 factor has also been applied to the 2004 data.

Diffusion Tubes Outside AQMA

Diffusion tubes outside the AQMA comprise of roadside, urban background and one kerbside site. The majority are within open environments. In the 2003 USA the bias factor from Errol Place, an urban background site close to the city centre, was considered generally representative of the tubes outwith the AQMA. For the 2006 USA the bias factor for Errol Place and the mean of the three continuous monitoring sites were used to correct the diffusion tubes outside the AQMA. There is less uncertainty over the 2003 Errol Place factor compared to Market Street and Union Street, however the 2002 factor was applied to both the 2003 and 2004 diffusion tube data.

Bias corrected diffusion tube values are shown in Tables A.3.2, A.3.3 and A.3.4 in Appendix 3. Values corrected to building façade and locations considered representative of population exposure are also provided.