Dundee City Council

Local Authority Air Quality Updating and Screening Assessment

May 2003

EXECUTIVE SUMMARY

This document has been produced as part of Dundee City Council's statutory obligation under the Environment Act 1995.

The Department for Environment, Food and Rural Affairs and the Scottish Executive published a revised strategic policy framework for air quality management in January 2003 and the Air Quality (Scotland) Amendment Regulations 2002. The strategy requires each local authority to undertake an updating and screening assessment to determine the progress with the management of local air quality to date.

There is a requirement that an updating and screening assessment be submitted every three years to the Scottish Executive. In addition, an annual report on progress towards improving air quality within the local authority area must be submitted in all other years until 2010. This document represents the first updating and screening assessment for Dundee City Council.

The findings of this report are that it is not believed that Dundee City will achieve all the National Air Quality Standards (NAQS) and Objectives for all pollutants and will have to proceed to detailed assessment.

It is not anticipated that any action will be required in order to achieve the NAQS for carbon monoxide, benzene, 1,3-butadiene and lead.

The guidance on nitrogen dioxide has been amended, now including specific reference to street canyons and streets where there is a significant proportion of heavy duty vehicle (HDV) traffic. This necessitates further investigation of these areas. It is anticipated that without air quality management, the nitrogen dioxide annual mean Air Quality Standard will not be achieved in certain areas of the City. This will include areas of the city centre and Lochee Road. As more street canyons are studied, the number of areas identified where the annual mean will not be achieved may increase. It is necessary to proceed to a detailed assessment in respect of nitrogen dioxide in relation to narrow congested streets and junctions. Further assessment is also needed for roads with a significant proportion of HDV. There are no recorded exceedances of the 1-hour mean for NO_2 at present, further information for relevant locations will be obtained from the three new real-time, continuous monitoring units that have been commissioned at Whitehall Street, Seagate and Lochee Road.

A single exceedance of the SO_2 15-minute mean was observed in 2002, thirty-five exceedances of this standard are permitted each year. This would indicate that the NAQS for SO_2 will be achieved. However, a further assessment of SO_2 emissions from Nynas AB UK will be undertaken as new residential development on the waterfront has commenced since the completion of the First Round assessment of air quality.

The NAQS annual mean for PM_{10} was altered in the Air Quality (Scotland) Amendment Regulation 2002. The revised NAQS reduces the permissible annual mean for PM_{10} from the previous standard of 40 $\mu g/m^3$ (2004) to 18 $\mu g/m^3$ (2010). This represents a significant decrease in the permitted PM_{10} annual mean; the annual means for 2002 were 21 $\mu g/m^3$ (Dock Street) and 23 $\mu g/m^3$ (Union Street). The guidance states that the anticipated background concentration of PM_{10} will fall by 2010. No source apportionment has been undertaken for PM_{10} emissions to date. There is evidence that the fluctuations of PM_{10} concentration recorded in Dundee are not caused by local emissions, but follow national trends of increased PM_{10} episodes. At this time, it is necessary to proceed to a detailed assessment in respect of PM_{10}.

Index

APPENDICES

List of Tables

List of Figures

1.0. Introduction

1.1. The local area of Dundee

1.1.1. Dundee City is Scotland's fourth largest city and is situated on the east coast at the mouth of the Tay Estuary (see Figure 1.1.). It is 67 miles south of Aberdeen and 60 miles north of Edinburgh.
The city is immediately bounded by:

- To the south, the River Tay, which is approximately 1 to 2 miles wide along Dundee's shoreline.
- To the west, Perth and Kinross, with a small suburban area before it becomes rural. Perth itself lies 21 miles west.
- To the north and east, Angus with a suburban area to the immediate east but otherwise rural.

Dundee has an area of 6,515 Ha (26 square miles) and a population of 145,460 (2001 GRO(S)) with a projected population of 115,551 in 2016 (GRO(S) 2000 based projection)[1]. The prevailing wind direction across the City is from the south-west.

1.1.2. Dundee is connected to major road and rail networks. Dundee is the main Regional Centre in the area, with a catchment population of 350,000. There are two universities, a university hospital and a college within the City. There are a number of industrial processes, which are authorised under the Environmental Protection Act 1990 Part I, within Dundee. There are 4 Part A processes (processes regulated in respect of pollutant releases to air, controlled waters, sewers and land). Integrated pollution control applies to the most potentially polluting industrial processes, which tend to be large-scale processes. There are also 49 Part B processes, which are processes involving emissions to air alone, and tend to be generally less polluting processes. These authorisations are issued by the Scottish Environmental Protection Agency (SEPA).

1.1.3. Dundee is connected to Fife by the Tay road and rail bridges and it is served by an airport, which has daily flights to London City. Dundee also has a modern deep-water port and large harbour area. A section of the centre of the city is pedestrianised.

1.1.4. Dundee has an inner ring road, the Marketgait, and five arterial routes - Broughty Ferry Road, Arbroath Road, Riverside, Lochee Road and Forfar Road. There is a City by-pass, the Kingsway, which consists of the A90(T), the main route from Edinburgh/Perth to Aberdeen, and the A972(T) the route to Arbroath. There are a significant number of busy road junctions across the City. A large proportion of roads in the City have a gradient due to a central topographical feature, an extinct volcano (height 174 metres above sea level).

1.1.5. In common with many Scottish cities the architecture consists of a significant number of 4 or 5-storey tenemental properties creating numerous street canyons[*]. In the commercial centres a common feature of these tenemental properties is that commercial premises are located on the ground floor with residential premises on the floors above.

1.1.6. Dundee City Council has a Corporate Plan which sets out the Council's vision for the City's future. The plan recognises that Dundee's strengths lie in its quality of life and environment and it is the intention of the Council to build on these strengths for the benefit of all its citizens. The Council is committed to sustaining, protecting, conserving and enhancing the environment through its policies and activities, and through partnership with others to ensure the City is clean, healthy, prosperous and safe, for the benefit of those who live, visit and work in the City. Agenda 21 recognises the interdependence of environmental, social, health and economic issues and promotes the development of a sustainable society.

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[1] Planning and Transportation Department 2002 *Demographics, statistics and general reference material* Dundee City Council

[*] A street canyon is defined as a relatively narrow street with buildings on both sides, where the height of the buildings is generally greater than the width of the road.

1.1.7. The Local Plan, produced by the Planning and Transportation Department, commits Dundee City Council to a strategy for environmental enhancement, this includes:

- protecting and enhancing the natural setting of Dundee and its environment by ensuring that new development respects landscape character, promotes biodiversity and facilitates public enjoyment and understanding of the outdoors; and,
- enhancing environmental quality within the Housing Investment Focus Areas, District centres, Principal Economic Development Areas and General Economic Development Areas in particular.

(Taken from Dundee Local Plan Review 2003)

Stage 1 Report

Main Findings of Stage 1 report

1.2.1. The principle conclusion of Dundee City Council's Stage 1 Report (1998) was that a Stage 2 and/or 3 Review was required for all seven key pollutants. The chief reasons for this conclusion were:

- a lack of specific monitoring information;
- the existence of certain processes considered to be significant sources of key pollutants;
- the lack of information concerning these sources; and,
- the uncertainty about the effects of road traffic.

Comments from Statutory Consultees

1.2.2. SEPA agreed with the main conclusions of the review with the exception of that for 1,3 butadiene[*]. In support of this view the author of the document pointed to information held by SEPA concerning monitoring carried out at the Nynas plant. SEPA also held that no regard had been paid to exposure over relevant periods, or the effects of sites outwith Dundee.

1.2.3. Both the Scottish Executive and SEPA considered that the potential effects of the smaller, Part B processes had been overestimated, and that of these, the only installations of concern were a foundry, a coal/coke process and certain processes with the potential for fugitive emissions.

1.3. Stage 2 Report

Main Findings of Stage 2 report

1.3.1. The principle findings of the Stage 2 report (2000) were that the National Air Quality Standards would be achieved for all pollutants with no action required.

1.3.2. A potential problem with achieving the Air Quality Standards for lead was identified in proximity of a foundry, relating primarily to uncontrolled/fugitive emissions. However, it was indicated that this process was to relocate to a purpose-built premises, and information obtained from SEPA stated that they anticipated that the process would comply with the National Air Quality Standards and Objectives. It was therefore assumed that the NAQS would be achieved through compliance with the authorisation conditions.

1.3.3. Limited information on nitrogen dioxide levels had been obtained across the City. Computer modelling indicated that there were two locations where there would be potential exceedances of the annual mean objective (see section 7.2.3.). However, as the computer models were known to overestimate pollution by a substantial percentage these results were treated with caution and further monitoring was instituted.

1.3.4. It was therefore deemed unnecessary to declare an Air Quality Management Area (AQMA) in Dundee at that time.

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[*] In respect of 1,3-butadiene it was recommended that no further investigation be undertaken as there were no significant sources in Dundee.

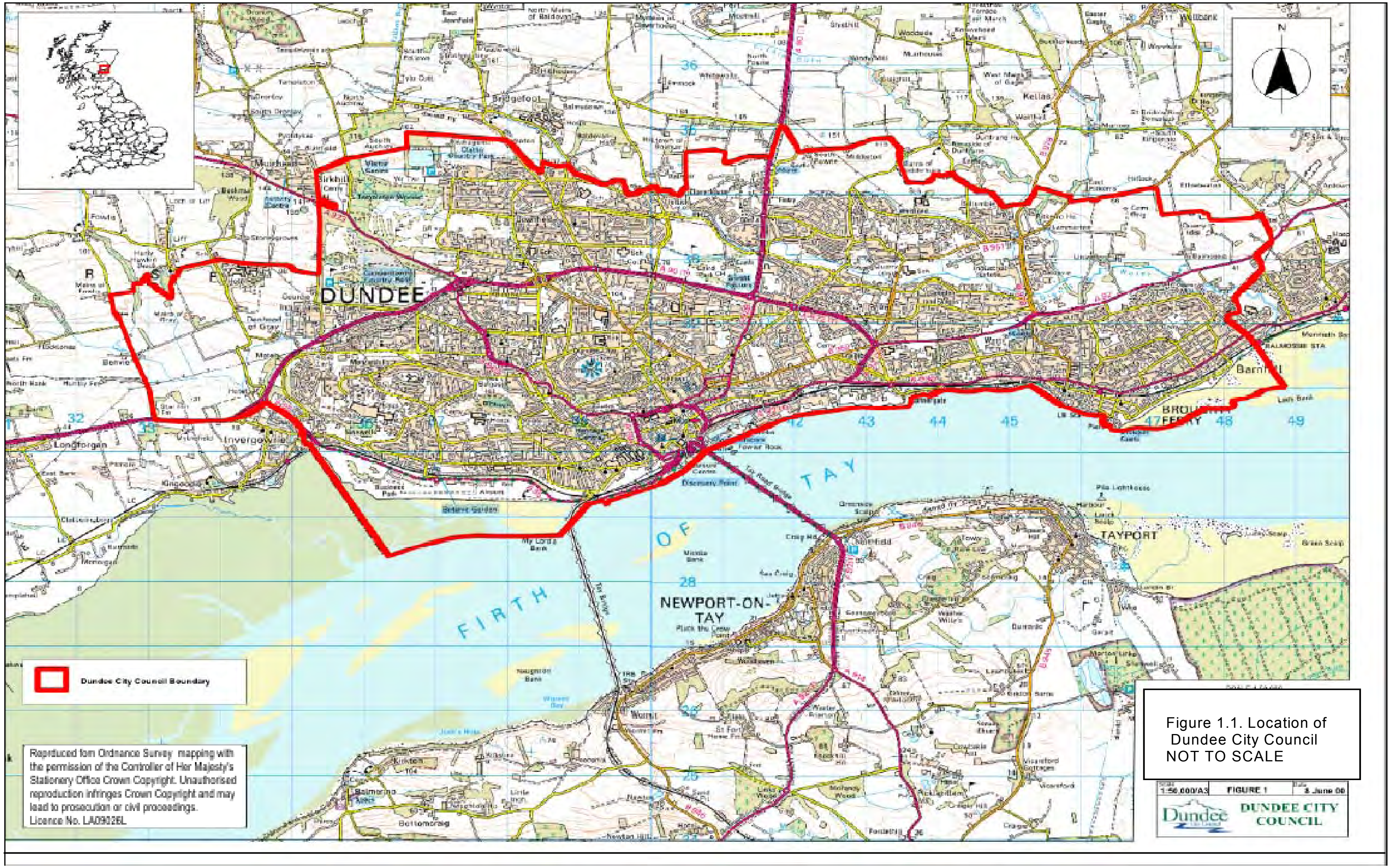

Figure 1.1. Location of Dundee City Council
NOT TO SCALE

Comments from Statutory Consultees

1.3.5. Whilst the conclusions of the Council were generally accepted, clarification of certain points was requested. It was recommended that real-time monitoring be carried out for at least 6 months at Union Street (Dundee) and that further diffusion tube monitoring be carried out at points along Union Street, Seagate and other road stretches where the Design Manual for Roads and Bridges (DMRB, Stanger version) screening model had predicted exceedances. The consultant, used by the Scottish Executive to give a general overview of the local authority review, considered that the report was detailed, thorough and provided most of the information specified in the guidance issued by the Scottish Executive. He agreed with the approach and conclusions reached for all pollutants. However, the Council was advised to carry out further work to confirm the decisions reached for nitrogen dioxide, PM_{10} and sulphur dioxide. In addition, the decision for lead was accepted on the basis that the foundry's authorisation was to be varied or the process was to be relocated.

1.3.6. Stage 1 and Stage 2 reports were produced in accordance with previous guidance. These two Stages will be referred to collectively as the First Round assessment.

1.4. Technical Guidance LAQM.TG(03)[2]

The National Perspective

1.4.1. The Air Quality Framework Directive (Directive 96/62/EC on ambient air quality assessment and management) establishes a framework under which the EU sets limit values or target values for specified pollutants. The first Air Quality Daughter Directive was agreed in 1998, establishing legally binding limit values for sulphur dioxide, nitrogen dioxide, particles and lead to be achieved by 1 January 2005 and 2010. The Daughter Directive was transposed into UK legislation via Regulations.

1.4.2. A new technical guidance document[2] was published in 2003 by the Department for the Environment Food and Rural Affairs (DEFRA) and the Scottish Executive to replace earlier guidance. The guidance is designed to support local authorities in carrying out their duties under the Environment Act 1995, the Air Quality Regulations 2000 and the Air Quality (Scotland) Amendment Regulations 2002. The National Air Quality Strategy establishes the framework for air quality improvements. This strategy is based on measures agreed at national and international level. However, it is recognised that areas of poor air quality will remain, and that these will be dealt with most effectively using local measures implemented through the Local Air Quality Management (LAQM) regime.

The Local Perspective

1.4.2. A duty is placed on each local authority requiring them to review and assess air quality in their area from time to time. The role of the local authority review and assessment process is to identify those areas, where it is considered likely that the Air Quality Standards or Objectives will be exceeded. Experience has shown that such areas may range from single residential properties to whole town centres.

1.4.3. The first step of the review and assessment process in accordance with LAQM.TG(03) is an Updating and Screening Assessment (USA), which is to be undertaken by all authorities. This is based on a checklist to identify those matters that have changed since the First Round was completed, and which may now require further assessment.

1.4.4. Where the USA identifies a risk that an Air Quality Objective will be exceeded at a location where the public could be exposed, the authority is required to proceed to a second step, a detailed assessment. This should identify with reasonable certainty whether an exceedance is likely to occur and should give sufficient information as to the magnitude and geographical extent of any exceedance. Where such an area is identified, the local authority must declare an Air Quality Management Area.

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[2] Department for Environment Food and Rural Affairs and Scottish Executive 2003 *Part IV of the Environment Act 1995 Local Air Quality Management Technical Guidance LAQM.TG(03)* DEFRA Publications

1.5. Relevant Receptors

1.5.1. The guidance[2] details the National Air Quality Standards (NAQS) and Objectives, (see Table 1.1.) and provides examples of where these standards should be applied. The standards apply only at sites where the public is liable to be exposed to unacceptable pollutant levels for a relevant time period. For example, an annual mean NAQS would apply at the façade of a residential premises or a public building such as a school or hospital. The 24-hour or 8-hour NAQS would apply at these locations and in residential gardens. The 1-hour and 15-minute NAQS are designed to apply to areas where it is foreseeable that the public would spend these periods outside, and include shopping centres, bus stations and parks.

1.5.2. Local Air Quality Management is not designed to take account of indoor air quality. It is not designed to protect persons at work (indoors or outdoors), as the health, safety and welfare of persons at work are covered under the Health and Safety at Work Act 1974.

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

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene	16.25 $\mu g/m^3$ 3.25 $\mu g/m^3$	running annual mean running annual mean	31.12.2003 31.12.2010
1,3-butadiene	2.25 $\mu g/m^3$	running annual mean	31.12.2003
Carbon Monoxide (CO)	10.0 mg/m^3	running 8-hour mean[a]	31.12.2003
Lead	0.5 $\mu g/m^3$ 0.25 $\mu g/m^3$	annual mean annual mean	31.12.2004 31.12.2008
Nitrogen Dioxide[b] (NO_2)	200 $\mu g/m^3$ not to be exceeded more than 18 times a year 40 $\mu g/m^3$	1-hour mean annual mean	31.12.2005 31.12.2005
Particles (PM_{10}) (gravimetric)[c]	50 $\mu g/m^3$ not to be exceeded more than 35 times a year 40 $\mu g/m^3$ 50 $\mu g/m^3$ not to be exceeded more than 7 times a year 18 $\mu g/m^3$	24-hour mean annual mean 24-hour mean annual mean	31.12.2004 31.12.2004 31.12.2010 31.12.2010
Sulphur Dioxide (SO_2)	350 $\mu g/m^3$ not to be exceeded more than 24 times a year 125 $\mu g/m^3$ not to be exceeded more than 3 times a year 266 $\mu g/m^3$ not to be exceeded more than 35 times a year	1-hour mean 24-hour mean 15-minute mean	31.12.2004 31.12.2004 31.12.2005

[a] The Air Quality Objective in Scotland has been defined in Regulations as the running 8-hour mean, in practice this is equivalent to the maximum daily running 8-hour mean.
[b] The objectives for nitrogen dioxide are provisional.
[c] Measured using the European gravimetric transfer sampler or equivalent.

2.0. Background Information

2.1. First Round Assessment

2.1.1. The outcome of the First Round assessment concluded that it was not necessary to declare an AQMA in respect of any pollutant at that time. However, it was recognised that further monitoring was required. This was reflected in the comments received from statutory consultees.

2.2. Planned developments which may affect air quality within Dundee

2.2.1. It is anticipated that a number of developments which have been granted planning permission have the potential to impact upon air quality.

Industrial Development

2.2.2. Dens Metals - relocated to purpose-built foundry premises at West Pitkerro Industrial Estate. For further information refer to section 6.4.

Housing and Commercial Development

2.2.3.

- Kingsway retail park - shopping complex
- Dundee Port re-development - housing and commercial
- Western Gate Development - 1150 houses by 2016 and light industrial/research and development/offices
- Balmossie - 100 houses
- Balgillo North - 150 houses
- South Road - superstore
- Dura Street - supermarket

Roads

2.2.4.

- Proposed upgrade of A972 to dual carriageway between Claypotts and Arbroath
- Improvements to NW and NE arterial routes, namely, Lochee Road and Albert Street respectively
- Bringing Confidence to Public Transport (BCPT) project with alterations to Whitehall Street, Victoria Road, Nethergate and St Andrews Street
- Central waterfront extension
- Traffic management at Brook Street, Broughty Ferry
- Park and Ride at Fife side of Tay road bridge (Fife structure plan)
- Forfar Road, junction upgrade

2.3. Information Technology

DataMAP GIS

2.3.1. A Geographic Information System (GIS) is a computer database capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their locations. At present, Dundee City Council utilises a GIS package called DataMAP v2.21, produced by SIA Ltd. It enables the user to display, control and analyse a diverse range of spatial information against a map background. This background is an Ordnance Survey (OS) Map. Distances between points, e.g. monitoring locations and receptors, can be accurately measured using GIS. The Environmental and Consumer Protection Department (ECPD) is in the process of transferring data to an alternative GIS format, ArcGIS.

ADMS-Urban

2.3.2. The Atmospheric Dispersion Modelling System (ADMS) Urban pollution modelling software is a comprehensive tool for tackling air pollution problems in cities and towns. It can be used to examine emissions from multiple sources simultaneously, including road traffic, industrial and 'background grid' emissions. Specific features include the ability to consider complex terrain including street canyons and coastal influences. It also allows the use of point, area, volume and line sources, and can predict both long-term and short-term concentrations.

Other
2.3.3. A number of tools are available to local authorities, provided on-line by DEFRA, these include:

- Design Manual for Roads and Bridges (DMRB) as revised (version 1.01). This is a screening model for traffic which can calculate emissions. The new version of the DMRB (version 1.01) has amended factors for benzene and PM_{10} in light of revised emission data, to allow a comparison with the amended NAQS.;
- Aerial photography, supplied by The GeoInformation Group via CR Viewer, from photographs taken 1st May 2001, used to determine land usage at receptor locations;
- LAQM website data provides information on ambient background concentrations of relevant pollutants (see appendix 3); and,
- Emissions calculator which predicts future emissions.

2.4. Road Traffic Data

2.4.1. Road traffic data has been obtained from the Planning and Transportation (P&T) Department and the National Air Quality Emissions Inventory (NAEI) website. This information dates from 1993 to 2002.

2.4.2. Where traffic data is entered into the DMRB, traffic has been assumed to be travelling at the applicable speed limit, except where junctions are studied. A default speed of 30 km/hr (19 mph) has been applied to junctions unless stated otherwise.
Where detailed traffic information has not been available, road specific estimates have been obtained from the Planning and Transportation Department.
The P&T Department have advised that the lower figure of the national growth factor for traffic growth should be applied for Dundee.

2.5. SEPA

2.5.1. Information has been obtained from SEPA regarding processes, that are authorised in accordance with Part I of the Environmental Protection Act 1990, which have the potential to have a significant impact on air quality. For a full list of authorised processes with the potential to impact on air quality refer to Appendix 1.

2.6. Monitoring Data

2.6.1. Monitoring data was obtained prior to compiling the Stage 1 and 2 reports. Further monitoring has been undertaken since the publication of the Stage 2 report.

Passive Diffusion Tubes
2.6.2. NO_2 tubes

- Increasing in number since monitoring began in Jan 1995.
- Includes 4 sites in the National Network (namely, Birnam Place, Woodside Avenue, Seagate and Union Street, refer to Table 7.2.) and 91 additional tubes over 67 sites

Benzene (BTEX) tubes

- September 1999 to April 2001

Continuous Monitoring

2.6.3. **Table 2.1. Summary of continuous monitoring locations**

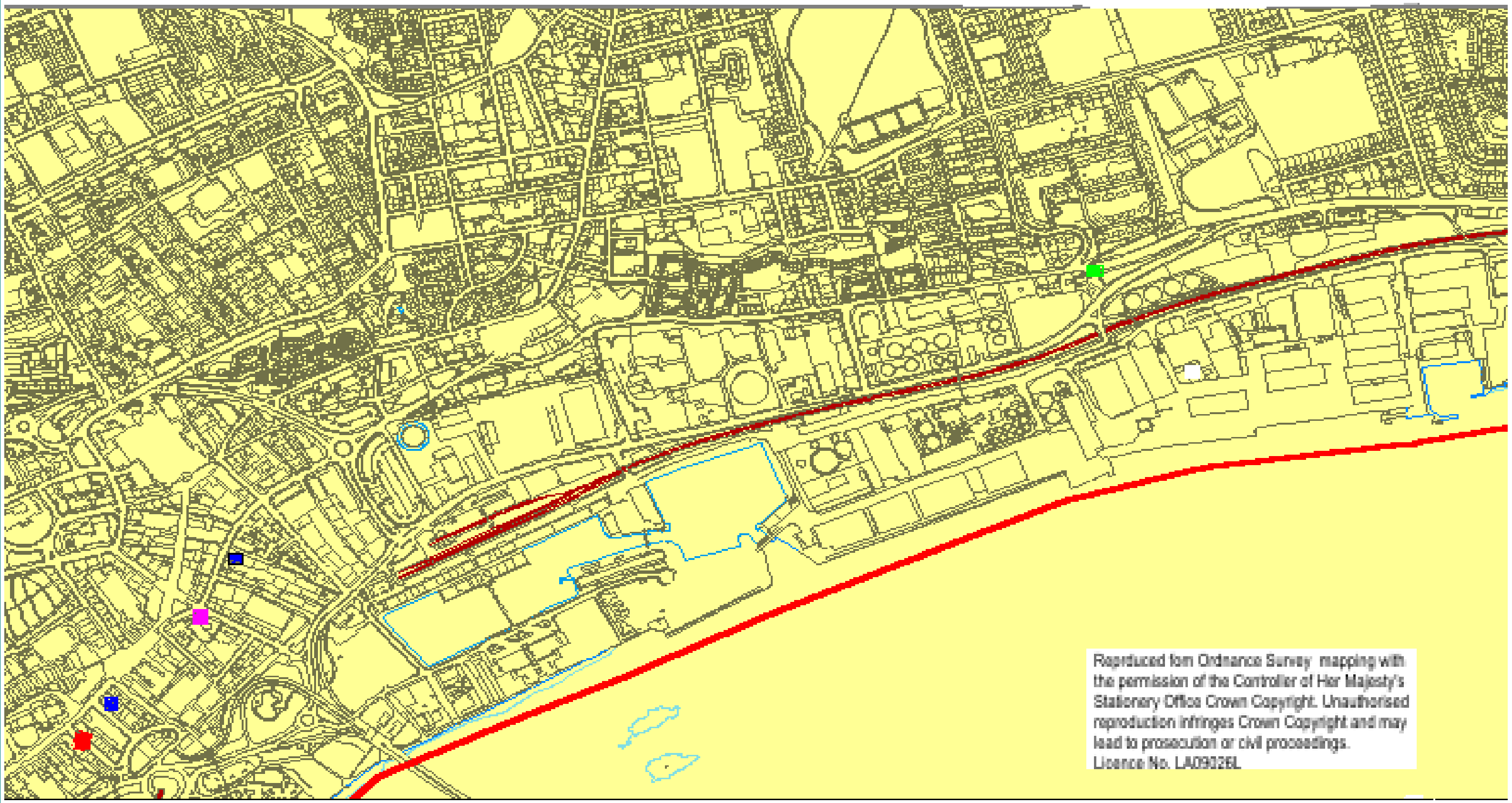
Location	Pollutants Monitored	Timescale
Commercial Street	CO / SO_2 / PM_{10} / NO_2	Periodic
Union Street	CO / PM_{10} / NO_2	18th November 2000 to present
Dock Street	PM_{10} / SO_2	14th January 2002 to present

Note - although the monitor is referred to as being located on Dock Street, it is located at the corner of Dock Street and Broughty Ferry Road, on Broughty Ferry Road.

2.6.4. The locations of the continuous monitoring sites are also shown on Figure 2.1.

Figure 2.1. Location of Continuous Monitoring Sites within Dundee

- Union St monitor
- Dock St monitor
- new monitoring locations (commissioned April 2003)
- Periodic monitoring site - Commercial St



3.0. Carbon Monoxide

3.1. Introduction

3.1.1. The Government and the Devolved Administrations have adopted an 8-hour running mean concentration of 11.6 mg/m^3 as the Air Quality Standard for carbon monoxide. The new Objective has been set at a slightly tighter level of 10 mg/m^3 as a maximum daily running 8-hour mean concentration, to be achieved by the end of 2003, bringing it into line with the second Air Quality Daughter Directive limit value.

3.1.2. The main source of carbon monoxide in the United Kingdom is road transport, which accounted for 67% of total releases in 2000 (the most recent year for which estimates are available). Annual emissions of carbon monoxide have been falling steadily since the 1970's, and are expected to continue to do so. Current projections indicated that road transport emissions will decline by a further 42% between 2000 and 2005.

3.1.3. The main threats to human health from exposure to carbon monoxide are the formation of carboxyhaemoglobin, which substantially reduces the capacity of the blood to carry oxygen and deliver it to the tissues, and the blockage of important biochemical reactions in cells. People who have an existing disease that affects the delivery of oxygen to the heart or brain (e.g. coronary heart disease) are likely to be at particular risk. The NAQS is designed to protect people at residential premises, including gardens, and public buildings such as schools and hospitals.

3.2. Conclusions of the First Round

3.2.1. There were no roads or junctions within Dundee with a current or projected annual average traffic flow greater than 80,000 vehicles/day (vpd). There were no known proposed developments that were considered to be significant for carbon monoxide emissions in 2003. Information from SEPA indicated that it was not thought that any of the authorised processes would exceed the objective.

3.2.2. Furthermore, the predicted running 8-hour mean carbon monoxide concentrations from the automatic monitor were well below the National Air Quality Standard for carbon monoxide.

3.2.3. It was therefore concluded that the National Air Quality Standard and Objective for carbon monoxide would be achieved with no action required.

3.3. Monitoring Data

3.3.1. Monitoring data for carbon monoxide indicates that there have been no exceedances of the National Air Quality Standard during the monitoring period. Monitoring has been undertaken periodically at the corner of Commercial Street and High Street. Although the numbers of vehicles using this junction do not approach 80,000 vpd, this is nevertheless seen as a sensitive site due to the possible canyon effects, the high proportion of buses and the proximity of housing and shopping areas.

3.3.2. A second continuous monitor, also equipped with an ML® 9830 Carbon Monoxide Analyser for continuous carbon monoxide monitoring, has been sited in Union Street since November 2000. The equipment is automatically calibrated every night using certified calibration gases. Union Street was selected as a city centre monitoring site as there are residential properties within the street, a number of bus routes use this street, there are possible street canyon effects and there is relevant exposure, in that, it is a shopping area.

Table 3.1. Summary of Union Street carbon monoxide raw monitoring data for period April 2002 to March 2003

Union Street Monitoring	Concentration (mg/m^3)
Average for period April 2002 to March 2003	0.12*
Minimum reading (15 min)	0.0
Maximum reading (15 min)	9.6

* This result is expressed as the integral average of the 15-minute readings for the period 2002, this information is not available as a running 8-hour mean in tabular format at this time.

3.3.3. The short term periodic monitoring results from Commercial Street reflected the above results for Union Street.

3.3.4. Figures 3.1. and 3.2. show the Union Street carbon monoxide monitoring results, expressed as 8-hour running means, from June and December 2002 respectively to give a representative picture of the seasonal variation for summer and winter conditions. The NAQS for carbon monoxide is shown on these Figures for comparison.

3.4. Very busy roads

3.4.1. Background concentrations for CO from the NAEI web-site[8] show the range of annual means for 1 km grid squares across the City for 2001 range from 0.154 to 0.246 mg/m^3 (see Appendix 3). Using the correction factor from the guidance[2] for the year 2003, this range becomes 0.127 to 0.203 mg/m^3. As the 2003 background for the city is expected to be less than 1 mg/m^3 further assessment of carbon monoxide is not required.

3.4.2. There are no roads falling into the classification of 'very busy' roads or junctions for CO within the city[2].

3.5. Conclusion

3.5.1. Having applied the checklist criteria for the assessment of carbon monoxide from the technical guidance it is concluded that the National Air Quality Standard and Objective for carbon monoxide will be achieved with no action required.

[2] Department for Environment Food and Rural Affairs and Scottish Executive 2003 *Part IV of the Environment Act 1995 Local Air Quality Management Technical Guidance LAQM.TG(03)* DEFRA Publications

[8] http://www.airquality.co.uk.co.uk/archive/laqm/tools/php

Figure 3.1. The carbon monoxide monitoring results from Union Street continuous monitoring unit for June 2002 (note, NAQS shown has now been replaced by lowered standard of 10mg/m^3)

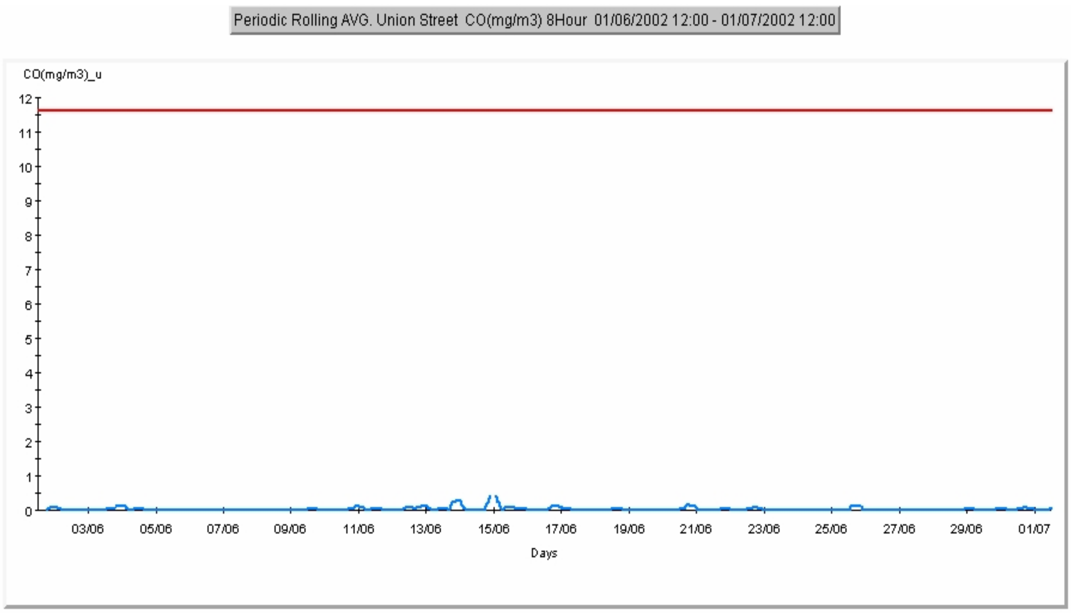
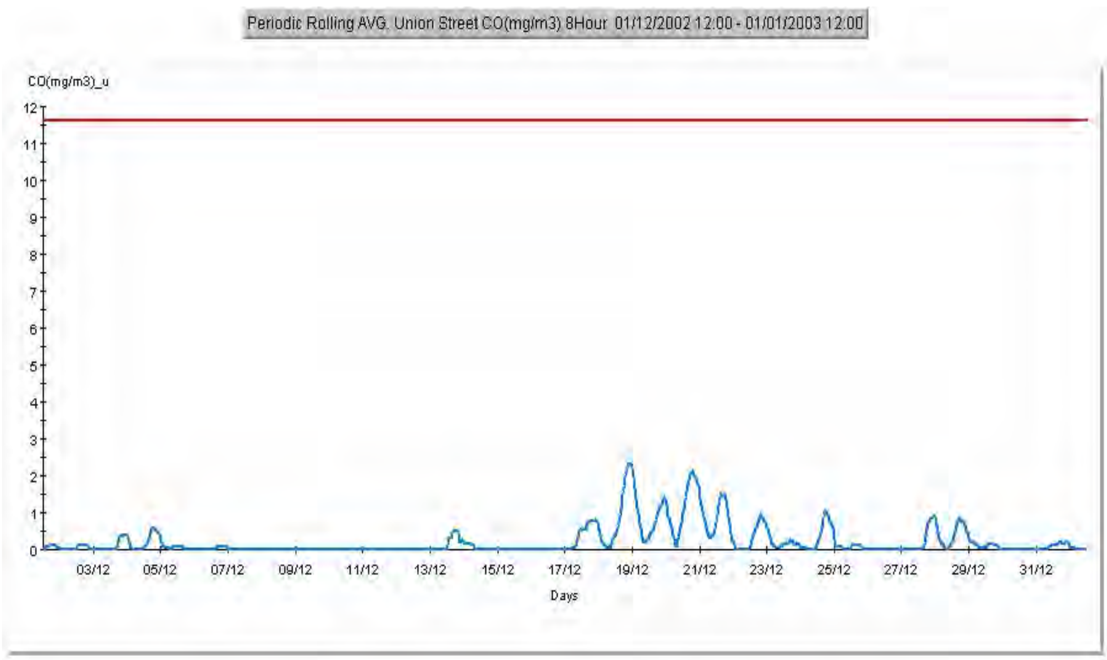


Figure 3.2. The carbon monoxide monitoring results from Union Street continuous monitoring unit for December 2002 (note, NAQS shown has now been replaced by lowered standard of 10mg/m^3)



4.0. Benzene

4.1. Introduction

4.1.1. The Government and the Devolved Administrations have adopted a running annual mean concentration of 16.25 $\mu g/m^3$ as the Air Quality Standard for benzene, with an Objective for the standard to be achieved by the end of 2003. However, in light of the health advice from EPAQS and the Department of Health's Committee on Carcinogenicity of Chemicals in Food, Consumer Products and the Environment to reduce concentrations of benzene in air to as low a level as possible, additional tighter objectives have also been set. In Scotland a running annual mean of 3.25 $\mu g/m^3$ has been adopted as an additional objective, to be achieved by the end of 2010.

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

4.1.3. A number of policy measures already in place, or planned for future years, will continue to reduce emissions of benzene. Since January 2000, EU legislation has reduced the maximum benzene content of petrol to 1% from a previous upper limit of 5%. 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.

4.1.4. It is recognised that benzene damages the genetic structure of cells and can cause cancer, that is, it is a genotoxic carcinogen. There is no absolutely safe level that can be specified for ambient air concentrations of benzene. It is recommended that exposure to benzene should be kept as low as possible, the NAQS for Scotland has been set accordingly. The NAQS is designed to protect people at residential premises (excluding gardens) and public buildings such as schools and hospitals.

4.2. Conclusions from First Round (Air Quality (Scotland) Regulations 2000)

4.2.1. The only potentially significant source of benzene in Dundee was identified as Nynas AB UK, East Camperdown Street, Dundee.

4.2.2. The results of monitoring undertaken using BTEX (benzene, toluene, xylene) tubes indicated that benzene concentrations of any fugitive emissions from the Nynas storage facilities would be significantly lower than the NAQS for benzene in 2003.

4.2.3. Information from SEPA indicated that monitoring carried out by Nynas showed the levels of Volatile Organic Compounds (VOCs) from the process itself were unlikely to result in a breach of standards. The only gap in information was the effect of potential fugitive emissions emanating from the Stannergate storage facilities. The monitoring undertaken was carried out with this in mind.

4.2.4. It was concluded that the National Air Quality Standard for benzene would be achieved with no further action required.

4.3. Monitoring Data Review (Air Quality (Scotland) Amendment Regulations 2002)

4.3.1. Further monitoring of benzene was undertaken after the publication of the Stage 2 report. Benzene monitoring was continued to ensure data capture for a calendar year. BTEX tubes were exposed at sites downwind of Nynas from September 1999 to April 2001, see Figure 4.1 for BTEX tube locations.

Figure 4.1. Location of BTEX tube sites used in monitoring survey in relation to refinery, Nynas AB UK.

4.3.2. The existing results obtained for the calendar year 2000 are as follows:

Table 4.1. Benzene (BTEX) Diffusion Tube Monitoring Results for 2000 showing National Air Quality Standards for Benzene

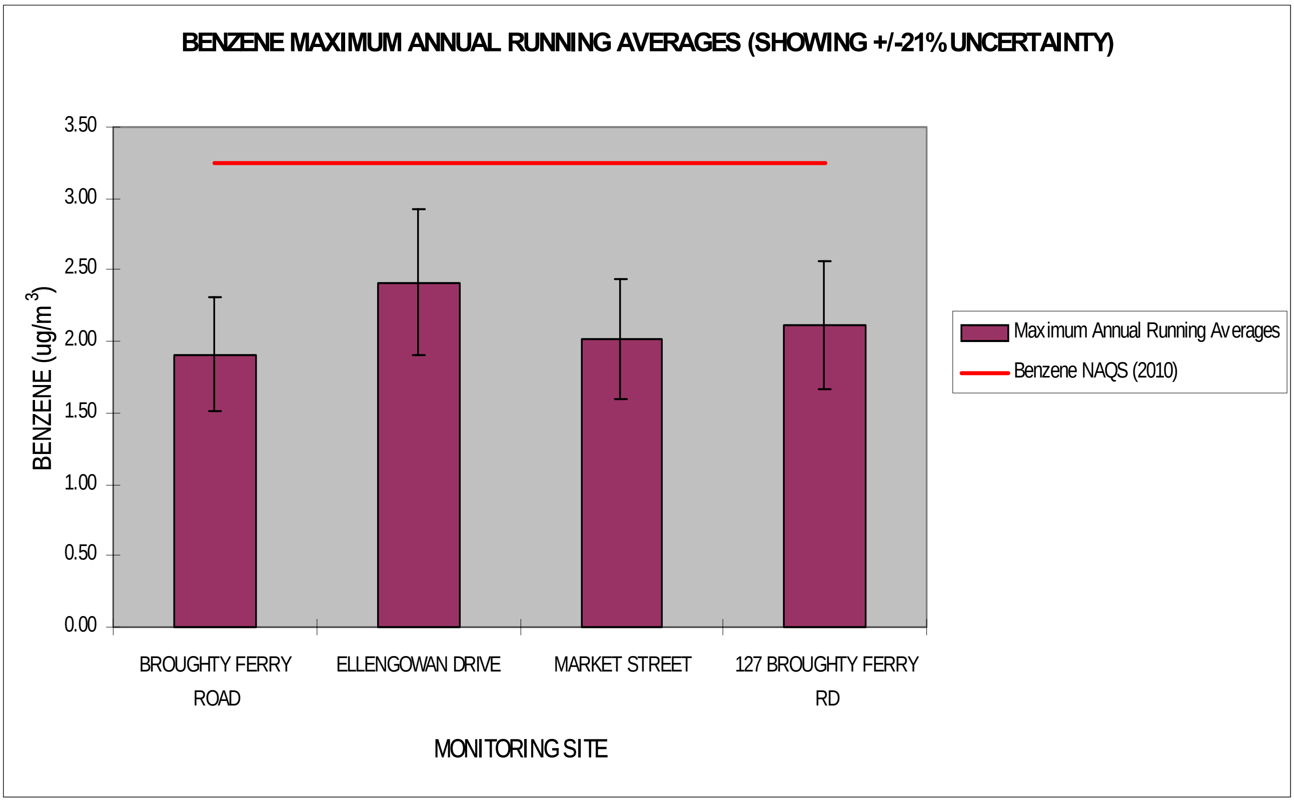
Broughty Ferry Road	Ellengowan Drive	Market Street	127 Broughty Ferry Road	Benzene NAQS ($\mu g/m^3$)
Annual Mean Measurement ($\mu g/m^3$)				16.25 (2003) running annual mean
1.73	2.19	1.83*	1.72	
Calculated Maximum Annual Running Mean ($\mu g/m^3$)				3.25(2010) running annual mean
1.90	2.40	2.00	1.90	

*92% data capture

4.3.3. These results are based on 12-months of BTEX diffusion tube exposure. Table 4.1. also shows the calculated maximum annual running average for 2000, these figures are obtained by multiplying the annual result by 1.1 in accordance with the technical guidance[3].

4.3.4. The results for the calculated maximum annual running averages for 2000 are shown in Figure 4.2. The results for the raw data from the four tubes over the monitoring period (20 months) are appended below (see Appendix 2).

Figure 4.2. Benzene Maximum Annual Running Averages for 2000, showing National Air Quality Standard for 2010 and range of uncertainty taking into account possible inaccuracies in tube methodology



4.3.5. The BTEX tube supplier Gradko stipulates an uncertainty in the results of +/-21%. These results are corrected for the uptake rate of the absorbent used in the tubes. Gradko,

[3]Part IV The Environment Act 1995 Local Air Quality Management - Review and Assessment Pollutant Specific Guidance LAQM.TG4(00) May 2000 DETR and Scottish Executive

an international company, participate in WASP (Workplace Analysis Scheme for Proficiency) accreditation and have in-house laboratory quality assurance procedures. Even when adjusted for the uncertainty (see the bars on Figure 4.2. showing the $^{+}$/-21%) the above results fall well below the NAQS (2003) for benzene and will not exceed the NAQS (2010).

4.4. Very busy roads or junctions in built-up areas

4.4.1. There are no roads falling into the classification of 'very busy' road or junctions for benzene within the City[2].

4.4.2. However, in light of the comments from SEPA below (paragraph 4.5.2.), it is assumed that the benzene monitoring results above are attributable to vehicle emissions. Consequently, a correction factor to reflect the reduction in the percentage of benzene in petrol vehicle emissions since 2000 should be applied to the monitoring results. Applying the correction factors taken from the guidance[2] for the year 2000 (1.069) and forward to 2010 (0.647) gives the figures shown in Table 4.2. below.

Table 4.2. Benzene monitoring results corrected forward to 2010 assuming that source is entirely vehicular emission

Broughty Ferry Road	Ellengowan Drive	Market Street	127 Broughty Ferry Road
Estimated Annual Mean obtained using correction factors to 2010			
1.05	1.33	1.11	1.04
Estimated Annual Running Mean using estimated figures for 2010			
1.16	1.47	1.22	1.15

4.5. Industrial Sources

Comments from SEPA

4.5.1. Clarification has been sought from SEPA regarding the possible contribution of Nynas AB UK to benzene emissions both through the stacks and from possible fugitive emissions.

4.5.2. A response from Nynas AB UK, given via SEPA, states the following:

"There are very low levels of benzene present in all crude oils including our crude. However as benzene has a boiling point of about 80^{o}C and our crude is stored at a maximum of 60^{o}C there will be no benzene emission from our crude oil storage tanks. Benzene liberated during our distillation process will be burnt in our vacuum heater or routed with our naphtha product which is stored at typically 10^{o}C in our floating roof naphtha tank. This floating roof will ensure minimal emission levels from the tank. As the Naphtha storage temperature is well below the benzene boiling point there will be no benzene emission from our Naphtha tank."

4.5.3. Information from the Local Authority Monitoring Helpdesk (operated by Netcen) suggests that it is unlikely that fugitive emissions would have a significant effect upon monitoring results at a distance of over 100 metres.

4.5.4. It is concluded that existing industrial sources will not have a significant impact on the benzene concentrations at any relevant receptors within Dundee.

4.6. Petrol stations

4.6.1. There are no petrol stations within the City where benzene is considered to be significant in accordance with the screening checklist[2].

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2 Department for Environment Food and Rural Affairs and Scottish Executive 2003 *Part IV of the Environment Act 1995 Local Air Quality Management Technical Guidance LAQM.TG(03)* DEFRA Publications

- None have a throughput of over $1000 m^3/yr$ where Stage-1 vapour recovery (that is vapour recovery during petrol delivery from road tankers) is not in place;
- None have a throughput greater than $2000 m^3/yr$ where pumps are within 10 metres of housing and have a busy road nearby.

This includes the new petrol filling station commissioned at Sainsbury's, Baldovie Road, since the completion of the First Round assessment.

4.6.2. There is one petrol station where the petrol throughput is greater than $2000\ m^3/yr$ and the pumps are less than 10 metres from a residential premises (a dwelling is 9.28 metres from pumps at Asda Kirkton). However, this petrol station is not located on a busy road according to the criteria stipulated in the guidance (LAQM.TG(03))[2]. It is therefore not considered necessary to proceed to a detailed assessment in respect of this petrol station.

4.7. Major fuel storage depots (petroleum only)

4.7.1. There are no major fuel depots in the City.

4.8. Conclusions

4.8.1. Having applied the checklist criteria for the assessment of benzene from the technical guidance it is concluded that the 2003 National Air Quality Standard and Objective for Benzene will be achieved with no action required. It is anticipated that the 2010 NAQS should be achieved, therefore, Dundee City Council will not proceed to detailed assessment for Benzene.

4.8.2. In order to confirm the source of benzene is vehicular emissions further monitoring using BTEX diffusion tubes will be undertaken.

5.0. 1,3-butadiene

5.1. Introduction

5.1.1. The Government and the Devolved Administrations have adopted a maximum running annual mean concentration of 2.25 $\mu g/m^3$ as an Air Quality Standard for 1,3-butadiene. The Objective is for the Standard to be achieved by the end of 2003.

5.1.2. The main source of 1,3-butadiene in the United Kingdom is emissions from motor vehicle exhausts. 1,3-butadiene is also an important industrial chemical and is handled in bulk at a small number of industrial premises.

5.1.3. The increasing numbers of vehicles equipped with three way catalysts will significantly reduce emissions of 1,3-butadiene in future years. Further recently agreed restrictions in vehicle emissions and improvements to fuel quality, including those as part of the Auto-Oil programme, are expected to further reduce emissions of 1,3-butadiene from vehicle exhausts. These measures are expected to deliver the Air Quality Objective by the end of 2003, and no further measures are thought to be needed. Only those authorities with relevant locations in the vicinity of major industrial processes which handle, store or emit 1,3-butadiene, are expected to proceed beyond the updating and screening assessment.

5.1.4. The health effect, which is of most concern in relation to 1,3-butadiene exposure, is the induction of cancers of the lymphoid systems and blood-forming tissues, lymphomas and leukemias. Like benzene, 1,3-butadiene is a genotoxic carcinogen, and so no absolutely safe level can be defined. The NAQS is designed to protect people at residential premises (excluding gardens) and public buildings such as schools and hospitals.

5.2. Conclusions from the First Round

5.2.1. Information from SEPA[4] indicated that Nynas AB UK undertook monitoring for VOCs including 1,3-butadiene throughout the year. These emission levels were shown to be very low during routine operations, the Nynas process was not considered a significant source of 1,3-butadiene.

5.2.2. It was anticipated that the National Air Quality Standard for 1,3-butadiene would be achieved with no further action required.

5.3. Monitoring Data

5.3.1. No monitoring for 1,3-butadiene has been undertaken.

5.4. New Industrial sources

5.4.1. There are no new or proposed industrial sources likely to emit 1,3-butadiene within the City.

5.5. Existing industrial sources with significantly increased emissions

5.5.1. There are no industrial sources with significantly increased emissions which are likely to emit 1,3-butadiene.

5.6. Conclusions

5.6.1. Having applied the checklist criteria for the assessment of 1,3-butadiene from the technical guidance it is concluded that the National Air Quality Standard and Objective for 1,3-butadiene will be achieved with no action required.

[4] Scottish Environmental Protection Agency Consultation Response to Dundee City Council's First Stage Review and Assessment of Air Quality

6.0. Lead

6.1. Introduction

6.1.1. The Government and Devolved Administrations have adopted an annual mean concentration of 0.5 $\mu g/m^3$ as the Air Quality Standard for lead, with an Objective for the Standard to be achieved by the end of 2004. In addition, a lower Air Quality Standard of $0.25\mu g/m^3$ to be achieved by the end of 2008 has also been set.

6.1.2. The agreement reached between the European Parliament and the Environment Council on the Directive on the Quality of Petrol and Diesel Fuels (part of the Auto-Oil Programme) led to a ban on sales of leaded petrol in the United Kingdom which took effect from 1 January 2000. Emissions of lead are now restricted to a variety of industrial activities, such as battery manufacture, pigments in paints and glazes, alloys, radiation shielding, tank lining and piping.

6.1.3. Detailed assessments of the potential impact of lead emissions from industrial processes have been undertaken by the Government and the Devolved Administrations, based upon both monitoring and sector analysis studies. The former has included a 12-month monitoring survey in the vicinity of 30 key industrial sites in the UK, which has been used to supplement information already provided from the non-automatic monitoring networks. These monitoring data have generally indicated no exceedances of the 2004 or 2008 objectives, although locations in proximity to non-ferrous metal production and foundry processes were deemed to be at risk, and further monitoring is under way.

6.1.4. Exposure to high levels of lead may result in toxic effects in humans which, in turn, can cause problems in the synthesis of haemoglobin, effects on the kidneys, gastrointestinal tract, joints and reproductive system, and short or long term damage to the nervous system. The possible effect of lead on brain development in children, and hence their intellectual development, is the greatest cause of concern. Normally, only a small fraction of total lead intake occurs through inhalation. The National Air Quality Standards are designed to protect people at residential premises (excluding gardens) and public buildings such as schools and hospitals.

6.2. Conclusions from the First Round

6.2.1. Ambient monitoring in the vicinity of Dens Metals suggested that an exceedance of the National Air Quality Standard for lead existed.

6.2.2. Modelling undertaken on behalf of Dundee City Council by an Environmental Consultant (Cordah) predicted an exceedance of the NAQS for lead in the immediate vicinity of the foundry. The study concluded that it was likely that the elevated levels of lead recorded at the monitoring sites could be attributed to uncontrolled emissions from the foundry.

6.2.3. Dundee City Council consulted with SEPA as the enforcing authority for Part A and Part B prescribed processes under the EPA 1990. SEPA indicated that the emission limits and controls, including fugitive emissions from the foundry, could be regulated to achieve the NAQS for lead through the process authorisation.

6.2.4. In addition Dens Metals (Dundee) Ltd had indicated that they were considering relocating to a purpose built plant.

6.2.5. Therefore, as there were no known proposed developments with the potential to emit lead, it was concluded that the NAQS and Objective for lead could be achieved. However, ambient monitoring was continued after completion of the Stage 2 report publication in order to confirm the annual mean concentration.

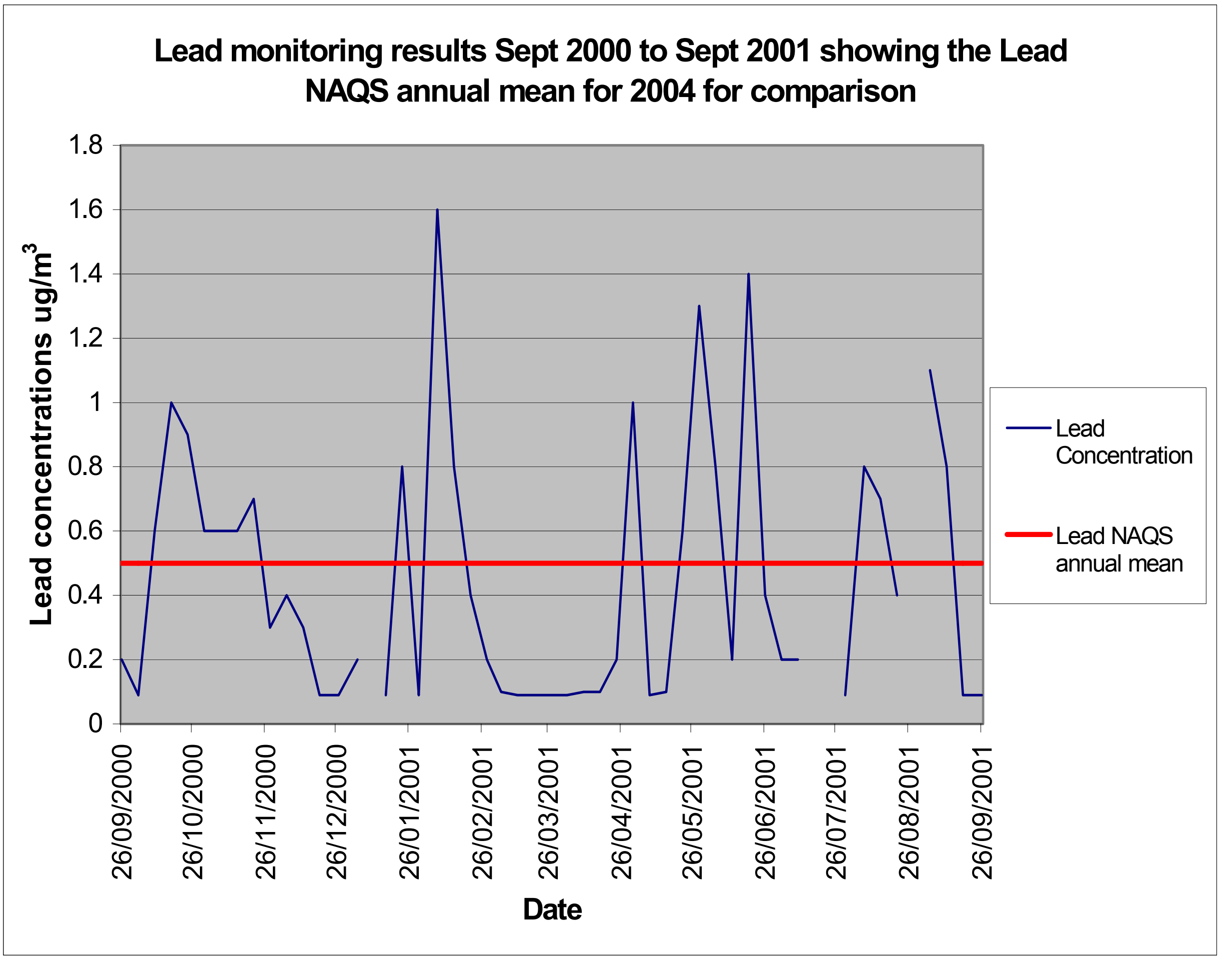
6.3. Monitoring data outside an AQMA

6.3.1. The industrial process linked with potential lead emissions, Dens Metals, ceased production at its Dens Road site in October 2002. Monitoring for ambient lead in air concentrations was undertaken for the period January 2000 to September 2001. The sampler used Millipore Aerosol Field Monitor filters with a pore size of 0.8 microns. A pump continuously drew a metered volume of air through a nitrocellulose membrane. The membranes were changed weekly, analysed in batches of four, together with a blank, using atomic absorption spectroscopy. Appropriate calibration standards were used for the atomic absorption spectroscopy in accordance with the methodology detailed in ISO 9855:1993(E). These results are summarised in Table 6.1 and Figure 6.1 below.

Table 6.1. Lead Monitoring results as Annual Mean for 2000 and the last 12-month period of monitoring

Sampling Period Dates	Annual Mean Lead Content of Air sampled (ug/m^3)	National Air Quality Strategy - Annual Mean (ug/m^3)
Jan - Dec 2000	0.82	0.5 (2004)
Sept 2000 - Sept 2001	0.45	0.25 (2008)

Figure 6.1. Lead monitoring results for period 26 September 2000 to 26 September 2001 showing National Air Quality Standard for lead for 2004



6.4. New industrial sources

6.4.1. The new site for Dens Metals was commissioned in November 2002. The process has now relocated to a new custom built premises where it is believed that fugitive emissions, which were previously an issue, will not be problematic. The stack abatement technology in the new premises is expected to prevent stack emissions of significant quantities of lead. The new location is significantly further from any relevant receptor locations. Furthermore, Dens Metals have significantly decreased the percentage of lead used in the alloys manufactured.

6.5. Industrial sources with significantly increased emissions

6.5.1. There are no other industrial sources, which are likely to emit lead, that have undergone a significant increase in emissions since the First Round.

6.6. Conclusions

6.6.1. Having applied the checklist criteria for the assessment of lead from the technical guidance it is concluded that the National Air Quality Standard and Objective for lead will be achieved with no action required.

7.0. Nitrogen Dioxide

7.1. Introduction

7.1.1. The Government and the Devolved Administrations have adopted two Air Quality Objectives for nitrogen dioxide, as an annual mean concentration of 40 $\mu g/m^3$, and a 1-hour mean concentration of 200 $\mu g/m^3$ not to be exceeded more than 18 times per year. The Objectives are to be achieved by the end of 2005.

7.1.2. The first Air Quality Daughter Directive also sets limit values for nitrogen dioxide, which have been transposed into UK legislation. The Directive includes a 1-hour limit value of 200 $\mu g/m^3$ not to be exceeded more than 18 times per year, and an annual mean limit value of 40 $\mu g/m^3$, both to be achieved by 1 January 2010.

7.1.3. Nitrogen Dioxide (NO_2) and nitric oxide (NO) are both oxides of nitrogen, and are collectively referred to as nitrogen oxides (NO_x). All combustion processes produce NO_x 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. It is nitrogen dioxide that is associated with adverse effects upon human health.

Sources

7.1.4. The principal source of NO_x 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, the contribution of road transport to local emissions will be much greater than for the national picture.

7.1.5. The contribution of road transport to NO_x emissions has declined significantly in recent years as a result of various policy measures, and further reductions are expected up until 2010 and beyond. For example, urban traffic NO_x emissions are estimated to fall by about 20% between 2000 and 2005, and by 46% between 2000 and 2010.

7.1.6. Other significant sources of NO_x emissions include the electricity supply industry and other industrial and commercial sectors, which accounted for about 24% and 23% respectively in 1999. Emissions from both sources have also declined dramatically, due to the fitting of low NO_x burners, and the increased use of natural gas plant. Industrial sources make only a very small contribution to annual mean nitrogen dioxide levels, although breaches of the hourly nitrogen dioxide Objective occur under rare, extreme meteorological conditions, due to emissions from these sources.

Considerations for Local Authorities

7.1.7. In practice, meeting the annual mean Objective in 2005, and the limit value in 2010, is expected to be considerably more demanding than achieving the one hour Objective. National studies have indicated that the annual mean Objective is likely to be achieved at all urban background locations outside of London by 2005, but that the Objective may be exceeded more widely at roadside sites throughout the UK in close proximity to busy road links. Projections for 2010 indicated that the EU limit value may still be exceeded at urban background sites in London, and at roadside locations in other cities.

7.1.8. A report by the University of West of England on behalf of DEFRA (2002) concludes that outside major conurbations, exceedances of the annual mean Objective are only likely to occur within about 10 metres of the kerbside of single carriageway roads. This includes roads with relatively low traffic flows (10,000 to 20,000 vehicles/day) if they are within congested town centres. This is particularly significant where towns have narrow streets with residential properties within 5 metres of the kerb.

7.1.9. These locations, where local authorities can expect pollutant concentrations to be the highest, are often referred to as 'hot spots'. Focussing on these areas should ensure that potential exceedances are not missed. If there are no exceedances of the objectives at the most polluted locations, then it can be reasonably concluded that there should be no exceedances elsewhere.

7.1.10 At relatively high concentrations, nitrogen dioxide causes inflammation of the airways. There is evidence to show that long term exposure to nitrogen dioxide may affect lung function and that exposure to nitrogen dioxide enhances the response to allergens in sensitised individuals. The annual average NAQS is designed to protect people at residential premises (excluding gardens) and public buildings such as schools and hospitals. In addition, the 1-hour mean NAQS is designed to protect people in residential gardens, car parks, bus/railway stations and pavements of busy shopping streets.

7.2. Conclusions of the First Round

7.2.1. Information from SEPA suggested that there was no significant risk that emissions of NO_2 from DERL, Michelin Tyres Plc and Nynas AB UK would exceed the Objectives. Furthermore, neither the combined impact of emissions from DERL/road traffic nor Nynas AB UK/road traffic predicted an exceedance of the Objectives.

7.2.2. The results of the automatic urban monitoring in the city centre, although insufficient to determine the possible exceedance of the annual mean, showed that no exceedance of the 1-hour mean was recorded. The five-month period of monitoring was spread evenly throughout the year. As the 1-hour mean Objective allowed for 18 possible exceedances of the Standard per year, it was considered that the risk of exceeding this Objective was unlikely.

7.2.3. The assessment of the impact of road emissions for NO_2 by modelling, predicted two locations where there were potential exceedances of the annual mean Objective, namely;

- Kingsway, between Woodside Avenue and Mains Loan; and,
- Forfar Road, south of Fintry Drive roundabout.

Similarly, the assessment of NO_2 at junctions identified three locations where there were predicted exceedances of the Objective, namely;

- Clepington Road/Forfar Road;
- Lochee Road/Dudhope Terrace; and,
- Marketgait/Nethergate.

7.2.4. However, a comparison of modelling results with diffusion tube results obtained by monitoring indicated that the modelled results should be treated with caution as the screening model was found to overestimate by a substantial percentage. Consequently, because of the uncertainty of the model, together with proposed traffic management improvements at the five identified road links/junctions, it was considered unlikely that any exceedance of the NO_2 Objective would occur.

7.2.5. NO_2 diffusion tube monitoring had been undertaken in Dundee since 1993. In general, the annual mean NO_2 concentrations of the diffusion tube results exhibited a decreasing trend in accordance with national trends and government predictions. The NO_2 annual mean concentrations were predicted for 2005, and the subsequent levels at background monitoring sites were found to be lower than the Netcen modelled background concentrations[8]. This indicated that the ambient background NO_2 concentrations in Dundee were generally good. Despite selecting worst case locations for the assessment of impact of road traffic emissions, only one exceedance of the annual mean Objective was predicted. However, the three other annual mean predictions at the same location (Union Street) were all below the Objective, as indeed was the average predicted concentration for that site. As emissions from road transport were the predominant source of NO_2 at the diffusion tube monitoring sites, it was considered unlikely that the 1-hour objective would be exceeded if the annual objective were not breached.

7.2.6. In conclusion, the diffusion tube monitoring data suggested that the predicted NO_2 concentrations were not expected to exceed the annual mean or the hourly Objective. It was

[8] http://www.airquality.co.uk/archive/laqm/tools/php

therefore concluded that the National Air Quality Standards and Objectives for NO_2 would be achieved.

7.3. Comments from Statutory Consultees

7.3.1. It was accepted that Dundee City Council was limited to its comparison of the three sites studied because it did not have adequate traffic data to model nitrogen dioxide concentrations at other diffusion tube monitoring locations. Due to the limited number and type of sites compared, it was considered that this information was insufficient to apply meaningful conclusions as to the accuracy of DMRB modelling in general. It was, for example, unreasonable to assume that the apparent modelling overestimate at Kingsway/Mains Loan could be applied equally well to other road links without a more representative sample of comparable sites. For this reason, it was recommended that more detailed traffic counts, including speed and type, be obtained for road stretches where DMRB had predicted exceedances, and for further diffusion tube monitoring to be carried out at these traffic monitoring points for comparison purposes. It was recommended that this information be available for use and inclusion in the next review and assessment in 2003.

7.4. Monitoring data outside an AQMA

7.4.1. The new technical guidance[2] advises that a greater emphasis be placed on identification of hot spots, these include areas where there is a significant proportion of heavy duty vehicles (HDV), that is, where heavy goods vehicles and buses constitute more than 25% of all traffic; refer to sections on road traffic below (7.6 to 7.11). Also, emphasis has been placed on street canyons, i.e., relatively narrow streets with buildings on both sides, where the height of the buildings is generally greater than the width of the road, refer to section 7.5. below.

7.4.2. As the previous guidance[3] had not highlighted these areas to the same extent, a number of areas requiring review under the current guidance have not been studied to date. This in turn means that some of the information required in the updating and screening assessment is not available at this time.

7.4.3. The continuous monitoring unit in Union Street has recorded an annual mean for nitrogen dioxide for the years 2001 and 2002. These results are summarised in Table 7.1. below. The automatic monitoring equipment is positioned at the kerbside in Union Street. The street carries a high proportion of buses and is potentially affected by a street canyon. Due to the proximity of housing and shopping areas, this location is relevant for assessment of both the annual average and 1-hour mean Objectives for NO_2.

Table 7.1. Annual mean derived from continuous monitoring at Union Street nitrogen dioxide monitor for 2001 and 2002, results predicted forward to 2005 for comparison with the annual mean Objective

Year	NO_2 monitoring result ($\mu g/m^3$)	Result predicted forward to 2005 ($\mu g/m^3$)	Annual mean NAQS for NO_2 2005
2001	51.2	45.7	40 $\mu g/m^3$
2002	42.8	39.4	

7.4.4. The monitoring units used in Dundee for NO_2 are equipped with ML®9841A nitrogen dioxide analysers for continuous nitrogen dioxide monitoring, and are automatically calibrated every night using certified calibration gases. The location of the new monitors at Whitehall

[2] Department for Environment Food and Rural Affairs and Scottish Executive 2003 *Part IV of the Environment Act 1995 Local Air Quality Management Technical Guidance LAQM.TG(03)* DEFRA Publications

[3] Part IV The Environment Act 1995 Local Air Quality Management - Review and Assessment Pollutant Specific Guidance LAQM.TG4(00) May 2000 DETR and Scottish Executive

Table 7.2. Diffusion tube results for nitrogen dioxide for years 2000 to 2002 with site location and receptor information plus correction forward to predicted 2005 concentrations.

	Distance to receptors	Receptor Type	Number of results	Monitoring begun	Annual Mean raw data 2000 (no correction bias applied)	Annual Mean 2001 (bias correction method changed in June)	Annual Mean 2002 (bias corrected)	2005 predicted results using 2002 annual mean (bias corrected)
ABERTAY	43m to housing	University	35	Pre 2000	34.65	38.2	49.5	**45.6**
ALBERT STREET 1	1.5m to GF	Housing	35	Pre 2000 duplicate since 2001 May	30.07	33.2	42.9	39.5
BALGAVIES PLACE	8.5m	Urban Background	34	Pre 2000	17.99	19.8	20.1	18.5
BANK ST/ REFORM ST	1.5m	Housing	33	Pre 2000	28.18	28.7	37	34.1
BIRNAM PLACE	3.85m	Urban Background	36	Pre 2000	12.58	14	15.7	14.5
BROOK STREET	1.8m	Housing	36	Pre 2000	26.99	30.4	30.6	28.2
CLEP RD/ FORFAR RD	2.4m	Housing	21	2001 April		35.7	45.8	**42.2**
COMMERCIAL ST	2.9m	Housing	30	Pre 2000	29.47	32.6	36.6	33.7
CRICHTON ST	2.7m to GF	Housing	18	2001 July		33.1	36.3	33.4
DOCK ST (UNICORN)	~1m to GF	Housing	20	2001 April		36.2	46.2	**42.5**
DYKEHEAD PLACE	façade	Urban Background	36	Pre 2000	17.58	19.8	24.3	22.4
HAWICK DRIVE	21.55m	Urban Background	36	Pre 2000	19.23	20.3	26.3	24.2
HEBRIDES DRIVE		Housing	20	2001 Jan		30.6	39.5	36.4
KINGSWAY/ MAINS LOAN 1		Housing	35	Pre 2000 duplicate since 2001 May	32.58	31.4	38.8	35.7
KINGSWAY/ PITKERRO RD	22.4m	Housing	35	Pre 2000	28.36	30.3	38.6	35.5
KINGSWAY/ STRATHMARTINE RD 1		Housing	36	Pre 2000 duplicate since 2001 May	36.53	38.4	49.1	**45.2**
LOCHEE ROAD 1	1.5m	Housing	24	2001 Jan duplicate since 2001 May		47.3	59.3	**54.6**

	Distance to receptors	Receptor Type	Number of results	Monitoring begun	Annual Mean raw data 2000 (no correction bias applied)	Annual Mean 2001 (bias correction method changed in June)	Annual Mean 2002 (bias corrected)	2005 predicted results using 2002 annual mean (bias corrected)
MARKETGAIT	3.9m	Housing	33	Pre 2000	37.56	34.1	43.5	**40.0**
MYREKIRK ROAD	16.4m	Housing	15	2001 Aug		30.8	34.9	32.1
NETHERGATE (LEONARDOS)	1.5m to GF	Housing	20	2001 Mar		30.5	40.2	37.0
NETHERGATE / MARKETGAIT	4.45m	Housing	22	2001 Jan		30.2	41.3	38.0
RIVERVIEW HOSTEL		Housing	27	Pre 00 - 02 May	24.1	25.7	30.4	28.0
SEAGATE	1.6m	Housing	36	Pre 2000	41.47	43.7	53.9	**49.6**
SEAGATE (BOND)	1.7m	Housing	15	2001 Oct		44.5	45.3	**41.7**
SEAGATE (YATES)	1.7m	Housing	20	2001 Mar		37.7	45.9	**42.3**
UNION STREET	1.5m	Housing	35	Pre 2000 triplicate since 2001 Mar	45.78	46.3	52.2	**48.1**
UNION STREET (GOOD FELLOWS)	1.6m	Housing	19	2001 April		35.9	40.3	37.1
UNION STREET (McINTYRES)	1.6m	Housing	21	2001 April		34.7	40.7	37.5
VICTORIA ROAD	3m	Housing	36	Pre 2000	33.58	34.3	46.1	**42.4**
WHITEHALL CR (XPRESSO)	3m to GF	Housing	18	2001 July		31.7	36.2	33.3
WHITEHALL ST (B)	3m to GF	Housing	15	2001 July		41.9	47.8	**44.0**
WHITEHALL ST (C)	2.25m to GF	Future Housing	24	6 months 2000 and '01, since 2002	55.52	59.6	69.2	**63.7**
WHITEHALL ST (D)	3m	Housing	23	2001 Jan		35.5	43.5	**40.0**
WHITEHALL ST (F)	3m to GF	Housing	18	2001 July		43.3	41.6	38.3
WOODSIDE AVENUE	14.3m	Urban Background	36	Pre 2000	17.39	18.8	23.2	21.4

Table 7.3. Diffusion tube results for nitrogen dioxide for periodic exposure within 2002 (annual mean not available) showing site location and receptor information plus correction forward to predicted 2005 concentrations

	Distance to receptors	Receptor Type	Number of results	Site commissioned	Periodic prediction of Annual Mean for 2002 (bias corrected)	2005 predicted results using 2002 annual mean (bias corrected)
LOGIE STREET (114)	1.5m	Housing	7	2002 May	46.4	**42.7**
DURA STREET (BAKERS)	1.5m	Housing	7	2002 May	36.4	33.5
TRADES LANE (31)	2m	Housing	7	2002 May	26.8	24.7
WHITEHALL STREET (A)	2.7m to GF	Future Housing	5	2002 Aug	43.6	**40.1**
WHITEHALL STREET (E)	2.5m to GF	Future Housing	3	2002 Aug	44.9	**41.3**
LOCHEE ROAD (164)	1.5m	Housing	8	2002 May	46.4	**42.7**

Street and Seagate also represent areas where there is a high proportion of buses and potential street canyon effects, with public exposure at housing and shopping areas. The location at Lochee Road is representative of a busy road (20,067 vpd (1994 count)) where there are possible street canyon effects, and where there is housing within three metres of the kerb.

7.4.5. The diffusion tube data, summarised in Table 7.2., has been ratified by removing any results which visually appear to be spurious, i.e., significantly outwith the expected range. The data has then been validated by comparing the results for diffusion tubes exposed in triplicate at the same location as the air intake for the Rollalong continuous monitoring unit in Union Street. This collocation study indicated that there is a slight over-read in the diffusion tubes (approximately 15%) for the year 2002, accordingly, a correction factor of 0.82 has been applied to all NO_2 tube results for 2002.

7.4.6. The collocation study was also carried out at Union Street during 2001, however, the methodology for the tube analysis was changed in June 2001. Accordingly, the figures given for 2001 are bias adjusted for the previous methodology for the first six months. The collocation of diffusion tubes under the previous methodology indicated that the tubes were under-reading. The adjustment for the latter six months was in accordance with the new methodology (an over-read). Although diffusion tube monitoring data has been recorded for Dundee City since 1993, accurate bias correction has only been available since the commissioning of the Union Street unit for collocation studies.

7.4.7. Figure 7.1.shows the comparison of the average diffusion tube reading for three collocated tubes at Union Street with continuous monitoring at Union Street (giving bias correction) from October 2000 to date. The ratio of the Union Street monitoring result against the diffusion tube mean for the triplicate exposure is used to determine the bias correction factor.

7.4.8. The ongoing monitoring of NO_2 using diffusion tubes has identified a number of hotspot areas where it is unlikely that the Air Quality Objective of 40$\mu g/m^3$ will be achieved.

Figure 7.1. **Diffusion tube and continuous monitor collocation study to determine bias correction factor for diffusion tubes from October 2000 to date**

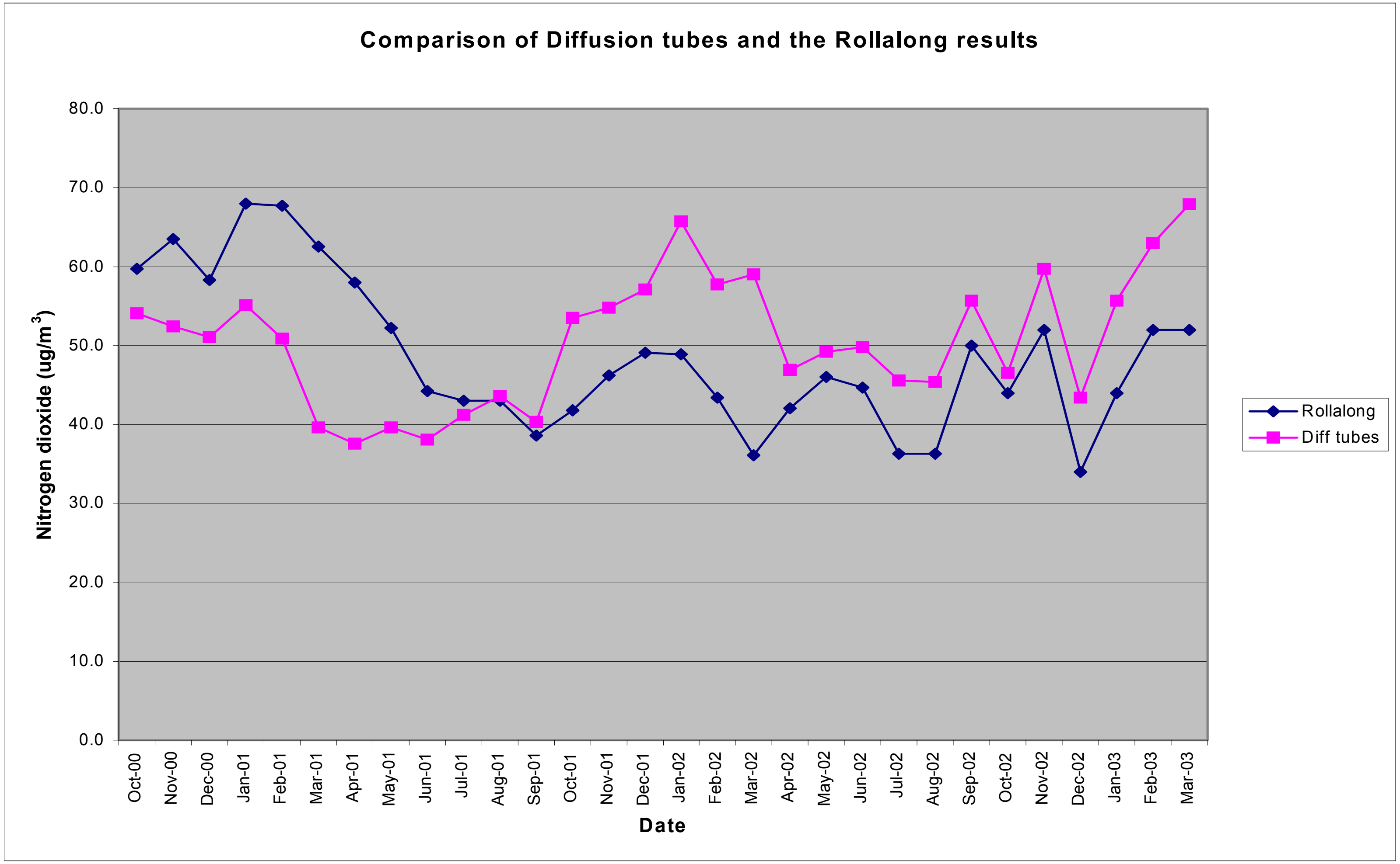
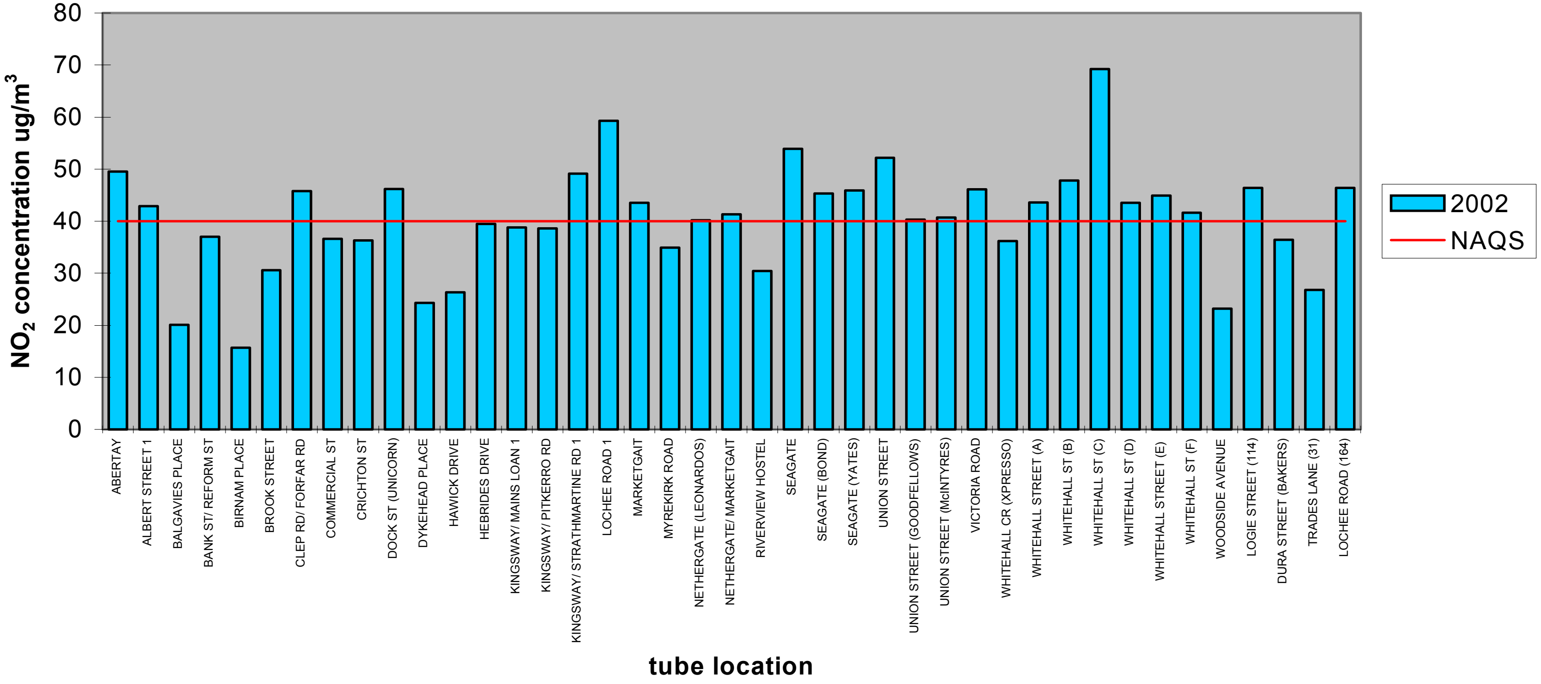


Figure 7.2. Annual mean diffusion tube concentrations (bias corrected) for 2002 showing annual mean NAQS (2005)



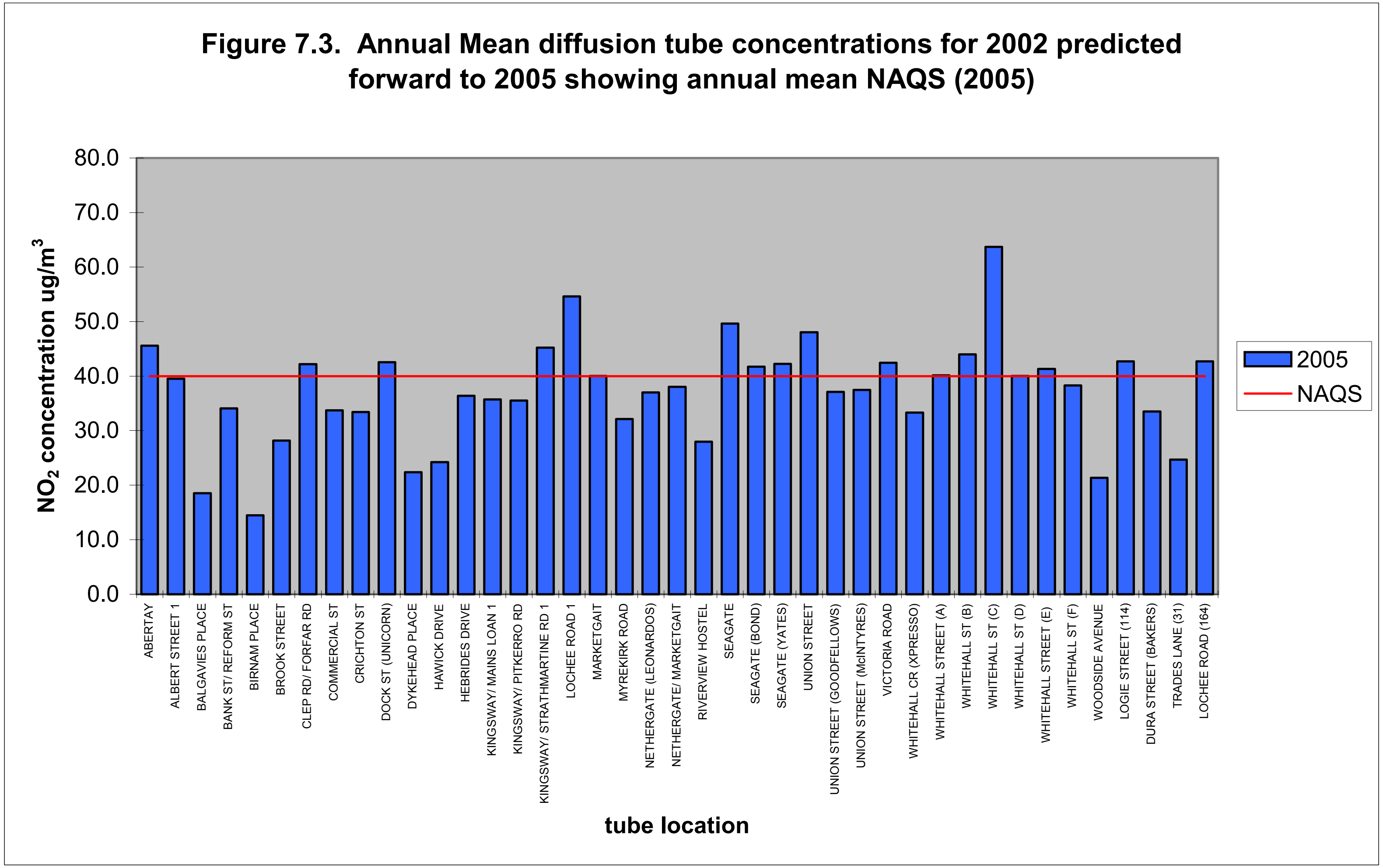
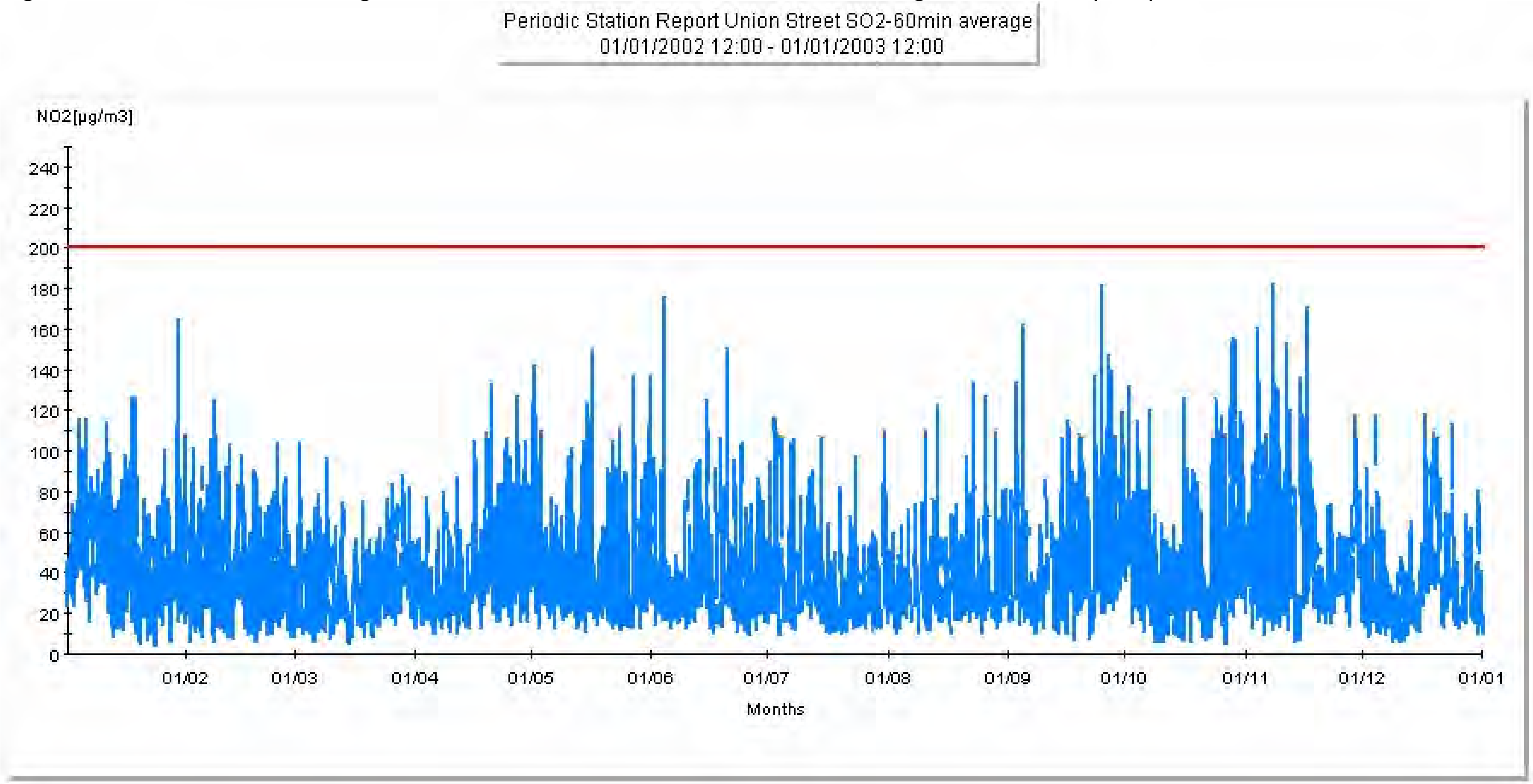


Figure 7.3. Annual Mean diffusion tube concentrations for 2002 predicted forward to 2005 showing annual mean NAQS (2005)
NO2 concentration ug/m3
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
ABERTAY
ALBERT STREET 1
BALGAVIES PLACE
BANK ST/ REFORM ST
BIRNAM PLACE
BROOK STREET
CLEP RD/ FORFAR RD
COMMERCIAL ST
CRICHTON ST
DOCK ST (UNICORN)
DYKEHEAD PLACE
HAWICK DRIVE
HEBRIDES DRIVE
KINGSWAY/ MAINS LOAN 1
KINGSWAY/ PITKERRO RD
KINGSWAY/ STRATHMARTINE RD 1
LOCHEE ROAD 1
MARKETGAIT
MYREKIRK ROAD
NETHERGATE (LEONARDOS)
NETHERGATE/ MARKETGAIT
RIVERVIEW HOSTEL
SEAGATE
SEAGATE (BOND)
SEAGATE (YATES)
UNION STREET
UNION STREET (GOODFELLOWS)
UNION STREET (McINTYRES)
VICTORIA ROAD
WHITEHALL CR (XPRESSO)
WHITEHALL STREET (A)
WHITEHALL ST (B)
WHITEHALL ST (C)
WHITEHALL ST (D)
WHITEHALL STREET (E)
WHITEHALL ST (F)
WOODSIDE AVENUE
LOGIE STREET (114)
DURA STREET (BAKERS)
TRADES LANE (31)
LOCHEE ROAD (164)
tube location
2005
NAQS

Figure 7.4. Continuous Monitoring of 1-hour means for Union Street for 2002 showing NAQS for NO_2 (2005)



Accordingly, a detailed assessment of NO_2 will be undertaken. Three continuous monitoring sites have now been established to identify the extent of any potential exceedance of the annual or 1-hour means, and an additional 22 passive diffusion tube sites have been erected.

7.4.9. The diffusion tube results for 2000 (raw data), 2001 (bias corrected, methodology used changed midway through calendar year), 2002 (bias corrected) and 2005 (2002 results estimated forward using correction factor from guidance) are shown in Table 7.2. The annual mean concentrations from the diffusion tube study are shown in Figure 7.2. and the predicted concentrations for 2005 are shown in Figure 7.3. Fifteen exceedences of the annual mean are predicted to occur in ten streets. Continuous monitoring will be undertaken in those streets where predicted exceedances are identified and where there is relevant exposure to the 1-hour mean (see section 7.4.10). Dundee City Council will proceed to detailed assessment in respect of these ten locations.

7.4.10. Continuous nitrogen dioxide monitoring is undertaken in Union Street. The 1-hour means for 2002 are shown in Figure 7.4. (and summarised in Table 7.1.). There are no exceedances of the 1-hour mean. There is relevant exposure on other streets within the city centre and local shopping centres across the City. Further continuous monitoring units have been installed at Whitehall Street, Seagate and on Lochee Road, the NW arterial route to the city centre. Information will be available on the likelihood of exceeding the 1-hour mean for nitrogen dioxide at these locations in due course. Based on the information available at this time, it is believed that the 1-hour mean for nitrogen dioxide will be achieved within Dundee.

7.5. Narrow congested streets with residential properties close to the kerb

7.5.1. Such locations, commonly referred to as street canyons, constitute a significant number of streets within Dundee, particularly in the architecturally older areas of the town, see Figure 7.5. These streets form the majority of new sites identified as locations for the additional NO_2 tubes.

7.5.2. The existing sites where exceedances of the nitrogen dioxide annual mean Objective have been identified within Dundee are exclusively areas where the streets are relatively narrow and congested with residential properties close to the kerb. However, the geographical extent of the exceedances of the annual mean are not established at this time.

7.5.3. A number of these sites are not believed to exceed the 10,000 vehicle per day traffic flow trigger, but as these locations were not targeted during the First Round, there is insufficient traffic data regarding a number of street canyons. Therefore, it is not possible to undertake the steps identified within the technical guidance[2] at this time. Accordingly, Dundee City Council will proceed to detailed assessment in respect of nitrogen dioxide in congested street canyoned areas where relevant receptors are located.

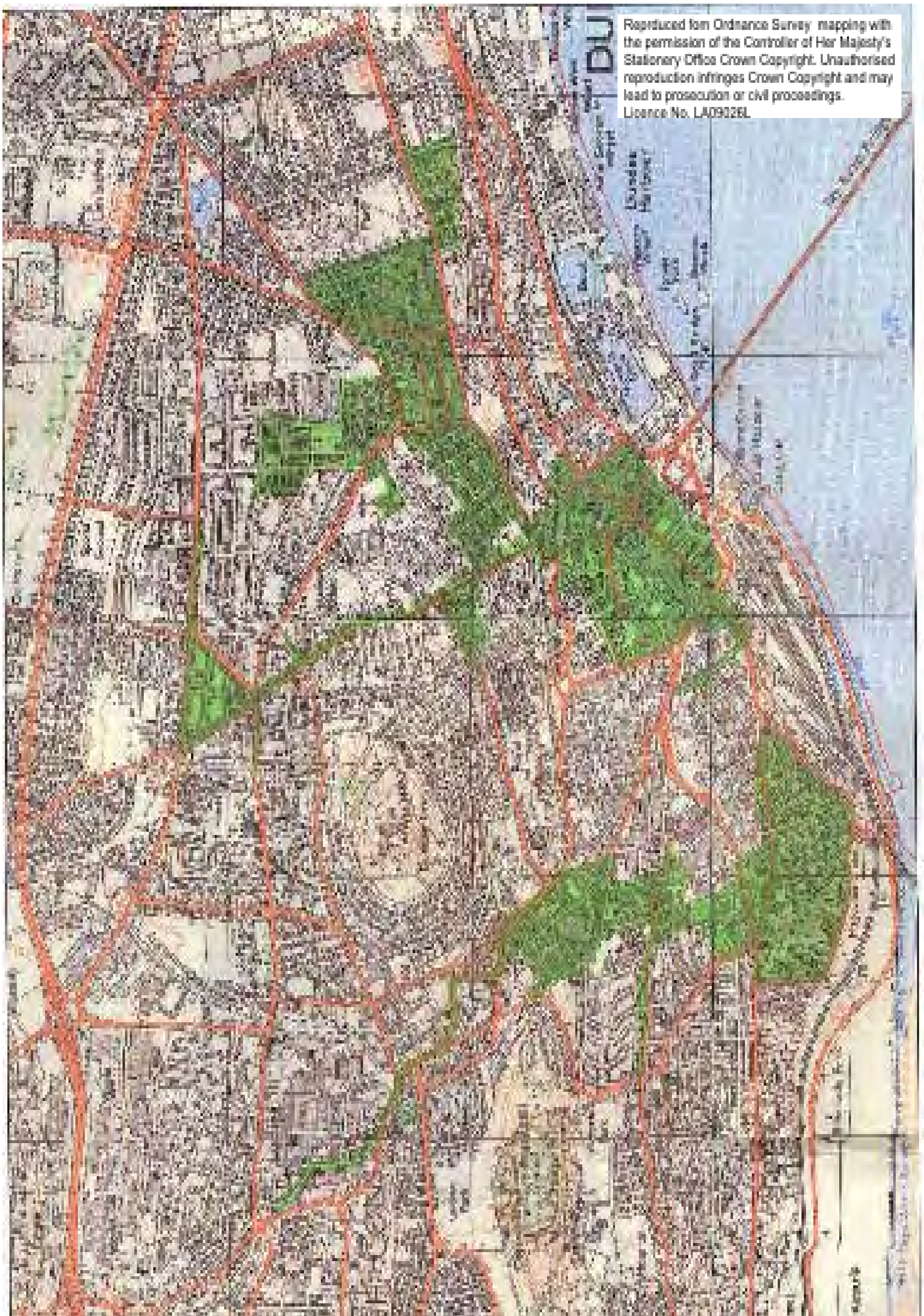
7.6. Note on use of background concentrations

7.6.1. The guidance[2] recommends that when using the background nitrogen dioxide concentrations, provided via the online database[8], that care be taken to avoid 'double counting'. It recommends that grid squares 4 either side of significant roads in suburban and rural areas be used to avoid counting the elevated background at the road as the background for an area, see Figure 7.6. Dundee City is a relatively small area with the major roads forming a bypass around the periphery of the City. Using background measurements 4 grid squares either side of these roads would not be representative as in most cases this would be a background for a rural site outwith the City.

7.6.2. The diffusion tube results for 2002 (corrected forward to 2005) for the background sites near the Kingsway (the A90(T) and A972(T)), namely Woodside Avenue and Balgavies Place, are compared to the predicted background figures from the online database in Table 7.4. below. These sites were selected as 'background NO_2 monitoring sites' in accordance with the criteria detailed in the National Nitrogen Dioxide Survey. The result for a diffusion

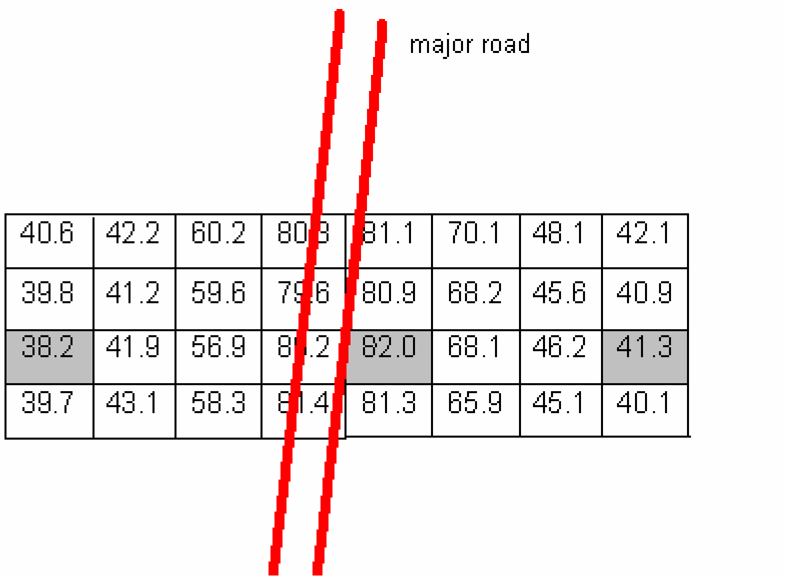
[8] http://www.airquality.co.uk.co.uk/archive/laqm/tools/php

Figure 7.5. Indicative location of street canyoned areas in Dundee city centre, highlighted in green



tube site adjacent to the Kingsway, (Mains Loan), is also shown for information. Woodside Avenue and Mains Loan lie in adjacent background grid squares, the Mains Loan tube is sited at the kerbside of the Kingsway, the Woodside Avenue site is 250 metres away in a residential location.

Figure 7.6. Method for avoiding double counting the background NO_2 concentration of a major road suggested in the technical guidance[2]



Using this technique from the guidance to avoid double counting the average of the two background 1km grid squares 4 either side of the square in question would be averaged, giving a background concentration of 39.8 µg/m^3 in place of the 'background' which includes the contribution of nitrogen dioxide from the road (82.0 µg/m^3).

Table 7.4. Results of NO_2 diffusion tube sampling 2002 (corrected forward to 2005) compared to the predicted background figures for 2005 from the database

Location	Corrected diffusion tube results for 2005 ($\mu g/m^3$)	Predicted background 2005 ($\mu g/m^3$)	Distance from Kingsway /metres
Balgavies Place	15.2	15.0	237
Woodside Avenue	17.5	17.9	250
Mains Loan	29.25	20.3	4

7.6.3. It is evident that there is a close correlation between the measured and predicted background sites in grid squares 1 square removed from major roads. Therefore, where it is necessary to correct the background figures to avoid double counting the Kingsway, the grid squares either side of the road shall be used.

7.7. Junctions

7.7.1. The methodology recommended in the guidance[2] for modelling junctions using the DMRB (Stanger version) has been amended (version 1.01). Accordingly, the modelling results presented during the First Round required to be reviewed, as previously average traffic flows for all links had been averaged at the centre point of the junctions. The links have now been studied independently, including HDV proportion. The results of the review are shown below in Table 7.5. and in Figure 7.7.

Table 7.5. DMRB results for junction modelling for nitrogen dioxide, predictions for 2005 with street canyons

Junction	Name	Receptor grid ref		speed	mean %	NO_2 annual	where street
		easting	northing	km/hr	HDV	mean 2005	canyon applied
1	Swallow Roundabout	No relevant receptor					
2	Riverside Av/Apollo Way	No relevant receptor					
3	Riverside Av/Main St (Inv)	No relevant receptor					
4	Riverside Av/Perth Rd 1	No relevant receptor					
6	Riverside Av/Perth Rd 2	336863	729856	30*	7	21.1	not applicable
7	Ninewells Av/Ninewells Dr	No relevant receptor					
8	Charleston Dr/Spey Dr	No relevant receptor					
9	South Rd/Mallaig Av	<10,000 vpd					
10	Perth Rd/ Ninewells Av	336082	730105	30	5	14.6	not applicable
11	Charleston Dr/Dickson Av	336062	731221	30*	9	19.1	not applicable
12	Kingsway/Coupar Angus Rd	No relevant receptor					
13	Macalpine Rd/Staffa Pl	No relevant receptor					
14	Staffa Pl/Telford Rd	338044	732986	30*	12	21.1	not applicable
15	Sinderins junction 1	338745	729835	30	6	22.5	not applicable
	Sinderins junction 2	338725	729802	30	6	22.2	not applicable
16	Charleston Dr/Etive Grdns	< 10,000 vpd					
17	Strathmartine Rd/Gillburn Rd	338971	733139	30*	5	20.8	not applicable
18	Trottick Mains roundabout	340217	733691	30	9	22.4	not applicable
19	Harefield Rd/Kings Cross Rd	No relevant receptor					
20	Strathmartine Rd/Clepington Rd 1	339504	732203	30	9	27.8	not applicable
	Strathmartine Rd/Clepington Rd 2	339524	732178	30	9	27.1	36.8
21	Loons Rd/Logie St 1	338172	731295	30	5	32.7	not applicable
	Loons Rd/Logie St 2	338211	731297	30	5	32.7	not applicable
22	Logie St/Ancrum Rd	338252	731205	30	7	26.0	not applicable
23	Logie St/City Rd	Not relevant junction					
24	City Rd/Tullideph	338425	730929	30	6	24.1	not applicable
25	Lochee Rd/Dudhope Ter	338928	730678	30	7	31.7	46.4
26	Lochee Rd/Polepark Rd	339003	730589	30	7	28.6	not applicable

Junction	Name	Receptor grid ref		speed	mean %	NO_2 annual	where street
		easting	northing	km/hr	HDV	mean 2005	canyon applied
27	Moncur Cres/Canning St	339951	731772	30*	4	22.4	not applicable
28	Dens Rd/Mains Rd	340012	731729	30*	4	23.0	not applicable
29	Strathmartine Rd/Hilltown 1	339986	731370	30	6	26.9	34.3
	Strathmartine Rd/Hilltown 2	339965	731383	30	6	26.7	34.9
30	Clepington Rd/Hindmarsh Av	340303	732141	30*	4	24.7	not applicable
31	Victoria Rd/Dens Rd	340733	731005	30	15	36.8	not applicable
32	Victoria Rd/Hilltown	340271	730721	30	9	31.0	45.0
33	Ladywell Roundabout	340134	730644	30	7	30.4	not applicable
34	Lochee Rd roundabout	339809	730640	30	6	25.1	not applicable
35	W. Marketgait/Ward Rd	339891	730385	30	8	29.4	not applicable
36	Westport Roundabout	no relevant receptor					
37	W. Marketgait/Nethergate	340075	729966	30	13	32.6	not applicable
38	N. Marketgait/King St	no relevant receptor					
39	Allen St Roundabout	340637	730631	30	8	30.1	not applicable
40	E. Marketgait/E Dock St	340764	730383	48	8	26.7	not applicable
41	Pitkerro Rd/Madeira St	341464	731804	30	4	15.3	not applicable
42	Forfar Rd/Clepington Rd	341397	732125	30	10	29.6	not applicable
43	Arbroath Rd/Dalkeith Rd	341805	731289	30*	4	24.8	not applicable
44	Arbroath Rd/Kenilworth Av	no relevant receptor					
45	Ballumbie Rd/Berwick Dr	< 10,000 vpd					
46	Drumgeith Rd/Ballumbie Rd	344704	733307	30*	9	20.9	not applicable
47	Kellas Rd/Drumsturdy Rd	345146	733330	48*	10	25.0	not applicable
48	Balunie Av/Ballindean Rd	no relevant receptor					
49	Balunie Dr/Ballindean Rd	< 10,000 vpd					
50	Balunie Dr/Balmoral Av	< 10,000 vpd					
51	Arbroath Rd/Fairfield Rd	no relevant receptor					
52	Stathern Rd/Fairfield Rd	no relevant receptor					

Junction	Name	Receptor grid ref		speed	mean %	NO_2 annual	where street
		easting	northing	km/hr	HDV	mean 2005	canyon applied
53	Forthill Road/Fintry Place	346208	731789	30	3	16.7	not applicable
54	Forthill Rd/Queen St BF	346182	731058	30	5	21.3	not applicable
55	Queen St/Claypotts Rd	345826	731137	30	6	25.0	not applicable
56	Broughty Ferry Rd/Greendykes Rd	no relevant receptor					
57	Stannergate roundabout	343313	731068	30*	9	25.8	not applicable

*denotes that the speed of one of the junction road links was taken to be the designated road speed limit instead of 30kph

Table 7.6. Results of the DMRB for new road counts undertaken since the First Round and, at new receptor locations identified since the First Round (in accordance with the latest guidance)

Road Number/ Name	Receptor Location	Receptor grid ref		speed km/hr	mean % HDV	NO_2 2005
		easting	northing			
A90	Brownhill Rd	336248	732140	80	9.3	23.3
A85	Riverside Pl	336174	730018	64	7.3	20.9
A991	Palais Crt	339951	730088	40	3.3	21.6
A991	Paradise Rd	340026	730649	48	2.1	22.1
A92	Dock St	340658	730353	40	3.7	25.2
A929	Princes St	341047	730934	48	5.6	21.3
A929	Clive St	341207	732104	48	5.7	21.9
A90	Hebrides Dr	341540	733478	64	10.4	24.6
A92	Broughty Ferry Rd	342240	731054	64	4.2	22.7
A9930	Dundee Rd	344333	731077	64	2.3	19.2
A92	Monifieth Rd	346963	731043	48	5.6	20.1
A92	Broughty Ferry Rd	343493	731756	64	8.8	21.9
Harefield Road	Harefield Road	338111	731851	48	6.4	23.7
Strathmartine Rd	Strathmartine Road	339231	732814	48	0.0	20.2

Figure 7.7 DMRB predicted NO_2 concentrations at junctions where traffic flow is greater than 10,000 vpd, with relevant exposure for 2005 showing 2005 NAQS

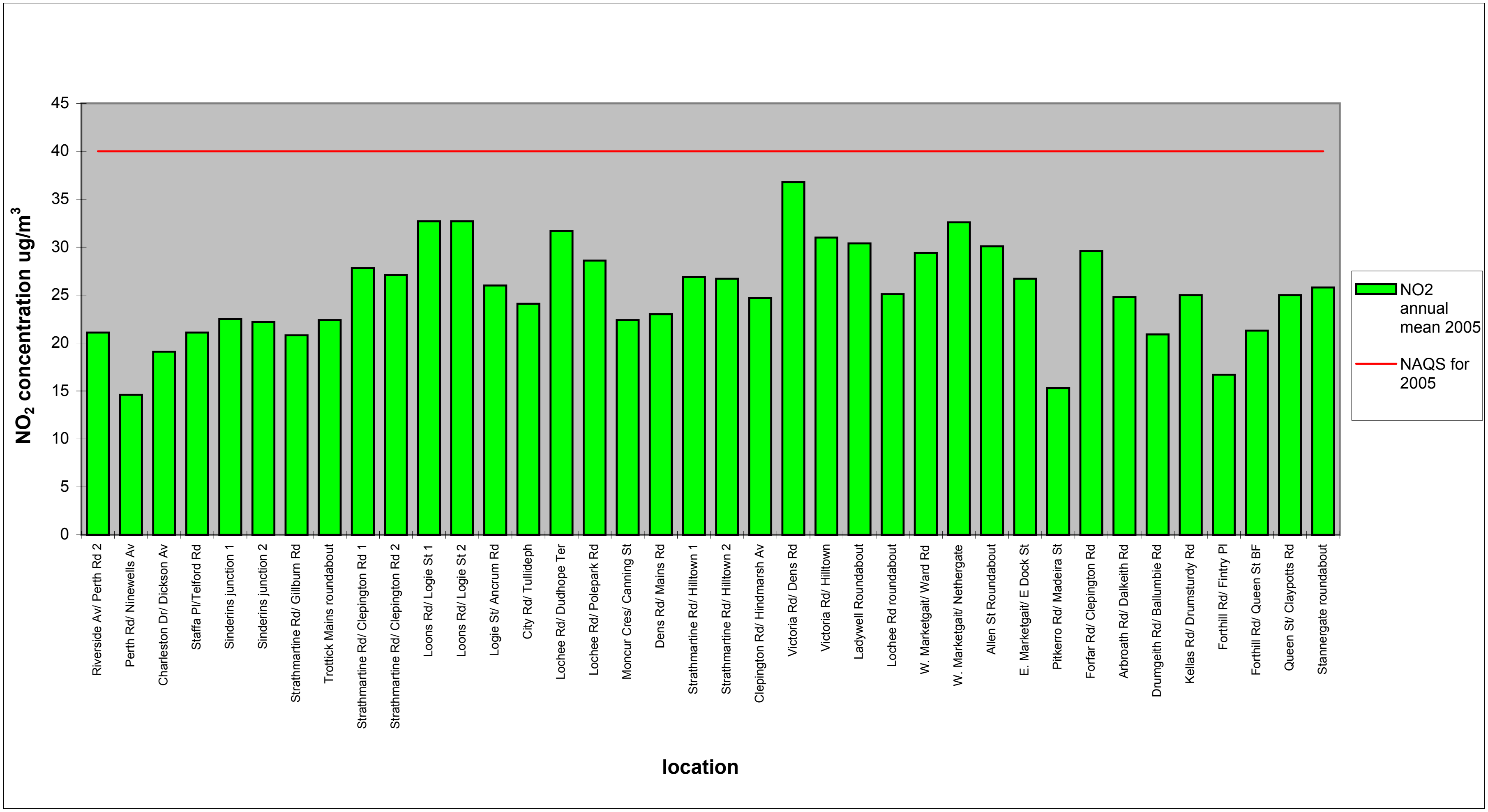
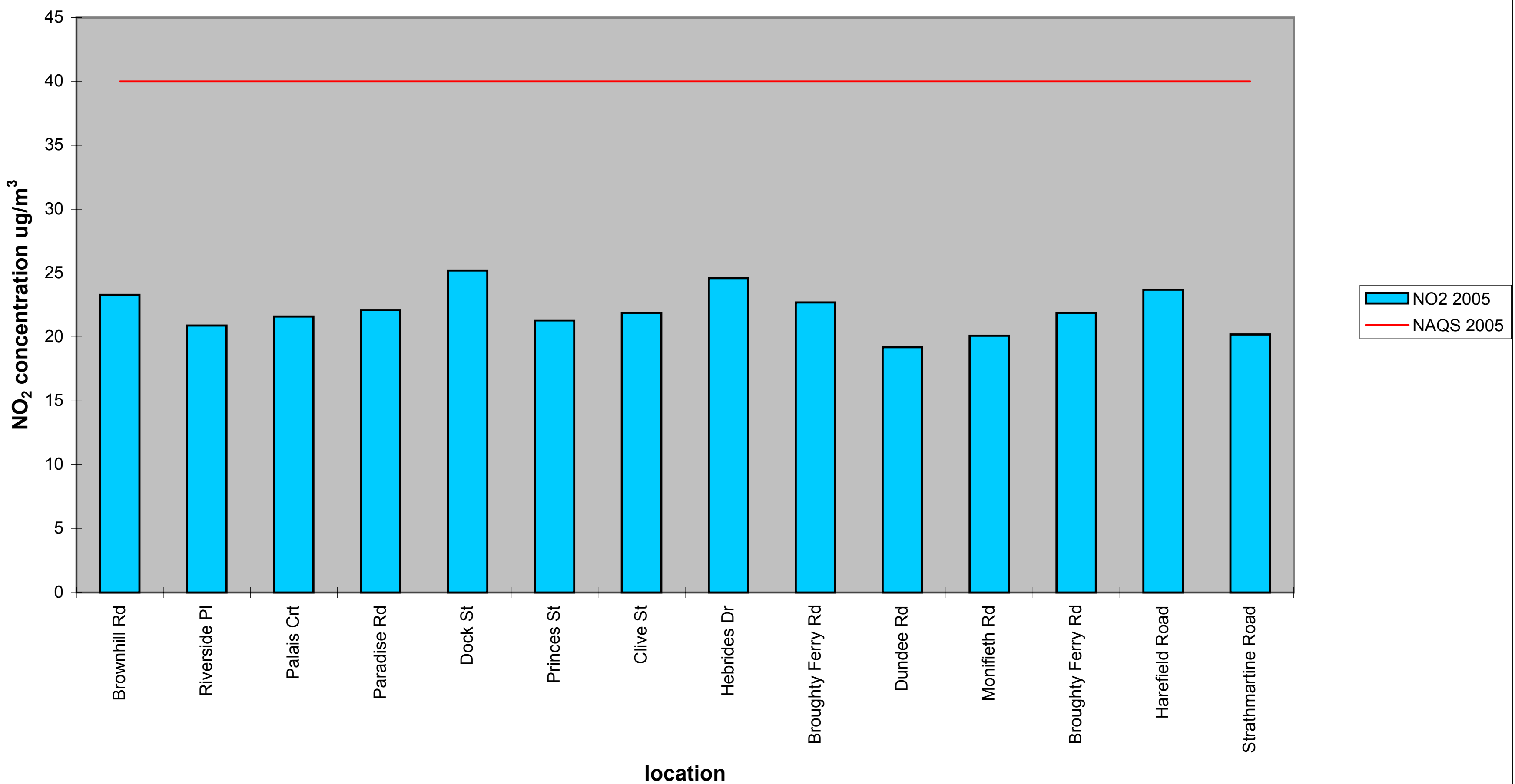


Figure 7.8. DMRB prediction of NO_2 concentrations at roads in 2005



7.7.2. There are no roads which have predicted exceedances of the NAQS for 2005. There are no junctions which exceed the NAQS until a correction for street canyons is applied. Where this correction is applied the following junctions are predicted to exceed the NAQS for nitrogen dioxide for 2005:

- Victoria Road/Hilltown; and
- Lochee Road/Dudhope Terrace,

with annual means of 45 $\mu g/m^3$ and 46.4 $\mu g/m^3$ respectively

7.8. Busy streets where people may spend 1-hour or more close to traffic

7.8.1. The main areas where it is likely that pedestrians may spend one hour or more close to traffic are shopping centres, namely:

- The city centre, a significant proportion of which is pedestrianised;
- Perth Road
- High Street, Lochee;
- Albert Street;
- Hilltown; and,
- Brook Street, Broughty Ferry.

7.8.2. Monitoring results for the Union Street continuous monitor are shown in Figure 7.4. It has been identified that information relating to streets in the city centre more commonly occupied by shoppers, is insufficient. The recent addition of new continuous monitoring equipment at Whitehall Street and the Seagate will assist in establishing the likelihood of any exceedances of the 1-hour mean. Continuous monitoring is also being initiated at Lochee Road, any exceedances of the 1-hour mean at this location will be identified by this monitoring.

7.8.3. There is insufficient information available at this time to determine whether a detailed assessment is required. No exceedances have been recorded at the Union Street location. Further assessment is required for other areas of the city centre.

7.9. Roads with high flow of buses and/or HGVs

7.9.1. The requirement to review roads where traffic flows are relatively low, that is below 20,000 vpd, but where there is a high proportion of HDV (buses and heavy goods vehicles) is an addition to the previous guidance[3]. A 'high proportion' is defined as greater than 25% of the total vehicle flow[2]. This change in the guidance reflects the identification of HDV as particularly significant NO_x sources. These roads were not required to be reviewed during the First Round. Further information on classified vehicle counts is required to undertake a full assessment of roads with a significant proportion of HDVs, where there are an excess of 2,500 HDV vpd and there is a relevant receptor within 10 metres of the kerb.

7.9.2. There are two streets in the City which are currently designated solely for buses (with other vehicles permitted for access only), namely: west end of King Street, Dundee and the west end of Dock Street. It is believed that these roads will fall into this category.

7.9.3. There are proposed traffic management changes around Whitehall Street and Albert Street which will increase the proportion of buses in these streets, both are likely to fall into this category after the traffic management alterations are implemented.

7.9.4. There are a number of roads where it is known that a proportion of vehicles will be HDVs, however, it is not clear whether the proportion will be greater than 25%. These areas include:

- Baird Avenue, access to the Tesco Distribution Centre
- Claymore Street, access to DERL
- Foundry Lane, buses leaving the depot
- Stannergate, access to the port area

[3] Part IV The Environment Act 1995 Local Air Quality Management - Review and Assessment Pollutant Specific Guidance LAQM.TG4(00) May 2000 DETR and Scottish Executive

Classified counts will be required for those streets where there is relevant exposure within 10 metres of the kerb.

7.9.5. There is relevant exposure within 10 metres of the kerb in King Street. There is also relevant exposure in Albert Street and Whitehall Street which will require these streets to be considered for HDV proportions if traffic management changes are implemented. Without traffic flow data it is not possible to accurately determine whether the flow of HDVs is greater than 2,500 vpd. Further information on classified vehicle counts is required to enable the DMRB screening model (version 1.01) to be used.

7.9.6. Diffusion tube screening of Albert Street and Whitehall Street is ongoing. The annual mean for the diffusion tube results for these two streets are shown below. Diffusion tubes have recently been placed on King Street.

Table 7.7. Diffusion tube results (bias corrected) for 2002 for Albert Street and Whitehall Street compared with NAQS annual mean of 40 $\mu g/m^3$

Tube Location	2002 NO_2 concentration ($\mu g/m^3$)	Comments
Albert Street	42.86	1.5 metres from façade of dwelling
Whitehall Street (A)	53.20	2.7 metres from façade, as yet unoccupied but flats granted planning permission from 2nd floor
Whitehall Street (B)	47.80	3 metres from façade of ground floor of tenement, flats from 2nd floor
Whitehall Street (C)	69.20	2.25 metres from façade, as yet unoccupied but flats granted planning permission from 2nd floor
Whitehall Street (D)	43.55	3 metres from façade of ground floor of tenement, flats from 2nd floor
Whitehall Street (E)	54.75	2.5 metres from façade, as yet unoccupied but flats granted planning permission from 2nd floor
Whitehall Street (F)	41.56	3 metres from façade of ground floor of tenement, flats from 3rd floor

7.9.7. There are proposals to alter traffic flows in Whitehall Street and Union Street, and it is likely that this will increase the proportion of buses using Whitehall Street. The properties in this street are all commercial at ground floor level. Residential properties are located from the second floor up, so nitrogen dioxide diffusion tubes have been placed at a height of approximately 10 metres to reflect exposure at the façade of relevant receptors as opposed to the ground level shops. An annual mean has not yet been derived from this study. The findings of this study, when available, may assist in validating modelling of street canyons within Dundee.

7.9.8. Insufficient information is available, further assessment is required in respect of roads with a high flow of HDVs within Dundee.

7.10. New roads constructed or proposed since First Round of review and assessment

7.10.1. A new road has been constructed joining Princes Street and Blackscroft. The road is approximately 150 metres in length. There is no relevant exposure along the length of this new road.

7.10.2. There are a number of proposed developments (see sections 2.2.3 and 2.2.4.) within Dundee that will require the construction of new roads. It is anticipated that Environmental Impact Assessments will be submitted in support of these proposals prior to the commencement of works. Therefore, it is not considered necessary to proceed to detailed assessment in respect of new roads constructed or proposed since the First Round.

7.11. Roads close to the objective during the First Round of review and assessment

7.11.1. The DMRB screening model has been modified since the First Round. The vehicle emissions factors in the Stanger version of the DMRB were found to underestimate emissions (predicted reductions in emissions due to technological advances had apparently been over-optimistic).

7.11.2. There is a requirement to review roads that were predicted in the First Round to be above 36 $\mu g/m^3$ but below 40$\mu g/m^3$ using the DMRB. The following roads fell between 36 - 40 ($\mu g/m^3$) during the First Round:

- Kingsway West, west of Kingsway Circus
- Kingsway West, east of Myrekirk Road roundabout
- Kingsway West, west of Liff Road
- Lochee Road, at traffic lights south of Rankine Street

7.11.3. The review of these roads in the DMRB showed that with the amended criteria for proximity of receptor to be within 10 metres and traffic flow to be greater than 10,000 vpd means that the Kingsway Circus is no longer requires to be assessed. The three remaining roads have been reviewed in the above sections relating to new traffic counts available since the First Round (see Table 7.6.), Lochee Road has been considered as a junction (see Table 7.5).

7.12. Roads with significantly changed traffic flows

7.12.1. There are no roads, which have undergone an increase in traffic flow of greater than 25% since the First Round. However, there are proposed traffic management alterations which will have a significant impact on the flow of several roads in the future. This matter will be kept under review, however, Dundee City Council will not proceed to detailed assessment in respect of roads with significantly changed traffic flows at this time.

7.13. Bus stations

7.13.1. The bus station is used primarily by companies travelling to destinations outwith Dundee. Local Dundee buses stop at streets within the city centre, in particular, St Andrews Street, Whitehall Street, Union Street, Nethergate, Seagate and Victoria Road.

7.13.2. The bus station waiting area is enclosed therefore, the waiting public is not exposed to emissions for a significant period of time, that is, the bus station is not considered a relevant receptor area for the 1-hour objective.

7.13.3. A nitrogen dioxide diffusion tube was placed opposite the bus station at the nearest residential premises. The bias corrected reading for periodic exposure (7 months) in 2002 was 32.66 $\mu g/m^3$.

7.13.4. As there is no evidence of an exceedance of the annual mean linked to the bus station and the bus station waiting area is enclosed, Dundee City Council will not proceed to a detailed assessment for nitrogen dioxide in respect of the bus station.

7.14. New Industrial sources

7.14.1. The processes identified as being potentially significant sources of NO_2 are listed in Table 7.8. below. It was established during the First Round that the foundry, Dens Metals, was not considered to be a significant source of nitrogen dioxide.

7.14.2. As there are no new industrial sources falling into the categories listed in Annex 2 of the guidance[2], Dundee City Council will not proceed to detailed assessment for NO_2 in respect of any new industrial sources.

Table 7.8. Potentially significant industrial sources of nitrogen dioxide in or bordering Dundee City

Company Name	Location	Process
Michelin Tyres Plc	Baldovie Road, Dundee	Boilers and furnaces
Nynas AB UK	East Camperdown Street, Dundee	Crude oil handling
DERL	Claymore Street, Dundee	Incineration

7.15. Industrial sources with substantially increased emissions

7.15.1. Information received from SEPA[5] during the First Round indicated that the authorised processes in Dundee would not be likely to cause an exceedance of the National Air Quality Standards at any relevant receptor.

7.15.2. The only industrial sources with increased emissions of greater than 30% since the First Round assessment is DERL. At the time of the completion of the First Round assessment, DERL was not operating at full capacity. The throughput of the process has increased by more than 30%, therefore, it is anticipated that the emissions will have increased by over 30%. Information from SEPA indicates that DERL has been operating within its emission limits for NO_x for both stacks.

7.15.3. Information obtained from DERL via SEPA indicates that the mass emissions rate from DERL were 5849 g/hr for Boiler 1 and 9878 g/hr for Boiler 2[9]. The effective stack heights for the process are 70 metres, with stack diameters of 1.15 metres for each stack. This corresponds to scaled emissions of 7.7 tonnes/annum and 13.0 tonnes/annum respectively. Using the nomograms in the technical guidance[2] , detailed assessment is required only where the emissions from stacks of this size are in excess of 180 tonnes/annum for the annual mean and 500 tonnes/annum for the 1-hour mean. As the emissions are below these emission thresholds, it is not necessary to proceed to a detailed assessment in relation to DERL.

7.16. Aircraft

7.16.1. Dundee airport has approximately 50,000 passengers per year and no freight. The requirement is to consider airports with more than 5 million passengers (or freight equivalent) per year, therefore, the airport is not considered to be a significant source of nitrogen dioxide. It is not necessary to proceed to a detailed assessment for nitrogen dioxide in respect of the airport.

7.17 Conclusions

7.17.1. Having applied the checklist criteria for the assessment of nitrogen dioxide from the technical guidance, it is concluded that Dundee City Council will proceed to a detailed assessment in respect of nitrogen dioxide. The screening monitoring data suggests that there will be exceedances of the annual mean National Air Quality Standard in the following locations:

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[5] Scottish Environmental Protection Agency - Additional Information for Stage 2 Air Quality Review and Assessment

[9] Scottish Environmental Protection Agency – Email correspondence from the Air Quality Management Specialist in the Local Authority Liaison Unit dated 28th April 2003

- Abertay (North Marketgait)
- Clepington Road/Forfar Road
- Dock Street
- Kingsway/Strathmartine Road
- Lochee Road
- Logie Street
- Seagate
- Union Street
- Victoria Road
- Whitehall Street

Dundee City Council will proceed to detailed assessment in respect of these ten locations. Further monitoring is also required to establish the possibility of exceedances of the 1-hour mean in those streets where there is relevant exposure. This will be used to validate future modelling which will predict the geographical extent of the exceedances at these locations in order to determine the boundaries of any Air Quality Management Areas, which may need to be declared.

7.17.2. There is insufficient information in relation to the checklist criteria stipulated in the guidance to determine whether a detailed assessment is required in respect to the following:

- narrow congested streets with residential properties close to the kerb;
- junctions;
- busy streets where people may spend 1-hour or more close to traffic; and,
- roads with high flow of buses and/or HGVs.

Further assessment will be undertaken of these matters to determine the likelihood of exceedances of the annual and 1-hour NAQS. Where traffic flow data has been sufficient to undertake DMRB modelling of junctions, the results show predicted exceedances at Victoria Road/Hilltown junction and Lochee Road/Dudhope Terrace junction. Detailed assessment of these junctions will therefore be required.

8.0. Sulphur Dioxide

8.1. Introduction

8.1.1. The Government and Devolved Administrations have adopted a 15-minute mean of 266 $\mu g/m^3$ as an Air Quality Standard for sulphur dioxide, with an Objective for the Standard not to be exceeded more than 35 times in a year by the end of 2005. Additional Objectives have also been set which are equivalent to the EU limit values specified in the First Air Quality Daughter Directive. These are for a 1-hour mean Objective of 350 $\mu g/m^3$, to be exceeded no more than 24 times per year, and a 24-hour Objective of 125 $\mu g/m^3$, to be exceeded no more than 3 times per year, all to be achieved by the end of 2004.

8.1.2. The main source of sulphur dioxide in the United Kingdom is power stations, which accounted for more than 71% of 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 currently accounts for less than 1% of emissions.

8.1.3. Local exceedances of the objectives (principally the 15-minute mean objective) may occur in the vicinity of small combustion plant (less than 20 MW) which burn coal or oil, in areas where solid fuels are the predominant form of domestic heating, and in the vicinity of major ports.

8.1.4. 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. The effects of sulphur dioxide on sensitive subjects appear almost immediately at the start of exposure.

8.1.5. The 24-hour mean NAQS is designed to protect people at residential premises, including gardens, and public buildings such as schools and hospitals. In addition the 1-hour mean NAQS is to reflect exposure in residential gardens, car parks, bus/railway stations and pavements of busy shopping streets. The 15-minute mean applies to all locations where members of the public may reasonably be exposed for a period of 15 minutes or longer.

8.2. Conclusions of the First Round

8.2.1. The SO_2 contributions of domestic sources and small combustion plant to air quality in Dundee were considered negligible. Furthermore, as HECA and Entec surveys on solid fuel usage showed a continued substantial move to natural gas, those sources were not considered to be significant for SO_2 to 2004/5. Information from SEPA suggested that there was no significant risk that emissions of sulphur dioxide from either DERL or Michelin Tyres Plc would exceed the Objectives. Although SO_2 dispersion modelling of emissions from Nynas predicted relatively high ground level concentrations of SO_2 in relation to the 15-minute mean, when combined with the predicted traffic SO_2 contribution, no exceedance of the NAQS for SO_2 was found. There were no known proposed developments which would be considered significant for SO_2 emissions in 2004/5. However, it was noted that the City Quay development, upwind of Nynas, included proposals for residential accommodation and this development required to be kept under review.

8.2.2. It was therefore concluded that the National Air Quality Standards and Objectives for sulphur dioxide would be achieved with no further action required.

8.3. Comments from Statutory Consultees

8.3.1. Further to the submission of the Stage 2 report the following comments were received via the Scottish Executive from the University of West of England Review and Assessment Appraisal Report[6]:

[6] Scottish Executive, 15 March 2001 Air Quality Strategy: Dundee City Council - Second Stage Review and Assessment - including comments from UWE and SEPA

The Nynas AB UK plant is a significant source of sulphur dioxide. The highest sulphur dioxide monitoring results were in the vicinity of this plant, although the technique was not suitable for identifying 15-minute concentrations. It is recommended that the authority carry out further assessment for this source, ideally using automatic monitoring at a location where the modelling suggests the maximum impact associated with relevant exposure.

8.4. Monitoring outside an AQMA

8.4.1. Monitoring information has been obtained from the Groundhog, which is sited in the city centre at the junction of Commercial Street and the High Street (see Figure 2.1), periodically. As the prevailing wind direction is from the south-west, this site is unaffected by SO_2 emissions from industrial sources and can be classified as an urban background site for SO_2 monitoring. The Groundhog is equipped with an ML®9850B sulphur dioxide analyser for continuous sulphur dioxide monitoring and it is calibrated every night using certified calibration gases. Figure 8.2 shows the monitoring results May 2002 at this location.

8.4.2. The continuous monitoring unit at Dock Street Rollalong (also shown on Figure 2.1.) was commissioned on 14th January 2002. It houses the same analyser as the Groundhog. The Dock Street site was selected as it is north-east of Nynas, downwind during the prevailing wind direction and was approximately representative of residential exposure in this area. This section of Dock Street was also shown to be the worst-case scenario for both long-term and 1-hour concentrations of SO_2 at relevant receptors at the time that modelling was undertaken by Cordah for Nynas[7]. Wind speed and direction are also monitored at the Dock Street site. Figure 8.1 shows the monitoring results for May 2002 at this location. Nynas was operating during this period, and comparison of these results with those at the background location (Figure 8.2.) show elevated levels of SO_2 concentrations at this monitoring site.

8.4.3. During 2002 one exceedance of the National Air Quality Standards was measured at Dock Street, see Figure 8.3. On the 26th August 2002 at midday a sulphur dioxide concentration of 288 $\mu g/m^3$ was recorded; an exceedance of the 15-minute NAQS. Thirty-five exceedances of this standard are permitted per year. Confirmation has been obtained from SEPA that the productivity over 2002 represents a typical year of processing for Nynas AB UK. It is concluded that NAQS for SO_2 will be achieved downwind of Nynas.

8.4.4. The location of the continuous monitoring site on Dock Street was selected as the most appropriate site, in regard to relevant exposure, at the time the continuous monitor was commissioned. However, the modelling undertaken by Cordah predicted that an area of vacant land to the southwest of Nynas would have higher ground level SO_2 concentrations. Housing development is in progress to the south-west of Nynas at the end of the South Victoria Dock Road, the area shown in the modelling to have a higher ground level concentration of SO_2 than Dock Street.

8.4.5. In order to determine the exposure at these new dwellings, it is intended to commission independent modelling of Nynas AB UK. The modelling results can be validated against the monitoring results obtained from the Dock Street unit. The authorisation of Nynas AB UK relates to the 1-hour and long term emissions only, it does not include a 15-minute emission limit. Accordingly, it will be necessary to model the 15-minute emission levels for the process.

8.4.6. In light of the new housing development in proximity to the Nynas AB UK process, it is necessary to proceed to a detailed assessment for sulphur dioxide in this location.

[7] Dr O Harrop, Cordah Environmental Management Consultant (February 2000) *Nynas UK AB - Air Quality Assessment Report*

8.5. New industrial sources

8.5.1. The following processes were identified as being potentially significant sources of SO_2 during the First Round (Table 8.1.).

Table 8.1. Potentially significant industrial sources of sulphur dioxide in or bordering Dundee City

Company Name	Location	Process
Michelin Tyres Plc	Baldovie Road, Dundee	Boilers and furnaces (emergency back up only)*
Nynas AB UK	East Camperdown Street, Dundee	Crude oil handling
DERL	Claymore Street, Dundee	Incineration

* Emergency boilers operate for no more than 7 days per year

8.5.2. There are no new industrial sources falling into the categories listed in Annex 2 of the guidance[2], Dundee City Council will not proceed to detailed assessment for SO_2 in respect of any new industrial sources.

8.6. Industrial sources with significantly increased emissions

8.6.1. At the time of the completion of the First Round assessment, DERL was not operating at full capacity. The throughput of the process has increased by more than 30%, therefore, it is anticipated that the emissions will have increased by over 30%. Information from SEPA indicates that SO_2 monitoring has been undertaken, however, the results show that the concentrations of SO_2 in the emissions are below the limit of detection for the sampling method ($<1 mg/m^3$) against a limit of 100 mg/m^3 (continuous monitoring)[9]. It is not necessary to proceed to a detailed assessment in respect of DERL for sulphur dioxide.

8.7. Areas of domestic coal burning

8.7.1. Dundee City Council has declared extensive smoke control areas across the City. However, for the purposes of assessing sulphur dioxide emissions from domestic coal burning, it is recommended that smokeless fuel be treated as solid fuel as the sulphur content is similar.

8.7.2. In 1994 2.4% of all housing tenures in Dundee were heated primarily by solid fuel/fuel oil. It was projected that by 2004 this figure would be significantly lower. Since the First Round assessment further progress has been made to the conversion of local authority and the local housing association stock to central heating. Of Dundee City Council owned housing stock (approximately 23% of the total housing tenure, some 17,000 dwellings) approximately 100 dwellings remain to be converted to central heating. In addition, records from the Eaga Partnership Limited, the administrator of funding for the Scottish Executive's Central Heating programme, indicate that 488 private dwellings have been converted to central heating in the DD postcode sector since September 2001.

8.7.3. A housing survey is currently in progress, which will identify the current extent of the use of solid fuel/heating oil. It is anticipated that the conclusion of the First Round will be supported, i.e., that the SO_2 contributions of domestic sources to air quality in 2004 would be negligible. It is not necessary to proceed to a detailed assessment for sulphur dioxide in relation to domestic coal burning.

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[9] Scottish Environmental Protection Agency – Email correspondence from the Air Quality Management Specialist in the Local Authority Liaison Unit dated 28th April 2003

Figure 8.1. SO_2 monitoring results from Dock Street continuous monitor downwind of Nynas AB UK (point source) showing 15-minute means for month of May 2002, with NAQS for comparison

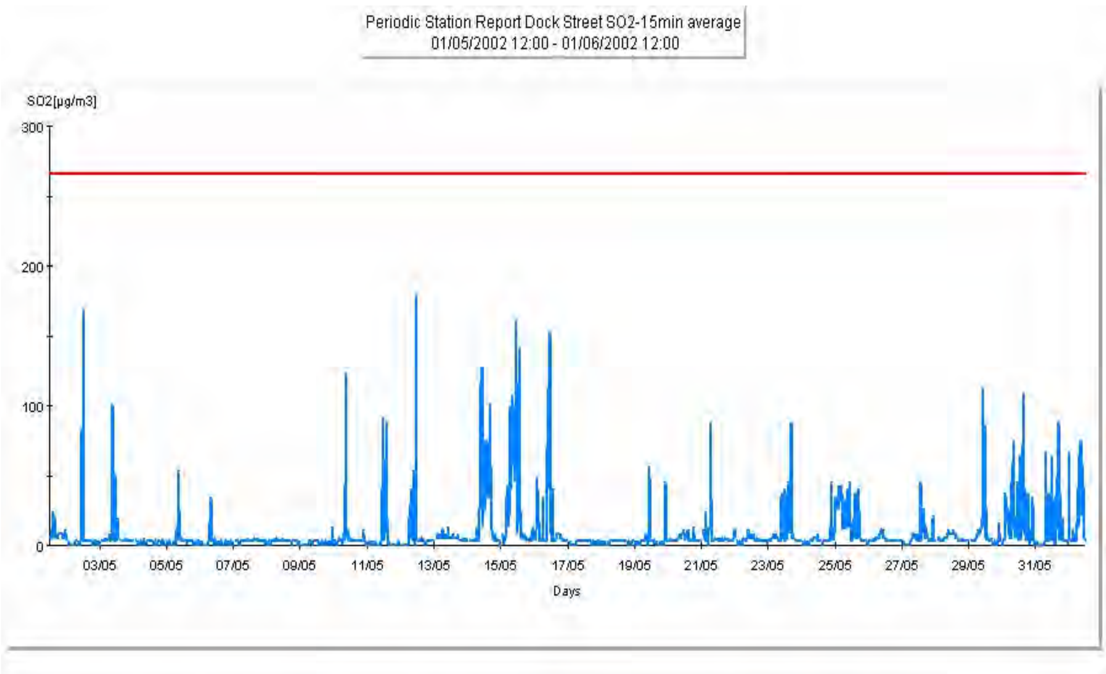


Figure 8.2. SO_2 monitoring results from Commercial Street continuous monitor, effective background monitor for SO_2, showing 15-minute means for month of May 2002, with NAQS for comparison

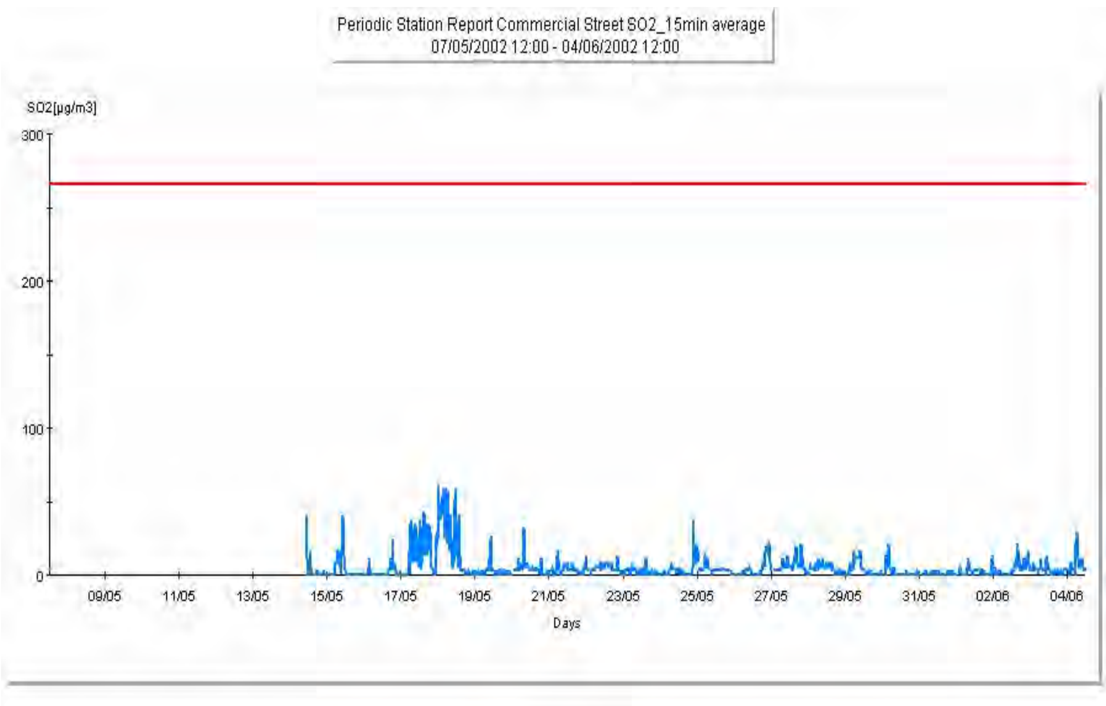
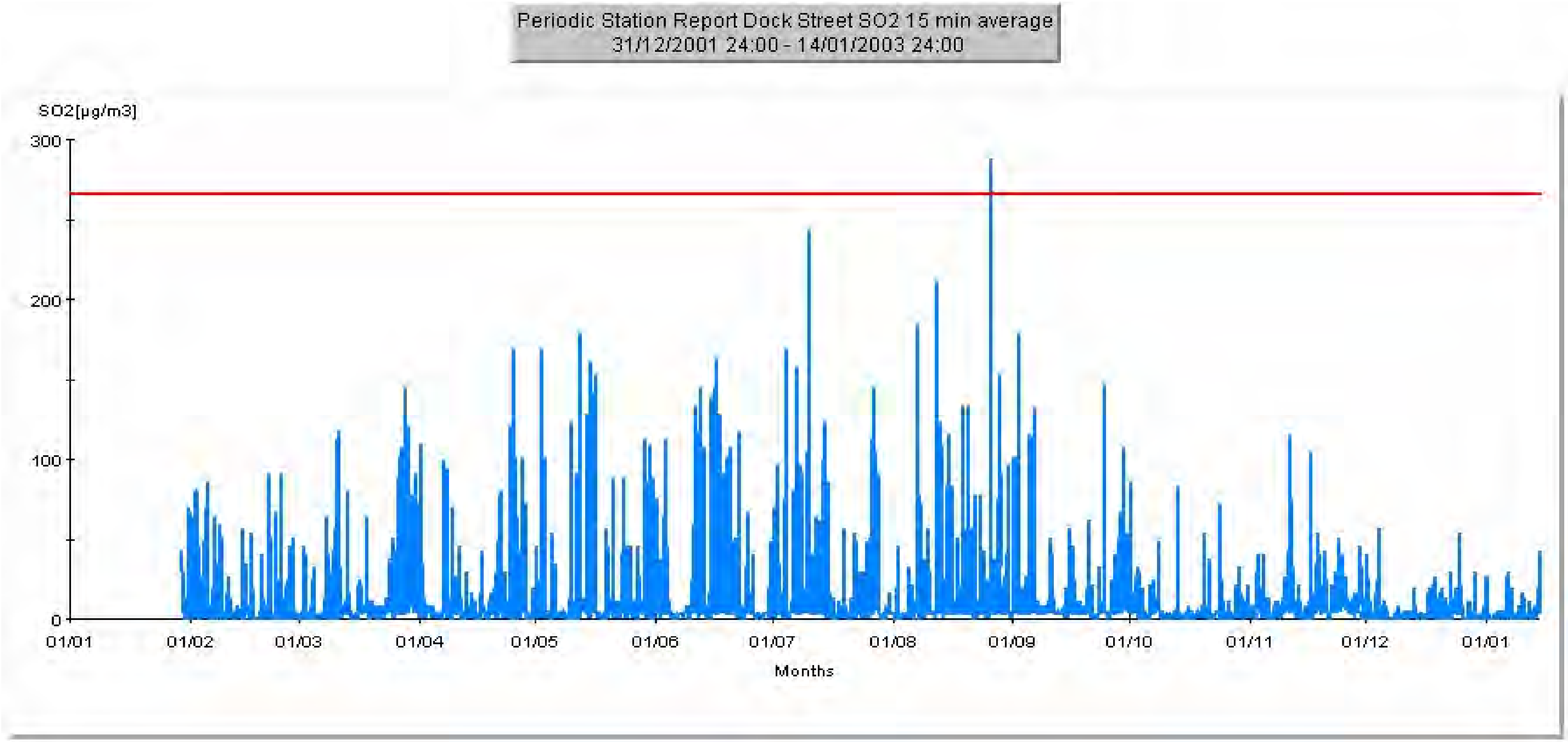


Figure 8.3. SO_2 monitoring results from Dock Street continuous monitor downwind of Nynas AB UK (point source) showing exceedance of the 15-minute mean NAQS on 26th August 2002



8.8. Small boilers (>5MW$_{(thermal)}$)

8.8.1. All small boilers >5MW$_{(thermal)}$ were identified during the First Round of assessment in Dundee. It was concluded that these boilers would not be significant sources of SO_2 in 2004.

8.8.2. The First Round assessment identified two small combustion plants, located at Kings Cross Hospital and J T Inglis, as potential sources of SO_2 that were due to convert from solid fuel to natural gas. Both these sites have now converted their plant to natural gas.

8.8.3 Therefore, it is believed that the conclusions of the First Round will be supported, it will not be necessary to proceed to a detailed assessment in respect of sulphur dioxide emissions from small boilers.

8.9. Shipping

8.9.1. Forth Ports (Dundee Port Management) indicate that there are approximately 2,500 shipping movements per year at Dundee Port. This is not close to the threshold of 5,000 movements requiring detailed assessment. Accordingly, a detailed assessment in respect of shipping movements will not be undertaken.

8.10. Railway Locomotives

8.10.1. The only site in Dundee where trains may be stationary for more than 15 minutes is Dundee Station. The station has an enclosed passenger waiting area. There are no receptors within 15 metres of Dundee main station. There are no sidings within the City where trains are routinely stationary for periods in excess of 15 minutes.

8.10.2. There is also a station at Broughty Ferry where there is potential exposure as there is no indoor waiting area at the station. There are proposals for an outdoor café on the southbound platform and the station is close to a shopping area. Four trains stop daily at this station, however, these trains are not stationary for periods in excess of 15 minutes, therefore, this is not considered significant.

8.11. Conclusions

8.11.1. Having applied the checklist criteria for the assessment of sulphur dioxide from the technical guidance, it is concluded that whilst it is not necessary to proceed to detailed assessment for the majority of the checklist criteria for sulphur dioxide, it is necessary to undertake further assessment in relation to the new housing in the proximity of Nynas AB UK for all SO_2 National Air Quality Standards.

9.0. PM_{10}

9.1. Introduction

9.1.1. The Government and Devolved Administrations have adopted two Air Quality Objectives for fine particles (PM_{10}), which are equivalent to the EU Stage 1 limit values in the first Air Quality Daughter Directive. The Objectives are 40μg/m^3 as the annual mean, and 50 μg/m^3 as the fixed 24-hour mean to be exceeded no more than 35 days per year, to be achieved by the end of 2004. The Objectives are based on measurements carried out using the European gravimetric transfer reference sampler or equivalent.

9.1.2. The EU has also set indicative limit values for PM_{10} which are to be achieved by 1 January 2010. These Stage 2 limit values are considerably more stringent, and are 20 μg/m^3 as the annual mean, and 50 μg/m^3 as the 24-hour mean to be exceeded no more than 7 days per year.

9.1.3. The Scottish Executive has incorporated new Objectives for 2010 into their Regulations, and authorities in Scotland will be required to review and assess air quality against them. These Objectives are a 24-hour mean of 50 μg/m^3 not to be exceeded more than 7 times per year, and an annual mean of 18 μg/m^3 to be achieved by the end of 2010.

Sources

9.1.4. There is a wide range of emission sources that contribute to PM_{10} concentrations in the UK. A report has confirmed that these sources can usefully be divided into 3 main categories. *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 wide 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.

9.1.5. A significant proportion of the current annual mean PM_{10} is derived from regional (including long distance transport from Europe) background sources. The exact regional background contribution at any site is variable, and will be greatly dependant upon the precise geographic location. Typical regional annual mean background contributions are currently within the range of about 14-21 μg/m^3 (gravimetric) and are outside of the control of local authorities.

Considerations for Local Authorities

9.1.6. The expected reduction in particle emissions in future years is different for each source type. For example, emissions from road transport will be governed by new legislation on vehicle emission standards; emissions of secondary particles will be largely governed by controls on power generation, industrial and transport SO_2 and NO_x emissions, both in the UK and Europe. Emissions of coarse particles are largely uncontrolled, and in general are not expected to decline in future years.

9.1.7. Particulate air pollution is associated with a range of effects on health including effects on the respiratory and cardiovascular systems, asthma and mortality. It has been concluded that particulate air pollution episodes are responsible for causing premature mortality among those with pre-existing lung and heart disease, and that there is a direct relationship between concentrations of PM_{10} and health effects, such that the higher the concentration of particles, the greater the effect on health.

9.1.8. There is emerging evidence that the health effects are due principally to ultra fine particles ($PM_{2.5}$). However, it is believed that the PM_{10} standards provide an appropriate level of protection for public health.

9.2. Conclusions of First Round (Air Quality (Scotland) Regulations 2000)

9.2.1. The PM_{10} contributions of domestic sources, quarries in neighbouring authorities, and two of the authorised processes were considered negligible. Information from SEPA suggested that there were no significant risks that emissions of PM_{10} from DERL, Michelin Tyres Plc and Nynas AB UK would exceed the Objectives. The impact of combined sources was not predicted to exceed the Objectives.

9.2.2. The DMRB screening model (Stanger version) predicted no exceedances of the PM_{10} objectives in 2004 for any of the roads identified as a significant source.

9.2.3. It was considered that because of the diverse characteristics and number of roads/junctions assessed, the model's predictions could be taken to represent the vast majority of Dundee's road network. Increases in traffic flows, as a result of known planned developments for 2004, were considered insufficient to substantially alter the model's predictions. Therefore, the PM_{10} emissions from the main road traffic network were not considered likely to exceed the Objectives at any relevant location.

9.2.4. Although the automatic monitoring results were insufficient to determine whether the annual objective had been exceeded, only three exceedances had been recorded over the 5-month monitoring period. The three exceedances were considered to be attributable to the transient effects of construction activities. Therefore, as the Objective allowed for 35 exceedances per annum, it was considered that the NAQS 24-hour mean for PM_{10} would be achieved.

9.2.5. It was therefore concluded that the National Air Quality Standards and Objectives for PM_{10} would be achieved with no further action required.

9.3. Comments from Statutory Consultees

9.3.1. Although it was accepted that the Nynas plant was operating within the terms of its process authorisation, the statutory consultees advised that this was insufficient to state that the plant was unlikely to cause an exceedance of the PM_{10} Objective. Depending on when it was issued, the authorisation may not have taken account of the PM_{10} Objective. The decision was accepted on the balance of probabilities, but Dundee City Council were advised to carry out further assessment, initially by using the nomogram approach in the Stage 1 guidance.

9.3.2. Note - the recommendation that screening using the nomograms provided in the technical guidance be used contradicts advice in the technical guidance[2]. There are 7 emission stacks from Nynas, housed within 2 flues (43 metres and 50 metres in height respectively) and the nearest building to the stacks is 18 metres high, at a distance of 53 metres. The guidance[2] states that where there are multiple stacks at the same site, a precautionary approach should be taken by assuming the total emissions (from all stacks) are released from the smallest stack. Where there are complex sites, with many stacks, the nomograms are unlikely to be applicable, and authorities are advised to proceed to detailed assessment.

9.4. Monitoring Data Review (Air Quality (Scotland) Amendment Regulations 2002)

9.4.1. The Amendment Regulations have introduced significantly more stringent Objectives for Scotland for the year 2010 in addition to the existing 2004 Objectives. The number of permissible exceedances of the 24-hour mean has been reduced from 35 to 7 per year. Furthermore, the annual mean has been reduced from 40 $\mu g/m^3$ to 18 $\mu g/m^3$. The reduction of the annual mean to 18 $\mu g/m^3$ creates a greater challenge for Scottish Local Authorities.

9.4.2. During the First Round limited monitoring data was available, namely periodic monitoring data from the Groundhog at the junction of Commercial Street and High Street, Dundee. From this it was not possible to calculate an annual mean for PM_{10}.

9.4.3. The monitoring data from the Groundhog for 2000 showed that there had been 3 exceedance over 5 months. Whilst this was not likely to point to a number of exceedances in excess of 35 per year permitted under the 2000 Regulations, there is a possibility that this may represent more than 7 exceedances per year as permitted under the Amended Regulations (2002).

9.5. Monitoring data outside an AQMA

9.5.1. Continuous monitoring has been installed at Union Street and Dock Street since the completion of the First Round. The annual mean for 2002 is shown in Figure 9.1. for Dock Street and Figure 9.2. for Union Street. Both units are equipped with TEOM Series 1400a Ambient Particulate Monitors, these are calibrated under software support using a single pre-weighed filter contained in the Mass Calibration Verification Kit. This verification is undertaken by the equipment suppliers on an annual basis as part of the maintenance contract. The results obtained from these units are multiplied by 1.3 to approximate gravimetric recordings in accordance with the guidance.

9.5.2. Union Street was selected as it represents a street with a high proportion of bus movements per day, there are possible street canyon effects and there is relevant exposure in that there are residential dwellings within the street, and it is a shopping area. Dock Street was selected as PM_{10} monitoring location as it is downwind of Dundee Port, Nynas AB UK and a cement batching process, it is also adjacent to a busy road (26,169 vpd (2000 count)) with residential exposure in this area.

9.5.3. The current annual mean is 21$\mu g/m^3$ for Dock Street and 23 $\mu g/m^3$ for Union Street. It is evident from this that at present the objective for 2010 of 18 $\mu g/m^3$ is not being achieved at either of the continuous monitoring sites. However, it is anticipated that the background concentration of PM_{10} in the UK will fall by 2010 due to measures outlined in section 9.1.above.

9.5.4. There are correction factors to be applied to the annual mean to predict the figure forward to both 2004 and 2010. However, these figures are based on assumed apportionment of the contribution of primary and secondary PM_{10} sources. These calculations are shown in Table 9.1. below, with the relevant NAQS for comparison. No attempts at source apportionment have been made to date within Dundee. Undertaking source apportionment is complicated in Dundee by the proximity to the coast as sea-salt may significantly affect the background concentration of PM_{10}.

Table 9.1. Annual mean PM_{10} measured results (gravimetric) for 2002 corrected forward to account for reducing primary and secondary source contributions in 2004 and 2010

Location of continuous monitor	Monitored concentration ($\mu g/m^3$) 2002	Predicted concentration ($\mu g/m^3$) 2004	NAQS for PM_{10} for 2004 ($\mu g/m^3$)	Predicted concentration ($\mu g/m^3$) 2010	NAQS for PM_{10} for 2010 ($\mu g/m^3$)
Dock Street	21	20.5	50	19.2	18
Union Street	23	22.4	50	20.9	18

9.5.5. There were 4 exceedances of the 24-hour mean of 50 $\mu g/m^3$ during 2002 at the Dock Street site. The details of these are shown in Table 9.2. below. This is within the permitted number of exceedances of the 24-hour mean per year (2010). The exceedances occurred between the 4th and 6th April and on the 13th September 2002. Due to a failure in the Union Street monitoring equipment in September 2002, it is not possible to compare the data from Dock Street and Union Street for this latter exceedance.

Figure 9.1. 24-hour means for PM_{10} for 2002 at Dock Street continuous monitor

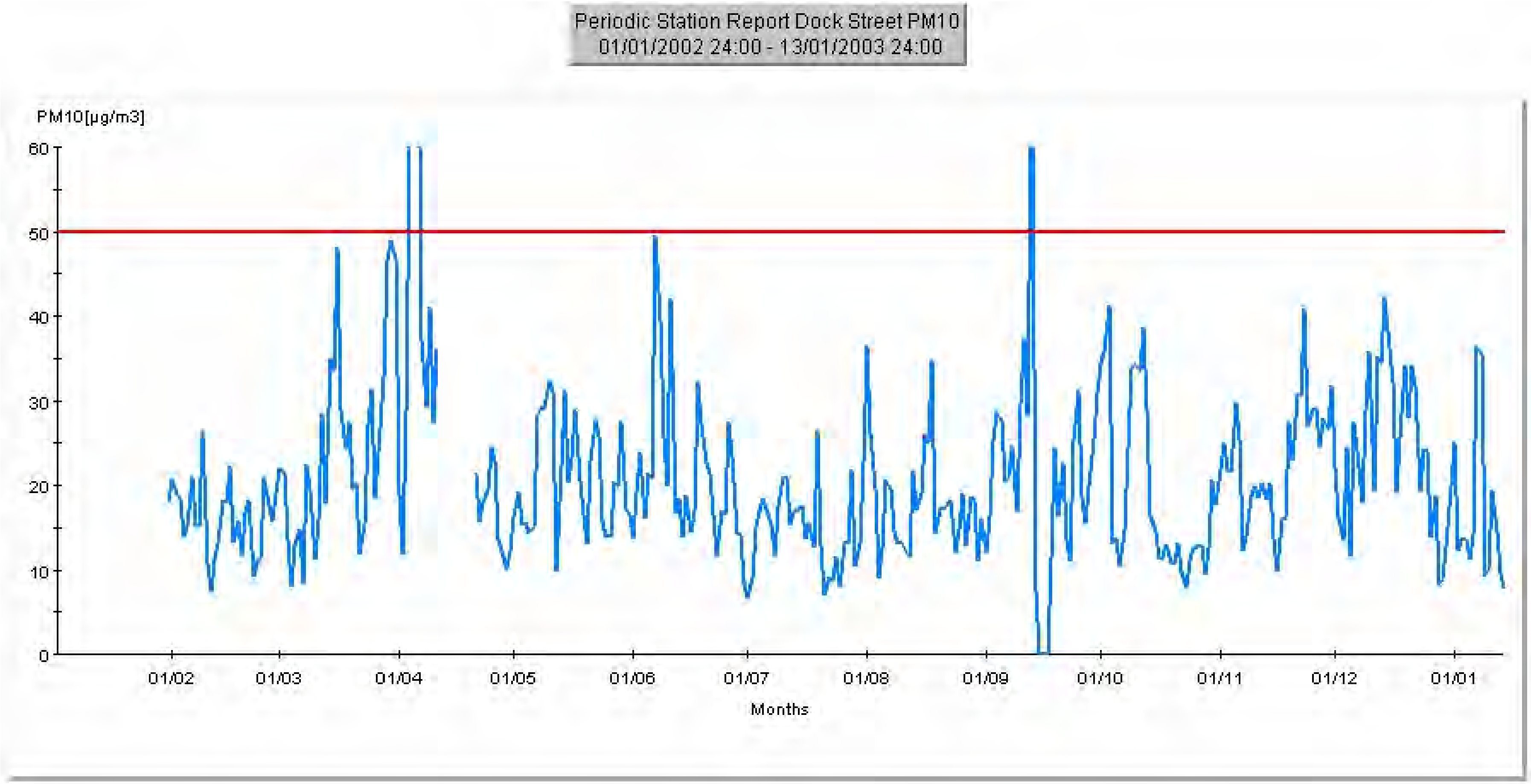


Figure 9.2. 24-hour means for PM_{10} for 2002 at Union Street continuous monitor

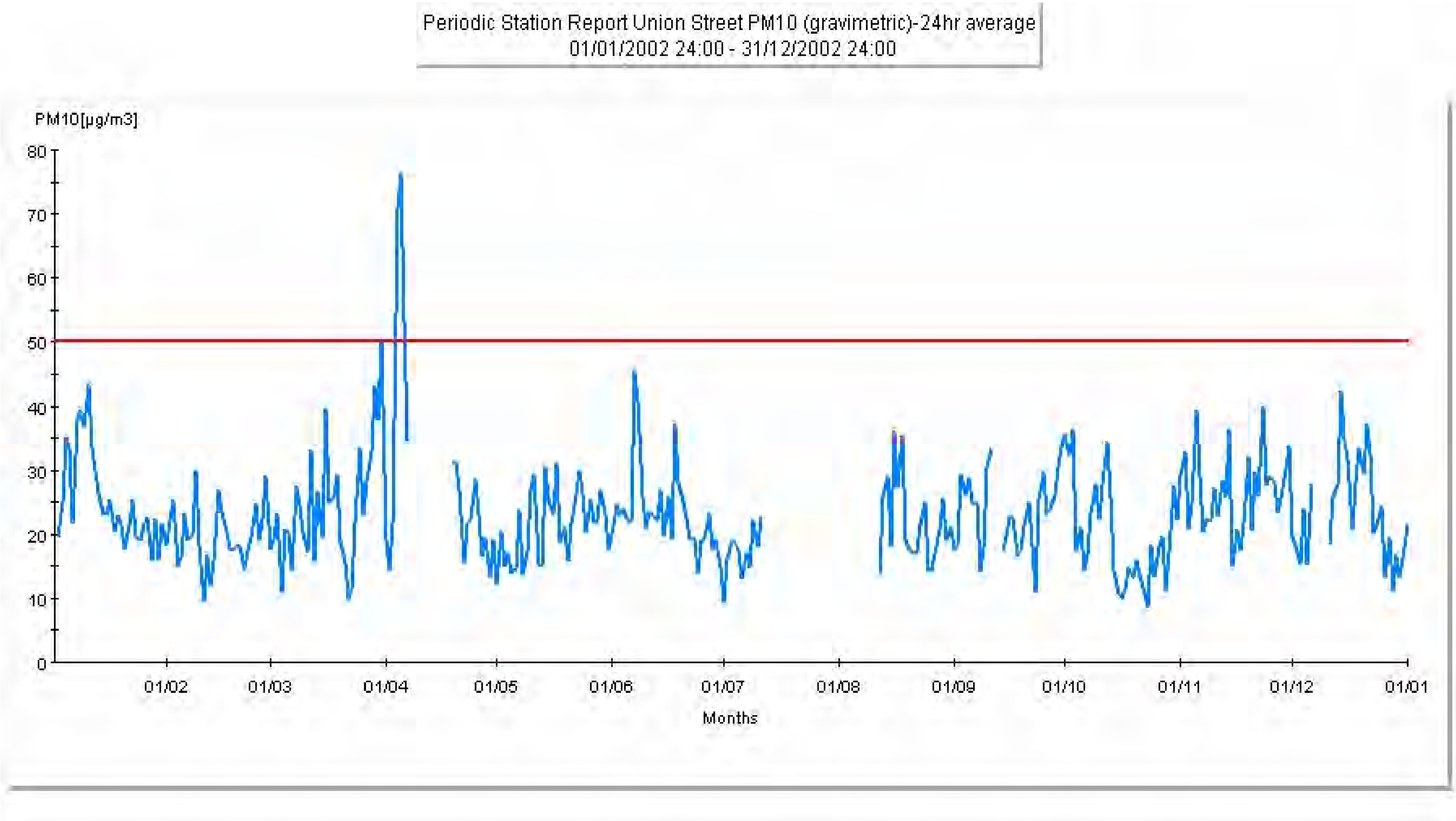


Table 9.2. Summary of exceedances of the 24-hour mean of 50 μg/m^3 during 2002 at Dock Street continuous monitoring unit

Date	PM10 μg/m^3	Wind direction degrees from N	Wind Speed m/s
04/04/02	72	307	3.6
05/04/02	83	294	1.5
06/04/02	67	317	3.7
13/09/02	69	132	1.5

9.5.6. It is interesting to note that during the exceedances of the 24-hour mean (where monitoring data is available for both sites, e.g. April 2002, February 2003) both sites register an exceedance. The sites are 1950 metres apart, which should be sufficiently distant to preclude a local source of PM_{10} from affecting both monitors.

9.5.7. A check of monitoring records for Edinburgh and Glasgow for the episode in April 2002 was also made to investigate the possibility that the exceedance of the PM_{10} 24-hour mean was not in fact a local emission, but was part of a national episode of elevated PM_{10} concentrations. An exceedance of the 24-hour mean was observed in Edinburgh and Glasgow from the 3rd to the 6th April 2002, the same period shown in Table 9.2. above. This would suggest that these exceedance of the PM_{10} National Air Quality Standard for 2010 may be caused by national rather than local issues.

9.5.8. The most recent exceedance of the PM_{10} 24-hour mean, which was evident at both sites, was in February 2003. Figure 9.3. shows the similarity in the exceedance at the two monitoring units in Dundee to demonstrate the linear relationship of the exceedances.

9.6. Busy roads and junctions in Scotland

9.6.1. The methodology recommended in the guidance[2] for modelling junctions using the DMRB (Stanger version) has been amended (version 1.01). Accordingly, the modelling results presented during the First Round required to be reviewed, as previously, traffic flows for all links had been averaged at the centre point of the junctions.

9.6.2. The estimated background PM_{10} concentrations taken from the on-line database[8] for 2010 indicate that there will be no areas within Dundee City where the background will be above 15 μg/m^3. Therefore, it is only necessary to undertake DMRB screening modelling for roads or junctions where traffic flow is greater than 10,000 vpd and where there is a relevant receptor within 10 metres of the kerb. Residential gardens are included as a relevant receptor for this screening model as the NAQS is for a 24-hour mean.

9.6.3. The junctions and roads have now been studied independently, including HDV proportion. The results of the review of junctions are shown below in Table 9.3. and Figures 9.4. and 9.5., and roads are shown in Table 9.4. and Figures 9.6. and 9.7.

[8] http://www.airquality.co.uk/archive/laqm/tools/php

Table 9.3. DMRB results for road junctions for 2004 and 2010 showing number of exceedances for each period and predicted exceedances of the annual mean 2010 (highlighted) where classified counts available

Junction	Name	Receptor grid ref		speed	mean %	PM_{10} annual	No. of	PM_{10} annual	No. of
		easting	northing	km/hr	HDV	mean 2004	exceedances	mean 2010	exceedances
1	Swallow Roundabout	No relevant receptor							
2	Riverside Av/Apollo Way	No relevant receptor							
3	Riverside Av/Main St (Inv)	No relevant receptor							
4	Riverside Av/Perth Rd 1	No relevant receptor							
6	Riverside Av/Perth Rd 2	336863	729856	30*	7	17.6	1	15.3	0
7	Ninewells Av/Ninewells Dr	No relevant receptor							
8	Charleston Dr/Spey Dr	No relevant receptor							
9	South Rd/Mallaig Av	< 10,000 vpd							
10	Perth Rd/ Ninewells Av	336082	730105	30	5	18.3	0	16.2	0
11	Charleston Dr/Dickson Av	336062	731221	30*	9	16.1	0	14.6	0
12	Kingsway/Coupar Angus Rd	No relevant receptors							
13	Macalpine Rd/Staffa Pl	338314	732940	30	9	20.4	4	17.1	1
14	Staffa Pl/Telford Rd	338044	732986	30*	12	16.5	1	14.9	0
15	Sinderins junction 1	338745	729835	30	6	15.7	0	18.0	1
	Sinderins junction 2	338725	729802	30	6	17.8	1	15.5	0
16	Charleston Dr/Etive Grdns	< 10,000 vpd							
17	Strathmartine Rd/Gillburn Rd	338971	733139	30*	5	17.0	1	15.2	0
18	Trottick Mains roundabout	340217	733691	30	9	17.6	1	15.4	0
19	Harefield Rd/Kings Cross Rd	338370	731865	30	9	20.0	3	16.8	1
20	Strathmartine Rd/Clepington Rd 1	339504	732203	30	9	20.5	4	17.3	1
	Strathmartine Rd/Clepington Rd 2	339524	732178	30	9	20.0	3	16.8	1
21	Loons Rd/Logie St 1	338172	731295	30	5	23.9	10	19.2	2
	Loons Rd/Logie St 2	338211	731297	30	5	23.9	10	19.2	2
22	Logie St/Ancrum Rd	338252	731205	30	7	20.1	4	17.9	1
23	Logie St/City Rd	Not relevant receptor							

Junction	Name	Receptor grid ref		speed km/hr	mean % HDV	PM_{10} annual mean 2004	No. of exceedances	PM_{10} annual mean 2010	No. of exceedances
24	City Rd/Tullideph	338425	730929	30	6	18.3	2	16.1	0
25	Lochee Rd/Dudhope Ter	338928	730678	30	7	23.5	9	18.7	2
26	Lochee Rd/Polepark Rd	339003	730589	30	7	21.1	5	17.4	1
27	Moncur Cres/Canning St	339951	731772	30*	4	16.7	1	15.1	0
28	Dens Rd/Mains Rd	340012	731729	30*	4	17.3	1	15.5	0
29	Strathmartine Rd/Hilltown 1	339986	731370	30	6	19.4	3	16.7	1
	Strathmartine Rd/Hilltown 2	339965	731383	30	6	19.3	3	16.6	1
30	Clepington Rd/Hindmarsh Av	340303	732141	30*	4	18.3	2	16.1	0
31	Victoria Rd/Dens Rd	340733	731005	30	15	26.2	16	20.2	4
32	Victoria Rd/Hilltown	340271	730721	30	9	22.5	7	18.2	2
33	Ladywell Roundabout	340134	730644	30	7	22.8	8	18.3	2
34	Lochee Rd roundabout	339809	730640	30	6	19.0	2	16.2	0
35	W. Marketgait/Ward Rd	339891	730385	30	8	21.7	6	17.7	1
36	Westport Roundabout	Not relevant receptor							
37	W. Marketgait/Nethergate	340075	729966	30	13	23.7	9	19.0	2
38	N. Marketgait/King St	340547	730750	30	29	22.5	7	18.3	2
39	Allen St Roundabout	340637	730631	30	8	22.1	7	18.2	2
40	E. Marketgait/E Dock St	340764	730383	48	8	19.2	3	16.3	0
41	Pitkerro Rd/Madeira St	341464	731804	30	4	21.8	0	17.0	1
42	Forfar Rd/Clepington Rd	341397	732125	30	10	21.9	6	18.0	1
43	Arbroath Rd/Dalkeith Rd	341805	731289	30*	4	18.3	2	16.0	0
44	Arbroath Rd/Kenilworth Av	341995	731359	30*	4	18.1	1	15.9	0
45	Ballumbie Rd/Berwick Dr	< 10,000 vpd							
46	Drumgeith Rd/Ballumbie Rd	344704	733307	30*	9	17.1	1	15.1	0
47	Kellas Rd/Drumsturdy Rd	345146	733330	48*	10	17.2	1	15.2	0
48	Balunie Av/Ballindean Rd	Not relevant receptor							
49	Balunie Dr/Ballindean Rd	< 10,000 vpd							
50	Balunie Dr/Balmoral Av	< 10,000 vpd							
51	Arbroath Rd/Fairfield Rd	344363	731822	30*	6	19.3	3	16.2	0

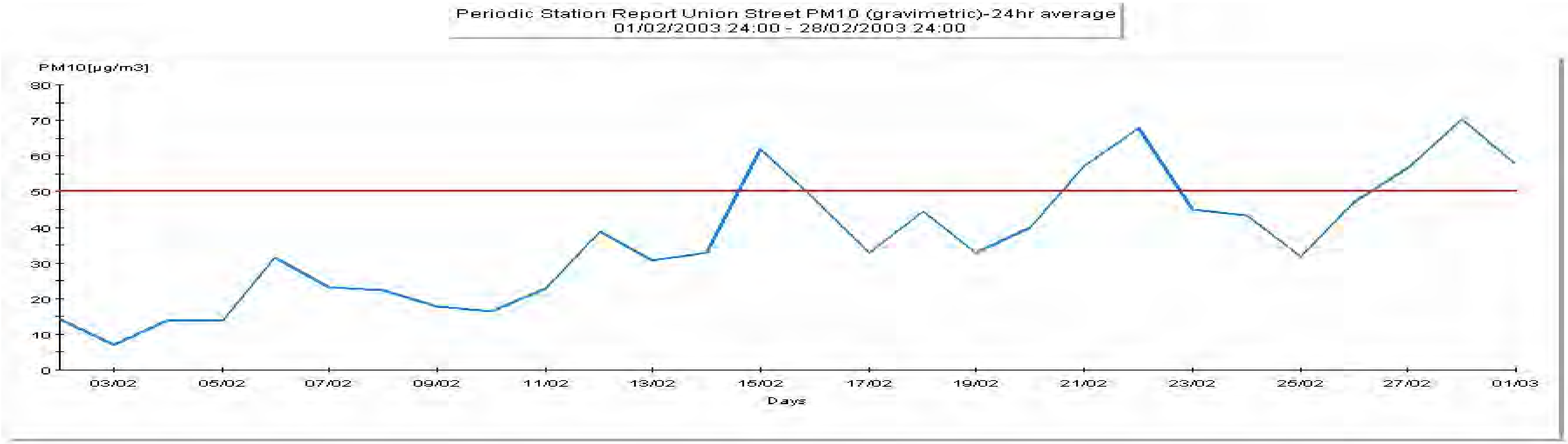
Junction	Name	Receptor grid ref		speed km/hr	mean % HDV	PM_{10} annual mean 2004	No. of exceedances	PM_{10} annual mean 2010	No. of exceedances
52	Strathern Rd/Fairfield Rd	No relevant receptor							
53	Forthill Rd/Fintry Pl	346208	731789	30	3	15.9	0	14.5	0
54	Forthill Rd/Queen St BF	346182	731058	30	5	18.9	2	16.2	0
55	Queen St/Claypotts Rd	345826	731137	30	6	20.9	5	17.4	1
56	Broughty Ferry Rd/Greendykes Rd	< 10,000 vpd							
57	Stannergate roundabout	343313	731068	30*	9	19.9	3	16.9	1

***denotes that the speed of one of the junction road links was taken to be the designated road speed limit instead of 30kph**

Table 9.4. Summary of DMRB results for PM_{10} for years 2004 and 2010 showing number of exceedances of respective years

Road Name	Receptor grid ref		speed km/hr	mean % HDV	PM_{10} annual mean 2004	No. of exeedances	PM_{10} annual mean 2010	No. of exceedances
	easting	northing						
Brownhill Rd	336248	732140	80	9.3	17.9	1	15.5	0
Riverside Pl	336174	730018	64	7.3	17.2	1	15	0
Palais Crt	339951	730088	40	3.3	16.8	1	15	0
Paradise Rd	340026	730649	48	2.1	17.2	1	15.3	0
Dock St	340658	730353	40	3.7	19	2	16.3	0
Princes St	341047	730934	48	5.6	16.7	1	14.9	0
Clive St	341207	732104	48	5.7	17	1	15.2	0
Hebrides Dr	341540	733478	64	10.4	18	1	15.6	0
Broughty Ferry Rd	342240	731054	64	4.2	17.3	1	15.2	0
Dundee Rd	344333	731077	64	2.3	16.4	0	14.7	0
Monifieth Rd	346963	731043	48	5.6	17.7	1	15.4	0
Broughty Ferry Rd	343493	731756	64	8.8	17	1	15	0
Harefield Road	338111	731851	48	6.4	17.5	1	15.5	0
Strathmartine Road	339231	732814	48	0.0	15.9	0	14.7	0

Figure 9.3. Comparison of exceedances in February 2003, showing similarity in trend between Union Street and Dock Street continuous monitors



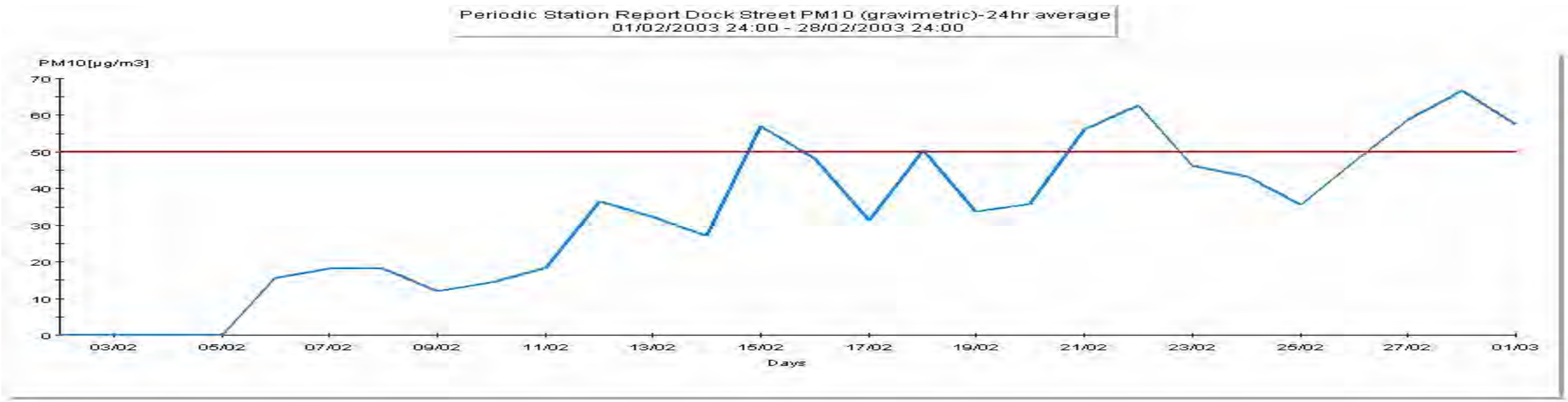


Figure 9.4. DMRB predictions for PM_{10} concentrations at relevant receptors for road junctions in 2004

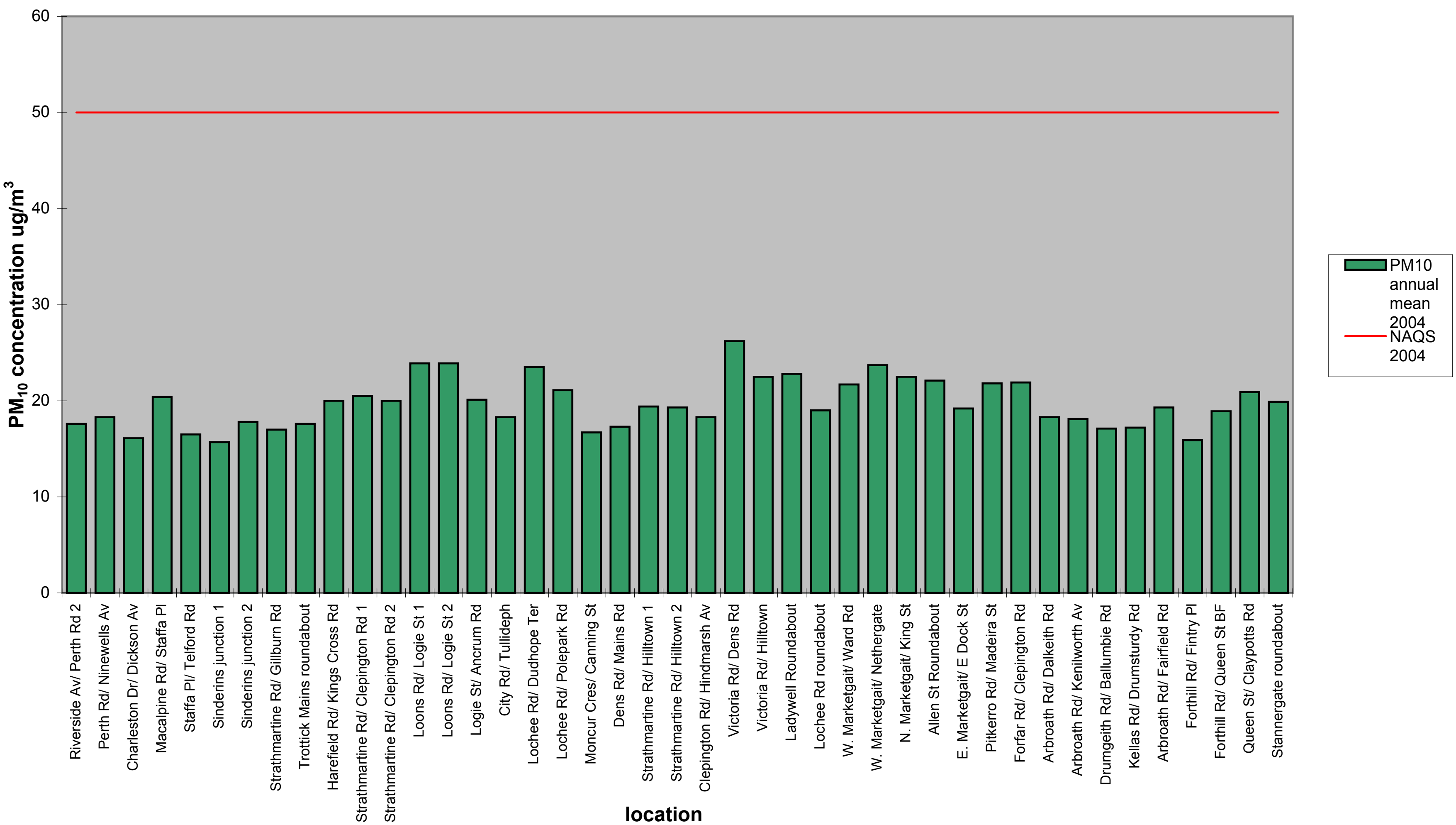


Figure 9.5. DMRB predictions of PM_{10} concentrations at relevant receptors for road junctions in 2010

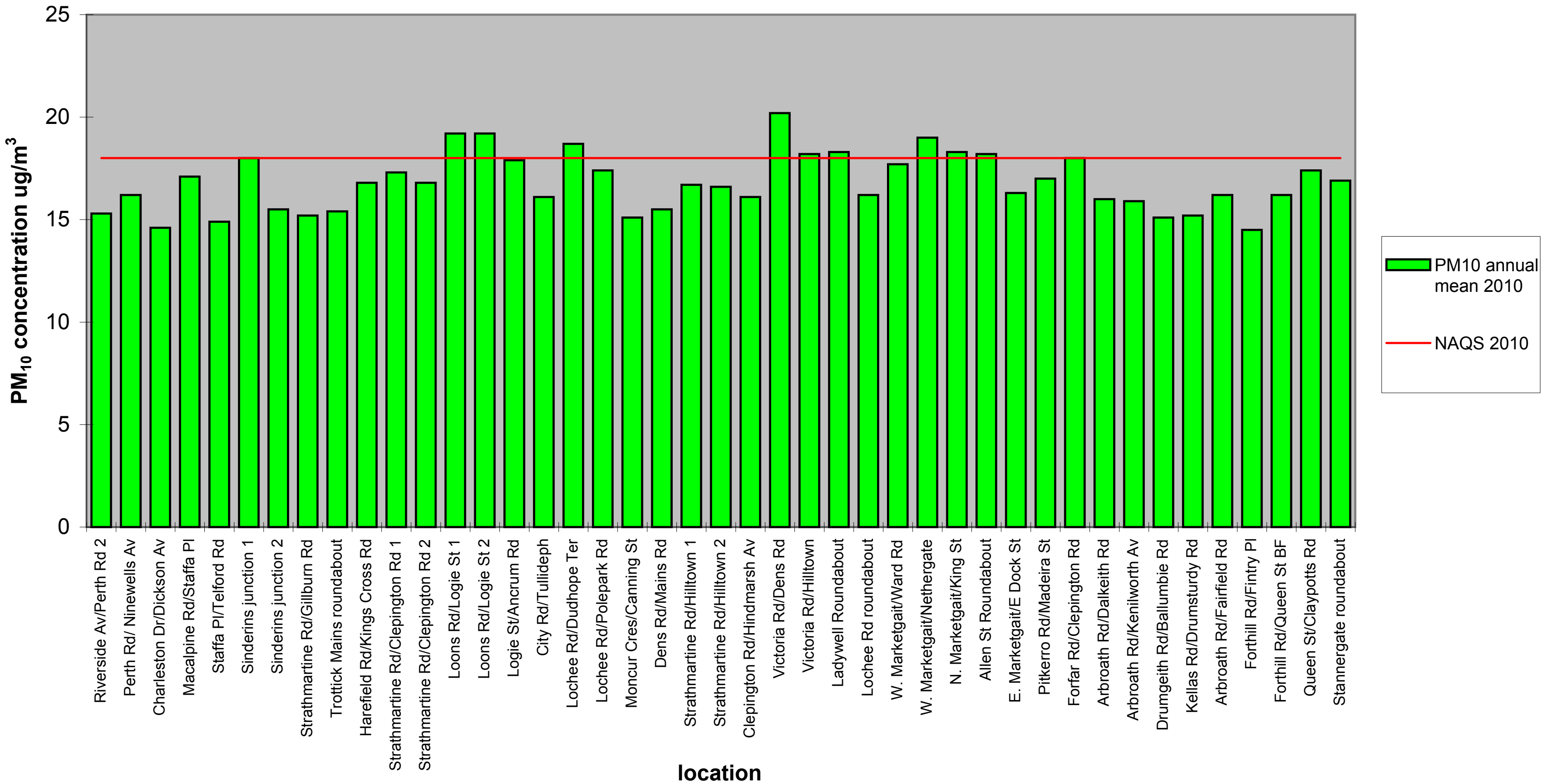


Figure 9.6. DMRB predictions of PM_{10} at relevant receptors at roadside in 2004

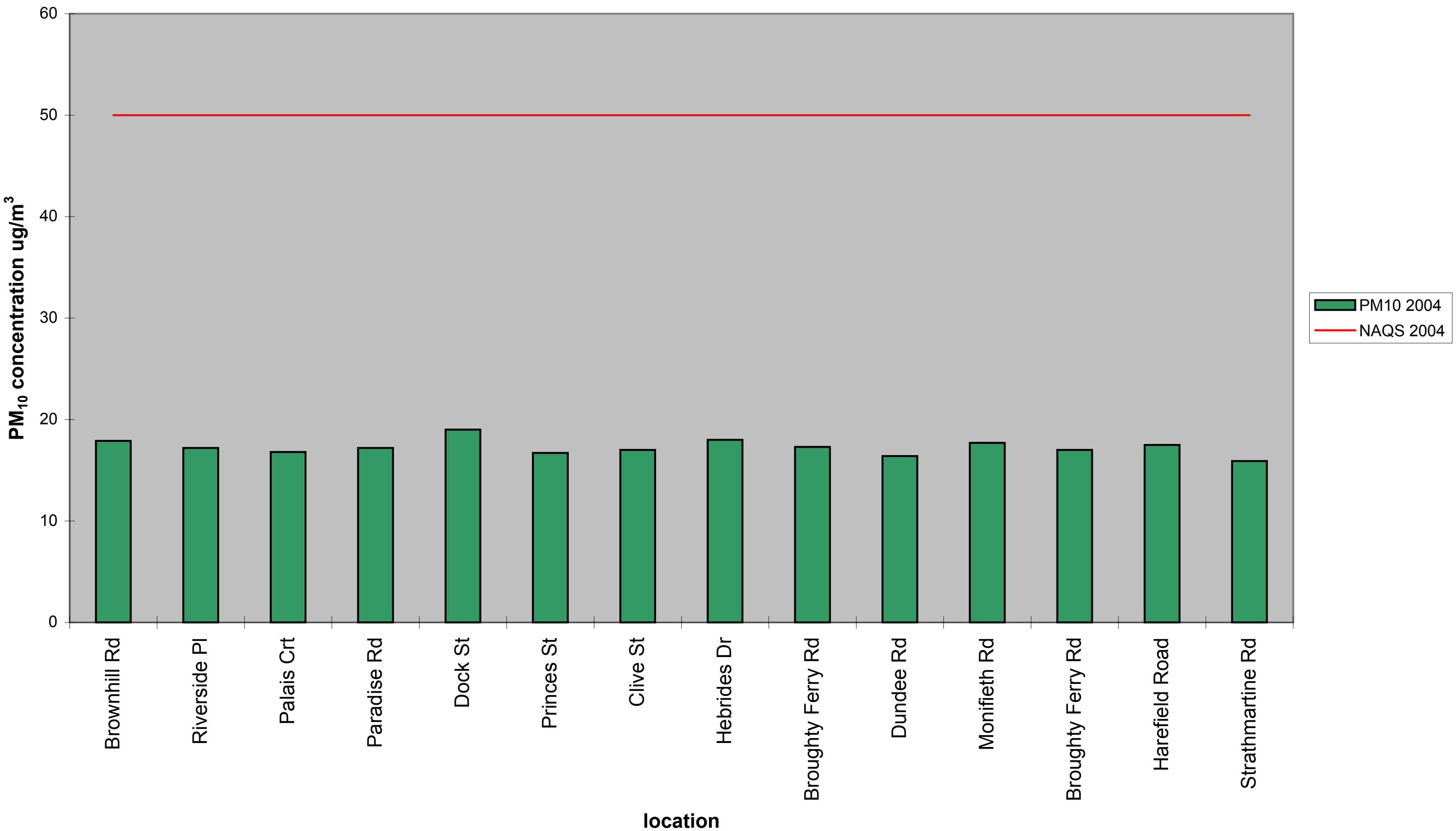
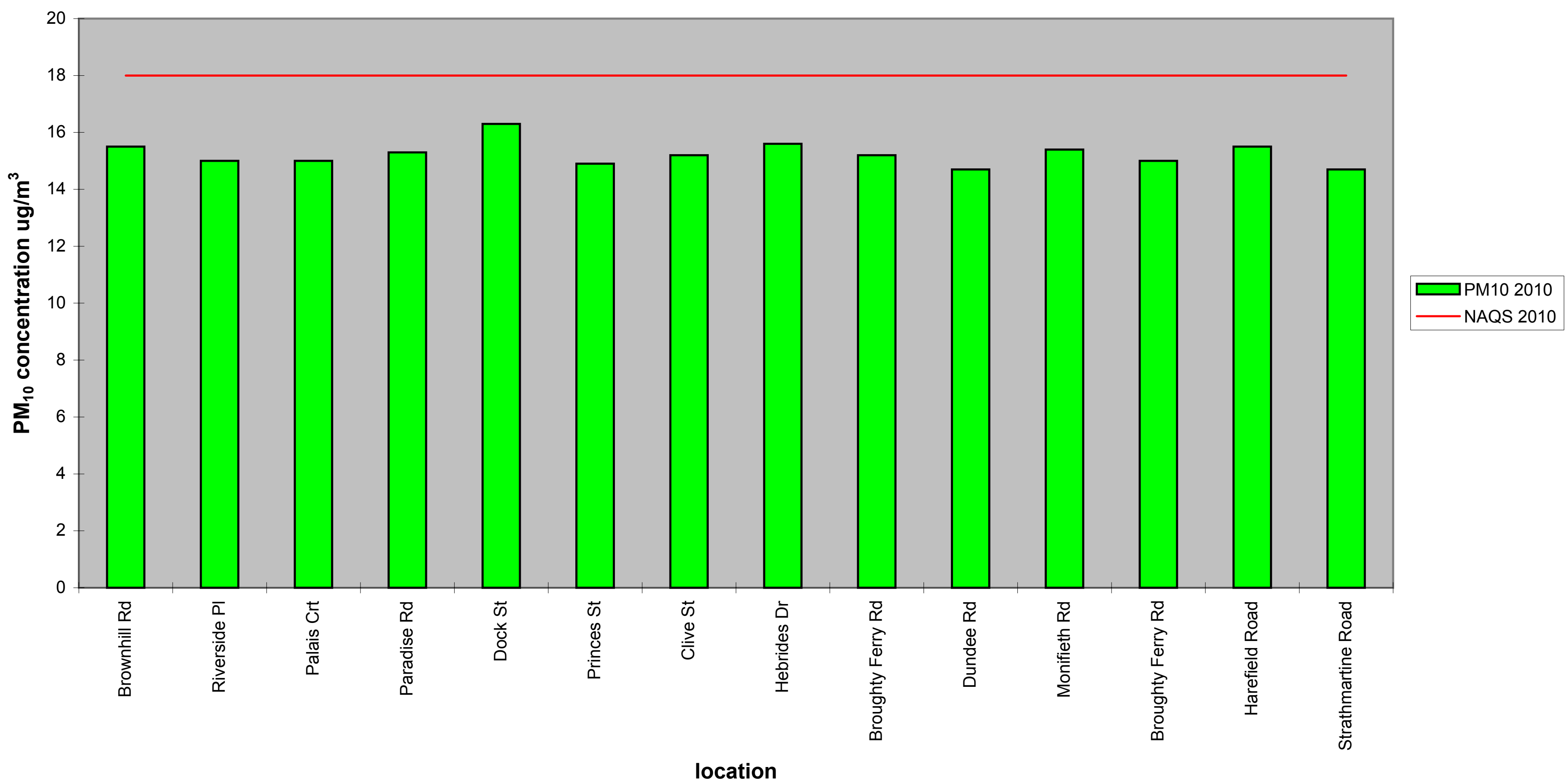


Figure 9.7. DMRB predictions of PM_{10} concentrations at relevant receptors at roadside in 2010



9.6.4. The DMRB modelling predicted no exceedances of the NAQS for 2004 or 2010 at roads for PM_{10}. Similarly, there were no exceedances predicted at junctions for 2004, however, modelling to 2010 showed that there were a number of junctions exceeding the annual mean Standard, namely:

- Sinderins;
- Loons Road/Logie Street;
- Lochee Road/Dudhope Terrace;
- Victoria Road/Dens Road;
- Victoria Road/Hilltown;
- Ladywell roundabout;
- West Marketgait/Nethergate;
- North Marketgait/King Street;
- Allen Street roundabout; and
- Forfar Road/Clepington Road.

9.6.5. It is necessary to proceed to a detailed assessment in respect of junctions for PM_{10} in relation to the 2010 annual mean NAQS.

9.7. Roads with high flow of buses and/or HGVs

9.7.1. In relation to PM_{10} a road is considered to have a high flow of HDV where these vehicles form more than 20% of the total flow and where there are more than 2,000 HDV movements per day [2]. This change in the guidance reflects the identification of HDVs as particularly significant PM_{10} sources. These roads were not required to be reviewed during the First Round. Further information on classified vehicle counts is required to undertake a full assessment of roads with a significant proportion of HDVs.

9.7.2. There are only two areas of the City which are currently designated solely for buses (with other vehicles permitted for access only), namely: the west end of King Street, Dundee and the west end of Dock Street.

9.7.3. There are proposed traffic management changes around Whitehall Street and Albert Street which will increase the proportion of buses in these streets, both are likely to fall into the category of greater than 20% HDV after the traffic management alterations are implemented.

9.7.4. There are a number of roads where it is known that a proportion of vehicles will be HDVs, however, it is not clear whether the proportion will be greater than 20%. These areas include:

- Baird Avenue, access to the Tesco Distribution Centre
- Claymore Street, access to DERL
- Foundry Lane, buses leaving the depot
- Stannergate, access to the port area

Classified counts will be required for those streets where there is relevant exposure within 10 metres of the kerb.

9.7.5. There is relevant exposure within 10 metres of the kerb in King Street . There is also relevant exposure in Albert Street and Whitehall Street, though it is not known at this time whether the vehicle flow is greater than 20% HDV, nor whether there are more than 2,000 HDV per day. Further information on classified vehicle counts is required to enable the DMRB screening model to be applied.

9.8. New roads constructed or proposed since First Round of review and assessment

9.8.1. A new road has been constructed joining Princes Street and Blackscroft. The road is approximately 150 metres in length. There is no relevant exposure along the length of this new road.

9.8.2. There are a number of proposed developments (see sections 2.2.3 and 2.2.4.) within Dundee that will require the construction of new roads. It is anticipated that Environmental Impact Assessments will be submitted in support of these proposals prior to the commencement of works. Therefore, it is not considered necessary to proceed to detailed assessment in respect of new roads constructed or proposed since the First Round.

9.9. Roads close to the Objective (2004) during the First Round of review and assessment

9.9.1. In the First Round assessment the results of the DMRB screening model (Stanger version) were expressed as 90th percentile PM_{10} $\mu g/m^3$ (2004). There is a requirement to identify all roads where the predicted concentrations for the 90^{th} percentile fell between 45 - 50 $\mu g/m^3$. None of the results fell within this concentration, therefore, no roads are considered close to the Objective in respect of this criterion.

9.10. Roads with significantly changed traffic flows

9.10.1. There are no roads, which have undergone an increase in traffic flow of greater than 25% since the First Round. However, there are proposed traffic management alterations which will have a significant impact on the flow of several roads in the future, namely changes to the Whitehall Street and Albert Street areas. This matter will be kept under review but Dundee City Council will not proceed to detailed assessment in respect of roads with significantly changed traffic flows at this time.

9.11. New industrial sources

9.11.1. The processes identified during the First Round as being potentially significant sources of PM_{10} are listed in Table 9.5. below. It was established during the First Round that the foundry, Dens Metals, was not considered to be a significant source of PM_{10}. Dens Metals have recently commissioned testing of the newly operational plant at West Pitkerro Industrial Estate, this included monitoring of particulate matter (all particulate matter will be assumed to be PM_{10}). The average PM_{10} emissions are 11g/hr, which corresponds to annual emission of 0.09 T/yr. The effective stack height is 17 metres, the stack diameter 0.71 metres. This level of emission is not significant enough to be shown on the nomograms in the technical guidance[2], therefore it is concluded that the PM_{10} emissions from Dens Metals will not be significant.

Table 9.5. Potentially significant industrial sources of PM_{10} in or bordering Dundee City

Company Name	Location	Process
Michelin Tyres Plc	Baldovie Road, Dundee	Boilers and furnaces
Nynas AB UK	East Camperdown Street, Dundee	Crude oil handling
DERL	Claymore Street, Dundee	Incineration
British Fuels Limited	Piper Street, Dundee	Coal minerals stockyard

9.11.2. There are no new industrial sources falling into the categories listed in Annex 2 of the guidance[2], Dundee City Council will not proceed to detailed assessment for PM_{10} in respect of any new industrial sources.

9.12. Industrial sources with substantially increased emissions

9.12.1. Information received from SEPA[5] during the First Round indicated that the authorised processes in Dundee would not be likely to cause an exceedance of the national air quality standards at any relevant receptor.

9.12.2. The only industrial sources with increased PM_{10} emissions of greater than 30% since the First Round assessment was undertaken, is DERL. At the time of the completion of the First Round assessment, DERL was not operating at full capacity. The throughput of the process has increased by more than 30%, therefore, it is anticipated that the emissions will have increased by over 30%. Information from SEPA indicates that up to date figures for PM_{10} emissions are not available from DERL[9]. However, results obtained for 2000 indicate that the mass emissions from the process were 0.8 g/minute. The effective stack height for the process is 70 metres and the stack diameter is 1.15 metres for each stack. This corresponds to an annual mass emission of 0.425 tonnes/annum. SEPA have not been able to provide data for a calendar year of full operation at this time. The plant became fully operational in April 2000 operating until October 2000 when it was closed due to technical failure. Assuming that this figure of 0.425 tonnes/annum represents five months of operation, a conservative estimate, the emissions for a full year could be taken to be 1.06 tonnes/annum (0.425 x 2.5).

9.12.3. Using the nomograms in the guidance[2] a detailed assessment is required only where emissions are greater than 30 tonnes/annum. Accordingly, it is not necessary to proceed to a detailed assessment in respect of DERL based on the information currently available.

9.13. Areas with domestic solid fuel burning

9.13.1. In 1994 2.4% of all housing tenures in Dundee were heated primarily by solid fuel/fuel oil. The previous guidance[3] recommended that it should be assumed that 10% of solid fuel burnt within smoke control areas is unauthorised fuel, i.e. likely to emit $PM_{10.}$ As smoke control areas have been declared across the majority of Dundee City area, it will therefore be assumed that 0.24% (2.4% divided by 10) households were likely to emit PM_{10}. It was projected that by 2004 the figure for unauthorised fuel burning, anticipating an increase in dwellings with central heating, would be 0.13% of households.

9.13.2. By 2004, it was predicted that the number of dwellings heated primarily by solid fuel/fuel oil would be significantly lower. Since the First Round assessment further progress has been made to the conversion of local authority and the local housing association stock to central heating. Of Dundee City Council owned housing stock (approximately 23% of the total housing tenure, some 17,000 dwellings) approximately 100 dwellings remain to be converted to central heating. In addition, records from the Eaga Partnership Limited, the administrator of funding for the Scottish Executive's Central Heating programme, indicate that 488 private dwellings have been converted to central heating in the DD postcode sector since September 2001.

9.13.3. A housing survey is currently in progress, which will identify the current extent of the use of solid fuel/heating oil. It is anticipated that the conclusion of the First Round, that the PM_{10} contributions of domestic sources to air quality in 2004 would be negligible, will be supported. It is not necessary to proceed to a detailed assessment for PM_{10} in relation to domestic coal burning

9.14. Quarries, landfill sites, opencast coal, handling of dusty cargoes at ports, etc

9.14.1. There are no quarries, active landfill sites or opencast coal mines within Dundee City. However, Ethiebeaton Quarry lies within Angus Council, on the eastern boundary of Dundee. The background PM_{10} concentration for this area is predicted to be 14.3 $\mu g/m^3$ (2004) and

[5] Scottish Environmental Protection Agency - Additional Information for Stage 2 Air Quality Review and Assessment

[9] Scottish Environmental Protection Agency – Email correspondence from the Air Quality Management Specialist in the Local Authority Liaison Unit dated 28th April 2003

13.5 (2010)[8]. At this background concentration, the guidance stipulates that receptors within 200 metres must be considered. There are no receptors within 200 metres of this quarry at this time. Land to the west of Ethiebeaton Quarry has been granted planning permission for housing development, this will be kept under review.

9.14.2. British Fuels Limited coal handling remains below the threshold for activities requiring authorisation under the Environmental Protection Act 1990. It is not believed this is a significant source of PM_{10} emissions.

9.14.3. There is a grain handling process at the port in Dundee. This activity is not regulated by SEPA, it is seasonal occurring predominantly in late summer/autumn. There have been a number of complaints to the Council regarding dust from this process, typically during periods of relatively low wind speed. However, the process is located downwind of the Dock Street continuous monitoring unit, and no exceedances of the 24-hour mean have been recorded at this location at times corresponding to grain handling activity.

9.14.4. It is not believed that these sources of PM_{10} are significant in Dundee, therefore, Dundee City Council will not proceed to a detailed assessment in relation to other sources.

9.15. Aircraft

9.15.1. Dundee airport has approximately 50,000 passengers per year and no freight. The requirement is to consider airports with more than 5 million passengers (or freight equivalent) per year, therefore, the airport is not considered to be a significant source of PM_{10}. It is not necessary to proceed to a detailed assessment for PM_{10} in respect of the airport.

9.16. Conclusions

9.16.1. It will be challenging for Scottish Local Authorities to achieve the lowered 2010 NAQS.

9.16.2. Having applied the checklist criteria for the assessment of PM_{10} from the technical guidance, it is concluded that further action is required in respect of PM_{10}.

9.16.3. In 2002 continuous monitoring at Union Street and Dock Street indicated that the number of exceedances of the 24-hour mean for PM_{10} was not exceeded for 2004 (35 exceedances) or 2010 (7 exceedances). The exceedances of the 24-hour mean that were identified were for the same monitoring period as exceedances identified in Glasgow and Edinburgh. This would suggest that there are national issues relating to PM_{10} which are beyond the control of Local Authorities.

9.16.4. The annual mean results for the continuous monitors showed that the annual mean of 40 $\mu g/m^3$ (2004) would be achieved. However, the annual mean of 18 $\mu g/m^3$ (2010) PM_{10} is currently being exceeded at both units.

9.16.5. There are a number of junctions which are showing predicted exceedances of the 2010 annual mean, there are no predicted exceedances of the 24-hour mean at junctions or roads within Dundee.

9.16.6. Accordingly, Dundee City Council will proceed to a detailed assessment in relation to PM_{10}.

10.0. Conclusions

10.1.1. It is not anticipated that any action will be required in order to achieve the NAQS for carbon monoxide, benzene, 1,3-butadiene and lead.

10.1.2. The guidance on nitrogen dioxide has changed, now including specific reference to street canyons and streets where there is a significant proportion of heavy duty vehicle (HDV) traffic. These streets were not considered in detail in the First Round assessment and require further assessment. It is anticipated that without action on air quality management, the nitrogen dioxide annual mean air quality standard will not be achieved in certain areas of the City. This will include areas of the city centre and arterial routes. As more street canyons are studied, the number of areas identified where the annual mean for NO_2 is not expected to be achieved may increase. It is necessary to proceed to a detailed assessment in respect of nitrogen dioxide in relation to narrow congested streets and junctions. Further assessment is also needed for roads with a significant proportion of HDV. It is not clear whether there will be any exceedances of the 1-hour mean for nitrogen dioxide. In order to determine this three new real-time, continuous monitoring units have been commissioned at Whitehall Street, Seagate and Lochee Road.

10.1.3. A single exceedance of the SO_2 15-minute mean was observed in 2002, thirty-five exceedances of this standard are permitted each year. This would indicate that the NAQS for SO_2 will be achieved. However, a further assessment of SO_2 from Nynas AB UK will be undertaken as new residential development on the waterfront has commenced since the completion of the First Round assessment of air quality, creating new potential receptor locations.

10.1.4. The NAQS for PM_{10} was modified by the Air Quality (Scotland) Amendment Regulation 2002. The revised NAQS reduces the permissible annual mean for PM_{10} from the previous standard of 40 $\mu g/m^3$ (2004) to 18 $\mu g/m^3$ (2010). This represents a significant decrease in the permitted PM_{10} annual mean; the annual means for 2002 were 21 $\mu g/m^3$ (Dock Street) and 23 $\mu g/m^3$ (Union Street). The guidance states that the anticipated background concentration of PM_{10} will fall by 2010. There is evidence that the fluctuations of PM_{10} concentration recorded in Dundee are not caused by local emissions, but follow national episodes of increased PM_{10} concentrations. No source apportionment has been undertaken for PM_{10} emissions to date. At this time, it is necessary to proceed to a detailed assessment in respect to PM_{10} for a number of roads and junctions and in order to address the exceedance of the annual mean at both monitoring locations.

10.0. Glossary

AADT	Annual Average Daily Traffic Flow
AAVF	Annual Average Vehicle Flow (Vehicles/hour)
AQMA	Air Quality Management Area
BATNEEC	Best Available Technology Not Entailing Excessive Cost
BTEX	Benzene, Toluene, Xylene (Diffusion Tubes)
CHP	Combined Heat and Power
CO	Carbon Monoxide
DERL	Dundee Energy Recycling Ltd
DETR	Department of Environment, Transport and Regions
DMRB	Design Manual for Roads and Bridges
Eaga	Energy action grants administration
EC	European Community
ECPD	Environmental and Consumer Protection Department
EPA	The Environmental Protection Act 1990
EPAQS	Expert Panel on Air Quality Standards
GF	Ground floor
HECA	Home Energy Conservation Act (1995)
HDV	Heavy goods vehicles and buses
HGV	Heavy Goods Vehicle
IPC	Integrated Pollution Control
MW	Mega Watts
mg/kg	Milligrams per Kilogram
mg/m^3	Milligrams per cubic metre
NAQS	National Air Quality Standard
NETCEN	National Environmental Technology Centre
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
ng/m^3	Nanograms per cubic metre
P&T	Planning and Transportation
PM_{10}	Particulate Matter less than 10 μm aerodynamic diameter
Pb	Lead
percentile	The percentage of results below a given value
ppb	Parts per billion
ppm	Parts per million
SCA	Smoke Control Area
SEPA	Scottish Environment Protection Agency
SO_2	Sulphur Dioxide
TEOM	Tapered Element Oscillating Microbalance
UKAS	United Kingdom Accreditation Service
$\mu g/m^3$	Micrograms per cubic metre
VOC	Volatile Organic Compound
vpd	vehicles per day
WASP	Workplace Analysis Scheme for Proficiency

11.0. References

1 Planning and Transportation Department 2002 *Demographics, statistics and general reference material* Dundee City Council

2 Department for Environment Food and Rural Affairs and Scottish Executive 2003 *Part IV of the Environment Act 1995 Local Air Quality Management Technical Guidance LAQM.TG(03)* DEFRA Publications

3 Part IV The Environment Act 1995 Local Air Quality Management - Review and Assessment Pollutant Specific Guidance LAQM.TG4(00) May 2000 DETR and Scottish Executive

4 Scottish Environmental Protection Agency Consultation Response to Dundee City Council's First Stage Review and Assessment of Air Quality

5 Scottish Environmental Protection Agency - Additional Information for Stage 2 Air Quality Review and Assessment

6 Scottish Executive, 15 March 2001 Air Quality Strategy: Dundee City Council - Second Stage Review and Assessment - including comments from UWE and SEPA

7 Dr O Harrop, Cordah Environmental Management Consultant (February 2000) *Nynas UK AB - Air Quality Assessment Report*

8 http://www.airquality.co.uk.co.uk/archive/laqm/tools/php

9 Scottish Environmental Protection Agency – Email correspondence from the Air Quality Management Specialist in the Local Authority Liaison Unit dated 28th April 2003

10 Dundee Local Plan Review - January 2003, Dundee City Council Planning and Transportation

11 Dundee City Council 2000 *Air Quality Review and Assessment Stage 2* Dundee City Council

12 Dundee City Council 1998 *Air Quality Review and Assessment Stage 1* Dundee City Council

13 Design Manual for Roads and Bridges screening method version 1.01 (February 2003) Highways Agency

14 Design Manual for Roads and Bridges - Stanger Version - Web site: http://www.stanger.co.uk

15 Department of the Environment, Transport and the Regions and Scottish Executive 2000 *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland - Working Together for Clean Air* DETR Publications

16 ISO 9855:1993(E) *Ambient air - Determination of the particulate lead content of aerosols collected in filters. Atomic absorption spectroscopy method.* International Standards Organisation

Processes Authorised under Part I of the Environmental Protection Act 1990 in Dundee APPENDIX 1

Part A processes

REF NO.	LOCATION OF PROCESS	DESCRIPTION OF PROCESS
IPC/E/20018	Dundee Energy Centre Ltd, Forties Road, Baldovie Industrial Estate, Dundee	Incineration
IPC/E/20012	J T Inglis, Riverside Works, Dundee	Textile Treatment
IPC/063/1993	Nynas, East Camperdown Street, Dundee	Petroleum
IPC/050/1993	Michelin, Baldovie Road, Dundee	Combustion

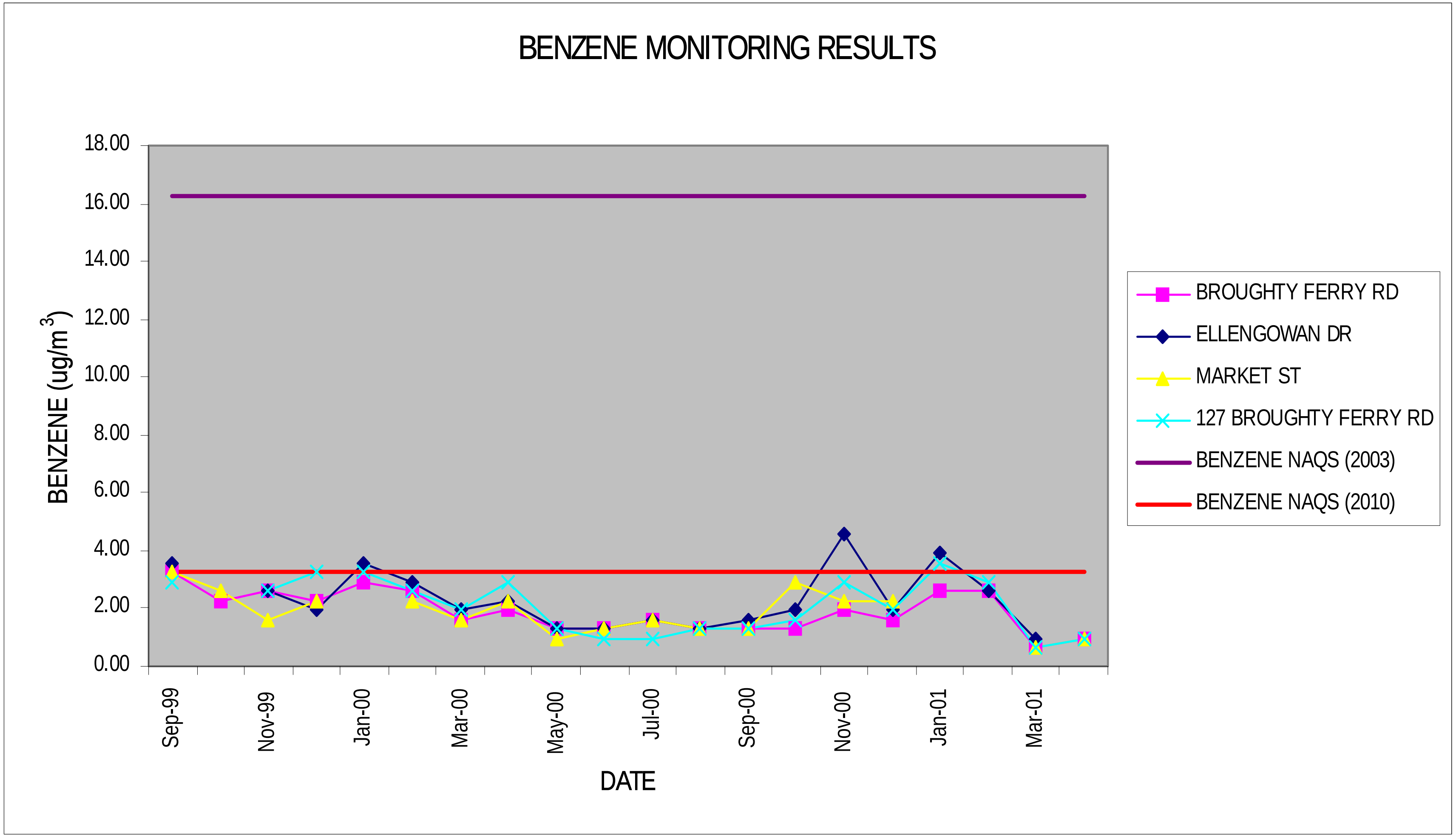
Part B processes

REF NO	LOCATION OF PROCESS	DESCRIPTION OF PROCESS
APC/E/333	RMC Readymix Ltd, Dock Street, Dundee, DD1 3JS.	Cement & Lime
APC/E/334	Hanson Quarry Products Europe Ltd, Piper Street, Dundee, DD4 0NT	Cement & Lime
APC/E/335	Aggregate Industries Ltd, Longtown Street, Dundee, DD4 8ZF	Cement & Lime
APC/E/344	Dignity Funerals Ltd, Dundee Crematorium, Macalpine Road, Dundee DD3 8SD	Incineration
APC/E/346	McTavish Ramsay & Co Ltd, Fowler Rd, W Pitkerro Ind Est, Dundee	Timber
APC/E/348	Teich Flexibles (UK) Ltd, Kemback Street, Dundee	Coating (flexible packaging).
APC/E/349	Fullarton Computers, Whittle Place, Gourdie Ind Est, Dundee.	Coating (powder).
APC/E/350	Michelin Tyres Plc, Baldovie Ind. Est, Baldovie Road, Dundee.	Coating (adhesive).
APC/E/352	D C Thomson & Co Ltd, 80 East Kingsway, Dundee.	Printing.
APC/E/355	Rockwell Flexible Packaging Ltd, Brunel Rd, Wester Gourdie Ind Est, Dundee, DD2 7NJ.	Coating (flexible packaging).
APC/E/356	Nationwide Crash Repair Centres Ltd, T/A. Heggie Plc, Gourdie Industrial Estate, Dundee.	Coating (vehicle respraying).
APC/E/361	Day International (UK) Ltd, Balgray Street, Dundee.	Coating Lithographic.
APC/E/363	Brown & Tawse Steelstock Ltd, Fowler Rd, West Pitkerro Ind Est, Dundee.	Coating (Metal).
APC/E/364	ABB Ltd, East Kingsway, Dundee, DD4 7RP	Coating (powder).
APC/E/365	Wilson & Son (Dundee) Ltd, Caledonian Mills, 324-330 B/Ferry Rd, Dundee.	Animal/vegetable matter.
APC/E/369	Broughty Ferry Auto Services, 17 Panmure Street, Broughty Ferry.	Coating (vehicle respraying).
APC/E/372	Arnold Clark Automobiles Ltd, 5 East Dock Street, Dundee, DD1 3HB.	Coating (vehicle respraying).
APC/E/374	JTC (65) Ltd, 27 Harrison Road, Dundee.	Timber
APC/E/380	Barnhill Garage, 20 Dalhousie Road, Barnhill, Dundee.	Combustion (WOB).
APC/E/382	A T Young (Motors) ltd, 15 Bath Street, Broughty Ferry.	Combustion (WOB).
APC/E/383	John A Hutcheon T/A Muirhead Garage, Newtyle Road, Dundee	Combustion (WOB).

REF NO	LOCATION OF PROCESS	DESCRIPTION OF PROCESS
APC/E/384	Brochtay Service Station, 145A Balgillo Road, Broughty Ferry.	Combustion (WOB).
APC/E/386	BRE Ltd, Fowler Road, West Pitkerro Road, Dundee.	Combustion (WOB).
APC/E/20045	Dundee Plant Co Ltd, Mobile Crushing Plant, Longtown St, Dundee	Mobile Crushing & Screening
APC/E/20085	Transco Plc, Balgray Site, Near Dundee.	Gas Odorisation Process.
APC/E/20131	Osprey Forecourts Ltd, City Road Filling Station, Dundee.	Petroleum
APC/E/20164	BP Express Shopping ltd, Kinsway West Filling Station, Dundee.	Petroleum (PVR)
APC/E/20165	BP Express Shopping Ltd - Kingsway West Filling Station, Dundee	Petroleum
APC/E/20198	Asda Stores Ltd - Milton of Craigie Road, Dundee.	Petroleum
APC/E/20199	Asda Stores Ltd - 7-9 Derwent Avenue, Kirkton, Dundee	Petroleum
APC/E/20202	Tesco Stores Ltd - Riverside Drive, Dundee	Petroleum
APC/E/20203	Tesco Stores Ltd - Methven Street, Dundee	Petroleum
APC/E/20211	Save Retail Limited - Charleston Drive, Dundee.	Petroleum
APC/E/20212	Save Retail Limited - 80 Balgillo Road, Broughty Ferry.	Petroleum
APC/E/20213	Save Retail Limited - 54 East Dock Road, Dundee.	Petroleum
APC/E/20226	Fuel Force Ltd, Marketgait Filling Station, Dundee	Petroleum
APC/E/20213	Save Retail Limited, 54 East Dock Street, Dundee	Petroleum
APC/E/20226	Fuel Force Ltd, Marketgait Filling Station, Dundee	Petroleum
APC/E/20262	Malthurst Ltd, Strathmartine Road, Dundee.	Petroleum
APC/E/20263	Malthurst Ltd, Coupar Angus Road, Dundee.	Petroleum
APC/E/20264	Shell UK, 61 Forfar Road, Dundee.	Petroleum
APC/E/20296	Shell UK Limited, East Kingsway, Dundee.	Petroleum
APC/E/20297	M D & E M Lorimar, 305-309 Queen Street, Broughty Ferry.	Petroleum
APC/E/20342	Esso Petroleum Co Ltd, Brochtay S/S 14a Dalhousie Road, Broughty Ferry	Petroleum
APC/E/20345	Mathurst Retail Ltd, Star Service Station, Forfar Road, Dundee, DD4 9BT	Petroleum
APC/E/20357	Esso Petroleum Co Ltd, McAlpine Service Station, Dundee.	Petroleum
APC/E/20365	Malthurst Retail Ltd, Star Service Station, Kingsway Circle, Kingsway West, Dundee, DD3 8QF	Petroleum
APC/E/20377	James Marr, Tayview Self Serve, 394 Perth Road, Dundee	Petroleum
APC/E/20404	Discovery Filling Station, Allan Street, Dundee	Petroleum
APC/E/20410	Alldays Stores, Coupar Angus Road, Birkhill	Petroleum
APC/E/20449	Motopart & Mototune Ltd, Brewery Lane, Dundee	Combustion (WOB).

REF NO	LOCATION OF PROCESS	DESCRIPTION OF PROCESS
APC/E/20451	Safedem Ltd, Arthustone Lodge, 8 Harrison Road, Dundee	Mobile
APC/E/20472	Lam-Art Ltd, 122 Liff Road, Dundee	Coating Process
APC/E/0120003	Dens Metals Ltd, West Pitkerro Industrial Estate, Broughty Ferry, Dundee	Coating Process
APC/E/0120009	Sainsburys Petrol, Baldobie Road, Claypotts, Dundee	Petroleum

Benzene (BTEX) tube raw data (ratified)



Appendix 3 Emissions background data taken from LAQM online database

X	Y	NOx 2001 ugm^3 as NO_2 annual mean	NOx 2005 ugm^3 as NO_2 annual mean	NOx 2010 ugm^3 as NO_2 annual mean	NO_2 2001 ugm^3 annual mean	NO_2 2005 ugm^3 annual mean	NO_2 2010 ugm^3 annual mean	PM_{10} 2001 ugm^3 grav. annual mean	PM_{10} 2004 ugm^3 grav. annual mean	PM_{10} 2010 ugm^3 grav. annual mean	PM_{10} secondary 2001 ugm^3 grav. annual mean	SO_2 2001 ugm^3 annual mean	Benzene 2001 ugm^3 annual mean	Benzene 2003 ugm^3 annual mean	Benzene 2010 ugm^3 annual mean	CO 2001 mgm^3 annual mean	1,3-butadine 2001 ugm^3 annual mean	1,3-butadine 2003 ugm^3 annual mean
333500	731500	17.2	14.5	11.1	13.5	11.3	8.67	14	13.6	12.9	3.78	1.43	0.151	0.133	0.102	0.168	0.0665	0.0532
333500	732500	17.3	14.6	11.1	13.6	11.4	8.73	14	13.6	12.9	3.78	1.42	0.153	0.135	0.104	0.169	0.0675	0.0539
334500	731500	18.5	15.6	11.9	14.4	12.2	9.34	14.1	13.7	13	3.78	1.59	0.176	0.155	0.119	0.176	0.0746	0.0595
334500	732500	18.4	15.5	11.8	14.3	12.1	9.28	14.1	13.7	13	3.78	1.49	0.177	0.157	0.12	0.177	0.0744	0.0592
335500	730500	20.1	16.7	13.1	15.2	13.1	10.2	14.3	13.9	13.1	3.78	2.03	0.212	0.186	0.142	0.189	0.0872	0.0691
335500	731500	20.8	17.3	13.5	15.6	13.5	10.6	14.4	14	13.2	3.78	2.95	0.225	0.198	0.15	0.194	0.0914	0.0722
335500	732500	20.3	16.8	13.1	15.3	13.2	10.3	14.3	13.9	13.2	3.78	1.99	0.222	0.195	0.149	0.193	0.0895	0.0706
335500	733500	17.6	14.7	11.5	13.8	11.5	9.03	14.2	13.8	13.1	3.78	1.61	0.196	0.173	0.132	0.181	0.0792	0.0628
336500	729500	19.2	16.2	12.8	14.8	12.7	10	14.3	13.9	13.1	3.78	1.71	0.217	0.191	0.146	0.189	0.0888	0.0704
336500	730500	22.4	18.7	14.7	16.4	14.5	11.5	14.5	14.1	13.3	3.78	2.04	0.249	0.219	0.167	0.203	0.102	0.08
336500	731500	23.5	19.7	15.4	17	15	12.1	14.7	14.2	13.4	3.78	2.27	0.271	0.238	0.181	0.21	0.109	0.0853
336500	732500	22.6	18.9	14.8	16.5	14.6	11.6	14.6	14.2	13.4	3.78	1.84	0.261	0.229	0.174	0.207	0.105	0.0819
336500	733500	20.1	16.9	13.2	15.2	13.2	10.3	14.4	14	13.3	3.78	1.63	0.231	0.204	0.155	0.195	0.0924	0.0728
336500	734500	17.4	14.6	11.4	13.6	11.4	8.94	14.1	13.7	13	3.78	1.58	0.197	0.174	0.133	0.182	0.0797	0.0638
337500	729500	20.8	17.9	14.4	15.6	14.1	11.3	14.4	14.1	13.3	3.78	1.69	0.255	0.225	0.172	0.199	0.1	0.079
337500	730500	25	21.3	16.9	17.7	15.9	13.2	14.8	14.4	13.6	3.78	1.82	0.3	0.264	0.201	0.218	0.119	0.0929
337500	731500	26.4	22.5	17.8	18.4	16.5	14	15	14.6	13.7	3.78	1.71	0.326	0.287	0.218	0.227	0.128	0.1
337500	732500	25.1	21.3	16.9	17.7	15.9	13.2	14.9	14.5	13.7	3.78	1.58	0.309	0.272	0.207	0.221	0.12	0.0937

X	Y	NOx 2001 ugm^3 as NO_2 annual mean	NOx 2005 ugm^3 as NO_2 annual mean	NOx 2010 ugm^3 as NO_2 annual mean	NO_2 2001 ugm^3 annual mean	NO_2 2005 ugm^3 annual mean	NO_2 2010 ugm^3 annual mean	PM_{10} 2001 ugm^3 grav. annual mean	PM_{10} 2004 ugm^3 grav. annual mean	PM_{10} 2010 ugm^3 grav. annual mean	PM_{10} secondary 2001 ugm^3 grav. annual mean	SO_2 2001 ugm^3 annual mean	Benzene 2001 ugm^3 annual mean	Benzene 2003 ugm^3 annual mean	Benzene 2010 ugm^3 annual mean	CO 2001 mgm^3 annual mean	1,3-butadine 2001 ugm^3 annual mean	1,3-butadine 2003 ugm^3 annual mean
337500	733500	22.1	18.6	14.7	16.3	14.5	11.5	14.7	14.2	13.5	3.78	1.69	0.264	0.232	0.177	0.205	0.104	0.0819
337500	734500	19	15.9	12.5	14.7	12.5	9.77	14.3	13.9	13.1	3.78	1.92	0.22	0.193	0.148	0.19	0.089	0.0708
338500	729500	22.6	19.7	15.9	16.5	15	12.5	14.6	14.2	13.4	3.78	1.97	0.294	0.26	0.199	0.211	0.112	0.088
338500	730500	27.5	23.6	18.9	18.9	17	14.6	15	14.6	13.8	3.78	1.87	0.347	0.305	0.232	0.232	0.134	0.105
338500	731500	29	24.9	19.9	19.6	17.6	15.1	15.2	14.8	13.9	3.78	1.68	0.379	0.333	0.253	0.243	0.144	0.112
338500	732500	27.6	23.6	18.9	18.9	17	14.6	15.1	14.7	13.8	3.78	1.66	0.361	0.317	0.242	0.237	0.136	0.106
338500	733500	22.9	19.4	15.3	16.7	14.9	12	14.7	14.3	13.5	3.78	2.02	0.286	0.251	0.192	0.212	0.112	0.0872
339500	729500	23.4	20.4	16.5	16.9	15.4	12.9	14.7	14.3	13.5	3.78	2.49	0.302	0.266	0.204	0.214	0.117	0.0918
339500	730500	28.4	24.4	19.5	19.3	17.4	14.9	15.1	14.7	13.8	3.78	2.13	0.356	0.313	0.237	0.237	0.141	0.11
339500	731500	31	26.6	21.3	20.5	18.5	15.9	15.4	14.9	14	3.78	1.77	0.398	0.35	0.267	0.25	0.154	0.12
339500	732500	30.3	26	20.7	20.2	18.2	15.6	15.3	14.9	14	3.78	1.91	0.384	0.338	0.258	0.246	0.148	0.115
339500	733500	26	22	17.3	18.2	16.2	13.6	14.9	14.5	13.6	3.78	2.16	0.312	0.274	0.21	0.222	0.124	0.0965
340500	730500	27.7	23.6	19	19	17	14.6	15.1	14.6	13.8	3.82	2.64	0.341	0.3	0.227	0.231	0.139	0.108
340500	731500	30	25.7	20.7	20.1	18.1	15.5	15.3	14.9	14	3.82	1.99	0.382	0.336	0.256	0.244	0.151	0.117
340500	732500	29.7	25.4	20.3	20	17.9	15.4	15.3	14.8	14	3.82	1.84	0.373	0.328	0.25	0.242	0.147	0.114
340500	733500	25.7	21.7	17.2	18.1	16	13.4	14.9	14.5	13.6	3.82	2.25	0.307	0.27	0.207	0.221	0.124	0.0968
340500	734500	22.7	18.9	14.9	16.6	14.6	11.7	14.6	14.2	13.4	3.82	1.7	0.259	0.228	0.175	0.205	0.106	0.0838
341500	730500	26.1	22.4	18	18.3	16.4	14.1	15	14.5	13.7	3.82	2.35	0.326	0.286	0.217	0.226	0.133	0.104
341500	731500	28.3	24.2	19.5	19.3	17.3	14.9	15.2	14.7	13.9	3.82	2.25	0.362	0.319	0.243	0.237	0.143	0.112

X	Y	NOx 2001 ugm3 as NO_2 annual mean	NOx 2005 ugm3 as NO_2 annual mean	NOx 2010 ugm3 as NO_2 annual mean	NO_2 2001 ugm3 annual mean	NO_2 2005 ugm3 annual mean	NO_2 2010 ugm3 annual mean	PM_{10} 2001 ugm3 grav. annual mean	PM_{10} 2004 ugm3 grav. annual mean	PM_{10} 2010 ugm3 grav. annual mean	PM_{10} secondary 2001 ugm3 grav. annual mean	SO_2 2001 ugm3 annual mean	Benzene 2001 ugm3 annual mean	Benzene 2003 ugm3 annual mean	Benzene 2010 ugm3 annual mean	CO 2001 mgm3 annual mean	1,3-butadine 2001 ugm3 annual mean	1,3-butadine 2003 ugm3 annual mean
341500	732500	28.3	24.2	19.5	19.3	17.3	14.9	15.2	14.7	13.9	3.82	1.83	0.359	0.316	0.241	0.236	0.141	0.11
341500	733500	24.9	21	16.6	17.7	15.7	13	14.9	14.4	13.6	3.82	2.32	0.302	0.266	0.203	0.218	0.122	0.0958
341500	734500	21.6	18.1	14.3	16	14.2	11.2	14.6	14.1	13.3	3.82	1.69	0.251	0.221	0.17	0.201	0.103	0.0818
342500	731500	25.7	21.9	17.6	18.1	16.2	13.8	14.9	14.5	13.6	3.82	1.79	0.326	0.287	0.219	0.226	0.13	0.103
342500	732500	26.1	22.2	17.8	18.3	16.3	14	14.9	14.5	13.7	3.82	1.78	0.329	0.289	0.22	0.227	0.131	0.103
342500	733500	24	20.2	16	17.2	15.3	12.6	14.7	14.3	13.5	3.82	2.83	0.291	0.256	0.195	0.215	0.119	0.0935
342500	734500	20.9	17.4	13.8	15.6	13.7	10.8	14.5	14	13.3	3.82	1.7	0.242	0.213	0.164	0.198	0.0986	0.079
343500	731500	23.3	19.7	15.9	16.9	15	12.4	14.8	14.3	13.5	3.82	1.7	0.287	0.252	0.193	0.213	0.117	0.0926
343500	732500	23.8	20	16.1	17.1	15.2	12.6	14.8	14.3	13.5	3.82	1.88	0.289	0.254	0.194	0.214	0.118	0.0932
343500	733500	23.6	19.8	15.9	17	15.1	12.4	14.8	14.3	13.5	3.82	2.22	0.286	0.251	0.192	0.213	0.116	0.0919
344500	731500	21.2	18	14.7	15.8	14.1	11.5	14.7	14.2	13.4	3.82	1.96	0.279	0.245	0.187	0.208	0.11	0.0871
344500	732500	21.5	18.3	15.3	16	14.3	12	14.7	14.2	13.4	3.82	1.89	0.279	0.245	0.187	0.208	0.11	0.0869
344500	733500	21.3	18.1	15.2	15.8	14.2	11.9	14.7	14.2	13.4	3.82	2.32	0.27	0.238	0.181	0.206	0.108	0.0853
345500	731500	20	16.9	13.8	15.2	13.2	10.8	14.6	14.1	13.4	3.82	2.39	0.268	0.236	0.181	0.203	0.103	0.0821
345500	732500	20.6	17.5	15.1	15.5	13.7	11.8	14.6	14.2	13.4	3.82	6.48	0.269	0.237	0.182	0.203	0.103	0.0819
345500	733500	27.8	25.3	31	19.1	17.9	20.5	14.6	14.1	13.4	3.82	2.31	0.261	0.23	0.176	0.201	0.101	0.0804
346500	731500	18.9	15.9	13	14.6	12.5	10.2	14.8	14.3	13.5	3.82	2.48	0.25	0.22	0.169	0.197	0.0967	0.0778
346500	732500	19.2	16.2	13.6	14.8	12.7	10.7	14.8	14.3	13.5	3.82	2.54	0.251	0.221	0.17	0.197	0.0967	0.0776
346500	733500	20	17.1	15.6	15.2	13.4	12.2	15	14.5	13.7	3.82	2.03	0.243	0.214	0.165	0.195	0.0953	0.0769
347500	731500	18.2	15.4	12.5	14.3	12	9.82	14.7	14.2	13.4	3.82	2.18	0.241	0.213	0.165	0.193	0.0931	0.0756
347500	732500	18.7	15.7	13	14.5	12.3	10.2	14.8	14.3	13.4	3.82	2.22	0.249	0.22	0.17	0.196	0.0959	0.0786
347500	733500	18.7	15.8	13.2	14.5	12.4	10.3	15	14.5	13.6	3.82	1.74	0.243	0.214	0.166	0.194	0.0952	0.0784
348500	733500	17.4	14.6	12	13.7	11.5	9.37	14.8	14.3	13.5	3.82	1.82	0.223	0.197	0.154	0.187	0.0884	0.0734

APPENDIX 4a

Roads information from NAEI roads database (2000)

Road No.	AADT 2004	AADT 2005	AADT 2010	% LDV 2004	% LDV 2005	% LDV 2010	%HDV 2004	%HDV 2005	% HDV 2010	Receptor locations x	y	Receptor to rd centre/m	Average speed kph	NOx 2005	NO_2 2005	PM_{10} 2004	PM_{10} 2010
A90*	29354	29738	31655	90.81	90.89	90.7	9.25	9.26	9.36	336248	732140	18.71	80	18.3	14.1	14.2	13.4
A85	14356	14543	15481	92.7	92.75	92.44	7.35	7.33	7.30	336174	730018	5.76	64	16.2	12.7	13.9	13.1
A991	12053	12210	12997	96.37	96.42	96.07	3.37	3.34	3.24	339951	730088	14.14	40	24.4	17.4	14.7	13.8
A991	21632	21914	23327	97.53	97.58	97.14	2.1	2.1	2.07	340026	730649	11.62	48	23.6	17	14.6	13.8
A92	43794	44366	47226	95.88	95.94	95.6	3.76	3.75	3.68	340658	730353	13.39	40	23.6	17	14.6	13.8
A929	9650	9776	10406	93.9	93.93	93.48	5.74	5.69	5.47	341047	730934	7.9	48	22.4	16.4	14.5	13.7
A929	10417	10554	11234	93.85	93.9	93.55	5.82	5.78	5.57	341207	732104	8.91	48	23	16.7	14.7	13.9
A90	26172	26514	28223	89.52	89.59	89.37	10.36	10.36	10.42	341540	733478	19.58	64	21	15.7	14.4	13.6
A92	27396	27753	29542	95.63	95.69	95.38	4.2	4.18	4.13	342240	731054	14.79	64	21.9	16.2	14.5	13.6
A930	17366	17592	18726	97.44	97.48	97.03	2.36	2.35	2.25	344333	731077	11.13	64	18	14.1	14.2	13.4
A92	16800	17020	18117	94.26	94.33	94.05	5.6	5.58	5.54	346963	731043	8.46	48	15.9	12.5	14.3	13.5
A92	12697	12862	13691	90.94	91.0	90.72	8.75	8.74	8.79	343493	731756	13	64	19.7	15	14.3	13.5
	15812	16017	17057	93.6	93.7	93.6	6.4	6.3	6.4	338111	731851	9.39	48	24.9	17.6	14.8	13.9
	9353	10086	9475	100	100	100	0	0	0	339231	732814	11.82	48	26.0	18.2	14.9	14.0

* Previously, DMRB screening of this location indicated that the NO_2 level in 2005 would be between 36-40 ug/m^3, therefore requiring to be reassessed with the DMRB version 1.01.

APPENDIX 4b Junctions data used to input to DMRB

No	Junction Name/ Description	Link Description	2004	2005	2010	HGV	NOx	NO_2	PM_{10}	PM_{10}	Ave daily vehicle speed	Receptor to road centre (m)	Receptor grid ref NO_2		Receptor to road centre (m)	Receptor grid ref PM_{10}	
			AADT	AADT	AADT	%	(2005)	(2005)	(2004)	2010							
							(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)	kph	for NO_2	easting	northing	for PM_{10}	easting	northing
1	Swallow Roundabout											No relevant receptor			No relevant receptor		
2	Riverside Av/Apollo Way											No relevant receptor			No relevant receptor		
3	Riverside Av/Main St (Inv)											No relevant receptor			No relevant receptor		
4	Riverside Av/Perth Rd 1											No relevant receptor			No relevant receptor		
6	Riverside Av/Perth Rd 2	A	9912	10042	10689	7	16.7	13.1	13.9	13.1	30	28.93	336863	729856	28.93	336863	729856
		B	8152	8259	8791	9	16.7	13.1	13.9	13.1	45	15.26	336863	729856	15.26	336863	729856
		C	7885	7988	8503	4	16.7	13.1	13.9	13.1	45	25.45	336863	729856	25.45	336863	729856
7	Ninewells Av/Ninewells Dr											No relevant receptor			No relevant receptor		
8	Charleston Dr/Spey Dr											No relevant receptor			No relevant receptor		
9	South Rd/Mallaig Av		< 10,000 vpd														
10	Perth Rd/ Ninewells Av	A-B	7390	7487	7969	6	18.7	14.5	14.1	13.3	30	16.97	336082	730105	11.34	336082	730105
		C	6357	6440	6855	4	18.7	14.5	14.1	13.3		51.98	336082	730105	48.09	336082	730105
11	Charleston Dr/Dickson Av	A-B	6439	6524	6944	10	15	14.2	14.2	13.4	48	14.15	336062	731221	14.15	336062	731221
		C	3985	4037	4298	8	15	14.2	14.2	13.4	30	21.24	336062	731221	21.24	336062	731221
12	Kingsway/Coupar Angus Rd											No relevant receptor					
13	Macalpine Rd/Staffa Pl	A-B	17345	N/A	18704	7	N/A	N/A	14.7	13.8	30	No relevant receptor			14.33	338314	732940
		C	7980	N/A	8605	11	N/A	N/A	14.7	13.8	30	No relevant receptor			18.66	338314	732940
14	Staffa Pl/Telford Rd	A-B	6280	6362	6771	13	22.2	16.3	14.5	13.7	30	23.78	338044	732986	23.78	338044	732986
		C	3204	3246	3455	11	22.2	16.3	14.5	13.7	48	12.5	338044	732986	12.5	338044	732986
15	Sinderins junction 1	A-C	8835	8951	9528	7	19.7	15	14.2	13.4	30	9.46	338745	729835	9.46	338745	729835
		B-D	7161	7254	7721	8	19.7	15	14.2	13.4	30	14.8	338745	729835	14.8	338745	729835
		E	524	531	565	2	19.7	15	14.2	13.4	30	32.06	338745	729835	32.06	338745	729835
	Sinderins junction 2	A-C	8835	8951	9528	7	19.7	15	14.2	13.4	30	14.82	338725	729802	14.82	338725	729802
		B-D	7161	7254	7721	8	19.7	15	14.2	13.4	30	12.77	338725	729802	12.77	338725	729802
		E	524	531	565	2	19.7	15	14.2	13.4	30	22.61	338725	729802	22.61	338725	729802
16	Charleston Dr/Etive Grdns		< 10,000 vpd														
17	Strathmartine Rd/Gillburn Rd	A-B	11642	11794	12554	6	19.4	14.9	14.3	13.5	48	15.53	338971	733139	15.53	338971	733139

No	Junction Name/ Description	Link Description	2004 AADT	2005 AADT	2010 AADT	HGV %	NOx (2005) (ug/m^3)	NO_2 (2005) (ug/m^3)	PM_{10} (2004) (ug/m^3)	PM_{10} 2010 (ug/m^3)	Ave daily vehicle speed kph	Receptor to road centre (m) for NO_2	Receptor grid ref NO_2 easting	Receptor grid ref NO_2 northing	Receptor to road centre (m) for PM_{10}	Receptor grid ref PM_{10} easting	Receptor grid ref PM_{10} northing
		C-D	5134	5201	5536	4	19.4	14.9	14.3	13.5	30	12.38	338971	733139	12.38	338971	733139
18	Trottick Mains roundabout	A-C	2124	8230	8760	9	21.7	16	14.5	13.6	30	10.5	340217	733691	10.5	340217	733691
		B-D	5772	5847	6224	8	21.7	16	14.5	13.6	30	25.57	340217	733691	25.57	340217	733691
19	Harefield Rd/Kings Cross Rd	A-B	17899	N/A	19301	8	N/A	N/A	14.8	13.9	30	No relevant receptor			14.72	338370	731865
		C	14358	N/A	15483	9	N/A	N/A	14.8	13.9	30				42.39	338370	731865
20	Strathmartine Rd/Clepington Rd 1	B-C	10901	11043	11755	8	24.3*	17.4*	14.9	14	30	10.93	339504	732203	10.93	339504	732203
		A-D	11461	11312	12041	9	24.3*	17.4*	14.9	14	30	10.77	339504	732203	10.77	339504	732203
	Strathmartine Rd/Clepington Rd 2	B-C	10901	11043	11755	8	24.3*	17.4*	14.9	14	30	21.49	339524	732178	21.49	339524	732178
		A-D	11461	11312	12041	9	24.3*	17.4*	14.9	14	30	8.43	339524	732178	8.43	339524	732178
21	Loons Rd/Logie St 1	A-B	19224	19475	20730	8	24.9	17.6	14.8	13.9	30	6.49	338172	731295	6.49	338172	731295
		C	8813	8928	9504	6	24.9	17.6	14.8	13.9	30	11.2	338172	731295	11.2	338172	731295
		D	1697	1791	1830	2	24.9	17.6	14.8	13.9	30	4.22	338172	731295	4.22	338172	731295
	Loons Rd/Logie St 2	A-B	19224	19475	20730	8	24.9	17.6	14.8	13.9	30	7.3	338211	731297	7.3	338211	731297
		C	8813	8928	9504	6	24.9	17.6	14.8	13.9	30	5.51	338211	731297	5.51	338211	731297
		D	1697	1791	1830	2	24.9	17.6	14.8	13.9	30	36.39	338211	731297	36.39	338211	731297
22	Logie St/Ancrum Rd	A-B	18708	18953	20174	9	24.9	17.6	14.8	13.9	30	33.37	338252	731205	23.93	338252	731205
		C	5071	5138	5469	4	24.9	17.6	14.8	13.9	30	9.96	338252	731205	15.16	338252	731205
23	Logie St/City Rd											Not relevant junction					
24	City Rd/Tullideph **	A-C	8331	8440	8984	6	23.6	17	14.6	13.8	30	7.88	338425	730929	7.88	338425	730929
		B-D	7437	7534	8019	6	23.6	17	14.6	13.8	30	8.83	338425	730929	8.83	338425	730929
25	Lochee Rd/Dudhope Ter	A-B	23801	24112	25666	8	23.6	17	14.6	13.8	30	6.29	338928	730678	6.29	338928	730678
		C	9300	9422	10029	6	23.6	17	14.6	13.8	30	13.91	338928	730678	13.91	338928	730678
26	Lochee Rd/Polepark Rd	A-B	22273	22564	24019	8	24.4	17.4	14.7	13.8	30	29.57	339003	730589	29.57	339003	730589
		C	10998	11142	11860	5	24.4	17.4	14.7	13.8	30	13.92	339003	730589	13.92	339003	730589
		C				5											
27	Moncur Cres/Canning St	A-B	10069	10200	10858	7	26.6	18.5	14.9	14	48	24.89	339951	731772	24.89	339951	731772

No	Junction Name/ Description	Link Description	2004 AADT	2005 AADT	2010 AADT	HGV %	NOx (2005) (ug/m^3)	NO_2 (2005) (ug/m^3)	PM_{10} (2004) (ug/m^3)	PM_{10} 2010 (ug/m^3)	Ave daily vehicle speed kph	Receptor to road centre (m) for NO_2	Receptor grid ref NO_2 easting	Receptor grid ref NO_2 northing	Receptor to road centre (m) for PM_{10}	Receptor grid ref PM_{10} easting	Receptor grid ref PM_{10} northing
		C	5000	5000	5000	0	26.6	18.5	14.9	14	30	15.41	339951	731772	15.41	339951	731772
28	Dens Rd/Mains Rd **	A-B	11670	11746	12584	6	25.7	18.1	14.9	14	48	25.99	340012	731729	25.99	340012	731729
		D	4243	4548	4607	5	25.7	18.1	14.9	14	30	32.43	340012	731729	32.43	340012	731729
		C	5000	5000	5000	0	25.7	18.1	14.9	14	30	16.72	340012	731729	16.72	340012	731729
29	Strathmartine Rd/Hilltown 1 **	A-B	8955	9072	9657	9	26.6	18.5	14.9	14	30	6.14	339986	731370	6.14	339986	731370
		C	5000	5000	5000	0	26.6	18.5	14.9	14	30	12.93	339986	731370	12.93	339986	731370
		D	5019	5084	5412	9	26.6	18.5	14.9	14	30	12.84	339986	731370	12.84	339986	731370
	Strathmartine Rd/Hilltown 2	A-B	8955	9072	9657	9	26.6	18.5	14.9	14	30	6.14	339965	731383	6.14	339965	731383
		C	5000	5000	5000	0	26.6	18.5	14.9	14	30	12.93	339965	731383	12.93	339965	731383
		D	5019	5084	5412	9	26.6	18.5	14.9	14	30	12.84	339965	731383	12.84	339965	731383
30	Clepington Rd/Hindmarsh Av	A-B	15509	15712	16725	8	23.7*	17.1*	14.8	14	48	10.13	340303	732141	10.13	340303	732141
		C	5000	5000	5000	0	23.7*	17.1*	14.8	14	30	18.33	340303	732141	18.33	340303	732141
31	Victoria Rd/Dens Rd	A	12688	12852	13680	16	25.7	18.1	14.9	14	30	9.36	340733	731005	9.36	340733	731005
		B	7677	7778	8279	17	25.7	18.1	14.9	14	30	14.25	340733	731005	14.25	340733	731005
		C	4852	4916	5233	14	25.7	18.1	14.9	14	30	22.59	340733	731005	22.59	340733	731005
		D	280	284	302	2	25.7	18.1	14.9	14	30	4.31	340733	731005	4.31	340733	731005
32	Victoria Rd/Hilltown	A-B	14692	14884	15843	14	23.6	17	14.6	13.8	30	8.21	340271	730721	8.21	340271	730721
		C	5199	5267	5606	3	23.6	17	14.6	13.8	30	16.12	340271	730721	16.12	340271	730721
33	Ladywell Roundabout	A-B	19973	20234	21538	6	23.6	17	14.6	13.8	30	14.06	340134	730644	14.06	340134	730644
		C	17457	17685	18824	7	23.6	17	14.6	13.8	30	17.63	340134	730644	17.63	340134	730644
34	Lochee Rd roundabout **	A	20716	20987	22340	5	24.4	17.4	14.7	13.8	30	20.9	339809	730640	20.9	339809	730640
		B	18761	19006	20231	6	24.4	17.4	14.7	13.8	30	90.62	339809	730640	90.62	339809	730640
		C	16446	16660	17734	8	24.4	17.4	14.7	13.8	30	120.47	339809	730640	120.47	339809	730640
35	W. Marketgait/Ward Rd	A-B	20732	21003	22357	6	24.4	17.4	14.7	13.8	30	11.61	339891	730385	11.61	339891	730385
		C	8887	9003	9583	10	24.4	17.4	14.7	13.8	30	21.48	339891	730385	21.48	339891	730385
36	Westport Roundabout											Not relevant junction					

No	Junction Name/ Description	Link Description	2004 AADT	2005 AADT	2010 AADT	HGV %	NOx (2005) (ug/m^3)	NO_2 (2005) (ug/m^3)	PM_{10} (2004) (ug/m^3)	PM_{10} 2010 (ug/m^3)	Ave daily vehicle speed kph	Receptor to road centre (m) for NO_2	Receptor grid ref NO_2 easting	Receptor grid ref NO_2 northing	Receptor to road centre (m) for PM_{10}	Receptor grid ref PM_{10} easting	Receptor grid ref PM_{10} northing
37	W. Marketgait/Nethergate	A-B	26852	27203	28956	7	23.6	17	14.6	13.8	30	27.02	340075	729966	27.02	340075	729966
		C	9075	9194	9786	7	23.6	17	14.6	13.8	30	35.04	340075	729966	35.04	340075	729966
		D	6203	6284	6689	22	23.6	17	14.6	13.8	30	8.83	340075	729966	8.83	340075	729966
38	N. Marketgait/King St	A-B	20557	20826	22168	4	N/A	N/A	14.6	13.8	30	Not relevant junction			18.5	340547	730750
		C	10113	10245	10906	12	N/A	N/A	14.6	13.8	30	Not relevant junction			18.87	340547	730750
		D	977	989	1053	72	N/A	N/A	14.6	13.8	30	Not relevant junction			28.29	340547	730750
39	Allen St Roundabout	A-B	16342	16555	17622	7	23.6	17	14.6	13.8	30	19.99	340637	730631	19.99	340637	730631
		C	13567	13744	14630	7	23.6	17	14.6	13.8	30	61.52	340637	730631	61.52	340637	730631
		D	9742	9869	10506	10	23.6	17	14.6	13.8	30	7.73	340637	730631	7.73	340637	730631
40	E. Marketgait/E Dock St	road only	31834	32250	34328	8	23.6	17	14.6	13.8	48	13.2	340764	730383	13.2	340764	730383
41	Pitkerro Rd/Madeira St	A-B	9714	9841	10475	8	24.2	17.3	14.7	13.9	30	16.63	341464	731804	16.63	341464	731804
		C	836	847	902	0	24.2	17.3	14.7	13.9	30	7.84	341464	731804	7.84	341464	731804
42	Forfar Rd/Clepington Rd	A-C	11597	11748	12506	11	23*	16.7*	14.7	13.9	30	12.65	341397	732125	12.65	341397	732125
		B-D	10791	10932	11637	8	23*	16.7*	14.7	13.9	30	6.59	341397	732125	6.59	341397	732125
43	Arbroath Rd/Dalkeith Rd	A-B	14050	14233	15151	8	24.2	17.3	14.7	13.9	48	15.68	341805	731289	15.68	341805	731289
		C-D	<5000	<5000	<5000	NK	24.2	17.3	14.7	13.9	30	14.01	341805	731289	14.01	341805	731289
44	Arbroath Rd/Kenilworth Av	A-B	14870	N/A	16035	7	N/A	N/A	14.7	13.9	48	Not relevant junction			16.12	341995	731359
		C	5000	N/A	5000	0	N/A	N/A	14.7	13.9	30	Not relevant junction			27.1	341995	731359
45	Ballumbie Rd/Berwick Dr		< 10,000 vpd														
46	Drumgeith Rd/Ballumbie Rd	A-B	9879	10008	10653	9	18.1	14.2	14.2	13.4	48	16.77	344704	733307	16.77	344704	733307
		C	4696	4757	5064	9	18.1	14.2	14.2	13.4	30	10.76	344704	733307	10.76	344704	733307
47	Kellas Rd/Drumsturdy Rd	A	7175	7269	7737	9	25.3	17.9	14.1	13.4	48	5.11	345146	733330	5.11	345146	733330
		B	3928	3979	4236	14	25.3	17.9	14.1	13.4	48	16.09	345146	733330	16.09	345146	733330
		C	3342	3386	3604	7	25.3	17.9	14.1	13.4	30	15.74	345146	733330	15.74	345146	733330
48	Balunie Av/Ballindean Rd											Not relevant junction			No receptor		
49	Balunie Dr/Ballindean Rd		< 10,000 vpd														
50	Balunie Dr/Balmoral Av		< 10,000 vpd														

No	Junction Name/ Description	Link Description	2004 AADT	2005 AADT	2010 AADT	HGV %	NOx (2005) (ug/m^3)	NO_2 (2005) (ug/m^3)	PM_{10} (2004) (ug/m^3)	PM_{10} 2010 (ug/m^3)	Ave daily vehicle speed kph	Receptor to road centre (m) for NO_2	Receptor grid ref NO_2 easting	Receptor grid ref NO_2 northing	Receptor to road centre (m) for PM_{10}	Receptor grid ref PM_{10} easting	Receptor grid ref PM_{10} northing
51	Arbroath Rd/Fairfield Rd	A-B	22013	N/A	23738	10	N/A	N/A	14.2	13.4	48	Not relevant junction			13.37	344363	731822
		C	3836	N/A	4136	2	N/A	N/A	14.2	13.4	30				16.27	344363	731822
52	Stathern Rd/Fairfield Rd											Not relevant junction			No receptor		
53	Forthill Rd/Fintry Pl	A-B	5608	5681	6048	5	16.9	13.2	14.1	13.4	30	11.31	346208	731789	11.31	346208	731789
		C-D	<5000	<5000	<5000	NK	16.9	13.2	14.1	13.4	30	13.87	346208	731789	13.87	346208	731789
54	Forthill Rd/Queen St BF	A-B	15491	15693	16705	7	15.9	12.5	14.3	13.5	30	24.52	346182	731058	24.52	346182	731058
		C	5366	5436	5787	7	15.9	12.5	14.3	13.5	30	15.13	346182	731058	15.13	346182	731058
		D	3698	3747	3988	2	15.9	12.5	14.3	13.5	30	40.02	346182	731058	40.02	346182	731058
55	Queen St/Claypotts Rd	A-B	14883	15077	16049	5	16.9	13.2	14.1	13.4	30	7.21	345826	731137	7.21	345826	731137
		C	6989	7080	7536	7	16.9	13.2	14.1	13.4	30	7.1	345826	731137	7.1	345826	731137
		D	4298	4354	4635	5	16.9	13.2	14.1	13.4	30	14.5	345826	731137	14.5	345826	731137
56	Broughty Ferry Rd/Greendykes Rd		< 10,000 vpd														
57	Stannergate roundabout	A-B	22375	22667	24128	4	19.7	15	14.3	13.5	48	11.87	343313	731068	11.87	343313	731068
		C	6948	7039	7492	7	19.7	15	14.3	13.5	30	30.62	343313	731068	30.62	343313	731068
		D	4429	4487	4776	3	19.7	15	14.3	13.5	30	43.07	343313	731068	43.07	343313	731068
		E	2294	2324	2474	13	19.7	15	14.3	13.5	30	32.1	343313	731068	32.1	343313	731068

* NOx and NO2 indicates that the background emission from the NAEI website has been amended to take account of proximity to the Kingsway

** Street canyon applied in DMRB

NK = data not known

N/A = not applicable