

**DUNDEE CITY COUNCIL**

**LAQM DETAILED AND FURTHER ASSESSMENT 2009**

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## Executive Summary

Part IV of the Environment Act 1995 places a statutory duty on local authorities to review and assess the air quality within their area and take account of Government guidance when undertaking such work.

The Detailed Assessment 2005 confirmed that there was a risk of exceedence of the annual mean nitrogen dioxide (NO<sub>2</sub>) objective at a number of busy roads and junctions in Dundee resulting in Dundee City Council declaring the whole of Dundee city centre as an Air Quality Management Area for NO<sub>2</sub> in 2006.

Bureau Veritas has been commissioned by Dundee City Council to provide a further assessment of air quality within the Dundee NO<sub>2</sub> AQMA, which will provide technical input into the Air Quality Action Plan.

In addition, a detailed assessment with regard to compliance with particulate (PM<sub>10</sub>) objectives at roads and junctions in the AQMA has been undertaken. This assessment specifically models road traffic sources (not all PM<sub>10</sub> sources) at specific roads and junctions in the AQMA as recommended in the Annual Progress Report 2007.

The further assessment has been undertaken in accordance with LAQM.TG (09)<sup>1</sup> Guidance methodologies. The further assessment aims, through assessment of monitoring data and modelled predictions:

- to confirm the original assessment of air quality in the AQMA against the prescribed objectives;
- to calculate more accurately how much of an improvement in air quality would be needed to deliver the air quality objectives within the AQMA;
- to refine knowledge of the sources of pollution so that air quality action plan measures can be properly targeted.

The information from the further assessment is required to assist the preparation of the Action Plan measures for the AQMA in order that the measures may be targeted and focused, thereby prioritising the most cost-effective approach to reducing air pollutant concentrations in the AQMA.

The findings of this report are the following:

- Monitoring data from the continuous analyser and diffusion tube monitoring sites indicate that exceedences of the annual mean NO<sub>2</sub> objective are being measured within the AQMA and confirm the need for the declaration;
- Updated modelled results indicate that there is a risk of exceedences of the annual mean NO<sub>2</sub> objective within the AQMA and confirm the need for the declaration;
- The maximum predicted NO<sub>x</sub> reduction required within the Dundee AQMA to comply with the NO<sub>2</sub> AQS objective is 221µg/m<sup>3</sup> in 2007 at the Dock Street/South Marketgait junction. In 2010, this reduces to 163µg/m<sup>3</sup>. The maximum predicted NO<sub>2</sub> reduction required within the Dundee AQMA to comply with the NO<sub>2</sub> AQS objective is 43µg/m<sup>3</sup> in 2007. In 2010, this reduces to 35µg/m<sup>3</sup>. This is the worst-case modelled location and may be an over prediction of the model at this location. All other modelled receptors require 18µg/m<sup>3</sup> or lower reduction of NO<sub>2</sub> in 2007; 13µg/m<sup>3</sup> or below in 2010. Consequently, the formulation of the Action Plan should aim to reduce the levels of NO<sub>x</sub> / NO<sub>2</sub> within the AQMA by this amount.
- The maximum predicted PM<sub>10</sub> reduction on the annual mean required within the AQMA to comply with the 2010 PM<sub>10</sub> annual mean AQS objective is 25µg/m<sup>3</sup> in 2007 at the Dock Street/South Marketgait junction. In 2010, this reduces to 19µg/m<sup>3</sup>. This is the worst-case modelled location and may be an over prediction of the model at this location. All other

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<sup>1</sup> Defra (2009), Local Air Quality Management Technical Guidance LAQM.TG(09)

modelled receptors require  $16\mu\text{g}/\text{m}^3$  or lower reduction of  $\text{PM}_{10}$  in 2007;  $13\mu\text{g}/\text{m}^3$  or below in 2010. These are still significant reductions at these hotspot locations. Based on the risk of exceedence of the  $\text{PM}_{10}$  objective at relevant receptors, it is recommended that the Council consider declaring an AQMA for  $\text{PM}_{10}$ .

- Source apportionment of  $\text{NO}_x$ , indicates road traffic emissions of  $\text{NO}_x$  are the main contribution to total  $\text{NO}_x$  concentrations, as they account for 74 - 91% of the total  $\text{NO}_x$  concentrations at receptors. Heavy-duty vehicles (HDVs) contribute around 38 - 77% to the total  $\text{NO}_x$  concentrations at receptors and exceed the LDV contributions. HDV contributions are disproportionately high given their proportion within the vehicle fleet in the AQMA.
- Source apportionment of  $\text{PM}_{10}$ , indicates background sources of  $\text{PM}_{10}$  make a significant contribution to total  $\text{PM}_{10}$  concentrations, as they account for 28-59% of the total  $\text{PM}_{10}$  concentrations at receptors, with the majority of this being made up of secondary particulates, residual and salt contributions. Road traffic contribute 41% to 72% of the total  $\text{PM}_{10}$  concentration at receptors. Light duty vehicles (LDVs) contribute around 7 – 24 and heavy-duty vehicles (HDVs) contribute around 11-36% to the total  $\text{PM}_{10}$  concentrations at receptors. Brake and tyre wear contribute around 13-29% to the total  $\text{PM}_{10}$  concentrations at receptors. HDV contributions are disproportionately high given their proportion within the vehicle fleet in the AQMA. On Commercial Street and Seagate, where there are significant bus movements, the HDV contribution exceeds the LDV contribution.

# 1 Introduction

## 1.1 Project Background

This report fulfils the requirements of the Local Air Quality Management (LAQM) process as set out in Part IV of the Environment Act (1995), the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 and the relevant Policy and Technical Guidance documents. The LAQM process places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether or not the air quality objectives are likely to be achieved. Where exceedences are considered likely the local authority must then declare an Air Quality Management Area (AQMA), and prepare an Air Quality Action Plan (AQAP) setting out the measures it intends to put in place in pursuit of the objectives.

This Further Assessment is a requirement of the third round of review and assessment for Dundee City Council. Its intention is to supplement information in the Air Quality Management Area (AQMA) resulting from the previous review and assessment.

Bureau Veritas was commissioned by Dundee City Council to undertake the Further Assessment of the AQMA declared for nitrogen dioxide (NO<sub>2</sub>) in 2006. This incorporates the requirements for assessment of NO<sub>2</sub> at two junctions (Forfar Road/Kingsway and Arbroath Road/Victoria Street/Princes Street) identified through the Council's Annual Progress Report 2008. In addition, the report includes consideration to the PM<sub>10</sub> objectives for roads and junctions within the AQMA. The PM<sub>10</sub> assessment specifically models road traffic sources (not all PM<sub>10</sub> sources) at specific roads and junctions in the AQMA as recommended in the Annual Progress Report 2007.

## 1.2 Air Quality Objectives

The air quality objectives applicable to LAQM in Scotland are set out in the Air Quality (Scotland) Regulations 2000 (Scottish SI 2000 No 97), the Air Quality (Scotland) (Amendment) Regulations 2002 (Scottish SI 2002 No 297), and are shown in Table 1.1. This table shows the objectives in units of microgrammes per cubic metre µg/m<sup>3</sup> (milligrammes per cubic metre, mg/m<sup>3</sup> for carbon monoxide) with the number of exceedences in each year that are permitted (where applicable).

## 1.3 Local Air Quality Management (LAQM) Review and Assessment

As established by the Environment Act 1995 Part IV, all local authorities in the UK are under a statutory duty to undertake an air quality assessment within their area and determine whether they are likely to meet the air quality objectives set down by Government for a number of pollutants. The process of review and assessment of air quality undertaken by local authorities is set out under the LAQM regime and involves a phased three yearly assessment of local air quality. Where the results of the review and assessment process highlight that problems in the attainment of health-based objectives for air quality will arise, the authority is required to declare an AQMA – a geographic area defined by high levels of pollution and exceedences of AQS objectives.

The LAQM regime was first set down in the 1997 National Air Quality Strategy (NAQS)<sup>2</sup> and introduced the idea of local authority 'Review and Assessment'. The UK Government subsequently published policy and technical guidance related to the review and assessment processes and this has since been revised. The latest documents include Policy Guidance (LAQM.PG (S) (09))<sup>3</sup> and Technical Guidance (LAQM.TG (09))<sup>4</sup>. The guidance lays down a progressive, but continuous, framework for the local authorities to carry out their statutory duties to monitor, assess and review air quality in their area and produce action plans to meet the air quality objectives.

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<sup>2</sup> DoE, 1997, 'The United Kingdom National Air Quality Strategy', The Stationery Office

<sup>3</sup> Policy Guidance LAQM.PG (S) (09) (2009), Part IV of the Environment Act 1995, Local Air Quality Management, Published by the Scottish Government, The Stationery Office

<sup>4</sup> Technical Guidance LAQM.TG (09) (2009), Part IV of the Environment Act 1995, Local Air Quality Management, Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland, The Stationery Office





Defra and the Devolved Administrations released the latest Policy and Technical Guidance in February 2009, in anticipation of the fourth round of review and assessment. The fourth round begins with the Updating and Screening Assessment (USA) required to be completed by local authorities by the end of April 2009, and builds upon the Council's previous work in the first three rounds.

**Table 1.1 Air Quality Objectives included in Regulations 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 $\mu\text{g}/\text{m}^3$	Running annual mean	31.12.2003
	3.25 $\mu\text{g}/\text{m}^3$	Running annual mean	31.12.2010
1,3-Butadiene	2.25 $\mu\text{g}/\text{m}^3$	Running annual mean	31.12.2003
Carbon monoxide	10.0 $\text{mg}/\text{m}^3$	Running 8-hour mean	31.12.2003
Lead	0.5 $\mu\text{g}/\text{m}^3$	Annual mean	31.12.2004
	0.25 $\mu\text{g}/\text{m}^3$	Annual mean	31.12.2008
Nitrogen dioxide	200 $\mu\text{g}/\text{m}^3$ not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
	40 $\mu\text{g}/\text{m}^3$	Annual mean	31.12.2005
Particles (PM <sub>10</sub> ) (gravimetric)	50 $\mu\text{g}/\text{m}^3$ , not to be exceeded more than 35 times a year	24-hour mean	31.12.2004
	40 $\mu\text{g}/\text{m}^3$	Annual mean	31.12.2004
	50 $\mu\text{g}/\text{m}^3$ , not to be exceeded more than 7 times a year	24-hour mean	31.12.2010
	18 $\mu\text{g}/\text{m}^3$	Annual mean	31.12.2010
Sulphur dioxide	350 $\mu\text{g}/\text{m}^3$ , not to be exceeded more than 24 times a year	1-hour mean	31.12.2004
	125 $\mu\text{g}/\text{m}^3$ , not to be exceeded more than 3 times a year	24-hour mean	31.12.2004
	266 $\mu\text{g}/\text{m}^3$ , not to be exceeded more than 35 times a year	15-minute mean	31.12.2005

#### 1.4 Summary of Review and Assessment in Dundee

Previous review and assessments have been reported as follows:

- Stage 1 (1998) and Stage 2 (2000)
- Updating and Screening Assessment (2003)
- Detailed Assessment (2005)
- Progress Report (2005)
- Updating and Screening Assessment (2006)
- Progress Report (2007)

The previous assessments of the air quality in Dundee City concluded that there were likely to be exceedences of the annual mean objective for NO<sub>2</sub> as a result of traffic sources in Dundee in the following areas:

- Seagate

- Nethergate / Marketgait Junction
- Dock Street
- Commercial Street
- Victoria Road / Hilltown/ Meadowside Junction
- Lochee Road / Rankine Street Junction
- Lochee Road / Dudhope Junction
- Logie Street / Loons Road Junction

Following the detailed modelling of the NO<sub>2</sub> and PM<sub>10</sub> concentrations in Dundee declared the whole of Dundee city centre as an AQMA for NO<sub>2</sub> in July 2006. The results of the Detailed Assessment were inconclusive for PM<sub>10</sub> as there was insufficient confidence in the verification of the modelled results for 2010. It was concluded that additional monitoring and modelling would be required to determine whether an AQMA for PM<sub>10</sub> would be required. This is assessed within this Further Assessment report.

The Scottish Environment Protection Agency (SEPA) and the Scottish Government accepted the conclusions of the Detailed Assessment and funded the expansion of the PM<sub>10</sub> monitoring network. This included OSIRIS particulate monitoring in potential areas of exceedence, a new background site, a local gravimetric factor intercomparison study and speciation of particles. The outcome of the Updating and Screening Assessment 2006 showed that the only monitored PM<sub>10</sub> concentrations predicted to exceed the annual mean objective (2010) were in Union Street. However, this result was adversely influenced by major construction projects in the vicinity and may not have been truly representative of ambient concentrations present at this location. The results of the monitoring studies are included in this assessment and have been used for model verification purposes.

The 2007 Annual Progress Report analysis of the 2006 data for nitrogen dioxide confirmed the need for continuance of the AQMA and development of the Action Plan. Two new areas of potential exceedence of the annual mean were identified at the Kingsway/Forfar Road and Arbroath Road/Albert Street Junctions, which have been considered in this 2009 Assessment.

Dundee City Council's 2006 PM<sub>10</sub> monitoring results indicated exceedences of the 2010 PM<sub>10</sub> annual mean objective for the following locations:

- Victoria Road / Hilltown Junction
- Seagate
- Logie Street
- Lochee Road

Union Street was also very close to exceeding the annual mean objective in 2010, and remains an area of concern due to increasing PM<sub>10</sub> concentrations at this city centre location. More than seven exceedences of the 24-hour mean standard were also recorded at the above locations during 2006. The PM<sub>10</sub> concentrations were measured using OSIRIS monitors, which are not recommended for detailed assessments. In addition, it has been predicted that the extra traffic and necessary junction works associated with a new superstore will lead to an exceedence of the PM<sub>10</sub> annual mean objective (2010) at existing receptors close to the Kingsway/Forfar Road junction. A six-month monitoring study will commence in the area once the junction works are completed to check the accuracy of the modelled predictions.

The 2006 PM<sub>10</sub> results indicated that a detailed assessment of PM<sub>10</sub> should be undertaken. These areas have all been considered in this 2009 Assessment.

The Sulphur dioxide monitoring results for 2006 indicated that all the NAQS objectives were met at monitoring locations in Dundee.

## 1.5 Scope and Methodology of the Further Assessment

The approach of the Further Assessment is to provide the Local Authority with an opportunity to supplement the information gathered in the previous LAQM reports and confirm whether the AQMA is still required or if it needs to be amended (increased or reduced).

The methodology is based on dispersion modelling and includes the following:

- Review of additional monitoring data acquired since the Detailed Assessment;
- Assessment of reduction in pollutant concentrations that is required to meet the AQS objectives in the AQMA;
- Source apportionment of pollutants (including relevance to background contributions and different vehicle classifications) on the roads of concern.

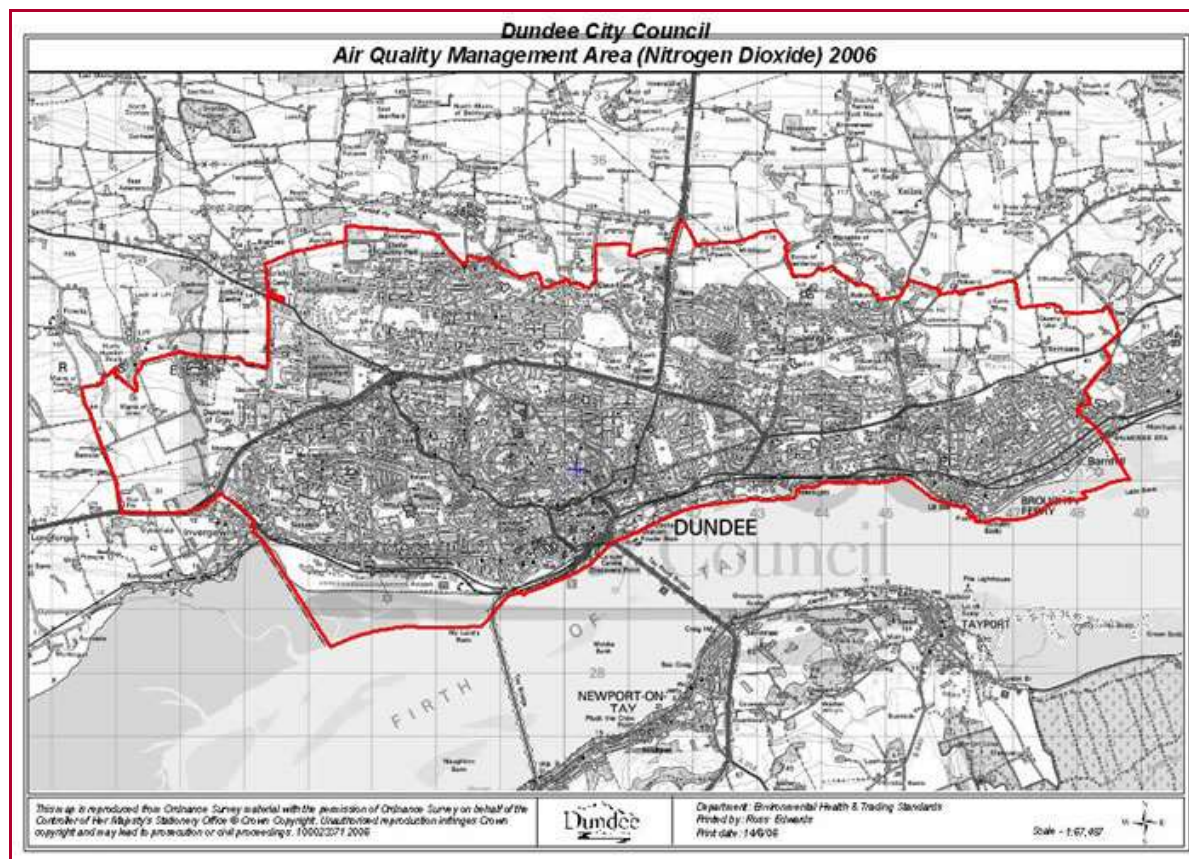
Detailed dispersion modelling was carried out as part of the Further Assessment based on the ADMS-Roads (v2.3) atmospheric dispersion model. Monitoring results from the automatic monitoring sites and diffusion tube sites were used to verify the modelled results. NO<sub>2</sub> and PM<sub>10</sub> concentrations predicted for the baseline (verification) year, 2007 and future year 2010 were completed. The dispersion modelling was undertaken in accordance with the methodologies provided in the Technical Guidance (LAQM.TG(09)) Guidance for detailed and further assessments.

## 2 Baseline Information

### 2.1 Air Quality Management Area

In 2006, Dundee City Council declared an AQMA for NO<sub>2</sub> encompassing the city centre. The designated NO<sub>2</sub> AQMA is shown in figure 2.1.

**Figure 2.1 – Dundee City Air Quality Management Area**



### 2.2 Traffic Data

Dundee City Council has provided updated traffic counts for the roads in the AQMA. Data included the annual average daily traffic (AADT), speed data and breakdown of traffic flows into vehicle categories. For the purpose of this assessment vehicle speed was reduced near junctions to 20kph to account for stop/ start emissions.

Traffic data were projected to 2010 using growth factors from Tempro<sup>5</sup> adjusted for the Dundee area as provided by Dundee City Council. These were for projection of 2007 to 2010, 1.011 for principal A roads and 1.037 for B roads.

<sup>5</sup> Tempro (Trip End Model Presentation Program) version 6.1, 5.4 datasets

A number of different traffic data sources were made available for use in this assessment, including automatic count data, 12-hour junction counts and peak hour data traffic model. The most robust available data for each road link has been incorporated into the model, including consideration to the length of the survey and available information on vehicle classifications. The 12-hour survey data was factored to 24-hour using a factor of 1.15 as supplied from Dundee City Council and derived from their 2007 Road Traffic Reduction Act monitoring sites. The peak hour data was factored to 24-hour by consultants SIAS Limited on behalf of Dundee City Council.

The traffic data used in this assessment are summarised in Appendix 1.

## 2.3 Air Quality Monitoring Data

### 2.3.1 Automatic Monitoring Locations

Dundee City Council undertakes automatic monitoring of PM<sub>10</sub> at seven sites in the city centre. These are all located within the Dundee AQMA (NO<sub>2</sub>).

Dundee City Council uses three types of measurement methods for PM<sub>10</sub> monitoring:

- The Partisol sampler is an equivalent method with the EU reference method for measuring particulates. The Partisol gravimetric sampler collects daily samples onto a filter for subsequent weighing to determine the PM<sub>10</sub> concentration.
- The tapered element oscillating microbalance (TEOM) system determines particulate concentrations by continuously weighing particles that are deposited onto a filter. This is an approved analyser for detailed and further assessments although is not gravimetric equivalent
- The OSIRIS particulate monitors supplied by Turnkey Instruments use a nephelometer which sizes and counts individual particles as they pass through a laser beam. This is an indicative analyser, which is suitable as a screening tool for LAQM, but results should be treated with some caution.

Locations of the analysers across the city are:

- Partisol at Broughty Ferry Road (with TEOM co-location);
- TEOM at Union Street (with OSIRIS co-location);
- TEOM at Mains Loan, and
- Four Osiris monitors located at Seagate, Victoria Road, Lochee Road and Logie Street.

The Partisol is considered as a gravimetric equivalent analyser in the "*UK Equivalence Programme for Monitoring of Particulate Matter*" and as such can be compared directly with the prescribed objectives. The TEOM and Osiris monitors are not gravimetric equivalent, and as such data is required to be adjusted to enable comparison with the prescribed objectives. In the absence of suitable sites to enable adjustment of TEOM results using the LAQM.TG(09) recommended methodology of applying the volatile correction model. Dundee City Council has derived their own local factors from co-location studies to enable adjustment of both TEOM and Osiris data.

Comparison of the equivalent daily averages in 2007 for the Partisol and TEOM co-location study at Broughty Ferry Road showed that the TEOM was under-reading compared to the Partisol and the TEOM results have therefore been factored by the local factor of 1.06. A comparison of all methods to factor the TEOM results (1.3, 1.14, local factor and VCM) is provided in Appendix 2.

Comparing equivalent daily averages in 2007 for the TEOM and OSIRIS at Union Street found that the OSIRIS was over-reading compared to the TEOM. This meant the OSIRIS would need to be divided by a factor of 1.1 to be equivalent to the TEOM. Hence, the annual mean OSIRIS results presented in this report have been adjusted prior to gravimetric correction factors being applied.

Automatic monitoring of nitrogen dioxide is undertaken at four sites in Dundee city centre: Whitehall Street, Union Street, Lochee Road and Seagate. All sites are roadside/kerbside sites within the AQMA.

The ratified results from the continuous monitoring in Dundee for 2007 are shown in Table 2.1 for NO<sub>2</sub> and PM<sub>10</sub>. The results indicate exceedences of the NO<sub>2</sub> annual mean objective at three sites Whitehall Street, Lochee Road and Seagate. There are potential exceedences at two Osiris sites with respect to the 2010 PM<sub>10</sub> objectives, although these are kerbside sites and not representative of relevant exposure. In addition, data from these analysers should be treated with some caution as they are screening tools, which are not recommended in the Technical Guidance LAQM.TG(09) for use for detailed and further assessments.

The data from roadside sites has been used for model verification purposes.

### 2.3.2 Diffusion Tube Monitoring Locations

Outside the continuous monitoring network, Dundee City Council operated 79 diffusion tube sites in 2007. Of, these 21 sites exceeded the annual mean NO<sub>2</sub> objective in 2007. These are all within the Dundee AQMA.

The diffusion tubes are supplied by Gradko and analysed by Dundee Scientific Services, utilising the 20% Triethanolamine (TEA) in water preparation method. Dundee Scientific Services participate in the Workplace Analysis Scheme for Proficiency (WASP) for NO<sub>2</sub> diffusion tube analysis and the Annual Field Inter-Comparison Exercise. These provide strict performance criteria for participating laboratories to meet, thereby ensuring NO<sub>2</sub> concentrations reported are of a high calibre. The lab follows the procedures set out in the Harmonisation Practical Guidance.

With regard to the application of a bias adjustment factor for the diffusion tubes, the technical guidance LAQM.TG (09) and Review and Assessment Helpdesk recommends use of a local bias adjustment factor where available and relevant to diffusion tube sites. Four local co-location studies were undertaken in 2007 with good data capture, which generated the following bias adjustment factors:

- Dundee Lochee Road - 0.92
- Dundee Seagate - 0.89
- Dundee Union Street - 0.71
- Dundee Whitehall Street - 0.94

These were provided to the Review and Assessment Helpdesk, who calculated the overall local bias for the four sites as:

- Dundee City Council - 0.86

The bias adjusted results are shown in Table 2.2 and mapped in Figure 2.2.



**Table 2.1: Dundee continuous analyser concentrations ( $\mu\text{g}/\text{m}^3$ ) in 2007**

Location	Site Type	X	Y	%Data Capture	2007 Annual Mean $\text{NO}_2$ in $\mu\text{g}/\text{m}^3$	2007 Number of Exceedences of the hourly mean objective	%Data Capture	2007 Annual Mean $\text{PM}_{10}$ in $\mu\text{g}/\text{m}^3$	2007 Number of Exceedences of the 24-hour mean $\text{PM}_{10}$ objective
Whitehall Street (Romon)	Kerbside	340278	730156	91	42	0	-	-	-
Union Street (Rollalong)	Roadside	340235	730091	99	36	0	90	18	3
Seagate (Osiris)	Kerbside	340539	730528	-	-	-	92	16	1
Seagate (Romon)	Kerbside	340487	730446	94	49	1	-	-	-
Lochee Road (Romon)	Kerbside	338861	730773	93	53	0	-	-	-
Lochee Road (Osiris)	Kerbside	338920	730693	-	-	-	91	22	3
Victoria Road (Osiris)	Kerbside	340230	730673	-	-	-	91	18	4
Logie Street (Osiris)	Kerbside	338176	731298	-	-	-	87	20	8
Mains Loan (Teom)	Urban Background	340972	731893	-	-	-	100	12	2
Broughty Ferry Road (Partisol)	Urban Industrial	341971	730978	-	-	-	100	15	4



**Table 2.2: Dundee NO<sub>2</sub> Diffusion Tube Concentrations (µg/m<sup>3</sup>) in 2007**

LOCATION	Site Type	X	Y	No. Months	Average Raw Data 2007	Bias Corrected 2007 Annual Mean
ABERTAY	Roadside	340047	730629	11	54.1	<b>46.5</b>
ALBERT ST (SHANDON PL)	roadside	341174	731578	12	39.9	34.3
ALBERT ST (1)	kerbside	341105	731210	12	38.4	33.0
ALBERT ST (FISH)	kerbside	341139	731476	12	35.7	30.7
ARBROATH RD (13)	kerbside	341111	731070	12	44.2	<b>38.0</b>
ARTHURSTONE TCE (10)	kerbside	341051	731203	12	26.9	23.1
BALGAVIES PL	urban background	343082	731465	12	20.5	17.6
BANK ST/ REFORM ST	kerbside	340228	730337	11	34.1	29.4
BIRNAM PL	urban background	337531	730914	12	12.5	10.8
BROOK ST B/F	kerbside	346293	730872	12	26.6	22.9
BROUGHTY FERRY RD (141)	roadside	343322	731074	12	47.0	<b>40.4</b>
CLAYPOTTS JUNCTION	roadside	345315	732103	12	28.6	24.6
CLEPINGTON RD/ FORFAR RD	kerbside	341385	732121	12	42.7	<b>36.8</b>
COMMERCIAL ST	kerbside	340328	730431	12	38.9	33.5
COMMERCIAL ST (WATERSTONES)	Roadside	340481	730325	12	46.7	<b>40.2</b>
COMMERCIAL ST /DOCK ST 2	roadside	340565	730263	12	44.9	<b>38.6</b>
CRICHTON ST	kerbside	340331	730162	12	36.8	31.6
DENS RD (CROSSING)	roadside	340726	731238	12	41.0	35.2
DOCK ST (CAROL WHYTE) 2	roadside	340524	730216	12	43.9	<b>37.8</b>
DOCK ST (SHERIDANS)	kerbside	340395	730086	12	54.3	<b>46.7</b>
DOCK ST (UNICORN)	roadside	340660	730348	11	43.7	<b>37.6</b>
DURA ST (FORTES)	kerbside	341150	731576	12	45.9	<b>39.4</b>
EARL GREY PL (PARK)	urban background	340699	730019	12	24.0	20.6
EASTPORT ROUNDABOUT	roadside	340651	730623	12	41.3	35.5
FORFAR RD	kerbside	341437	732360	12	53.2	<b>45.7</b>
HAREFIELD RD (35)	kerbside	338360	731854	11	37.9	32.6
HILLTOWN (SUITES)	roadside	340088	731116	12	38.6	33.2
KING ST (12/14)	kerbside	340598	730757	12	33.4	28.7
KINGSWAY EAST ROUNDABOUT	roadside	343107	731740	10	46.5	<b>40.0</b>
KINGSWAY/ MAINS LOAN	roadside	341123	732469	12	39.6	34.1
KINGSWAY/ PITKERRO RD	roadside	341959	732300	12	35.7	30.7
KINGSWAY/ STRATHMARTINE RD (S)	kerbside	339219	732832	12	50.3	<b>43.3</b>
LOCHEE RD (138)	kerbside	338936	730680	12	61.2	<b>52.6</b>

**Table 2.2 (Continued): Dundee NO<sub>2</sub> Diffusion Tube concentrations (µg/m<sup>3</sup>) in 2007**

LOCATION	Site Type	X	Y	No. Months	Average	Bias corrected 2007 Annual Mean
LOCHEE RD (140 TRAFFIC LTS)	roadside	338927	730685	12	62.1	<b>53.4</b>
LOCHEE RD (184)	kerbside	338767	730856	12	44.3	<b>38.1</b>
LOCHEE RD (ROMON Triplicate)	kerbside	338861	730773	12	57.2	<b>49.2</b>
LOCHEE RD/POLEPARK RD	kerbside	339016	730586	12	35.9	30.9
LOGIE ST (114)	roadside	338184	731293	12	60.7	<b>52.2</b>
LOGIE ST (98)	kerbside	338252	731258	10	40.9	35.2
LOONS RD (1)	roadside	338211	731293	12	45.5	<b>39.1</b>
MARKETGAIT	roadside	339956	730090	12	38.4	33.0
MEADOWSIDE	roadside	340245	730651	12	71.4	<b>61.4</b>
MUIRTON RD (6)	roadside	338152	731293	12	33.0	28.4
MYREKIRK RD	kerbside	335420	731733	12	38.2	32.9
NETHERGATE (B&B)	kerbside	340163	730061	12	50.1	<b>43.1</b>
NETHERGATE (BRADFORD)	roadside	340274	730171	12	43.5	<b>37.4</b>
NETHERGATE (CHARLIE T)	kerbside	340033	729957	12	45.4	<b>39.1</b>
NETHERGATE (TRADES HOUSE)	roadside	340230	730124	12	46.1	<b>39.6</b>
NETHERGATE/ MARKETGAIT	roadside	340074	729984	12	41.9	<b>36.0</b>
NETHERGATE/SOUTH TAY ST	roadside	339987	729919	12	34.4	29.6
PERTH RD/HAWKHILL	kerbside	338742	729828	12	29.0	25.0
RANKINE ST (2)	roadside	338768	730900	12	46.4	<b>39.9</b>
SEAGATE	roadside	340545	730532	12	49.2	<b>42.3</b>
SEAGATE (Triplicate)	kerbside	340487	730446	12	55.3	<b>47.5</b>
SEAGATE (YATES)	roadside	340467	730388	12	47.1	<b>40.5</b>
SOAPWORK LANE	roadside	340100	730649	12	40.7	35.0
ST ANDREWS ST (JAF)	kerbside	340514	730587	12	40.5	34.8
ST ANDREWS ST (PB)	kerbside	340532	730551	12	48.2	<b>41.5</b>
ST MARY'S FLATS	roadside	339039	730624	12	23.9	20.6
STRATHMORE AVE (353)	roadside	339609	731871	12	44.2	<b>38.0</b>
TRADES LANE (31)	kerbside	340584	730488	12	42.2	<b>36.3</b>
UNION ST (GOODFELLOWS)	kerbside	340260	730083	12	37.7	32.4

\* Exceedences of the annual mean objective are shown in bold. Results from sites approaching the annual mean objective (>36µg/m<sup>3</sup>) are highlighted in red.

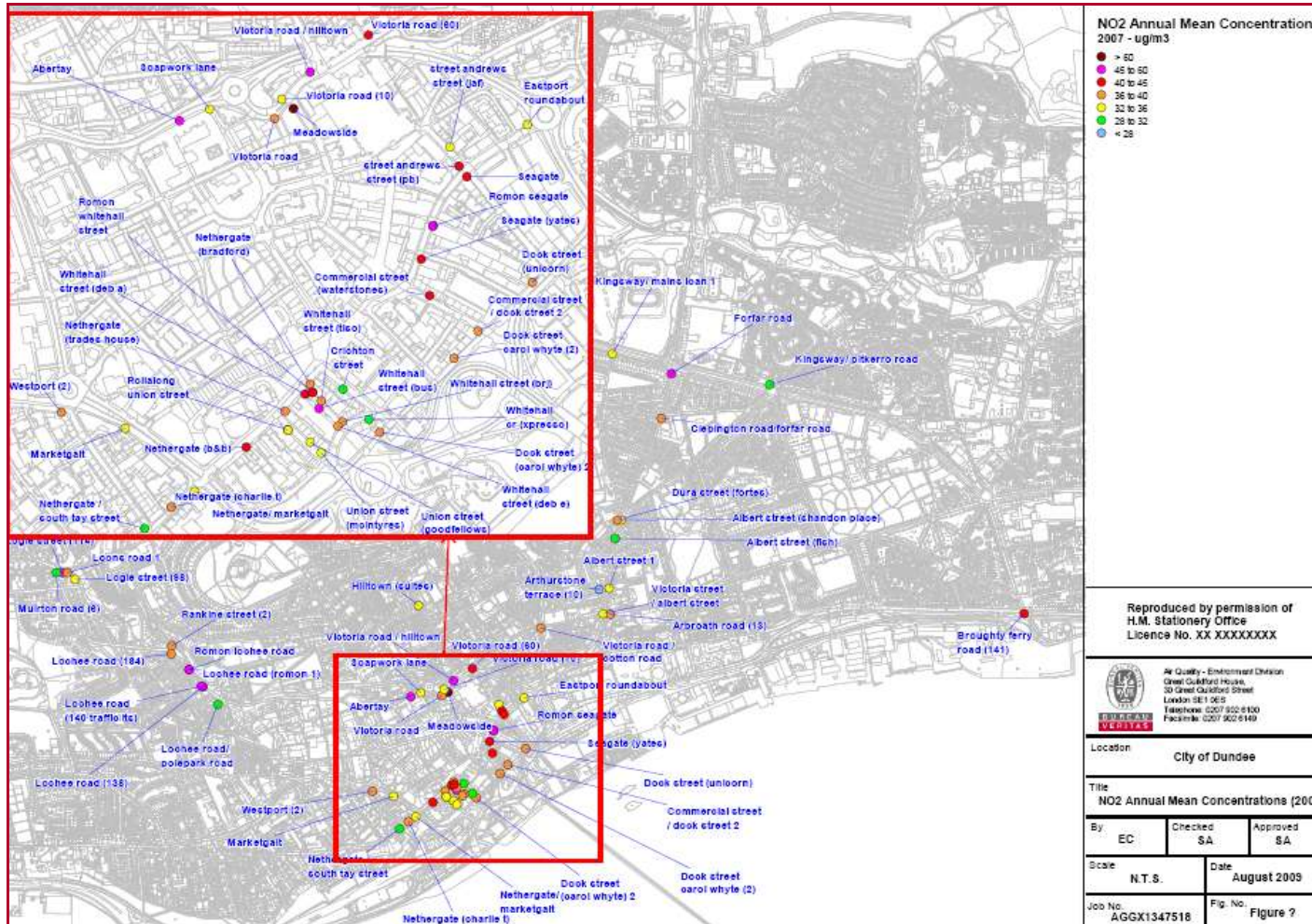
**Table 2.2 (Continued): Dundee NO<sub>2</sub> Diffusion Tube concentrations (µg/m<sup>3</sup>) in 2007**

LOCATION	Site Type	X	Y	No. Months	Average	Bias corrected 2007 Annual Mean
UNION ST (McINTYRES)	kerbside	340293	730051	12	38.1	32.7
UNION ST (ROLLALONG Triplicate)	roadside	340235	730091	12	50.4	<b>43.4</b>
VICTORIA RD	roadside	340212	730633	12	42.7	<b>36.7</b>
VICTORIA RD (10)	roadside	340225	730667	12	38.2	32.9
VICTORIA RD (60)	roadside	340375	730779	12	47.8	<b>41.1</b>
VICTORIA RD / COTTON RD	kerbside	340740	730996	12	42.5	<b>36.6</b>
VICTORIA RD / HILLTOWN	roadside	340274	730714	12	64.9	<b>55.8</b>
VICTORIA ST / ALBERT ST	kerbside	341071	731072	12	39.7	34.1
WESTPORT (2)	roadside	339842	730122	12	45.2	<b>38.9</b>
WHITEHALL CR (XPRESSO)	kerbside	340376	730109	12	35.2	30.3
WHITEHALL ST (BRJ)	kerbside	340330	730106	12	42.2	<b>36.3</b>
WHITEHALL ST (BUS)	roadside	340289	730128	12	56.5	<b>48.6</b>
WHITEHALL ST (DEB A)	kerbside	340265	730153	12	50.4	<b>43.4</b>
WHITEHALL ST (DEB E)	kerbside	340322	730098	11	42.9	<b>36.9</b>
WHITEHALL ST (ROMON Triplicate)	roadside	340278	730156	12	44.8	<b>38.5</b>
WHITEHALL ST (TISO)	roadside	340293	730142	12	45.1	<b>38.8</b>
WOODSIDE AVE	urban background	340776	732307	11	21.0	18.1

\* Exceedences of the annual mean objective are shown in bold. Results from sites approaching the annual mean objective (>36µg/m<sup>3</sup>) are highlighted in red.



Figure 2.2 – Dundee NO<sub>2</sub> Diffusion Tube Monitoring Sites



### 2.3.3 Background Concentrations

Local background monitoring data from the automatic background monitoring station at Mains Loan was used to derive background PM<sub>10</sub> for the modelling assessment. For NO<sub>2</sub>, data was used from the diffusion tube monitoring in the city centre. An average was taken of the three background sites, which were considered as representative to the modelled area: Balgavies Place, Earl Grey Place and Woodside Avenue. For NO<sub>x</sub>, the equivalent NO<sub>x</sub> to NO<sub>2</sub> concentration was taken from the modelled Air Quality Archive background maps<sup>6</sup>. Background concentrations for 2010, were also projected from the Air Quality Archive background maps.

**Table 2.3 - Background Concentrations for Dundee (µg/m<sup>3</sup>)**

Pollutant	2007 Background (µg/m <sup>3</sup> )	2010 Background (µg/m <sup>3</sup> )
NO <sub>x</sub>	27.8	23.9
NO <sub>2</sub>	18.8	16.7
PM <sub>10</sub>	12.0	11.6

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<sup>6</sup> [www.airquality.co.uk](http://www.airquality.co.uk)

### 3 Dispersion Modelling Methodology

Detailed dispersion modelling of PM<sub>10</sub> was undertaken based on ADMS-Roads Extra (version 2.3) atmospheric dispersion model from Cambridge Environmental Research Consultants (CERC).

ADMS-Roads is a Gaussian plume dispersion model, which has been extensively used in local air quality management and has formed the basis for many AQMA declarations. A number of validation studies have been completed during the model development, which show overall good agreement between model outputs and observations at continuous monitoring sites. The street canyon option was activated for sections of Dundee city centre where properties on both sides are close to the road, including Seagate, Union Street, Commercial Street, Crichton Street, Nethergate, Victoria Street, Meadowside, Albert Street and Dock Street. With respect to treatment of North Marketgait tunnel, all roads in this area have been set at the same height in the model; therefore, the model runs are more precautionary with respect to receptors above North Marketgait on Victoria Road/Hilltown.

Whilst vehicle exhaust emissions are expected to decline in future years, emissions associated with both brake and tyre wear, and resuspension, are unlikely to reduce, unless traffic flows change substantially. Brake and tyre wear emissions are considered to make a substantial contribution to road traffic PM<sub>10</sub> emissions and have therefore been modelled in the assessment. This component has been modelled separately for PM<sub>10</sub> using the specific emissions factors from the National Atmospheric Emissions Inventory<sup>7</sup> data warehouse. The contribution has then been added to the modelled vehicle exhaust emissions to calculate the total roads PM<sub>10</sub> prior to model verification.

The modelled area includes roads with gradients greater than 2.5%, which may affect vehicle exhaust emissions as the power demand from the vehicle engine alters. Dundee city council has provided the gradients for roads in the modelled area that meet this criterion. For heavy-duty vehicle contributions, amended speed related emissions factors have been added to the model to improve model accuracy.

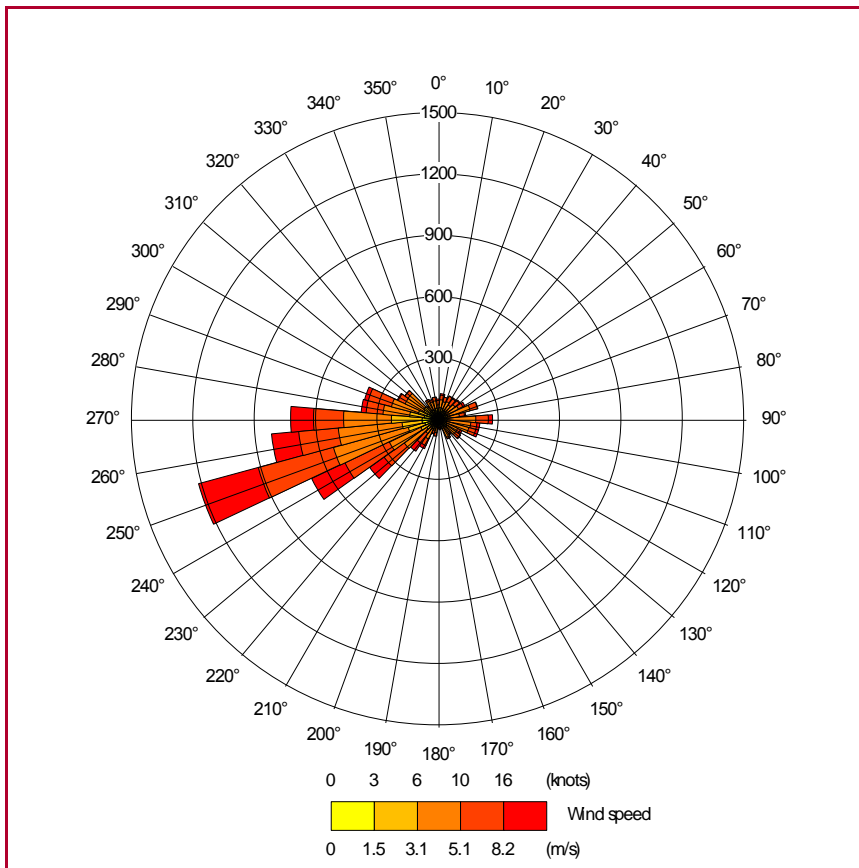
Dispersal of pollutant emissions is dependent (amongst other factors like topography and street canyon effects) upon the prevailing meteorological conditions at the time of emissions release. Hourly sequential meteorological data from the nearest representative Met Office station (Leuchars) was used in this assessment, based on year 2007. The wind rose for meteorological data is shown in figure 3.1.

Most Gaussian-type models do not use the lines in the meteorological data set, which have calm winds in its calculations. ADMS-Roads treats calm wind conditions by setting the minimum wind speed to 0.75 m/s. It is recommended in LAQM.TG (09) that the meteorological data file be tested within a dispersion model and the relevant output log file checked, as this will confirm the number of missing hours and calm hours calculated by the dispersion model. This is important when considering predictions of high percentiles and the number of exceedences. The Leuchars 2007 met file has 8583 lines of useable met data out of the total 8760 for the year i.e. 98% data capture. Of these, there are 291 lines of calm conditions where the minimum wind speed has been set to 0.75 m/s.

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<sup>7</sup> [www.naei.org.uk/data\\_warehouse.php](http://www.naei.org.uk/data_warehouse.php).

**Figure 3.1 – Leuchars 2007 Hourly Sequential Meteorological Data**



## 4 Results

### 4.1 Model Verification and Adjustment

Model verification at specific locations was carried out prior to predicting concentrations within the AQMA through contour mapping. The objectives of the model verification are:

- to evaluate model performance,
- to show that the baseline is well established, and
- to provide confidence in the assessment

Comparison of the modelled and monitored results was carried out based on local NO<sub>2</sub> and PM<sub>10</sub> monitoring data from (automatic and diffusion tube) roadside sites in Dundee.

Modelled results may not compare well with monitored data for a number of reasons including:

- Errors in traffic flow and speed data estimates,
- Model setup (including street canyons, road widths, receptor locations),
- Model limitations (treatment of roughness and meteorological data),
- Uncertainty in monitoring data (notably use of short-term data or singly placed diffusion tubes).
- Uncertainty in emissions factors.

The above factors were investigated as part of the model verification process to minimise the uncertainties as far as practicable. Street canyon width was adjusted to make sure that the monitoring site was effectively within the modelled street canyon. A comparison of monitored and verified modelled results is provided in Table 4.1.

Model verification for PM<sub>10</sub> was undertaken using the Union Street TEOM and Broughty Ferry Road Partisol as these were considered the most robust monitoring data for this purpose. Comparison with Osiris monitors has also been made (Appendix 2) and the verification shows similar results between monitors within street canyons – Union Street, Seagate and Victoria Road. Model verification has been undertaken in the central Dundee area and Lochee Road/Logie Street area using the Union Street verification factor. For the Broughty Ferry modelled area, the Broughty Ferry Road Partisol has been used for verification, as this is more representative of this area. For NO<sub>x</sub>/NO<sub>2</sub> verification, the central Dundee area has been separated from the Lochee Road/Logie Street and Broughty Ferry Road areas, as the model shows differing performance between these areas (within the central Dundee area street canyons have been incorporated into the model).

The full verification methodology for both PM<sub>10</sub> and NO<sub>x</sub>/NO<sub>2</sub> is shown in Appendix 3.



**Table 4.1 – Model Verification Results at Monitoring Sites in Dundee**

Site	Pollutant	Site Type	2007 Annual Mean Modelled Concentrations ( $\mu\text{g}/\text{m}^3$ )	2007 Annual Mean Monitored Concentrations ( $\mu\text{g}/\text{m}^3$ )	Difference predicted / monitored 2007 (%)
Union Street TEOM PM <sub>10</sub> (Gravimetric)	PM <sub>10</sub>	R	18	18	0
Broughty Ferry Road Partisol PM <sub>10</sub> (Gravimetric)	PM <sub>10</sub>	R	14.7	14.7	0
Abertay	NO <sub>2</sub>	R	42.6	46.5	-8
Albert Street (fish)	NO <sub>2</sub>	K	39.6	30.7	29
Albert Street (shandon place)	NO <sub>2</sub>	R	34.2	34.3	0
Albert Street 1	NO <sub>2</sub>	K	38.4	33	16
Arbroath Road (13)	NO <sub>2</sub>	K	36.4	38	-4
Arthurstone terrace (10)	NO <sub>2</sub>	K	23	23.1	0
Clepington Road/Forfar Road	NO <sub>2</sub>	K	28	36.8	-24
Commercial Street (waterstones)	NO <sub>2</sub>	R	39	40.2	-3
Crichton Street	NO <sub>2</sub>	K	35	31.6	11
Dock street (carol whyte) 2	NO <sub>2</sub>	R	51.1	37.8	35
Dock street (unicorn)	NO <sub>2</sub>	R	29.4	37.6	-22
Dura street (fortes)	NO <sub>2</sub>	K	33.4	39.4	-15
Eastport roundabout	NO <sub>2</sub>	R	31.6	35.5	-11
Kingsway/ mains loan 1	NO <sub>2</sub>	R	46.2	34.1	36
Kingsway/ pitkerro road	NO <sub>2</sub>	R	23	30.7	-25
Marketgait	NO <sub>2</sub>	R	30	33	-9
Meadowside	NO <sub>2</sub>	R	41.3	61.4	-33
Nethergate (b&b)	NO <sub>2</sub>	K	30.6	43.1	-29
Nethergate (bradford)	NO <sub>2</sub>	R	37.1	37.4	-1
Nethergate (charlie t)	NO <sub>2</sub>	K	30	39.1	-23
Nethergate (trades house)	NO <sub>2</sub>	R	36.3	39.6	-8
Nethergate/ Marketgait	NO <sub>2</sub>	R	30.5	36	-15
Seagate	NO <sub>2</sub>	R	39.2	42.3	-8
Seagate (yates)	NO <sub>2</sub>	R	36.4	40.5	-10
Soapwork Lane	NO <sub>2</sub>	R	39.4	35	13
Street Andrews Street (jaf)	NO <sub>2</sub>	K	31	34.8	-11
Street Andrews Street (pb)	NO <sub>2</sub>	K	27.9	41.5	-33
Union Street (goodfellows)	NO <sub>2</sub>	K	33.5	32.4	3
Union Street (mcintyres)	NO <sub>2</sub>	K	35.4	32.7	8
Victoria Road	NO <sub>2</sub>	R	30.2	36.7	-18
Victoria Road (10)	NO <sub>2</sub>	R	33.1	32.9	1
Victoria Road (60)	NO <sub>2</sub>	R	37.2	41.1	-10
Victoria Road / Cotton Road	NO <sub>2</sub>	K	30.4	36.6	-17
Victoria Road / Hilltown	NO <sub>2</sub>	R	59	55.8	6
Victoria street / Albert Street	NO <sub>2</sub>	K	40.1	34.1	18
Whitehall Cr (xpresso)	NO <sub>2</sub>	R	41.6	30.3	37

Table 4.1 (Continued) – Model Verification Results at Monitoring Sites in Dundee

Site	Pollutant	Site Type	2007 Annual Mean Modelled Concentrations ( $\mu\text{g}/\text{m}^3$ )	2007 Annual Mean Monitored Concentrations ( $\mu\text{g}/\text{m}^3$ )	Difference predicted / monitored 2007 (%)
Whitehall Street (brj)	NO <sub>2</sub>	K	33.5	36.3	-8
Whitehall Street (bus)	NO <sub>2</sub>	K	46.2	48.6	-5
Whitehall Street (deb a)	NO <sub>2</sub>	R	52.3	43.4	21
Whitehall Street (deb e)	NO <sub>2</sub>	K	32.4	36.9	-12
Whitehall Street (tiso)	NO <sub>2</sub>	K	32.9	38.8	-15
Forfar Road	NO <sub>2</sub>	R	33.3	45.7	-27
Commercial Street / Dock Street 2	NO <sub>2</sub>	R	41.3	38.6	7
Dock Street Carol Whyte (2)	NO <sub>2</sub>	R	29.2	37.8	-23
Nethergate / South Tay Street	NO <sub>2</sub>	R	25.5	29.6	-14
Dock Street Sheridans	NO <sub>2</sub>	R	51.3	46.7	10
Rollalong Union Street	NO <sub>2</sub>	R	31.5	35.8	-12
Romon Whitehall Street	NO <sub>2</sub>	R	36.6	42	-13
Romon Seagate	NO <sub>2</sub>	K	36.0	49.1	-27
Broughty Ferry Road (141)	NO <sub>2</sub>	R	40.4	40.4	0
Lochee Road (138)	NO <sub>2</sub>	K	38.8	52.6	-26
Lochee Road (140 traffic lts)	NO <sub>2</sub>	R	37.3	53.4	-30
Lochee Road (184)	NO <sub>2</sub>	K	41.0	38.1	8
Lochee Road/PolePark Road	NO <sub>2</sub>	K	29.5	30.9	-4
Logie Street (114)	NO <sub>2</sub>	R	43.2	52.2	-17
Logie Street (98)	NO <sub>2</sub>	K	41.9	35.2	19
Loons Road 1	NO <sub>2</sub>	R	46.0	39.1	18
Muirton Road (6)	NO <sub>2</sub>	R	29.8	28.4	5
Rankine Street (2)	NO <sub>2</sub>	R	54.7	39.9	37
Romon Lochee Road	NO <sub>2</sub>	K	44.9	52.8	-15

Summary Table	Number of Monitoring Sites
Within +10%	8
Within -10%	14
<b>Within +-10%</b>	<b>21</b>
Within +10 to 25%	7
Within -10 to 25%	19
<b>Within +-10 to 25%</b>	<b>26</b>
Over +25%	5
Under -25%	7
<b>Greater +-25%</b>	<b>12*</b>
<b>Within +-25%</b>	<b>48</b>
<b>Total</b>	<b>60</b>

\* Sites where the model is significantly overpredicting include Rankine Street, Whitehall Crescent, Kingsway/Mains Loan, Dock Street (Carol Whyte) and Albert Street (Fish); sites significantly underpredicting include Lochee Road (138&140), Romon Seagate, Forfar Road, St Andrews Street (PB), Nethergate (B&B) and Meadowside.

## 4.2 Modelled NO<sub>2</sub> concentrations

Annual average NO<sub>2</sub> concentrations were predicted for the baseline year 2007 and 2010 at a number of specific receptors representing relevant public exposure, located at the facade of properties. Additionally, predictions were made to a 5m-grid spacing across the assessment areas to produce NO<sub>2</sub> concentration contour maps for year 2007. Contour results were predicted at 1.5m from the ground to represent locations of relevant exposure at ground floor level.

Appendix 4 summarises predicted NO<sub>2</sub> results for years 2007 and 2010 at specific receptor locations in the AQMA. NO<sub>2</sub> concentration contours for year 2007 are also illustrated in Appendix 5.

The model predicted exceedences of the AQS objective in 2007 at receptors relevant of public exposure (facade of properties), within the AQMA nearest to the roadside.

Predicted results for year 2010 show a slight decrease at most of the receptors. This is due to predicted decrease in background pollution and road emissions that compensate expected traffic growth. Nevertheless, the objective is still likely to be exceeded by this date at several locations within the AQMA.

The model results at the receptor locations nearest to the road junctions in the city centre identified as at risk of exceedence of the NO<sub>2</sub> annual mean objective of 40µg/m<sup>3</sup> are shown in Table 4.2 below. Predicted concentrations above 36µg/m<sup>3</sup> are also highlighted, as these are marginally below the objective and potentially at risk of exceedence of the NO<sub>2</sub> annual mean objective.

The model results show predicted exceedences at relevant receptors along Victoria Road, Meadowside, Lochee Road, Logie Street, Commercial Street, Seagate, Dock Street, West Marketgait, Arbroath Road and Albert Street.

**Table 4.2 – NO<sub>2</sub> 2007 and 2010 Modelled Results**

Receptor name	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2010 Predicted Annual Mean NO <sub>2</sub>
41	Arbroath Road	341189	731098	<b>48.7</b>	<b>42.9</b>
120	Victoria Street	341061	731072	<b>38.3</b>	33.8
130	Lochee Road	338813	730814	<b>36.4</b>	31.8
152	Lochee Road	338791	730832	<b>36.6</b>	32.0
178	Lochee Road	338786	730837	<b>37.4</b>	32.7
206	Commercial Street	340501	730298	<b>46.1</b>	<b>41.3</b>
211	Commercial Street	340483	730326	<b>39.1</b>	34.2
221	Commercial Street	340549	730291	<b>39.0</b>	34.1
277	Albert Street	341092	731109	<b>36.4</b>	31.6
282	Eden Bank	341199	731084	<b>49.8</b>	<b>43.9</b>
294	Seagate	340499	730501	<b>37.1</b>	32.2
314	Seagate	340494	730493	<b>45.8</b>	<b>40.1</b>
367	Lochee Road	338942	730674	<b>40.5</b>	35.3
446	St Marys Street	339112	730612	<b>41.9</b>	<b>36.6</b>
486	Lochee Road	338801	730823	<b>36.2</b>	31.6
495	Lochee Road	338841	730790	<b>37.1</b>	32.4
501	Lochee Road	338922	730689	<b>39.4</b>	34.3
517	Whitehall Crescent	340347	730094	<b>36.7</b>	32.0
572	Albert Street	341155	731496	<b>36.6</b>	32.2
579	Albert Street	341092	731097	<b>37.1</b>	32.2
908	Princes Street	341058	730967	<b>40.0</b>	35.3
943	Logie Street	338232	731268	<b>40.5</b>	35.3

**Table 4.2 (Continued) – NO<sub>2</sub> 2007 and 2010 Modelled Results**

Receptor name	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2010 Predicted Annual Mean NO <sub>2</sub>
984	Seagate	340486	730440	<b>36.1</b>	31.3
1006	Arbroath Road	341205	731101	<b>54.7</b>	<b>48.6</b>
1813	Loons Road	338206	731297	<b>38.2</b>	33.4
1943	Albert Street	341093	731125	<b>41.4</b>	<b>36.4</b>
2105	Lochee Road	338931	730682	<b>39.6</b>	34.5
2229	Doig Court	338276	731237	<b>50.9</b>	<b>44.8</b>
2265	Logie Street	338249	731257	<b>39.2</b>	34.0
2311	Seagate	340535	730522	<b>37.6</b>	32.8
2514	Kingsway	341229	732426	<b>36.5</b>	32.0
3072	Forfar Road	341482	732497	<b>36.7</b>	31.9
3189	Whitehall Street	340272	730165	<b>37.9</b>	32.9
3207	Kingsway	341246	732422	<b>36.1</b>	31.6
3503	Loons Road	338213	731293	<b>37.0</b>	32.2
3615	Seagate	340518	730501	<b>42.5</b>	<b>37.3</b>
4156	Commercial Street	340524	730304	<b>44.8</b>	<b>40.7</b>
4647	Victoria Street	341078	731110	<b>37.6</b>	32.7
4674	Victoria Street	341077	731095	<b>38.5</b>	33.5
4884	Logie Street	338259	731251	<b>39.8</b>	34.6
5125	Victoria Street	341076	731076	<b>43.5</b>	<b>38.1</b>
5296	Seagate	340508	730488	<b>56.1</b>	<b>49.8</b>
5297	Seagate	340504	730480	<b>53.0</b>	<b>46.9</b>
5300	Dock Street	340330	730030	<b>83.3</b>	<b>75.3</b>
5309	West Marketgait	339811	730391	<b>58.0</b>	<b>52.6</b>
5334	Broughty Ferry Road	343315	731073	<b>39.9</b>	35.3
m1	Victoria Road	340263	730711	<b>37.1</b>	32.4
m2	Victoria Road	340235	730684	<b>51.0</b>	<b>45.0</b>
m4	Meadowside	340241	730656	<b>43.8</b>	<b>38.4</b>
m5	Meadowside	340253	730637	<b>39.3</b>	34.2
m6	Meadowside	340259	730628	<b>38.7</b>	33.7

### 4.3 Modelled PM<sub>10</sub> concentrations

Annual average PM<sub>10</sub> concentrations were predicted for the baseline year 2007 and 2010 at a number of specific receptors representing relevant public exposure, located at the facade of properties closest to the busiest junctions where exceedences were predicted in the Detailed Assessment. Additionally, predictions were made at a 5m-grid spacing across the assessment areas to produce PM<sub>10</sub> concentration contour maps for the year 2007. Contour results were predicted at 1.5m from the ground to represent locations of relevant exposure at ground floor level.

Appendix 4 shows predicted PM<sub>10</sub> results for 2007 at specific receptor locations in the AQMA. PM<sub>10</sub> concentration contours for the year 2007 are also illustrated in Appendix 5.

The model results at the receptor locations nearest to the road junctions in Dundee identified as at risk of exceedence of the 2010 PM<sub>10</sub> objectives are shown in Table 4.3 below. Receptors with predicted concentrations within 10% of the annual mean objective are also highlighted, as they are marginally below the objective level. The 2007 results show potential risk of exceedences of the 2010 annual mean objective of 18µg/m<sup>3</sup> at Seagate, Commercial Street, Dock Street, West Marketgait, Crescent Road (North Marketgait), Victoria Road, Meadowside, Albert Street, Victoria Street, Princes Street and Arbroath Road. The 2010 model predictions show reductions in concentrations with time, but there are still predicted exceedences at Seagate, Commercial Street, Dock Street, West Marketgait, Victoria Road, Meadowside, Albert Street, Victoria Street and Arbroath Road. A risk of the short-term 2010 objective is additionally predicted at Seagate, Dock Street, West Marketgait, Victoria Road and Arbroath Road.

It should also be noted that at roadside monitoring sites, PM<sub>10</sub> concentrations have been showing an increasing trend in the city centre. This is in contrast to the expected reduction in future years predicted through vehicle emissions factors and background concentration improvements.

**Table 4.3 - PM<sub>10</sub> 2007 and 2010 Modelled Results**

Receptor No.	Road Name	X(m)	Y(m)	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> objective	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> objective
7	Park Avenue	341134	731371	16.0	0	15.1	0
32	Arbroath Road	341127	731086	18.3	2	16.9	1
41	Arbroath Road	341189	731098	25.1	13	22.9	8
114	Union Street	340277	730069	16.0	0	15.0	0
120	Victoria Street	341061	731072	19.6	3	18.1	1
131	Arbroath Road	341106	731082	18.1	2	16.8	1
132	Forfar Road	341492	732566	16.1	0	15.1	0
171	Arbroath Road	341107	731067	18.2	2	16.8	1
175	Brown Street	339786	730394	17.1	1	16.2	0
179	Dura Street	341130	731556	17.2	1	16.2	0
183	Brown Street	339771	730443	16.9	1	16.0	0
189	Parker Street	339802	730656	16.1	0	15.3	0
194	Parker Street	339807	730648	16.6	1	15.7	0
206	Commercial Street	340501	730298	20.6	4	18.8	2
211	Commercial Street	340483	730326	18.1	2	16.5	0
221	Commercial Street	340549	730291	18.2	2	16.7	1
250	Albert Street	341160	731518	16.6	1	15.6	0
264	Albert Street	341144	731433	16.1	0	15.2	0
265	Albert Street	341167	731542	16.6	1	15.6	0
266	Albert Street	341137	731478	16.5	1	15.6	0
277	Albert Street	341092	731109	18.0	1	16.6	1
278	Albert Street	341079	731133	17.2	1	16.1	0
282	Eden Bank	341199	731084	25.8	14	23.5	9

**Table 4.3 (Continued) - PM<sub>10</sub> 2007 and 2010 Modelled Results**

Receptor No.	Road Name	X(m)	Y(m)	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> objective	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> objective
294	Seagate	340499	730501	17.8	1	16.3	0
314	Seagate	340494	730493	21.2	5	19.0	2
315	Candle Lane	340495	730460	16.2	0	15.1	0
362	Forfar Road	341490	732551	16.2	0	15.2	0
412	Forfar Road	341497	732597	16.5	0	15.5	0
517	Whitehall Crescent	340347	730094	17.3	1	15.9	0
521	Whitehall Crescent	340376	730106	16.3	0	15.2	0
523	Whitehall Crescent	340342	730090	16.2	0	15.0	0
572	Albert Street	341155	731496	18.2	2	17.0	1
579	Albert Street	341092	731097	18.3	2	16.9	1
583	Albert Street	341134	731464	16.4	0	15.5	0
618	Seagate	340478	730417	17.3	1	15.9	0
631	Robertson Street	341115	731057	16.1	0	15.1	0
670	Forfar Road	341235	731772	16.4	0	15.4	0
763	Arbroath Road	341115	731084	18.2	2	16.9	1
792	Forfar Road	341431	732368	16.1	0	15.0	0
862	Parker Street	339812	730636	17.6	1	16.6	1
869	Kingsway	341286	732411	17.0	1	15.9	0
908	Princes Street	341058	730967	18.6	2	17.3	1
984	Seagate	340486	730440	17.4	1	16.0	0
1006	Arbroath Road	341205	731101	29.1	24	26.4	16
1043	Arbroath Road	341092	731063	16.4	0	15.3	0
1058	Forfar Road	341226	731747	16.6	1	15.5	0
1082	Union Street	340298	730049	16.7	1	15.5	0
1249	Albert Street	341139	731489	16.5	1	15.6	0
1263	Albert Street	341131	731448	16.4	0	15.4	0
1279	Albert Street	341125	731412	16.4	0	15.4	0
1363	Arbroath Road	341140	731089	18.1	1	16.8	1
1381	Crescent Road	339860	730625	18.3	2	17.2	1
1473	Park Avenue	341139	731404	16.1	0	15.2	0
1476	Langland's Street	341123	731398	16.5	0	15.5	0
1504	Kingsway	341308	732407	16.7	1	15.7	0
1506	Kingsway	341268	732416	17.4	1	16.3	0
1508	Kingsway	341324	732401	16.3	0	15.3	0
1574	Albert Street	341095	731141	16.9	1	15.8	0
1764	Arbroath Road	341173	731105	17.4	1	16.2	0
1786	Forfar Road	341485	732514	16.9	1	15.7	0
1823	Pitkerro Road	341239	731637	16.8	1	15.8	0
1943	Albert Street	341093	731125	20.3	4	18.8	2
2211	Kingsway	341341	732397	16.2	0	15.2	0
2229	Doig Court	338276	731237	17.3	1	16.0	0
2311	Seagate	340535	730522	18.0	1	16.5	0
2331	Dura Street	341120	731544	17.3	1	16.3	0

**Table 4.3 (Continued) - PM<sub>10</sub> 2007 and 2010 Modelled Results**

Receptor No.	Road Name	X(m)	Y(m)	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> objective	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> objective
2405	Forfar Road	341494	732579	16.2	0	15.2	0
2514	Kingsway	341229	732426	17.9	1	16.8	1
3072	Forfar Road	341482	732497	17.6	1	16.3	0
3189	Whitehall Street	340272	730165	17.2	1	15.6	0
3207	Kingsway	341246	732422	17.8	1	16.7	1
3527	Ward Road	339837	730380	18.8	2	17.7	1
3557	Gellatly Street	340474	730402	16.2	0	15.0	0
3615	Seagate	340518	730501	19.9	3	18.0	1
3676	Laburn Street	339855	730640	16.2	0	15.4	0
3898	Albert Street	341170	731551	16.7	1	15.6	0
3960	Dura Street	341114	731538	17.3	1	16.3	0
4156	Commercial Street	340524	730304	20.1	4	18.7	2
4602	Arbroath Road	341109	731082	18.2	2	16.8	1
4647	Victoria Street	341078	731110	18.4	2	17.0	1
4674	Victoria Street	341077	731095	18.8	2	17.3	1
4697	Victoria Street	341039	731067	16.9	1	15.8	0
4836	Princes Street	341088	731056	16.1	0	15.1	0
4975	West Marketgait	339940	730132	17.0	1	15.9	0
4983	Forfar Road	341487	732532	16.4	0	15.4	0
5125	Victoria Street	341076	731076	21.2	5	19.4	3
5126	Forfar Road	341212	731707	16.5	0	15.4	0
5202	Commercial Road	340453	730343	17.0	1	15.6	0
5296	Seagate	340508	730488	26.4	16	23.2	8
5297	Seagate	340504	730480	24.8	12	21.8	6
5300	Dock Street	340330	730030	43.0	102	37.1	61
5308	Dudhope Roundabout	339778	730641	17.1	1	16.1	0
5309	West Marketgait	339811	730391	33.6	43	31.1	32
5324	Pitkerro Road	341252	731647	16.8	1	15.7	0
5325	Pitkerro Road	341283	731672	16.8	1	15.8	0
5326	Pitkerro Road	341297	731683	17.1	1	16.1	0
m1	Victoria Road	340263	730711	18.7	2	17.3	1
m2	Victoria Road	340235	730684	24.8	12	22.2	7
m3	Victoria Road	340222	730668	17.8	1	16.6	1
m4	Meadowside	340241	730656	20.7	4	18.7	2
m5	Meadowside	340253	730637	18.2	2	16.7	1
m6	Meadowside	340259	730628	17.9	1	16.3	0
m7	Meadowside	340269	730613	16.7	1	15.5	0
m8	Meadowside	340287	730573	16.0	0	14.9	0

#### 4.4 NO<sub>x</sub> Source Apportionment

The breakdown of vehicle classification was taken into account in the model set-up. This has allowed determining NO<sub>x</sub> source apportionment at specific (worst case) receptors in the AQMA. The source apportionment was carried out for the following vehicle classes: Light duty vehicles (LDVs) and Heavy-duty vehicles (HDVs). To enable source apportionment of the background contribution, the modelled maps from the air quality archive have been utilised, as these incorporate a break down of background concentrations of NO<sub>x</sub> by source. Proportions of each background source category have been used to categorise the total background NO<sub>x</sub> and NO<sub>2</sub> in the assessment area.

Table 4.4 and Table 4.5 summarises the results at (worst case) receptors representing public exposure in the AQMA. The source apportionment indicates that:

- Road traffic emissions of NO<sub>x</sub> are the main contribution to total NO<sub>x</sub> concentrations, as they account for 74-91% of the total NO<sub>x</sub> concentrations at receptors;
- Local background sources contribute 8% to 23% of the total NO<sub>x</sub> concentration at receptors, while regional background sources (outside the local authority's control) contribute 1% to 4% of the total NO<sub>x</sub> concentration at receptors;
- Light duty vehicles (LDVs) contribute around 11 - 44% to the total NO<sub>x</sub> concentrations at receptors;
- Heavy-duty vehicles (HDVs) contribute around 38 - 77% to the total NO<sub>x</sub> concentrations at receptors and exceed the LDV contributions. HDV contributions are disproportionately high given their proportion within the vehicle fleet in the AQMA.





**Table 4.4 - Source Apportionment of NO<sub>x</sub> Concentrations at Specific Receptors**

Receptor (Maximum modelled concentration)	R206 Commercial Street	R1006 Arbroath Road	R2229 Doig Court, Lochee Road	R5296 Seagate	R5300 Dock Street	R5309 West Marketga it	M2 Victoria Road/ Meadowside
<b>Total NO<sub>x</sub> 2007 in µg/m<sup>3</sup> (Total Background + Local Road Source)</b>	105.2	141.8	124.4	148.3	304.1	157.2	125.1
<b>NO<sub>x</sub> Total Background (Local + Regional) in µg/m<sup>3</sup></b>	27.8 (100%)						
<b>NO<sub>x</sub> Local Background in µg/m<sup>3</sup> Includes:</b>	24.1 (86.7%)						
▪ <i>Road sources (minor)*</i>	10.6 (38.3%)						
▪ <i>Industry (combustion in industry, energy production, extraction of fossil fuel, and waste)</i>	5.8 (20.9%)						
▪ <i>Domestic**</i>	0 (0%)						
▪ <i>Aircraft</i>	0 (0%)						
▪ <i>Rail</i>	0.6 (2%)						
▪ <i>Other (ships, offroad and other emissions)</i>	4.8 (17.3%)						
▪ <i>Point sources</i>	2.3 (8.1%)						
<b>NO<sub>x</sub> Regional Background in µg/m<sup>3</sup></b>	3.7 (13.3%)						
<b>Local Road Source Contributions (LDV + HDV) in µg/m<sup>3</sup></b>	77.4	114.0	96.6	120.5	276.3	129.4	97.3
▪ <b>NO<sub>x</sub> LDV</b>	11.8	49.7	37.5	22.4	43.4	69.3	30.0
▪ <b>NO<sub>x</sub> HDV</b>	65.6	64.3	59.1	98.2	232.9	60.1	67.2
<b>% Local background</b>	22.9%	17.0%	19.4%	16.2%	7.9%	15.3%	19.3%
<b>% Regional background</b>	3.5%	2.6%	3.0%	2.5%	1.2%	2.4%	3.0%
<b>% Total Background (Local + Regional)</b>	26.4%	19.6%	22.3%	18.7%	9.1%	17.7%	22.2%
<b>% Road traffic</b>	73.6%	80.4%	77.7%	81.3%	90.9%	82.3%	77.8%
▪ <b>% due to LDV traffic</b>	11.2%	35.0%	30.1%	15.1%	14.3%	44.1%	24.0%
▪ <b>% due to HDV traffic</b>	62.3%	45.4%	47.5%	66.2%	76.6%	38.2%	53.8%
▪ <b>% LDV contribution of total road traffic</b>	15.3%	43.6%	38.8%	18.6%	15.7%	53.5%	30.9%
▪ <b>% HDV contribution of total road traffic</b>	84.7%	56.4%	61.2%	81.4%	84.3%	46.5%	69.1%

\* Minor roads contribution (only); as principal roads are included in the dispersion model.

\*\* Significant errors in background map contributions for domestic emissions; therefore removed from consideration in this assessment.



**Table 4.5 - Source Apportionment of NO<sub>2</sub> Concentrations at Specific Receptors**

Receptor (Maximum concentration) modelled	R206 Commercial Street	R1006 Arbroath Road	R2229 Doig Court, Lochee Road	R5296 Seagate	R5300 Dock Street	R5309 West Marketgait	M2 Victoria Road/ Meadowside
<b>Total NO<sub>2</sub> 2007 µg/m<sup>3</sup> (Total Background + Local Road Source Contributions)</b>	46.1	54.7	50.9	56.1	83.3	58.0	51.0
<b>NO<sub>2</sub> Total Background (Local + Regional)</b>	18.8						
▪ <b>NO<sub>2</sub> Local Background</b>	16.4						
▪ <b>NO<sub>2</sub> Regional Background</b>	2.4						
<b>Local Road Source Contributions (LDV + HDV)</b>	27.3	35.9	32.1	37.3	64.5	39.2	32.2
▪ <b>NO<sub>2</sub> LDV</b>	4.2	15.7	12.4	6.9	10.1	21.0	9.9
▪ <b>NO<sub>2</sub> HDV</b>	23.1	20.3	19.6	30.4	54.4	18.2	22.3
<b>% Local background</b>	35.6	30.0	32.3	29.2	19.7	28.3	32.2
<b>% Regional background</b>	5.2	4.4	4.7	4.3	2.9	4.1	4.7
<b>% Road traffic</b>	59.2	65.7	63.0	66.5	77.4	67.6	63.1
▪ <b>% due to LDV traffic</b>	9.0	28.6	24.5	12.4	12.2	36.2	19.5
▪ <b>% due to HDV traffic</b>	50.2	37.0	38.6	54.2	65.3	31.4	43.6
▪ <b>% LDV contribution of total road traffic</b>	15.3	43.6	38.8	18.6	15.7	53.5	30.9
▪ <b>% HDV contribution of total road traffic</b>	84.7	56.4	61.2	81.4	84.3	46.5	69.1

## 4.5 PM<sub>10</sub> Source Apportionment

The breakdown of vehicle classification was taken into account in the model set-up. This allowed determining PM<sub>10</sub> source apportionment at specific receptor locations in the AQMA. The source apportionment was carried out for the following vehicle classes: Light duty vehicles (LDVs) and Heavy-duty vehicles (HDVs) in addition to brake and tyre wear contributions. To enable source apportionment of the background contribution, the modelled maps from the air quality archive have been utilised, as these incorporate a break down of background concentrations of PM<sub>10</sub> by source.

Table 4.6 and Table 4.7 summarises the results at (worst case) receptors representing public exposure in the AQMA. The source apportionment of PM<sub>10</sub> (2007) indicates that:

- Background sources of PM<sub>10</sub> make a significant contribution to total PM<sub>10</sub> concentrations, as they account for 28-59% of the total PM<sub>10</sub> concentrations at receptors, with the majority of this being made up of secondary particulates, residual and salt contributions;
- Road traffic contribute 41% to 72% of the total PM<sub>10</sub> concentration at receptors;
- Light duty vehicles (LDVs) contribute around 7 - 24% to the total PM<sub>10</sub> concentrations at receptors;
- Heavy-duty vehicles (HDVs) contribute around 11-36% to the total PM<sub>10</sub> concentrations at receptors. HDV contributions are disproportionately high given their proportion within the vehicle fleet in the AQMA. On Commercial Street and Seagate, where there are significant bus movements, the HDV contribution exceeds the LDV contribution.
- Brake and tyre wear contribute around 13-29% to the total PM<sub>10</sub> concentrations at receptors.

Similarly, in 2010, background sources are a significant contribution to total PM<sub>10</sub> concentrations. With time, total PM<sub>10</sub> concentrations improve and the percentage contribution from background sources increases. The contribution from road source vehicle exhaust emissions reduces with time, and notably heavy-duty vehicle emissions become less significant, with expected improvements in emissions through national policy measures. However, brake and tyre wear emissions do not decrease with time and therefore become a more significant contribution.

**Table 4.6 - Source apportionment of PM<sub>10</sub> Background Concentrations**

Background Sources Dundee AQMA	2007 PM <sub>10</sub> in µg/m <sup>3</sup>	2007 % of Total Background	2010 PM <sub>10</sub> in µg/m <sup>3</sup>	2010 % of Total Background
PM <sub>10</sub> Total Background Includes:	12.0	100	11.6	100
▪ Road sources*	0.5	4.3	0.3	3.0
▪ Industry/ Commercial	0.9	7.1	0.8	7.3
▪ Domestic**	0.0	0.0	0.0	0.0
▪ Rail	0.006	0.1	0.006	0.1
▪ Other (off road)	0.5	4.5	0.5	4.7
▪ PM <sub>10</sub> Secondary	3.7	30.9	3.5	30.2
▪ Residual and Salt	6.2	52.0	6.2	53.6
▪ Point sources	0.1	1.1	0.1	1.2

\* Minor roads contribution (only); as principal roads are included in the dispersion model.

\*\* Significant errors in background map contributions for domestic emissions; therefore removed from consideration in this assessment.



**Table 4.7 - Source Apportionment of PM<sub>10</sub> Road Source Concentrations**

Receptor	Year	PM <sub>10</sub> Annual Mean in µg/m <sup>3</sup>	Local Road Source Contributions (LDV + HDV + Brake and tyre wear)	% Background	% Road traffic	% due to LDV traffic	% due to HDV traffic	% due to Brake and tyre wear	% LDV contribution of total road traffic	% HDV contribution of total road traffic	% Brake and tyre wear contribution of total road traffic
R206 Commercial Street	2007	20.6	8.6	58.2	41.8	7.3	21.0	13.4	17.5	50.4	32.1
R1006 Arbroath Road	2007	29.1	17.1	41.2	58.8	20.1	13.4	25.4	34.1	22.7	43.2
R1943 Albert Street	2007	20.3	8.3	59.2	40.8	14.2	10.8	15.8	34.9	26.4	38.7
R5125 Victoria Street	2007	21.2	9.2	56.5	43.5	15.6	13.3	14.6	35.9	30.5	33.6
R5296 Seagate	2007	26.4	14.4	45.4	54.6	11.8	26.2	16.6	21.7	47.9	30.4
R5300 Dock Street	2007	43.0	31.0	27.9	72.1	13.1	35.7	23.3	18.1	49.5	32.3
R5309 West Marketgait	2007	33.6	21.6	35.7	64.3	24.3	11.1	29.0	37.7	17.3	45.0
M2 Victoria Road	2007	24.8	12.8	48.4	51.6	17.9	17.0	16.7	34.7	32.9	32.4
R206 Commercial Street	2010	18.8	7.2	61.6	38.4	6.9	15.9	15.6	17.9	41.5	40.6
R1006 Arbroath Road	2010	26.4	14.8	44.0	56.0	18.2	9.5	28.3	32.4	17.0	50.5
R1943 Albert Street	2010	18.8	7.2	61.8	38.2	12.9	7.7	17.6	33.8	20.2	46.0
R5125 Victoria Street	2010	19.4	7.8	59.9	40.1	14.2	9.5	16.3	35.5	23.8	40.8
R5296 Seagate	2010	23.2	11.6	50.0	50.0	11.1	19.6	19.2	22.3	39.3	38.4
R5300 Dock Street	2010	37.1	25.5	31.3	68.7	12.8	27.9	28.0	18.6	40.5	40.8
R5309 West Marketgait	2010	31.1	19.5	37.3	62.7	22.1	8.1	32.5	35.3	12.8	51.9
M2 Victoria Road	2010	22.2	10.6	52.2	47.8	16.6	12.3	18.9	34.6	25.7	39.6

#### 4.6 NO<sub>x</sub>/NO<sub>2</sub> Required Reduction

A requirement of the Further Assessment is to determine the amount of NO<sub>2</sub> reduction required at the worst-case receptors within an AQMA. This approach highlights the maximum reduction in NO<sub>2</sub> required (as NO<sub>x</sub>, in µg/m<sup>3</sup>) to comply with the AQS objective, and assumes that other receptors will require less of a reduction. For the current assessment, the approach to estimate the required NO<sub>2</sub> reduction was to determine the levels of NO<sub>x</sub> for the highest concentrations predicted at sensitive receptors relevant of public exposure. The results are shown in Table 4.8.

In order to determine the required reduction in NO<sub>x</sub>, the equivalent NO<sub>x</sub> concentration (based on local background monitored NO<sub>x</sub> and the latest NO<sub>x</sub>/NO<sub>2</sub> conversion model) was calculated for the NO<sub>2</sub> annual mean AQS objective of 40µg/m<sup>3</sup>.

The maximum predicted NO<sub>x</sub> reduction required within the Dundee AQMA to comply with the NO<sub>2</sub> AQS objective is 221µg/m<sup>3</sup> in 2007 at the Dock Street/South Marketgait junction. In 2010, this reduces to 163µg/m<sup>3</sup>. The maximum predicted NO<sub>2</sub> reduction required within the Dundee AQMA to comply with the NO<sub>2</sub> AQS objective is 43µg/m<sup>3</sup> in 2007. In 2010, this reduces to 35µg/m<sup>3</sup>. This is the worst-case modelled location and may be an over prediction of the model at this location. All other modelled receptors require 18µg/m<sup>3</sup> or lower reduction of NO<sub>2</sub> in 2007; 13µg/m<sup>3</sup> or below in 2010. These are still significant reductions at these hotspot locations. Reductions in future years are attributed to implementation of national policy measures within the UK Air Quality Strategy that focuses on both a reduction in background but, more importantly, on the implementation of tighter Euro standards for vehicles which leads to general improvements in air quality as a consequence of reductions in vehicle emissions.

Consequently, the formulation of the Action Plan should aim to reduce the levels of NO<sub>x</sub> / NO<sub>2</sub> within the AQMA by this amount.



**Table 4.8 – Required NO<sub>x</sub> and NO<sub>2</sub> Reduction**

Receptor location	Year	Modelled NO <sub>x</sub> (µg/m <sup>3</sup> )	NO <sub>x</sub> (equivalent to 40µg/m <sup>3</sup> NO <sub>2</sub> ) µg/m <sup>3</sup>	Reduction NO <sub>x</sub> required (µg/m <sup>3</sup> )	% Reduction NO <sub>x</sub>	Modelled NO <sub>2</sub> (µg/m <sup>3</sup> )	NO <sub>2</sub> AQS objective (µg/m <sup>3</sup> )	Reduction NO <sub>2</sub> required (µg/m <sup>3</sup> )	% Reduction NO <sub>2</sub>
R206 Commercial Street	2007	105.2	83.6	21.6	25.8	46.1	40	6.1	15.3
R1006 Arbroath Road	2007	141.8	83.6	58.2	69.6	54.7		14.7	36.9
R2229 Doig Court, Lochee Road	2007	124.4	83.6	40.8	48.8	50.9		10.9	27.1
R5296 Seagate	2007	148.3	83.6	64.7	77.4	56.1		16.1	40.3
R5300 Dock Street	2007	304.1	83.6	220.5	263.8	83.3		43.3	108.4
R5309 West Marketgait	2007	157.2	83.6	73.6	88.1	58.0		18.0	44.9
M2 Victoria Road/ Meadowsides	2007	125.1	83.6	41.5	49.6	51.0		11.0	27.5
R206 Commercial Street	2010	88.0	83.9	4.1	4.9	41.3		1.3	3.2
R1006 Arbroath Road	2010	114.6	83.9	30.7	36.6	48.6		8.6	21.5
R2229 Doig Court, Lochee Road	2010	100.4	83.9	16.5	19.7	44.8		4.8	12.1
R5296 Seagate	2010	119.2	83.9	35.3	42.1	49.8		9.8	24.4
R5300 Dock Street	2010	246.5	83.9	162.6	193.8	75.3		35.3	88.3
R5309 West Marketgait	2010	130.8	83.9	46.9	55.9	52.6		12.6	31.4
M2 Victoria Road/ Meadowsides	2010	101.0	83.9	17.1	20.3	45.0		5.0	12.5

## 4.7 PM<sub>10</sub> Required Reduction

A requirement of the Further Assessment is to determine the amount of PM<sub>10</sub> reduction required at the worst-case receptors within an AQMA. This approach highlights the maximum reduction in PM<sub>10</sub> required to comply with the AQS objective, and assumes that other receptors will require less of a reduction. For the current assessment, the approach to estimate the required PM<sub>10</sub> reduction was to determine the levels of PM<sub>10</sub> for the highest concentrations predicted at sensitive receptors relevant of public exposure. The results are shown in Table 4.9.

The maximum predicted PM<sub>10</sub> reduction on the annual mean required within the AQMA to comply with the 2010 PM<sub>10</sub> annual mean AQS objective is 25µg/m<sup>3</sup> in 2007 at the Dock Street/South Marketgait junction. In 2010, this reduces to 19µg/m<sup>3</sup>. This is the worst-case modelled location and may be an over prediction of the model at this location. All other modelled receptors require 16µg/m<sup>3</sup> or lower reduction of NO<sub>2</sub> in 2007; 13µg/m<sup>3</sup> or below in 2010. These are still significant reductions at these hotspot locations.

**Table 4.9 – Required PM<sub>10</sub> Reduction**

Receptor location	Year	Modelled PM <sub>10</sub> (µg/m <sup>3</sup> )	PM <sub>10</sub> Annual Mean objective (µg/m <sup>3</sup> )	Reduction PM <sub>10</sub> required (µg/m <sup>3</sup> )	% Reduction PM <sub>10</sub>
R206 Commercial Street	2007	20.6	18.0	2.6	14.5
R1006 Arbroath Road	2007	29.1		11.1	61.7
R1943 Albert Street	2007	20.3		2.3	12.6
R5125 Victoria Street	2007	21.2		3.2	18.0
R5296 Seagate	2007	26.4		8.4	46.9
R5300 Dock Street	2007	43.0		25.0	138.9
R5309 West Marketgait	2007	33.6		15.6	86.9
M2 Victoria Road	2007	24.8		6.8	37.8
R206 Commercial Street	2010	18.8		0.8	4.7
R1006 Arbroath Road	2010	26.4		8.4	46.5
R1943 Albert Street	2010	18.8		0.8	4.2
R5125 Victoria Street	2010	19.4		1.4	7.5
R5296 Seagate	2010	23.2		5.2	28.9
R5300 Dock Street	2010	37.1		19.1	105.9
R5309 West Marketgait	2010	31.1		13.1	72.6
M2 Victoria Road	2010	22.2		4.2	23.5

## 5 Conclusions and Recommendations

As part of the Local Air Quality Management (LAQM) regime a further assessment has been carried out based on detailed dispersion modelling for the Dundee city centre AQMA. The AQMA was declared for nitrogen dioxide in 2006 due to exceedences of the annual mean Air Quality Strategy objective. However, this assessment additionally considers PM<sub>10</sub> at roads and junctions within the AQMA.

The further assessment is required as part of the review and assessment of air quality for local authorities that have declared (or amended) an AQMA, with the objective to supplement information gathered in the previous assessments.

This assessment was based on advanced atmospheric dispersion modelling of NO<sub>x</sub> and PM<sub>10</sub> traffic emissions, relying on updated background pollutant concentrations, monitoring, traffic and meteorological data for the year 2007.

Source apportionment of pollutant contribution was carried out to determine contributions of vehicle emissions and other sources to NO<sub>x</sub> and PM<sub>10</sub> concentrations in the AQMA. The NO<sub>x</sub> and PM<sub>10</sub> reduction to comply with the AQS objectives was calculated based on the highest concentration results at sensitive receptors relevant of public exposure (facades of properties).

The findings of this report are the following:

- Monitoring data from the continuous analyser and diffusion tube monitoring sites indicate that exceedences of the annual mean NO<sub>2</sub> objective are being measured within the AQMA and confirm the need for the declaration;
- Updated modelled results indicate that there is a risk of exceedences of the annual mean NO<sub>2</sub> objective within the AQMA and confirm the need for the declaration;
- The maximum predicted NO<sub>x</sub> reduction required within the Dundee AQMA to comply with the NO<sub>2</sub> AQS objective is 221µg/m<sup>3</sup> in 2007 at the Dock Street/South Marketgait junction. In 2010, this reduces to 163µg/m<sup>3</sup>. The maximum predicted NO<sub>2</sub> reduction required within the Dundee AQMA to comply with the NO<sub>2</sub> AQS objective is 43µg/m<sup>3</sup> in 2007. In 2010, this reduces to 35µg/m<sup>3</sup>. This is the worst-case modelled location and may be an over prediction of the model at this location. All other modelled receptors require 18µg/m<sup>3</sup> or lower reduction of NO<sub>2</sub> in 2007; 13µg/m<sup>3</sup> or below in 2010. Consequently, the formulation of the Action Plan should aim to reduce the levels of NO<sub>x</sub> / NO<sub>2</sub> within the AQMA by this amount.
- The maximum predicted PM<sub>10</sub> reduction on the annual mean required within the AQMA to comply with the 2010 PM<sub>10</sub> annual mean AQS objective is 25µg/m<sup>3</sup> in 2007 at the Dock Street/South Marketgait junction. In 2010, this reduces to 19µg/m<sup>3</sup>. This is the worst-case modelled location and may be an over prediction of the model at this location. All other modelled receptors require 16µg/m<sup>3</sup> or lower reduction of PM<sub>10</sub> in 2007; 13µg/m<sup>3</sup> or below in 2010. These are still significant reductions at these hotspot locations. Based on the risk of exceedence of the PM<sub>10</sub> objective at relevant receptors, it is recommended that the Council consider declaring an AQMA for PM<sub>10</sub>.
- Source apportionment of NO<sub>x</sub>, indicates road traffic emissions of NO<sub>x</sub> are the main contribution to total NO<sub>x</sub> concentrations, as they account for 74 - 91% of the total NO<sub>x</sub> concentrations at receptors. Heavy-duty vehicles (HDVs) contribute around 38 - 77% to the total NO<sub>x</sub> concentrations at receptors and exceed the LDV contributions. HDV contributions are disproportionately high given their proportion within the vehicle fleet in the AQMA.
- Source apportionment of PM<sub>10</sub>, indicates background sources of PM<sub>10</sub> make a significant contribution to total PM<sub>10</sub> concentrations, as they account for 28-59% of the total PM<sub>10</sub> concentrations at receptors, with the majority of this being made up of secondary particulates, residual and salt contributions. Road traffic contribute 41% to 72% of the total PM<sub>10</sub> concentration at receptors. Light duty vehicles (LDVs) contribute around 7 – 24 and heavy-duty vehicles (HDVs) contribute around 11-36% to the total PM<sub>10</sub> concentrations at receptors. Brake and tyre wear contribute around 13-29% to the total PM<sub>10</sub> concentrations at receptors. HDV contributions are disproportionately high given their proportion within the vehicle fleet in





the AQMA. On Commercial Street and Seagate, where there are significant bus movements, the HDV contribution exceeds the LDV contribution.



## Appendix 1 – Traffic Data

**Table A1-1 – Dundee Traffic Data**

Source	Road	Date	AADT	%HDV	2007 AADT	2010 AADT
ATC Count data	A90 Kingsway	2007	39011	9.4	39011	39440
ATC Count data	A92 Broughty Ferry Road	2007	28708	5.0	28708	29024
ATC Count data	A92 South Marketgait	2007	30129	4.2	30129	30460
ATC Count data	A92 Greendykes Road	2007	14405	5.5	14405	14563
ATC Count data	A930 Dundee Road West	2007	17605	2.3	17605	17799
ATC Count data	A92 East Dock Street	2007	26633	4.4	26633	26926
ATC Count data	A972 Kingsway East	2007	27476	5.9	27476	27778
ATC Count data	A92 South Marketgait	2007	23200	4.2	23200	23455
ATC Count data	A90 Forfar Road	2007	36787	9.5	36787	37192
ATC Count data	A991 Marketgait	2007	20340	2.9	20340	20564
Air Traffic AQ 09 Permanant	Lochee Road (North of Rankine Street)	2008	13291	6.6	13238	13384
Air Traffic AQ 09 Permanant	Pitkerro Road	2008	10102	6.1	10005	10375
Air Traffic AQ 09 Temp	Strips of Craigie Road	2006	4714	2.3	4733	4908
Air Traffic AQ 09 Temp	Craigie Drive	2006	8923	2.3	8959	9290
12 Hour Count junction data 2007	A929 Forfar Road (North)	2007	9086	8.7	9086	9186
12 Hour Count junction data 2007	A929 Forfar Road (South)	2007	8684	7.8	8684	8779
12 Hour Count junction data 2007	A923 High Street (N)	2007	15818	6.5	15818	15992
12 Hour Count junction data 2007	Muirton Road	2007	1403	0.9	1403	1455
12 Hour Count junction data 2007	A923 High Street (S)	2007	17347	5.8	17347	17537
12 Hour Count junction data 2007	Loons Rd	2007	8231	2.7	8231	8535
12 Hour Count junction data 2007	A929 Victoria Road	2007	18796	9.0	18796	19002
12 Hour Count junction data 2007	A991 Victoria Way	2007	14797	3.7	14797	14960
12 Hour Count junction data 2007	Meadowside	2007	4272	27.1	4272	4430
12 Hour Count junction data 2007	Hilltown	2007	4748	3.5	4748	4924
12 Hour Count junction data 2007	A929 Victoria Road (North of Hilltown)	2007	14017	10.9	14017	14172



**Table A1-1 (Continued) – Dundee Traffic Data**

Source	Road	Date	AADT	%HDV	2007 AADT	2010 AADT
12 Hour Count junction data 2007	High Street	2007	3158	46.5	3158	3275
12 Hour Count junction data 2007	Union Street	2007	2238	22.6	2238	2321
12 Hour Count junction data 2007	Whitehall Crescent (e)	2007	2529	27.3	2529	2622
12 Hour Count junction data 2007	Whitehall Crescent (w)	2007	2148	51.0	2148	2228
12 Hour Count junction data 2007	West Marketgait	2007	20249	7.1	20249	20472
12 Hour Count junction data 2007	Nethergate	2007	5153	13.4	5153	5344
12 Hour Count junction data 2007	South Marketgait	2007	17199	3.6	17199	17389
12 Hour Count junction data 2007	Nethergate	2007	4953	33.5	4953	5136
12 Hour Count junction data 2007	Forfar Road	2007	9264	6.8	9264	9607
12 Hour Count junction data 2007	Albert Street	2007	9842	6.6	9842	10206
12 Hour Count junction data 2007	Victoria Street	2007	5694	6.7	5694	5904
12 Hour Count junction data 2007	Princes Street	2007	12251	7.9	12251	12386
12 Hour Count junction data 2007	Arbroath Road	2007	11912	6.6	11912	12043
12 Hour Count junction data 2007	Lochee Road	2007	17713	6.2	17713	17908
12 Hour Count junction data 2007	West Marketgait	2007	25547	4.6	25547	25828
12 Hour Count junction data 2007	A991 North Marketgait	2007	29376	2.8	29376	29699
12 Hour Count junction data 2007	Rankine Street	2007	7581	1.8	7581	7861
12 Hour Count junction data 2007	A923 Lochee Road (n)	2007	13837	6.6	13837	13989
12 Hour Count junction data 2007	Cleghorn Street	2007	2842	1.5	2842	2947
12 Hour Count junction data 2007	A923 Lochee Road (n)	2007	20756	5.0	20756	20985
12 Hour Count junction data 2007	A923 Lochee Road (s)	2007	18874	5.5	18874	19081
12 Hour Count junction data 2007	Dudhope Terrace	2007	6745	3.3	6745	6994
12 Hour Count junction data 2007	Dura Street	2007	10986	3.0	10986	11392
12 Hour Count junction data 2007	Mains Loan	2007	940	2.4	940	975
12 Hour Count junction data 2007	Hawkhill	2007	18067	4.3	18067	18265
12 Hour Count junction data 2007	South Ward Road	2007	6103	1.0	6103	6329
12 Hour Count junction data 2007	West Bell Street	2007	4975	8.0	4975	5159
12 Hour Count junction data 2007	Court House Square	2007	4485	8.0	4485	4651



**Table A1-1 (Continued) – Dundee Traffic Data**

Source	Road	Date	AADT	%HDV	2007 AADT	2010 AADT
12 Hour Count junction data 2007	Ward Street (South of N Lindsey St)	2007	4670	2.9	4670	4843
12 Hour Count junction data 2007	Ward Street (North of N Lindsey St)	2007	4552	10.3	4552	4720
12 Hour Count junction data 2007	North Lindsey Street	2007	5553	1.3	5553	5759
12 Hour Count junction data 2007	Dens Road	2007	10090	10.2	10090	10463
12 Hour Count junction data 2007	Cotton Road	2007	208	2.2	208	216
12 Hour Count junction data 2007	Clepington Road (West)	2007	12699	4.8	12699	13169
12 Hour Count junction data 2007	Clepington Road (East)	2007	10807	4.1	10807	11206
12 Hour Count junction data 2004	Seagate (N)	2004	6847	20.4	7053	7314
12 Hour Count junction data 2004	Seagate (S)	2004	5570	24.7	5737	5949
12 Hour Count junction data 2004	St Andrews Street	2004	2536	24.9	2612	2709
12 Hour Count junction data 2004	Seagate (E)	2004	8932	8.8	9200	9540
12 Hour Count junction data 2004	Trades Lane	2004	2251	13.8	2318	2404
12 Hour Count junction data 2004	Castle Street	2004	768	3.4	791	820
12 Hour Count junction data 2004	Dock St W	2004	3436	55.6	3539	3670
12 Hour Count junction data 2004	Dock St E	2004	1535	3.4	1581	1640
12 Hour Count junction data 2004	Dock St W	2004	4842	25.8	4987	5172
12 Hour Count junction data 2004	Commercial St (N)	2004	6283	31.4	6472	6711
12 Hour Count junction data 2004	Gellatly St (S car park)	2004	2677	2.9	2757	2860
12 Hour Count junction data 2004	Pole Park Road	2004	6079	3.5	6261	6493
12 Hour Count junction data 2004	Whitehall Street	2004	2077	29.7	2139	2218
Based on Peak Hour Model	Broughty Ferry Road	2007	5752	6.2	5752	5965



## Appendix 2 – Comparison of Methods for Calculation of Gravimetric Equivalence

PM<sub>10</sub> Annual Mean in µg/m<sup>3</sup>

Location	Broughty Ferry	Broughty Ferry	Mains Loan	Union Street	Victoria Road	Logie Street	Union Street	Lochee Road	Seagate
PM <sub>10</sub> Analyser	Partisol	TEOM	TEOM	TEOM	Osiris	Osiris	Osiris	Osiris	Osiris
Data Capture (%)	100	98.9	100	89.9	90.7	87.1	90.4	91.0	91.5
Annual Mean in µg/m <sup>3</sup>	14.7	13.8	11.3	17.0	18.5	21.0	18.6	23.1	17.1
TEOM equivalence (TEOM/Osiris =1.1)	-	-	-	-	16.9	19.2	17.0	21.1	15.6
1.06 local factor	-	14.7	12.0	18.0	17.9	20.3	18.0	22.3	16.5
1.14 Scottish factor	-	15.8	12.9	19.3	19.3	21.8	19.3	24.0	17.8
1.3 Old TEOM correction factor	-	18.0	14.7	22.1	22.0	24.9	22.1	27.4	20.2

Number of Exceedences of the PM<sub>10</sub> Daily Mean Objective

Location	Broughty Ferry	Broughty Ferry	Mains Loan	Union Street	Victoria Road	Logie Street	Union Street	Lochee Road	Seagate
PM <sub>10</sub> Analyser	Partisol	TEOM	TEOM	TEOM	Osiris	Osiris	Osiris	Osiris	Osiris
Data Capture (%)	100	98.9	100	89.9	90.7	87.1	90.4	91.0	91.5
Number of Exceedences of the PM <sub>10</sub> Daily Mean Objective	4	2	0	3	5	8	10	5	2
TEOM equivalence (TEOM/Osiris =1.1)	-	-	-	-	7	9	12	9	4
1.06 local factor	-	2	2	3	9	9	12	16	8
1.14 Scottish factor	-	3	2	5	13	13	15	23	11
1.3 Old TEOM correction factor	-	4	4	7	18	25	21	36	17

The Review and Assessment Helpdesk advised DCC to use the Volatile Correction Model (VCM) to adjust PM<sub>10</sub> data and then calculate the number of exceedences. DCC informed the Helpdesk that they were using their local co-location factor instead; following the advice from the Scottish Government in February 2009 that there was insufficient FDMS to use the VCM and that local authorities should continue using 1.3, 1.14 or a local factor if available. The Helpdesk advised that even for 2007 the VCM should be used and that the appraisal team would be looking for a comparison to be made between all the methods (1.3,1.14, local factor and VCM) as this would help with distinguishing overall trends and sensitivity analysis. Unfortunately, error messages appear when trying to use the VCM for 2007 for the Dundee area, as FDMS data is not available to apply the correction. A summary table of the output is shown below.

### Volatile Correction Model Summary Table

Summary	Text/Value
Site Name	Union Street
Start Date	01/01/2007
End Date	01/01/2008
TEOM data already corrected with 1.3 factor	No
EPA Constant A	3
EPA Constant B	1.030
Instrument Temperature	25
Instrument Pressure	1013
Instrument reports to local ambient readings	No
Timescale	Daily
Pressure Site	Barking & Dagenham 1 - Rush Green (BG1)
Pressure Site Warning	Distant site ( 582km).
Temperature Site	Broxbourne (Roadside) (BB1)
Temperature Site Warning	Distant site ( 565km).
FDMS Site 1	Edinburgh St Leonards (ED0)
FDMS Site 1 Warning	Data capture 24%.
FDMS Site 2	Auchencorth Moss (AM0)
FDMS Site 2 Warning	Cannot find second FDMS site with data for chosen dates. Data capture 0%.
FDMS Site 3	
FDMS Site 3 Warning	Cannot find third FDMS site within range.



## Appendix 3 – Model Verification

### PM<sub>10</sub> Verification

Site	Site Type	X(m)	Y(m)	Modelled PM <sub>10</sub>	Modelled Roads PM <sub>10</sub> (Minus Background: Mains Loan 12µg/m <sup>3</sup> )	Monitored PM <sub>10</sub>	Monitored Roads PM <sub>10</sub> (Minus Background: Mains Loan 12µg/m <sup>3</sup> )	Verification Factor for site	Verification Factor used for Assessment*	Corrected roads PM <sub>10</sub>	Corrected total PM <sub>10</sub>	% Difference (Monitored /Modelled)
Union Street TEOM PM <sub>10</sub> (Gravimetric)	R	340235	730091	13.2	1.2	18.0	6.0	5.0	5.0	6.0	18.0	0.0
OSIRIS Union Street PM <sub>10</sub> (Gravimetric)	R	340235	730091	13.2	1.2	18.0	6.0	5.0		6.0	18.0	0.0
OSIRIS Victoria Road PM <sub>10</sub> (Gravimetric)	K	340230	730673	13.9	1.9	17.9	5.9	3.2		9.3	21.3	18.9
OSIRIS Seagate PM <sub>10</sub> (Gravimetric)	K	340539	730528	14.0	2.0	16.5	4.5	2.3		9.9	21.9	32.7
OSIRIS Logie Street PM <sub>10</sub> (Gravimetric)	K	338176	731298	13.5	1.5	20.3	8.3	5.7		7.3	19.3	-5.0
OSIRIS Lochee Road PM <sub>10</sub> (Gravimetric)	K	338920	730693	12.9	0.9	22.3	10.3	11.5		4.5	16.5	-26.2
Broughty Ferry Road Partisol PM <sub>10</sub> (Gravimetric)	R	341971	730978	13.4	1.4	14.7	2.7	1.9	1.9	2.7	14.7	0.0

\* Verification has been based on the Union Street TEOM and Broughty Ferry Road Partisol sites, as the OSIRIS sites are not recommended for detailed and further assessments. For central Dundee and Lochee Road/Logie Street area the verification factor from the Union Street TEOM has been used, for the Broughty Ferry Road area the Broughty Ferry Road Partisol has been used.

R=Roadside; K=Kerbside.



**NO<sub>x</sub>/NO<sub>2</sub> Verification**

Site	Site Type	Background NO <sub>2</sub> (µg/m <sup>3</sup> )	Background NO <sub>x</sub> (µg/m <sup>3</sup> )	Monitored Total NO <sub>x</sub> (µg/m <sup>3</sup> )	Monitored Road Contribution NO <sub>x</sub> (µg/m <sup>3</sup> )	Modelled Road Contribution NO <sub>x</sub> (µg/m <sup>3</sup> )	Ratio of Monitored Road NO <sub>x</sub> /Modelled Road NO <sub>x</sub>	Adjustment Factor (Regression) for Modelled Road Contribution	Adjusted Modelled Road Contribution NO <sub>x</sub> (µg/m <sup>3</sup> )	Adjusted Modelled Total NO <sub>x</sub> (µg/m <sup>3</sup> )	Modelled Total NO <sub>2</sub> (µg/m <sup>3</sup> )	Monitored Total NO <sub>2</sub> (µg/m <sup>3</sup> )	% Difference NO <sub>2</sub> [(Modelled - Monitored)/ Monitored]
Abertay	R	18.8	27.8	106.8	79.0	59.0	1.34	1.094	64.5	92.3	42.6	46.5	-8
Albert street (fish)	K	18.8	27.8	56.0	28.2	49.8	0.57	1.094	54.5	82.3	39.6	30.7	29
Albert street (shandon place)	R	18.8	27.8	66.1	38.3	34.7	1.10	1.094	37.9	65.7	34.2	34.3	0
Albert street 1	K	18.8	27.8	62.5	34.7	46.4	0.75	1.094	50.7	78.5	38.4	33.0	16
Arbroath road (13)	K	18.8	27.8	77.2	49.4	40.7	1.21	1.094	44.5	72.3	36.4	38.0	-4
Arthurstone terrace (10)	K	18.8	27.8	37.4	9.6	8.6	1.12	1.094	9.4	37.2	23.0	23.1	0
Cleington road/forfar road	K	18.8	27.8	73.3	45.5	19.5	2.34	1.094	21.3	49.1	28.0	36.8	-24
Commercial street (waterstones)	R	18.8	27.8	84.1	56.3	48.1	1.17	1.094	52.6	80.4	39.0	40.2	-3
Crichton street	K	18.8	27.8	58.7	30.9	36.9	0.84	1.094	40.4	68.2	35.0	31.6	11
Dock street (carol whyte) 2	R	18.8	27.8	76.4	48.6	89.5	0.54	1.094	97.9	125.7	51.1	37.8	35
Dock street (unicorn)	R	18.8	27.8	75.8	48.0	22.8	2.10	1.094	25.0	52.8	29.4	37.6	-22
Dura street (fortes)	K	18.8	27.8	81.7	53.9	32.7	1.65	1.094	35.8	63.6	33.4	39.4	-15
Eastport roundabout	R	18.8	27.8	69.6	41.8	28.1	1.49	1.094	30.7	58.5	31.6	35.5	-11
Kingsway/ mains loan 1	R	18.8	27.8	65.4	37.6	71.0	0.53	1.094	77.7	105.5	46.2	34.1	36
Kingsway/ pitkerro road	R	18.8	27.8	56.2	28.4	8.6	3.29	1.094	9.4	37.2	23.0	30.7	-25
Marketgait	R	18.8	27.8	62.3	34.5	24.2	1.43	1.094	26.5	54.3	30.0	33.0	-9
Meadowside	R	18.8	27.8	174.8	147.0	55.0	2.67	1.094	60.1	87.9	41.3	61.4	-33
Nethergate (b&b)	K	18.8	27.8	94.2	66.4	25.6	2.59	1.094	28.0	55.8	30.6	43.1	-29
Nethergate (bradford)	R	18.8	27.8	75.4	47.6	42.5	1.12	1.094	46.5	74.3	37.1	37.4	-1
Nethergate (charlie t)	K	18.8	27.8	80.6	52.8	24.3	2.17	1.094	26.5	54.3	30.0	39.1	-23
Nethergate (trades house)	R	18.8	27.8	82.4	54.6	40.4	1.35	1.094	44.2	72.0	36.3	39.6	-8

R=Roadside; K=Kerbside.





NO<sub>x</sub>/NO<sub>2</sub> Verification (Continued)

Site	Site Type	Background NO <sub>2</sub> (µg/m <sup>3</sup> )	Background NO <sub>x</sub> (µg/m <sup>3</sup> )	Monitored Total NO <sub>x</sub> (µg/m <sup>3</sup> )	Monitored Road Contribution NO <sub>x</sub> (µg/m <sup>3</sup> )	Modelled Road Contribution NO <sub>x</sub> (µg/m <sup>3</sup> )	Ratio of Monitored Road NO <sub>x</sub> /Modelled Road NO <sub>x</sub>	Adjustment Factor (Regression) for Modelled Road Contribution	Adjusted Modelled Road Contribution NO <sub>x</sub> (µg/m <sup>3</sup> )	Adjusted Modelled Total NO <sub>x</sub> (µg/m <sup>3</sup> )	Modelled Total NO <sub>2</sub> (µg/m <sup>3</sup> )	Monitored Total NO <sub>2</sub> (µg/m <sup>3</sup> )	% Difference NO <sub>2</sub> [(Modelled - Monitored)/ Monitored]
Nethergate/ Marketgait	R	18.8	27.8	71.0	43.2	25.3	1.71	1.094	27.7	55.5	30.5	36.0	-15
Seagate	R	18.8	27.8	91.5	63.7	48.5	1.31	1.094	53.0	80.8	39.2	42.3	-8
Seagate (yates)	R	18.8	27.8	85.2	57.4	40.7	1.41	1.094	44.5	72.3	36.4	40.5	-10
Soapwork Lane	R	18.8	27.8	68.0	40.2	49.3	0.82	1.094	53.9	81.7	39.4	35.0	13
Street Andrews Street (jaf)	K	18.8	27.8	67.5	39.7	26.6	1.49	1.094	29.1	56.9	31.0	34.8	-11
Street Andrews Street (pb)	K	18.8	27.8	88.6	60.8	19.4	3.13	1.094	21.2	49.0	27.9	41.5	-33
Union Street (goodfellows)	K	18.8	27.8	60.8	33.0	32.9	1.00	1.094	35.9	63.7	33.5	32.4	3
Union street (mcintyres)	K	18.8	27.8	61.7	33.9	38.0	0.89	1.094	41.5	69.3	35.4	32.7	8
Victoria Road	R	18.8	27.8	73.3	45.5	24.7	1.84	1.094	27.1	54.9	30.2	36.7	-18
Victoria Road (10)	R	18.8	27.8	62.0	34.2	32.0	1.07	1.094	35.0	62.8	33.1	32.9	1
Victoria road (60)	R	18.8	27.8	87.4	59.6	42.9	1.39	1.094	46.9	74.7	37.2	41.1	-10
Victoria Road / Cotton Road	K	18.8	27.8	72.8	45.0	25.1	1.79	1.094	27.5	55.3	30.4	36.6	-17
Victoria Road / Hilltown	R	18.8	27.8	146.9	119.1	123.2	0.97	1.094	134.7	162.5	59.0	55.8	6
Victoria street / Albert Street	K	18.8	27.8	65.6	37.8	51.4	0.73	1.094	56.2	84.0	40.1	34.1	18
Whitehall Cr (xpresso)	R	18.8	27.8	80.0	52.2	55.9	0.49	1.094	61.1	88.9	41.6	30.3	37
Whitehall Street (brj)	K	18.8	27.8	55.0	27.2	33.0	1.34	1.094	36.1	63.9	33.5	36.3	-8
Whitehall Street (bus)	K	18.8	27.8	71.9	44.1	71.0	1.23	1.094	77.7	105.5	46.2	48.6	-5
Whitehall Street (deb a)	R	18.8	27.8	114.9	87.1	94.2	0.71	1.094	103.0	130.8	52.3	43.4	21
Whitehall Street (deb e)	K	18.8	27.8	95.1	67.3	30.1	1.53	1.094	32.9	60.7	32.4	36.9	-12
Whitehall Street (tiso)	K	18.8	27.8	73.9	46.1	31.5	1.65	1.094	34.4	62.2	32.9	38.8	-15
Forfar Road	R	18.8	27.8	79.6	51.8	32.5	2.34	1.094	35.5	63.3	33.3	45.7	-27

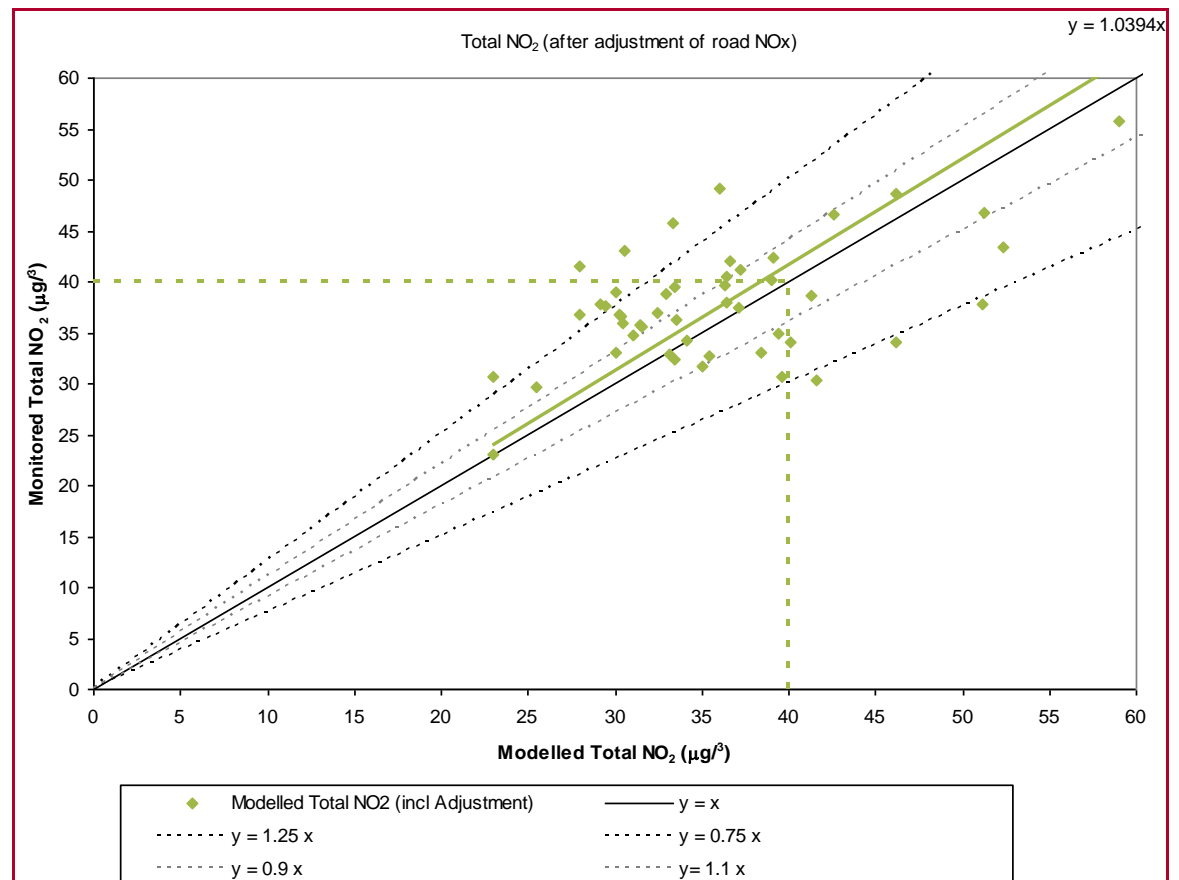
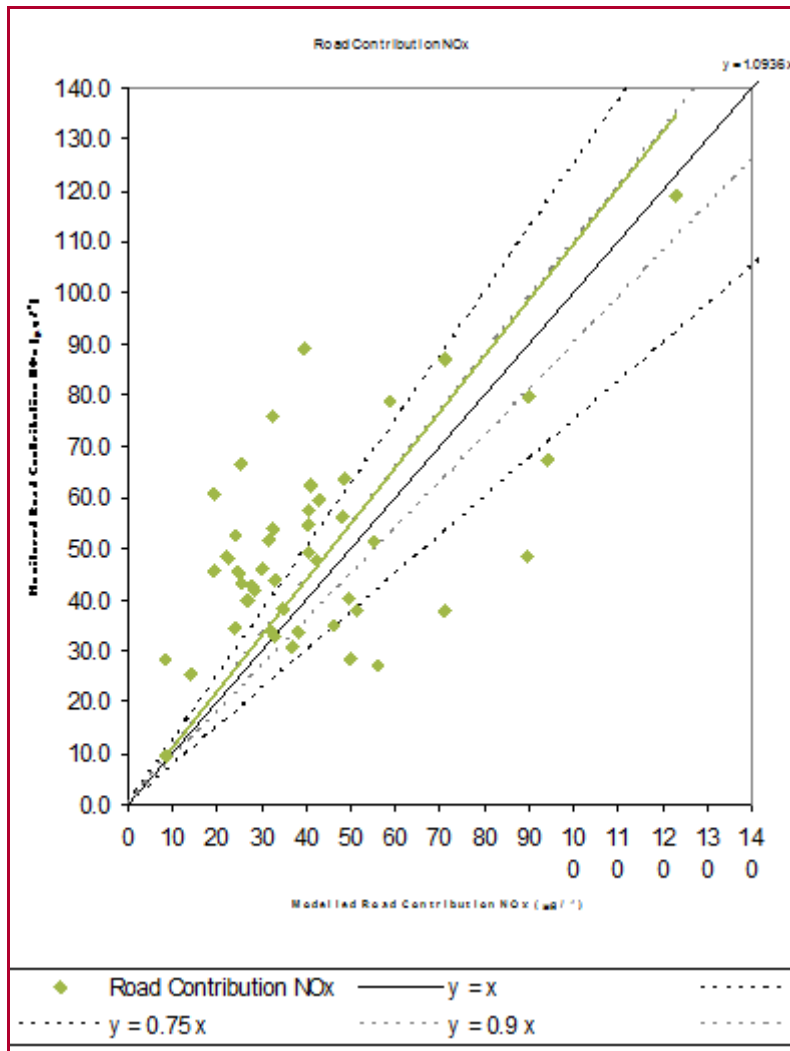
R=Roadside; K=Kerbside.

**NO<sub>x</sub>/NO<sub>2</sub> Verification (Continued)**

Site	Site Type	Background NO <sub>2</sub> (µg/m <sup>3</sup> )	Background NO <sub>x</sub> (µg/m <sup>3</sup> )	Monitored Total NO <sub>x</sub> (µg/m <sup>3</sup> )	Monitored Road Contribution NO <sub>x</sub> (µg/m <sup>3</sup> )	Modelled Road Contribution NO <sub>x</sub> (µg/m <sup>3</sup> )	Ratio of Monitored Road NO <sub>x</sub> /Modelled Road NO <sub>x</sub>	Adjustment Factor (Regression) for Modelled Road Contribution	Adjusted Modelled Road Contribution NO <sub>x</sub> (µg/m <sup>3</sup> )	Adjusted Modelled Total NO <sub>x</sub> (µg/m <sup>3</sup> )	Modelled Total NO <sub>2</sub> (µg/m <sup>3</sup> )	Monitored Total NO <sub>2</sub> (µg/m <sup>3</sup> )	% Difference NO <sub>2</sub> [(Modelled - Monitored)/ Monitored]
Commercial Street / Dock Street 2	R	18.8	27.8	79.1	51.3	55.1	0.93	1.094	60.2	88.0	41.3	38.6	7
Dock Street Carol Whyte (2)	R	18.8	27.8	76.4	48.6	22.2	2.19	1.094	24.3	52.1	29.2	37.8	-23
Nethergate / South Tay Street	R	18.8	27.8	53.3	25.5	13.9	1.83	1.094	15.2	43.0	25.5	29.6	-14
Dock Street Sheridans	R	18.8	27.8	107.5	79.7	90.1	0.89	1.094	98.5	126.3	51.3	46.7	10
Rollalong Union Street	R	18.8	27.8	70.5	42.7	27.8	1.53	1.094	30.4	58.2	31.5	35.8	-12
Romon Whitehall Street	R	18.8	27.8	90.3	62.5	41.2	1.52	1.094	45.0	72.8	36.6	42.0	-13
Romon Seagate	K	18.8	27.8	117.1	89.3	39.5	2.26	1.094	43.2	71.0	36.0	49.1	-27
Broughty Ferry Road (141)	R	18.8	27.8	84.9	57.1	13.1	4.36	4.36	57.1	84.9	40.4	40.4	0
Lochee Road (138)	K	18.8	27.8	132.1	104.3	17.2	6.08	3.02	51.8	79.6	38.8	52.6	-26
Lochee Road (140 traffic lts)	R	18.8	27.8	135.6	107.8	15.6	6.91	3.02	47.1	74.9	37.3	53.4	-30
Lochee Road (184)	K	18.8	27.8	77.6	49.8	19.6	2.54	3.02	59.1	86.9	41.0	38.1	8
Lochee Road/PolePark Road	K	18.8	27.8	56.6	28.8	8.4	3.45	3.02	25.2	53.0	29.5	30.9	-4
Logie Street (114)	R	18.8	27.8	130.4	102.6	22.1	4.65	3.02	66.7	94.5	43.2	52.2	-17
Logie Street (98)	K	18.8	27.8	68.7	40.9	20.6	1.99	3.02	62.1	89.9	41.9	35.2	19
Loons Road 1	R	18.8	27.8	80.8	53.0	25.5	2.08	3.02	77.0	104.8	46.0	39.1	18
Muirton Road (6)	R	18.8	27.8	50.2	22.4	8.6	2.62	3.02	25.9	53.7	29.8	28.4	5
Rankine Street (2)	R	18.8	27.8	83.2	55.4	37.6	1.47	3.02	113.6	141.4	54.7	39.9	37
Romon Lochee Road	K	18.8	27.8	132.9	105.1	24.1	4.35	3.02	72.9	100.7	44.9	52.8	-15

R=Roadside;

K=Kerbside.



## Appendix 4 – Modelled Specific Receptor Results

Receptor No.	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective	2010 Predicted Annual Mean NO <sub>2</sub>	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective
1	TRADES LANE	340626	730456	25.6	14.3	0	22.5	13.6	0
2	TRADES LANE	340598	730491	26.1	14.4	0	22.8	13.6	0
4	BARRACK ROAD	339820	730668	26.4	15.1	0	23.2	14.3	0
5	EXCHANGE STREET	340507	730266	26.0	14.3	0	22.7	13.6	0
7	PARK AVENUE	341134	731371	31.0	<b>16.0</b>	0	27.1	15.1	0
9	UNION STREET	340242	730080	25.7	14.1	0	22.5	13.3	0
12	GRAHAM PLACE	341082	731001	29.1	15.2	0	25.4	14.3	0
23	FORFAR ROAD	341420	732302	25.2	14.0	0	22.0	13.3	0
24	NETHERGATE	340210	730088	26.3	14.2	0	23.0	13.4	0
25	CRESCENT STREET	340998	731011	24.8	13.9	0	21.7	13.3	0
27	LOCHEE ROAD	338893	730726	32.1	13.7	0	27.9	13.0	1
28	DURA STREET	341086	731490	23.2	13.5	0	20.4	13.0	1
32	ARBROATH ROAD	341127	731086	35.6	<b>18.3</b>	2	31.0	<b>16.9</b>	1
34	EXCHANGE STREET	340516	730278	27.5	14.7	0	24.0	13.9	0
37	DOCK STREET	340541	730233	28.6	15.5	0	24.9	14.6	0
39	FORFAR ROAD	341191	731652	26.9	14.6	0	23.4	13.8	0
41	ARBROATH ROAD	341189	731098	<b>48.7</b>	<b>25.1</b>	<b>13</b>	<b>42.9</b>	<b>22.9</b>	<b>8</b>
43	UNION STREET	340260	730062	25.8	14.1	0	22.6	13.4	0
44	ST MARY STREET	339053	730635	30.6	13.5	0	26.7	12.9	1
49	CARDEAN STREET	341165	731469	25.9	14.3	0	22.7	13.6	0
62	TRADES LANE	340584	730470	24.8	14.0	0	21.7	13.3	0
68	TEMPLE LANE	339809	730122	24.6	14.2	0	21.6	13.5	0
81	ELIZA STREET	341106	731511	23.4	13.6	0	20.6	13.0	1
94	PARK AVENUE	341167	731406	24.3	13.7	0	21.3	13.1	0
95	GRAHAM PLACE	341100	730996	27.4	14.7	0	23.9	13.9	0
98	EXCHANGE STREET	340481	730231	25.6	14.3	0	22.4	13.6	0
103	FORFAR ROAD	341202	731681	30.0	15.6	0	26.0	14.7	0

Receptor No.	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective	2010 Predicted Annual Mean NO <sub>2</sub>	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective
108	CARDEAN STREET	341184	731449	23.6	13.5	0	20.7	12.9	1
114	UNION STREET	340277	730069	32.7	16.0	0	28.5	15.0	0
118	WHITEHALL STREET	340259	730150	33.3	15.9	0	28.9	14.6	0
120	VICTORIA STREET	341061	731072	38.3	19.6	3	33.8	18.1	1
123	CASTLE STREET	340411	730270	24.7	14.0	0	21.6	13.3	0
130	LOCHEE ROAD	338813	730814	36.4	14.3	0	31.8	13.6	0
131	ARBROATH ROAD	341106	731082	35.5	18.1	2	30.9	16.8	1
132	FORFAR ROAD	341492	732566	31.9	16.1	0	27.7	15.1	0
137	CRESCENT LANE	341019	731004	25.3	14.1	0	22.2	13.4	0
143	DOCK STREET	340654	730346	29.2	16.0	0	25.5	15.1	0
152	LOCHEE ROAD	338791	730832	36.6	14.3	0	32.0	13.6	0
157	LOCHEE ROAD	338832	730797	35.8	14.2	0	31.2	13.5	0
159	BROWN STREET	339754	730488	29.0	16.0	0	25.4	15.2	0
163	FORFAR ROAD	341354	732079	24.8	13.9	0	21.7	13.2	0
164	UNION STREET	340228	730118	28.3	14.7	0	24.7	13.8	0
169	LOONS ROAD	338319	731334	35.4	14.7	0	31.0	14.0	0
171	ARBROATH ROAD	341107	731067	35.7	18.2	2	31.0	16.8	1
174	BALMORE STREET	341096	731435	22.5	13.2	0	19.8	12.7	1
175	BROWN STREET	339786	730394	31.6	17.1	1	27.8	16.2	0
178	LOCHEE ROAD	338786	730837	37.4	14.4	0	32.7	13.7	0
179	DURA STREET	341130	731556	31.3	17.2	1	27.6	16.2	0
183	BROWN STREET	339771	730443	31.0	16.9	1	27.3	16.0	0
189	PARKER STREET	339802	730656	28.7	16.1	0	25.2	15.3	0
194	PARKER STREET	339807	730648	29.8	16.6	1	26.1	15.7	0
195	WHITEHALL CRESCENT	340320	730093	27.9	14.6	0	24.3	13.8	0
206	COMMERCIAL STREET	340501	730298	46.1	20.6	4	41.3	18.8	2
211	COMMERCIAL STREET	340483	730326	39.1	18.1	2	34.2	16.5	0
215	SOUTH TAY STREET	339856	730109	25.6	14.5	0	22.5	13.8	0
216	SOUTH TAY STREET	339914	730073	23.3	13.5	0	20.5	12.9	1

Receptor No.	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective	2010 Predicted Annual Mean NO <sub>2</sub>	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective
221	COMMERCIAL STREET	340549	730291	39.0	18.2	2	34.1	16.7	1
227	CLEGHORN STREET	338806	730730	26.0	13.0	1	22.7	12.4	1
228	CLEGHORN STREET	338824	730744	27.1	13.1	0	23.7	12.6	1
233	CLEGHORN STREET	338834	730751	28.3	13.2	0	24.7	12.7	1
240	DUDHOPE GARDENS	338907	730810	30.4	13.5	0	26.6	12.9	1
241	CLEGHORN STREET	338812	730716	26.3	13.0	1	23.1	12.5	1
243	COMMERCIAL STREET	340520	730287	31.7	15.8	0	27.5	14.8	0
248	ALBERT STREET	341174	731561	28.2	15.3	0	24.7	14.5	0
250	ALBERT STREET	341160	731518	31.9	16.6	1	27.9	15.6	0
251	ALBERT STREET	341120	731384	23.8	13.6	0	20.9	13.0	1
254	NAIRN STREET	341628	732323	24.8	13.9	0	21.7	13.3	0
256	LOGIE STREET	338180	731294	33.9	14.2	0	29.5	13.5	0
257	RAGLAN STREET	341103	731145	29.7	15.6	0	25.9	14.7	0
264	ALBERT STREET	341144	731433	31.1	16.1	0	27.2	15.2	0
265	ALBERT STREET	341167	731542	31.7	16.6	1	27.8	15.6	0
266	ALBERT STREET	341137	731478	32.3	16.5	1	28.3	15.6	0
277	ALBERT STREET	341092	731109	36.4	18.0	1	31.6	16.6	1
278	ALBERT STREET	341079	731133	34.0	17.2	1	29.7	16.1	0
282	EDEN BANK	341199	731084	49.8	25.8	14	43.9	23.5	9
294	SEAGATE	340499	730501	37.1	17.8	1	32.2	16.3	0
301	MORGAN STREET	341227	731589	23.8	13.7	0	20.9	13.0	1
304	PALAIS COURT	339968	730073	26.3	14.4	0	23.0	13.6	0
314	SEAGATE	340494	730493	45.8	21.2	5	40.1	19.0	2
315	CANDLE LANE	340495	730460	32.7	16.2	0	28.4	15.1	0
316	WEST PORT	339825	730121	25.8	14.6	0	22.6	13.9	0
317	MORGAN STREET	341206	731571	23.9	13.7	0	21.0	13.1	1
321	CRICHTON STREET	340306	730178	27.1	14.2	0	23.6	13.4	0
324	CANDLE LANE	340627	730409	24.6	14.0	0	21.5	13.3	0
331	TRADES LANE	340638	730441	25.8	14.4	0	22.6	13.6	0

Receptor No.	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective	2010 Predicted Annual Mean NO <sub>2</sub>	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective
345	FORFAR ROAD	341207	731695	30.6	15.8	0	26.6	14.9	0
349	MUIRTON ROAD	338088	731279	23.4	12.6	1	20.5	12.2	1
351	UNION STREET	340253	730069	25.7	14.1	0	22.5	13.3	0
353	NETHERGATE	340045	729973	24.0	13.6	0	21.0	13.0	1
355	LOCHEE ROAD	338823	730805	35.8	14.2	0	31.2	13.5	0
362	FORFAR ROAD	341490	732551	32.1	16.2	0	27.9	15.2	0
365	CASTLE STREET	340407	730230	24.2	13.7	0	21.2	13.1	0
367	LOCHEE ROAD	338942	730674	40.5	15.1	0	35.3	14.2	0
369	PARK AVENUE	341170	731386	23.9	13.6	0	21.0	13.0	1
393	NETHERGATE	340169	730059	26.1	14.1	0	22.8	13.4	0
401	MARTIN STREET	341549	732343	26.6	14.5	0	23.3	13.8	0
410	PARK AVENUE	341157	731403	25.4	14.1	0	22.2	13.4	0
412	FORFAR ROAD	341497	732597	32.8	16.5	0	28.5	15.5	0
415	CARDEAN STREET	341178	731471	24.3	13.8	0	21.3	13.1	0
416	LAMMERTON TERRACE	341364	732195	22.4	13.1	0	19.6	12.5	1
418	PARK AVENUE	341146	731379	26.8	14.6	0	23.4	13.8	0
419	DOCK STREET	340388	730084	30.4	15.7	0	26.5	14.7	0
441	BROWN STREET	339808	730324	26.6	15.0	0	23.4	14.3	0
443	CRESCENT STREET	340995	731029	25.1	14.1	0	22.0	13.4	0
446	ST MARY STREET	339112	730612	41.9	15.2	0	36.6	14.4	0
457	ALLOWAY PLACE	341614	732413	26.6	14.5	0	23.3	13.8	0
482	EXCHANGE STREET	340510	730230	26.7	14.7	0	23.3	13.9	0
486	LOCHEE ROAD	338801	730823	36.2	14.2	0	31.6	13.5	0
493	MAINS LOAN	341161	731614	23.6	13.6	0	20.7	12.9	1
495	LOCHEE ROAD	338841	730790	37.1	14.4	0	32.4	13.7	0
498	TRADES LANE	340660	730393	26.3	14.6	0	23.0	13.9	0
501	LOCHEE ROAD	338922	730689	39.4	14.7	0	34.3	13.9	0
512	WOODVILLE PLACE	341197	731756	24.2	13.7	0	21.1	13.0	1
513	FORFAR ROAD	341185	731729	23.8	13.5	0	20.8	12.9	1

Receptor No.	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective	2010 Predicted Annual Mean NO <sub>2</sub>	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective
517	WHITEHALL CRESCENT	340347	730094	36.7	17.3	1	32.0	15.9	0
521	WHITEHALL CRESCENT	340376	730106	33.4	16.3	0	29.1	15.2	0
523	WHITEHALL CRESCENT	340342	730090	33.2	16.2	0	28.9	15.0	0
527	WHITEHALL CRESCENT	340384	730107	30.1	15.4	0	26.2	14.4	0
535	CLEGHORN STREET	338816	730737	26.5	13.0	1	23.3	12.5	1
538	COMMERCIAL STREET	340428	730380	23.7	13.6	0	20.8	12.9	1
542	MITCHELL STREET	338982	730630	33.2	13.9	0	28.8	13.2	0
560	SOUTH TAY STREET	339923	730064	23.0	13.4	0	20.2	12.8	1
562	COMMERCIAL STREET	340434	730367	24.3	13.7	0	21.3	13.0	1
563	PRINCES STREET	341076	731020	28.5	15.0	0	24.8	14.2	0
564	COMMERCIAL STREET	340434	730367	24.3	13.7	0	21.3	13.0	1
566	ALBERT STREET	341184	731584	24.9	14.0	0	21.8	13.4	0
569	ALBERT STREET	341178	731570	25.0	14.1	0	21.9	13.4	0
572	ALBERT STREET	341155	731496	36.6	18.2	2	32.2	17.0	1
577	POLEPARK ROAD	339002	730611	31.8	13.7	0	27.6	13.0	1
579	ALBERT STREET	341092	731097	37.1	18.3	2	32.2	16.9	1
583	ALBERT STREET	341134	731464	32.0	16.4	0	28.1	15.5	0
601	ALBERT STREET	341157	731503	30.6	15.9	0	26.9	15.0	0
610	WEST PORT	339836	730120	26.5	14.9	0	23.3	14.2	0
618	SEAGATE	340478	730417	35.8	17.3	1	31.1	15.9	0
628	MORGAN STREET	341189	731504	23.8	13.6	0	20.9	13.0	1
631	ROBERTSON STREET	341115	731057	30.7	16.1	0	26.7	15.1	0
649	PALAIS COURT	339940	730080	24.9	14.0	0	21.8	13.3	0
650	TRADES LANE	340608	730479	25.8	14.3	0	22.6	13.6	0
652	MAINS LOAN	341159	731623	23.2	13.4	0	20.4	12.9	1
670	FORFAR ROAD	341235	731772	32.4	16.4	0	28.1	15.4	0
681	BALMORE STREET	341087	731467	23.0	13.5	0	20.3	12.9	1
686	PITKERRO ROAD	341219	731621	27.3	14.9	0	23.9	14.1	0
688	WHORTERBANK	338109	731375	24.1	12.7	1	21.1	12.2	1



Receptor No.	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective	2010 Predicted Annual Mean NO <sub>2</sub>	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective
700	GRAHAM PLACE	341088	731000	28.3	14.9	0	24.7	14.1	0
712	WHORTERBANK	338109	731359	27.2	13.1	0	23.8	12.6	1
723	DOCK STREET	340566	730260	29.2	15.5	0	25.5	14.6	0
726	CARDEAN STREET	341165	731444	25.2	14.0	0	22.1	13.4	0
727	FORFAR ROAD	341458	732344	31.0	15.9	0	26.9	14.8	0
741	CASTLE STREET	340399	730283	24.5	14.0	0	21.5	13.3	0
753	FORFAR ROAD	341408	732259	24.0	13.6	0	21.0	13.0	1
758	FORFAR ROAD	341186	731639	26.1	14.4	0	22.9	13.7	0
763	ARBROATH ROAD	341115	731084	35.6	<b>18.2</b>	2	30.9	<b>16.9</b>	1
772	EXCHANGE STREET	340504	730225	26.7	14.7	0	23.3	14.0	0
786	FORFAR ROAD	341424	732322	26.4	14.4	0	23.0	13.6	0
787	TRADES LANE	340575	730496	26.0	14.3	0	22.7	13.6	0
792	FORFAR ROAD	341431	732368	31.6	<b>16.1</b>	0	27.5	15.0	0
803	WHITEHALL STREET	340301	730137	28.6	14.5	0	24.9	13.6	0
809	PARK AVENUE	341157	731382	24.9	14.0	0	21.9	13.3	0
818	EXCHANGE STREET	340527	730252	26.8	14.7	0	23.4	13.9	0
844	FORFAR ROAD	341196	731664	28.5	15.1	0	24.8	14.3	0
845	DURA STREET	341096	731500	23.3	13.6	0	20.5	13.0	1
849	DUFF STREET	341325	732115	22.5	13.2	0	19.8	12.6	1
862	PARKER STREET	339812	730636	31.7	<b>17.6</b>	1	27.8	<b>16.6</b>	1
864	ALLAN LANE	340603	730461	25.0	14.0	0	21.9	13.3	0
869	KINGSWAY	341286	732411	34.0	<b>17.0</b>	1	29.7	15.9	0
878	KINGSWAY	341376	732388	31.4	16.0	0	27.3	15.0	0
893	COMMERCIAL STREET	340434	730367	24.3	13.7	0	21.3	13.0	1
908	PRINCES STREET	341058	730967	<b>40.0</b>	<b>18.6</b>	2	35.3	<b>17.3</b>	1
914	MITCHELL STREET	338962	730619	27.3	13.1	1	23.8	12.5	1
924	NAIRN STREET	341567	732338	26.0	14.3	0	22.7	13.6	0
940	LOGIE STREET	338231	731284	35.4	14.5	0	30.9	13.7	0
943	LOGIE STREET	338232	731268	<b>40.5</b>	15.3	0	35.3	14.4	0

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948	ALBERT STREET	341142	731418	30.9	16.0	0	27.1	15.1	0
949	LOGIE STREET	338241	731279	35.0	14.4	0	30.5	13.6	0
965	MORGAN STREET	341223	731602	25.2	14.1	0	22.1	13.4	0
967	MORGAN STREET	341210	731555	23.3	13.5	0	20.5	12.9	1
977	ROBERTSON STREET	341116	731008	26.9	14.6	0	23.5	13.8	0
984	SEAGATE	340486	730440	<b>36.1</b>	<b>17.4</b>	1	31.3	16.0	0
987	MORGAN STREET	341206	731544	23.3	13.5	0	20.5	12.9	1
1004	FORFAR ROAD	341428	732238	25.3	14.1	0	22.1	13.4	0
1006	ARBROATH ROAD	341205	731101	<b>54.7</b>	<b>29.1</b>	<b>24</b>	<b>48.6</b>	<b>26.4</b>	<b>16</b>
1016	UNION STREET	340215	730103	27.3	14.4	0	23.8	13.6	0
1020	PARK AVENUE	341179	731409	23.5	13.5	0	20.7	12.9	1
1023	BARRACK ROAD	339796	730665	27.5	15.5	0	24.1	14.8	0
1037	CROSS LANE	339865	730092	23.8	13.7	0	20.9	13.1	0
1041	GRAHAM PLACE	341068	730992	28.8	15.0	0	25.2	14.2	0
1042	NETHERGATE	340029	729956	29.1	15.2	0	25.4	14.3	0
1043	ARBROATH ROAD	341092	731063	31.9	<b>16.4</b>	0	27.8	15.3	0
1057	ANCRUM ROAD	338127	731277	24.4	12.8	1	21.4	12.3	1
1058	FORFAR ROAD	341226	731747	32.9	<b>16.6</b>	1	28.5	15.5	0
1065	UNION STREET	340272	730074	32.6	16.0	0	28.5	14.9	0
1066	MUIRTON ROAD	338160	731295	33.6	14.2	0	29.2	13.5	0
1068	FORFAR ROAD	341352	732074	25.0	13.9	0	21.8	13.2	0
1082	UNION STREET	340298	730049	34.4	<b>16.7</b>	1	30.0	15.5	0
1083	UNION STREET	340278	730044	26.5	14.4	0	23.1	13.6	0
1102	LAMMERTON TERRACE	341379	732233	22.6	13.2	0	19.8	12.6	1
1118	TRADES LANE	340566	730507	26.7	14.5	0	23.3	13.7	0
1129	DOCK STREET	340672	730364	26.8	14.9	0	23.4	14.1	0
1184	ALLAN LANE	340629	730428	24.9	14.1	0	21.8	13.4	0
1249	ALBERT STREET	341139	731489	32.3	<b>16.5</b>	1	28.3	15.6	0
1263	ALBERT STREET	341131	731448	31.9	<b>16.4</b>	0	27.9	15.4	0

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1279	ALBERT STREET	341125	731412	31.9	16.4	0	28.0	15.4	0
1294	PALAIS COURT	339961	730079	26.7	14.5	0	23.3	13.8	0
1313	CLEPINGTON ROAD	341376	732156	24.9	14.1	0	21.8	13.4	0
1335	GRAHAM PLACE	341098	730977	27.5	14.7	0	24.0	14.0	0
1356	NETHERGATE	340203	730093	26.8	14.3	0	23.4	13.5	0
1363	ARBROATH ROAD	341140	731089	35.1	18.1	1	30.5	16.8	1
1379	NETHERGATE	340050	729954	24.0	13.6	0	21.0	13.0	1
1381	DUDHOPE CRESCENT ROAD	339860	730625	33.1	18.3	2	29.0	17.2	1
1395	ALLOWAY PLACE	341550	732435	29.4	15.4	0	25.6	14.5	0
1401	DUFF STREET	341320	732091	22.1	13.0	1	19.5	12.5	1
1406	FORFAR ROAD	341455	732334	29.7	15.4	0	25.8	14.5	0
1421	LOCHEE ROAD	338886	730735	32.0	13.7	0	27.9	13.1	1
1456	UNION STREET	340255	730090	30.2	15.3	0	26.3	14.3	0
1473	PARK AVENUE	341139	731404	31.1	16.1	0	27.3	15.2	0
1475	BALMORE STREET	341116	731453	23.5	13.5	0	20.6	12.9	1
1476	LANGLANDS STREET	341123	731398	32.3	16.5	0	28.3	15.5	0
1486	FORFAR ROAD	341213	731718	30.6	15.8	0	26.5	14.9	0
1504	KINGSWAY	341308	732407	33.4	16.7	1	29.2	15.7	0
1506	KINGSWAY	341268	732416	35.0	17.4	1	30.7	16.3	0
1508	KINGSWAY	341324	732401	32.2	16.3	0	28.1	15.3	0
1529	HIGH STREET	340342	730287	22.8	13.3	0	20.0	12.7	1
1542	SOUTH TAY STREET	340011	729939	28.9	15.1	0	25.2	14.2	0
1574	ALBERT STREET	341095	731141	33.1	16.9	1	29.0	15.8	0
1625	CLEPINGTON ROAD	341434	732155	24.8	14.1	0	21.7	13.4	0
1648	MOLISON STREET	341154	731642	22.8	13.3	0	20.0	12.7	1
1667	FORFAR ROAD	341436	732266	25.7	14.2	0	22.5	13.5	0
1673	MARTIN STREET	341517	732352	27.9	14.9	0	24.3	14.1	0
1682	FORFAR ROAD	341391	732203	23.6	13.5	0	20.7	12.9	1
1690	FORFAR ROAD	341407	732173	26.3	14.5	0	22.9	13.7	0

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1691	FORFAR ROAD	341411	732269	24.2	13.7	0	21.2	13.0	1
1699	WHITEHALL STREET	340279	730157	29.5	14.7	0	25.7	13.8	0
1732	FORFAR ROAD	341436	732266	25.7	14.2	0	22.5	13.5	0
1755	FYFFE STREET	338991	730574	25.7	12.9	1	22.5	12.4	1
1758	BALMORE STREET	341107	731430	23.0	13.4	0	20.2	12.8	1
1764	ARBROATH ROAD	341173	731105	33.5	17.4	1	29.1	16.2	0
1786	FORFAR ROAD	341485	732514	34.5	16.9	1	30.0	15.7	0
1803	BALMORE STREET	341095	731463	22.8	13.4	0	20.1	12.8	1
1813	LOONS ROAD	338206	731297	38.2	15.0	0	33.4	14.2	0
1815	MUIRTON ROAD	338089	731269	22.4	12.5	1	19.7	12.0	1
1823	PITKERRO ROAD	341239	731637	32.3	16.8	1	28.3	15.8	0
1834	NETHERGATE	340183	730073	26.2	14.1	0	22.9	13.4	0
1836	FORFAR ROAD	341355	732084	24.4	13.8	0	21.3	13.1	0
1846	NETHERGATE	340153	730045	26.4	14.3	0	23.1	13.5	0
1873	ST ANDREWS STREET	340523	730557	25.1	14.0	0	21.9	13.3	0
1875	BENVIE ROAD	338798	730766	26.0	12.9	1	22.7	12.4	1
1898	CLEGHORN STREET	338873	730753	32.6	13.8	0	28.3	13.2	0
1943	ALBERT STREET	341093	731125	41.4	20.3	4	36.4	18.8	2
2004	SEAGATE	340535	730545	26.2	14.3	0	22.9	13.6	0
2025	SEAGATE	340268	730054	26.0	14.2	0	22.8	13.5	0
2035	KINGSWAY EAST	341491	732358	29.4	15.4	0	25.6	14.5	0
2052	FORFAR ROAD	341416	732286	24.7	13.8	0	21.6	13.2	0
2088	FORFAR ROAD	341426	732337	28.2	14.9	0	24.5	14.0	0
2102	WHORTERBANK	338109	731353	29.3	13.4	0	25.7	12.8	1
2105	LOCHEE ROAD	338931	730682	39.6	14.9	0	34.5	14.0	0
2211	KINGSWAY	341341	732397	31.9	16.2	0	27.8	15.2	0
2224	PRINCES STREET	341085	731047	29.8	15.6	0	26.0	14.6	0
2229	DOIG COURT	338276	731237	50.9	17.3	1	44.8	16.0	0
2265	LOGIE STREET	338249	731257	39.2	15.0	0	34.0	14.1	0

Receptor No.	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective	2010 Predicted Annual Mean NO <sub>2</sub>	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective
2305	MAINS TERRACE	341376	732281	23.2	13.3	0	20.3	12.7	1
2311	SEAGATE	340535	730522	37.6	18.0	1	32.8	16.5	0
2331	DURA STREET	341120	731544	31.5	17.3	1	27.7	16.3	0
2333	UNION STREET	340249	730096	30.3	15.3	0	26.4	14.3	0
2360	CASTLE STREET	340440	730240	25.5	14.3	0	22.3	13.6	0
2364	MUIRTON ROAD	338156	731294	31.9	13.9	0	27.7	13.2	0
2395	OLD MUIRTON ROAD	338075	731317	24.0	12.7	1	21.0	12.2	1
2405	FORFAR ROAD	341494	732579	32.0	16.2	0	27.8	15.2	0
2408	WHORTERBANK	338109	731369	25.0	12.8	1	21.9	12.3	1
2466	LAMMERTON TERRACE	341354	732188	22.2	13.1	1	19.5	12.5	1
2486	WHITEHALL STREET	340327	730112	28.7	14.7	0	25.0	13.8	0
2508	MUIRTON ROAD	338092	731261	22.2	12.4	1	19.6	12.0	1
2514	KINGSWAY	341229	732426	36.5	17.9	1	32.0	16.8	1
2530	ALLAN LANE	340619	730440	24.8	14.0	0	21.8	13.3	0
2571	DUDHOPE GARDENS	338912	730799	30.6	13.5	0	26.7	12.9	1
2603	NAIRN STREET	341592	732333	25.5	14.2	0	22.3	13.5	0
2619	CLEPINGTON ROAD	341347	732150	23.5	13.6	0	20.6	13.0	1
2658	EXCHANGE STREET	340494	730280	26.1	14.3	0	22.8	13.5	0
2676	FORFAR ROAD	341367	732125	26.2	14.6	0	22.9	13.8	0
2693	FERGUSON STREET	341005	731009	24.9	14.0	0	21.8	13.3	0
2704	UNION STREET	340264	730082	32.6	16.0	0	28.5	14.9	0
2708	BARRACK ROAD	339809	730668	26.7	15.2	0	23.5	14.4	0
2742	CRESCENT LANE	340994	730966	25.1	14.0	0	22.0	13.3	0
2749	NETHERGATE	340168	730036	25.3	14.0	0	22.1	13.3	0
2927	LOGIE STREET	338203	731283	32.9	14.1	0	28.6	13.3	0
2958	SEAGATE	340453	730392	24.6	13.8	0	21.5	13.1	0
3051	WHORTERBANK	338165	731357	25.7	12.9	1	22.4	12.4	1
3055	FORFAR ROAD	341436	732266	25.7	14.2	0	22.5	13.5	0
3072	FORFAR ROAD	341482	732497	36.7	17.6	1	31.9	16.3	0

Receptor No.	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective	2010 Predicted Annual Mean NO <sub>2</sub>	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective
3091	CARDEAN STREET	341149	731458	30.8	16.0	0	27.0	15.1	0
3100	FORFAR ROAD	341449	732285	25.2	14.0	0	22.0	13.3	0
3150	FORFAR ROAD	341453	732321	27.6	14.8	0	24.0	13.9	0
3185	DOCK STREET	340531	730223	29.0	15.7	0	25.3	14.8	0
3189	WHITEHALL STREET	340272	730165	<b>37.9</b>	<b>17.2</b>	1	32.9	15.6	0
3195	WHITEHALL CRESCENT	340347	730116	28.6	14.7	0	24.9	13.9	0
3207	KINGSWAY	341246	732422	<b>36.1</b>	<b>17.8</b>	1	31.6	<b>16.7</b>	1
3239	DUDHOPE GARDENS	338909	730805	30.5	13.5	0	26.6	12.9	1
3306	PALAIS COURT	339954	730050	23.0	13.4	0	20.2	12.8	1
3307	CRICHTON STREET	340329	730159	33.7	15.9	0	29.3	14.8	0
3316	MORGAN STREET	341197	731543	23.7	13.6	0	20.8	13.0	1
3334	FORFAR ROAD	341416	732200	25.3	14.1	0	22.1	13.4	0
3397	WOODVILLE PLACE	341209	731755	25.7	14.1	0	22.4	13.4	0
3435	CASTLE STREET	340432	730249	25.2	14.2	0	22.0	13.5	0
3440	FORFAR ROAD	341359	732094	24.2	13.8	0	21.2	13.1	0
3503	LOONS ROAD	338213	731293	<b>37.0</b>	14.8	0	32.2	14.0	0
3527	WARD ROAD	339837	730380	35.3	<b>18.8</b>	2	31.1	<b>17.7</b>	1
3557	GELLATLY STREET	340474	730402	32.2	<b>16.2</b>	0	27.9	15.0	0
3604	NAIRN STREET	341612	732326	24.9	14.0	0	21.8	13.3	0
3615	SEAGATE	340518	730501	<b>42.5</b>	<b>19.9</b>	3	<b>37.3</b>	<b>18.0</b>	1
3616	MORGAN STREET	341193	731509	23.6	13.5	0	20.7	12.9	1
3664	WEST MARKETGAIT	339986	730060	26.0	14.2	0	22.7	13.5	0
3676	LABURN STREET	339855	730640	28.9	<b>16.2</b>	0	25.4	15.4	0
3760	CROSS LANE	339860	730101	24.6	14.1	0	21.6	13.4	0
3779	NETHERGATE	340075	729981	26.0	14.3	0	22.7	13.5	0
3820	BALMORE STREET	341117	731427	23.9	13.6	0	21.0	13.0	1
3828	WHORTERBANK	338109	731380	23.5	12.6	1	20.6	12.1	1
3833	HIGH STREET	340387	730296	23.9	13.7	0	21.0	13.1	0
3898	ALBERT STREET	341170	731551	31.8	<b>16.7</b>	1	27.9	15.6	0

Receptor No.	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective	2010 Predicted Annual Mean NO <sub>2</sub>	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective
3948	PALAIS COURT	339948	730047	22.8	13.3	0	20.0	12.7	1
3960	DURA STREET	341114	731538	31.4	<b>17.3</b>	1	27.7	<b>16.3</b>	0
3962	MAINS LOAN	341156	731634	22.9	13.3	0	20.1	12.8	1
3965	BROWN STREET	340041	729945	23.5	13.5	0	20.6	12.8	1
3967	FORFAR ROAD	341422	732221	25.3	14.1	0	22.1	13.4	0
3997	DUFF STREET	341323	732099	22.2	13.1	1	19.5	12.5	1
4014	FORFAR ROAD	341427	732345	29.2	15.2	0	25.3	14.3	0
4022	FORFAR ROAD	341430	732361	31.0	15.8	0	26.9	14.8	0
4043	FORFAR ROAD	341391	732112	26.0	14.5	0	22.6	13.7	0
4112	WHORTERBANK	338165	731350	26.8	13.1	0	23.5	12.5	1
4156	COMMERCIAL STREET	340524	730304	<b>44.8</b>	<b>20.1</b>	4	<b>40.7</b>	<b>18.7</b>	2
4180	POLEPARK ROAD	339008	730591	28.9	13.3	0	25.2	12.7	1
4256	MUIRTON ROAD	338151	731293	30.4	13.7	0	26.5	13.0	1
4351	WHORTERBANK	338165	731364	24.7	12.8	1	21.7	12.3	1
4355	MARTIN STREET	341511	732342	26.7	14.5	0	23.3	13.7	0
4384	FORFAR ROAD	341449	732285	25.2	14.0	0	22.0	13.3	0
4428	NETHERGATE	340015	729921	23.7	13.5	0	20.8	12.9	1
4452	FORFAR ROAD	341412	732187	25.7	14.3	0	22.4	13.5	0
4488	SOUTH TAY STREET	339996	729952	22.4	13.1	0	19.7	12.6	1
4556	MORGAN STREET	341182	731508	24.3	13.8	0	21.4	13.2	0
4602	ARBROATH ROAD	341109	731082	35.6	<b>18.2</b>	2	30.9	<b>16.8</b>	1
4604	FORFAR ROAD	341420	732214	25.3	14.1	0	22.1	13.4	0
4631	ANCRUM ROAD	338137	731281	25.5	12.9	1	22.3	12.4	1
4647	VICTORIA STREET	341078	731110	<b>37.6</b>	<b>18.4</b>	2	32.7	<b>17.0</b>	1
4667	CASTLE STREET	340431	730225	24.7	13.9	0	21.7	13.3	0
4669	LYON STREET	341045	731126	24.2	13.7	0	21.2	13.1	0
4674	VICTORIA STREET	341077	731095	<b>38.5</b>	<b>18.8</b>	2	33.5	<b>17.3</b>	1
4697	VICTORIA STREET	341039	731067	32.3	<b>16.9</b>	1	28.3	15.8	0
4702	WHORTERBANK	338165	731371	24.1	12.7	1	21.0	12.2	1

Receptor No.	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective	2010 Predicted Annual Mean NO <sub>2</sub>	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective
4711	TRADES LANE	340582	730488	25.7	14.2	0	22.5	13.5	0
4753	FORFAR ROAD	341403	732157	27.1	14.9	0	23.6	14.0	0
4836	PRINCES STREET	341088	731056	31.3	16.1	0	27.2	15.1	0
4884	LOGIE STREET	338259	731251	39.8	15.0	0	34.6	14.1	0
4921	MORGAN STREET	341201	731505	23.2	13.4	0	20.4	12.8	1
4948	FORFAR ROAD	341357	732089	24.3	13.8	0	21.2	13.1	0
4971	OLD MUIRTON ROAD	338067	731313	23.1	12.6	1	20.3	12.1	1
4972	FORFAR ROAD	341403	732240	23.8	13.6	0	20.8	12.9	1
4975	WEST MARKETGAIT	339940	730132	32.5	17.0	1	28.4	15.9	0
4983	FORFAR ROAD	341487	732532	33.1	16.4	0	28.8	15.4	0
4988	LOCHEE ROAD	338915	730695	32.0	13.7	0	27.8	13.0	1
5003	WHORTERBANK	338109	731364	25.9	12.9	1	22.7	12.4	1
5004	OLD MUIRTON ROAD	338087	731322	26.0	12.9	1	22.7	12.4	1
5024	BROWN STREET	339641	730578	24.9	14.2	0	21.8	13.6	0
5119	FORFAR ROAD	341394	732122	26.7	14.8	0	23.3	13.9	0
5124	LOCHEE ROAD	338861	730770	32.5	13.8	0	28.3	13.1	0
5125	VICTORIA STREET	341076	731076	43.5	21.2	5	38.1	19.4	3
5126	FORFAR ROAD	341212	731707	32.5	16.5	0	28.2	15.4	0
5158	KINGSWAY	341400	732382	31.1	15.9	0	27.1	14.9	0
5165	CLEGHORN STREET	338850	730739	29.6	13.5	0	25.8	12.9	1
5202	COMMERCIAL STREET	340453	730343	35.8	17.0	1	31.3	15.6	0
5296	Seagate	340508	730488	56.1	26.4	16	49.8	23.2	8
5297	Seagate	340504	730480	53.0	24.8	12	46.9	21.8	6
5300	Dock Street	340330	730030	83.3	43.0	102	75.3	37.1	61
5306	Dudhope RAB	339645	730623	25.5	14.4	0	22.3	13.7	0
5307	Dudhope RAB	339727	730650	27.5	15.5	0	24.1	14.7	0
5308	Dudhope RAB	339778	730641	30.9	17.1	1	27.1	16.1	0
5309	West Marketgait	339811	730391	58.0	33.6	43	52.6	31.1	32
5311	Johnston Street	339862	730326	28.4	15.8	0	24.9	15.0	0



Receptor No.	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective	2010 Predicted Annual Mean NO <sub>2</sub>	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective
5312	Johnston Street	339896	730336	27.2	15.3	0	23.9	14.5	0
5313	Johnston Street	339910	730323	25.7	14.7	0	22.6	14.0	0
5314	North Lindsey Street	339925	730308	25.1	14.5	0	22.0	13.8	0
5317	Dura Street	341080	731482	23.1	13.5	0	20.3	12.9	1
5318	Balmore Street	341066	731454	23.2	13.6	0	20.5	13.0	1
5319	Balmore Street	341077	731449	22.6	13.3	0	19.9	12.7	1
5320	Dura Street	341049	731448	22.7	13.4	0	20.0	12.8	1
5321	Dura Street	341037	731452	22.0	13.1	0	19.4	12.6	1
5322	Dura Street	341031	731446	21.9	13.1	1	19.3	12.5	1
5323	Dura Street	341026	731440	21.8	13.0	1	19.2	12.5	1
5324	Pitkerro Road	341252	731647	32.3	16.8	1	28.3	15.7	0
5325	Pitkerro Road	341283	731672	32.0	16.8	1	28.1	15.8	0
5326	Pitkerro Road	341297	731683	32.7	17.1	1	28.7	16.1	0
5328	Dundee Road West	343381	731105	33.2	13.0	1	29.3	12.5	1
5329	Dundee Road West	343413	731106	30.8	12.8	1	27.1	12.3	1
5330	Dundee Road West	343430	731106	30.1	12.7	1	26.4	12.3	1
5331	Dundee Road West	343447	731106	29.5	12.7	1	25.9	12.2	1
5332	Dundee Road West	343464	731106	29.1	12.7	1	25.5	12.2	1
5333	Craigie Place	343386	731130	34.5	13.1	0	30.5	12.6	1
5334	Broughty Ferry Road	343315	731073	39.9	13.6	0	35.3	13.0	1
5335	Broughty Ferry Road	343300	731106	32.2	12.9	1	28.3	12.4	1
5336	Broughty Ferry Road	343289	731105	31.9	12.9	1	28.1	12.4	1
5337	Broughty Ferry Road	343276	731103	31.9	12.9	1	28.0	12.4	1
5338	Broughty Ferry Road	343266	731103	31.6	12.8	1	27.8	12.4	1
5339	Redmyre Gardens	343243	731106	30.8	12.8	1	27.1	12.3	1
5340	Broughty Ferry Road	343223	731120	29.0	12.6	1	25.4	12.2	1
5341	Redmyre Gardens	343202	731109	30.3	12.7	1	26.6	12.3	1
5342	Broughty Ferry Road	343180	731076	34.1	13.0	1	30.0	12.5	1
5343	Craigie Drive	343411	731160	32.9	13.0	1	29.1	12.5	1

Receptor No.	Road Name	X(m)	Y(m)	2007 Predicted Annual Mean NO <sub>2</sub>	2007 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective	2010 Predicted Annual Mean NO <sub>2</sub>	2010 Annual Mean PM <sub>10</sub>	No. Exceedences 24-Hour PM <sub>10</sub> Objective
5344	Broughty Ferry Road	343128	731115	29.8	12.7	1	26.1	12.2	1
5345	Broughty Ferry Road	343123	731115	29.8	12.7	1	26.2	12.2	1
5346	Broughty Ferry Road	343105	731114	30.1	12.7	1	26.4	12.2	1
5347	Broughty Ferry Road	343102	731114	30.1	12.7	1	26.4	12.2	1
5348	Dundee Road West	343482	731106	28.7	12.6	1	25.2	12.2	1
5349	Dundee Road West	343499	731106	28.4	12.6	1	25.0	12.1	1
5350	Dundee Road West	343516	731105	28.3	12.6	1	24.8	12.1	1
m1	Victoria Road	340263	730711	<b>37.1</b>	<b>18.7</b>	2	32.4	<b>17.3</b>	1
m10	Meadowside	340308	730569	28.5	14.7	0	24.8	13.8	0
m11	Meadowside	340294	730554	33.3	15.8	0	28.9	14.7	0
m2	Victoria Road	340235	730684	<b>51.0</b>	<b>24.8</b>	<b>12</b>	<b>45.0</b>	<b>22.2</b>	7
m3	Victoria Road	340222	730668	33.6	<b>17.8</b>	1	29.3	<b>16.6</b>	1
m4	Meadowside	340241	730656	<b>43.8</b>	<b>20.7</b>	4	<b>38.4</b>	<b>18.7</b>	2
m5	Meadowside	340253	730637	<b>39.3</b>	<b>18.2</b>	2	34.2	<b>16.7</b>	1
m6	Meadowside	340259	730628	<b>38.7</b>	<b>17.9</b>	1	33.7	<b>16.3</b>	0
m7	Meadowside	340269	730613	35.7	<b>16.7</b>	1	31.0	15.5	0
m8	Meadowside	340287	730573	34.2	<b>16.0</b>	0	29.7	14.9	0
m9	Meadowside	340302	730581	33.3	15.6	0	28.3	14.6	0

## Appendix 5 – Modelled Contour Results for NO<sub>2</sub>

Figure 5.1a Central Area NO<sub>2</sub> Annual Mean 2007 Contour

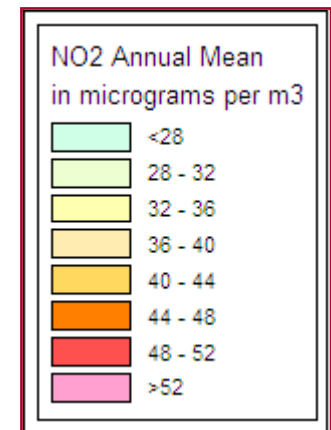
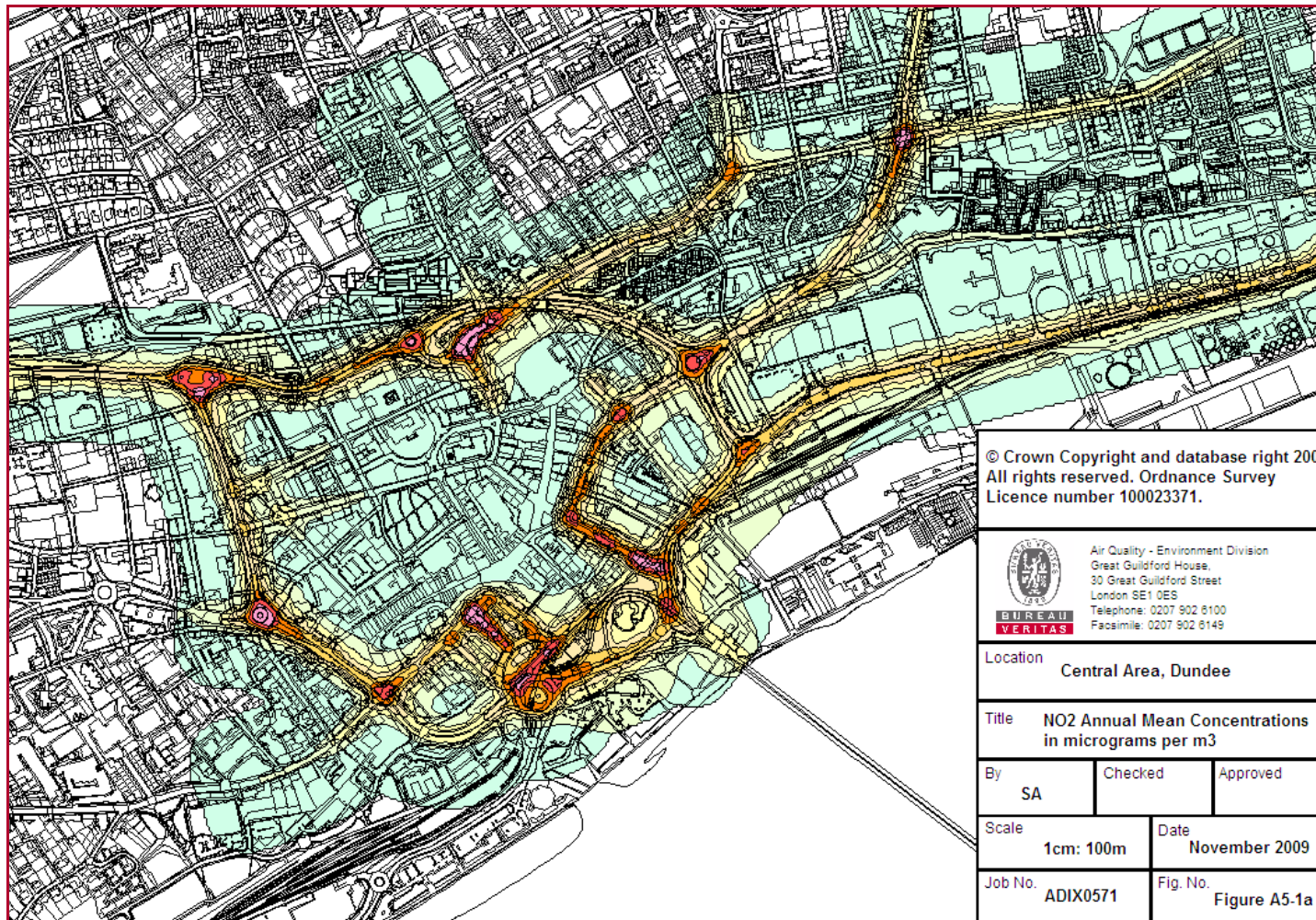


Figure 5.1a Central Area NO<sub>2</sub> Annual Mean 2007 Contour (Focus on Forfar Road)

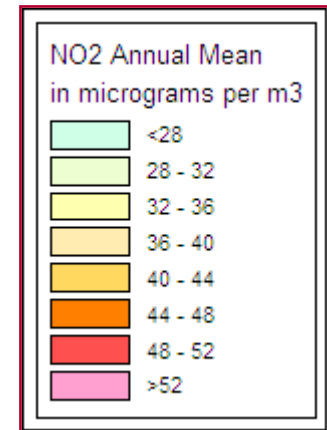
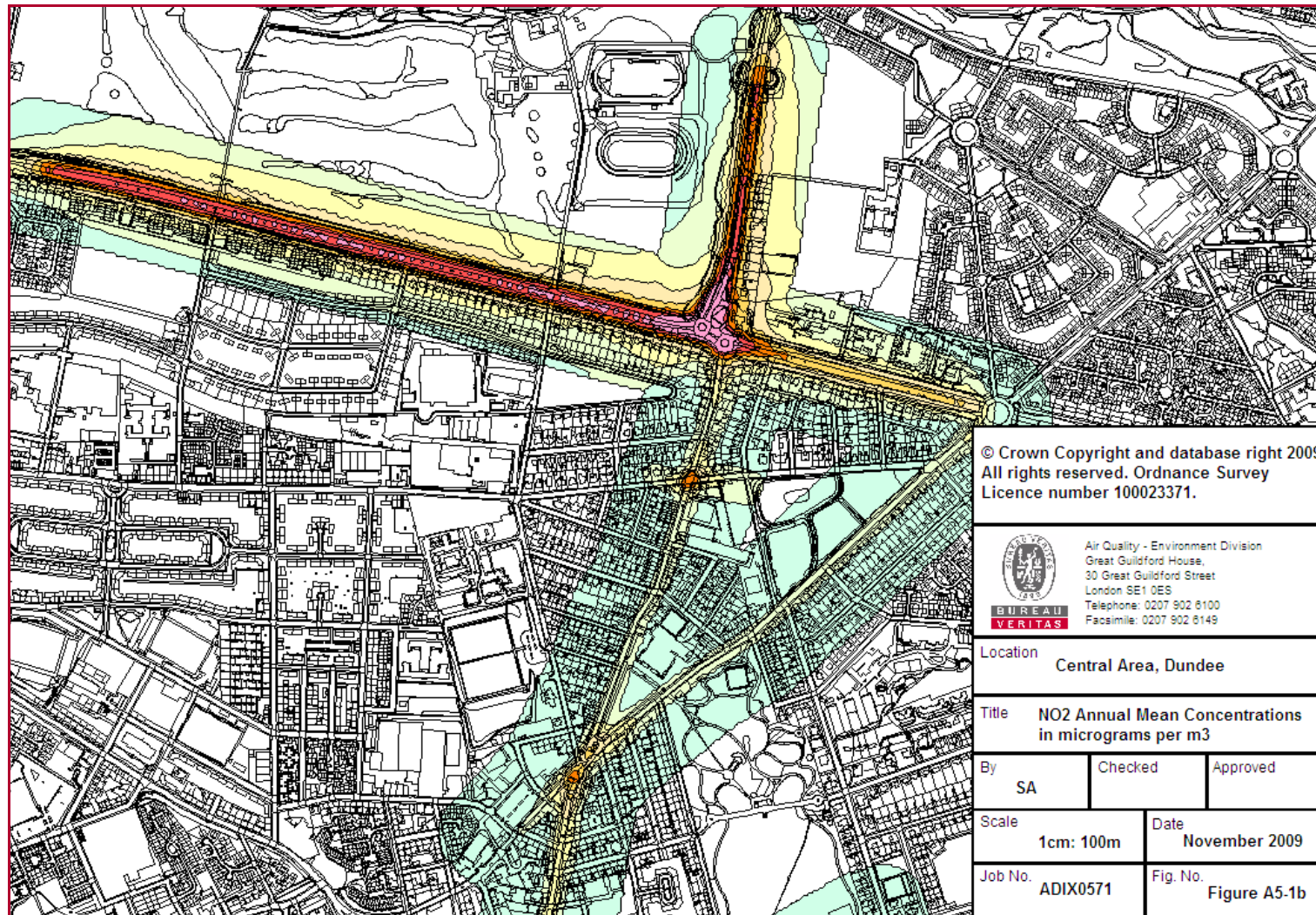


Figure 5.2 Lochee Road and Logie Street NO<sub>2</sub> Annual Mean 2007 Contour

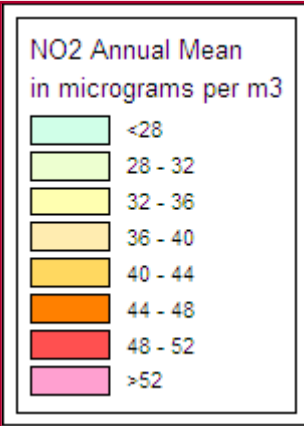
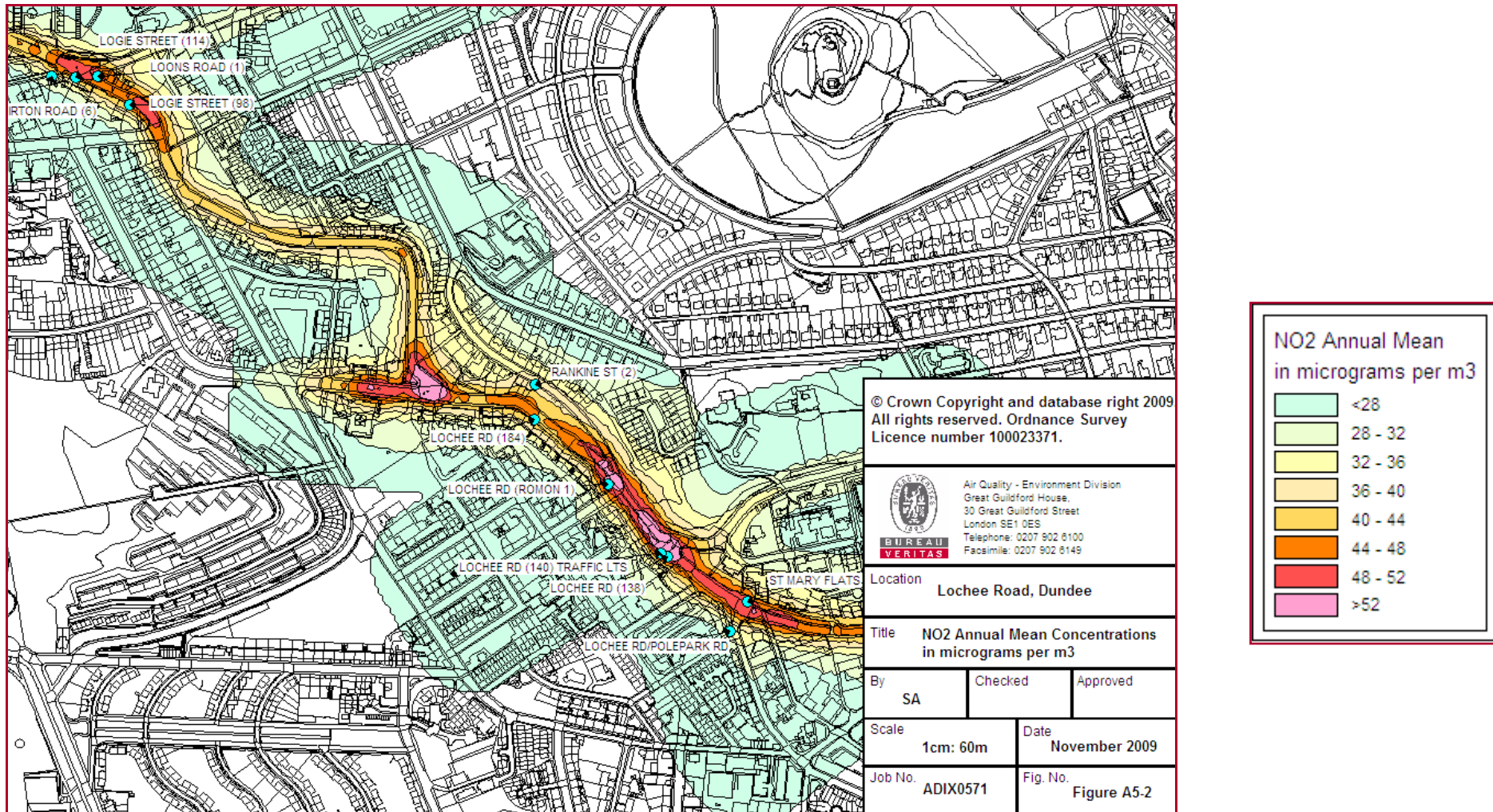
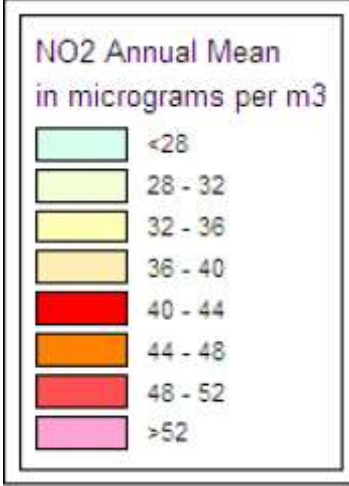
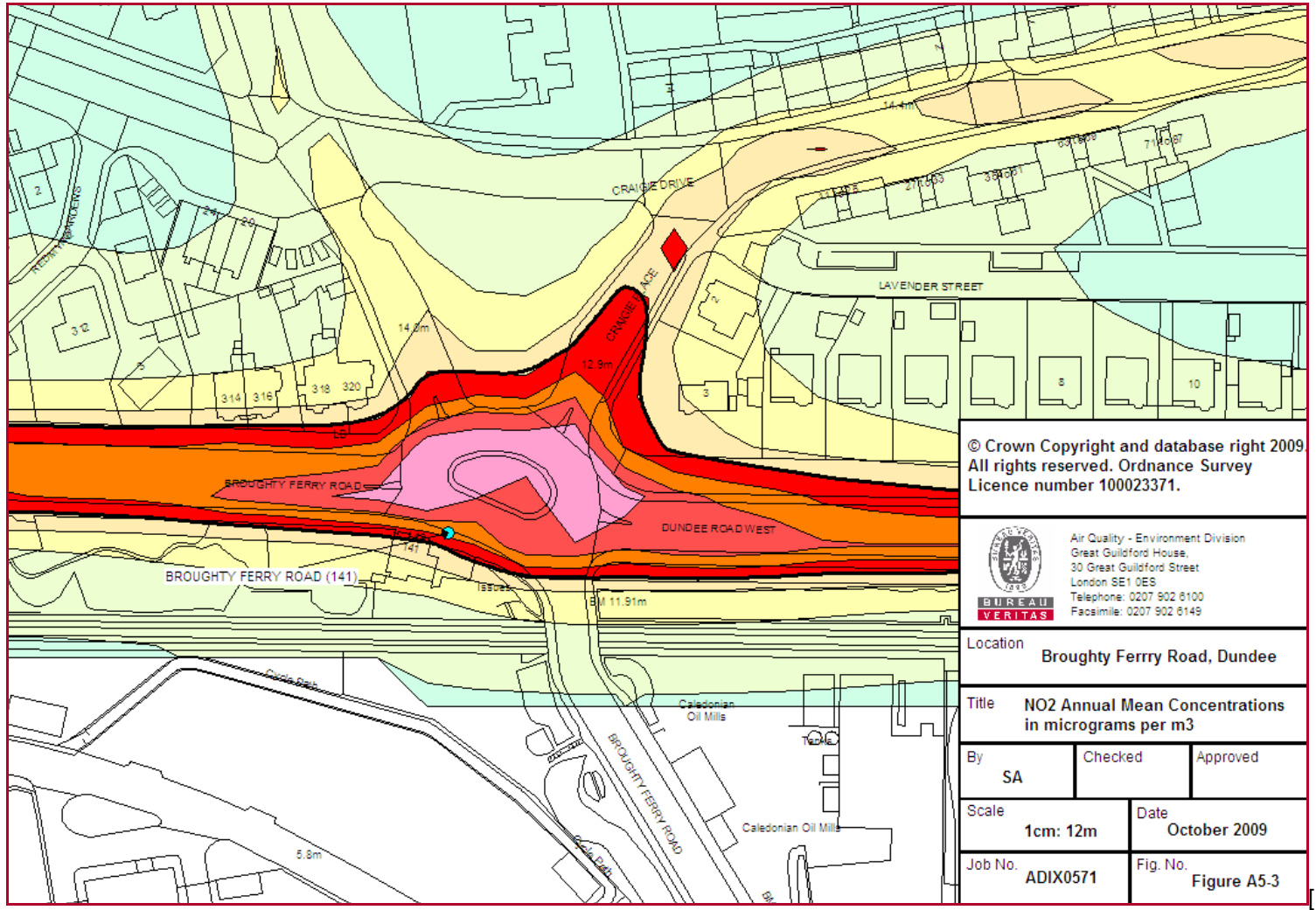



Figure 5.3 Broughty Ferry NO<sub>2</sub> Annual Mean 2007 Contour



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Location **Broughty Ferry Road, Dundee**

Title **NO<sub>2</sub> Annual Mean Concentrations  
 in micrograms per m<sup>3</sup>**

By <b>SA</b>	Checked	Approved
Scale <b>1cm: 12m</b>	Date <b>October 2009</b>	
Job No. <b>ADIX0571</b>	Fig. No. <b>Figure A5-3</b>	

## Appendix 6 – Modelled Contour Results for PM<sub>10</sub>

Figure 6.1a Central Area PM<sub>10</sub> Annual Mean 2007 Contour

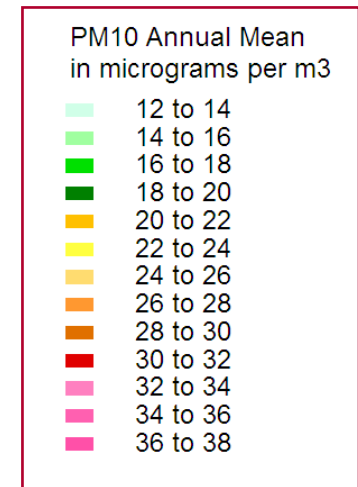
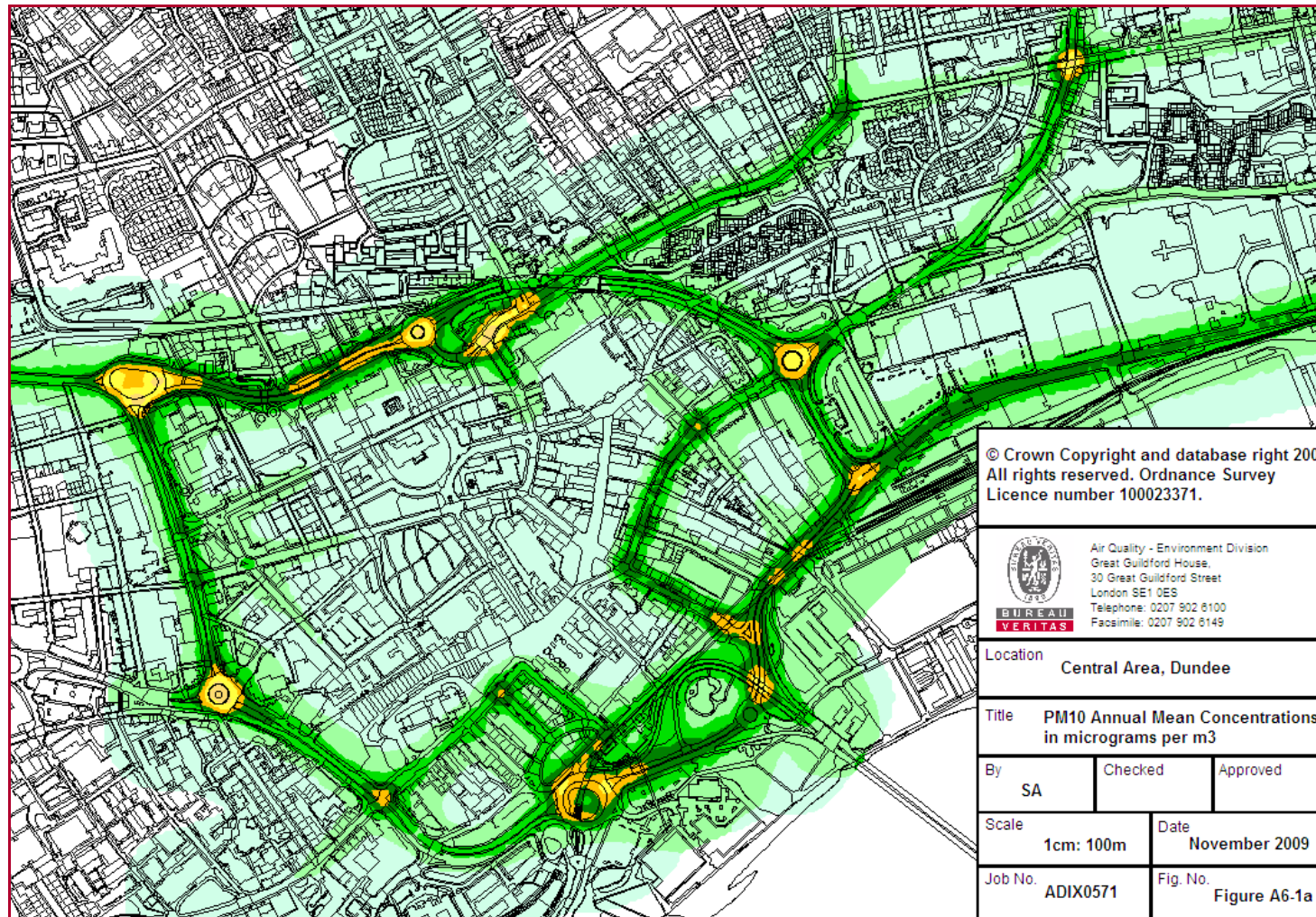
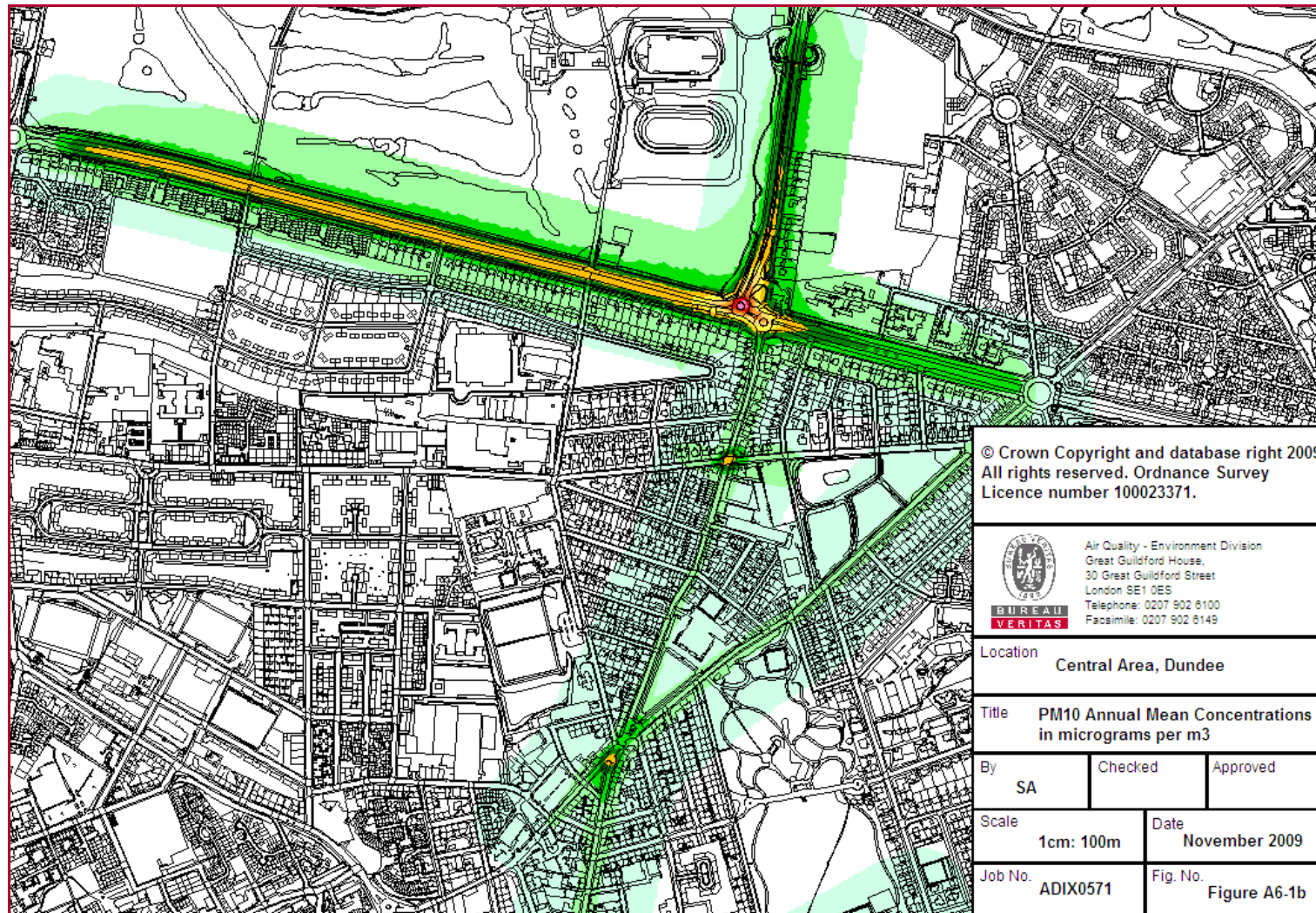


Figure 6.1b Central Area PM<sub>10</sub> Annual Mean 2007 Contour (Focus on Forfar Road)



PM10 Annual Mean  
 in micrograms per m3

- 12 to 14
- 14 to 16
- 16 to 18
- 18 to 20
- 20 to 22
- 22 to 24
- 24 to 26
- 26 to 28
- 28 to 30
- 30 to 32
- 32 to 34
- 34 to 36
- 36 to 38

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 Facsimile: 0207 902 8149

Location **Central Area, Dundee**

Title **PM10 Annual Mean Concentrations  
 in micrograms per m3**

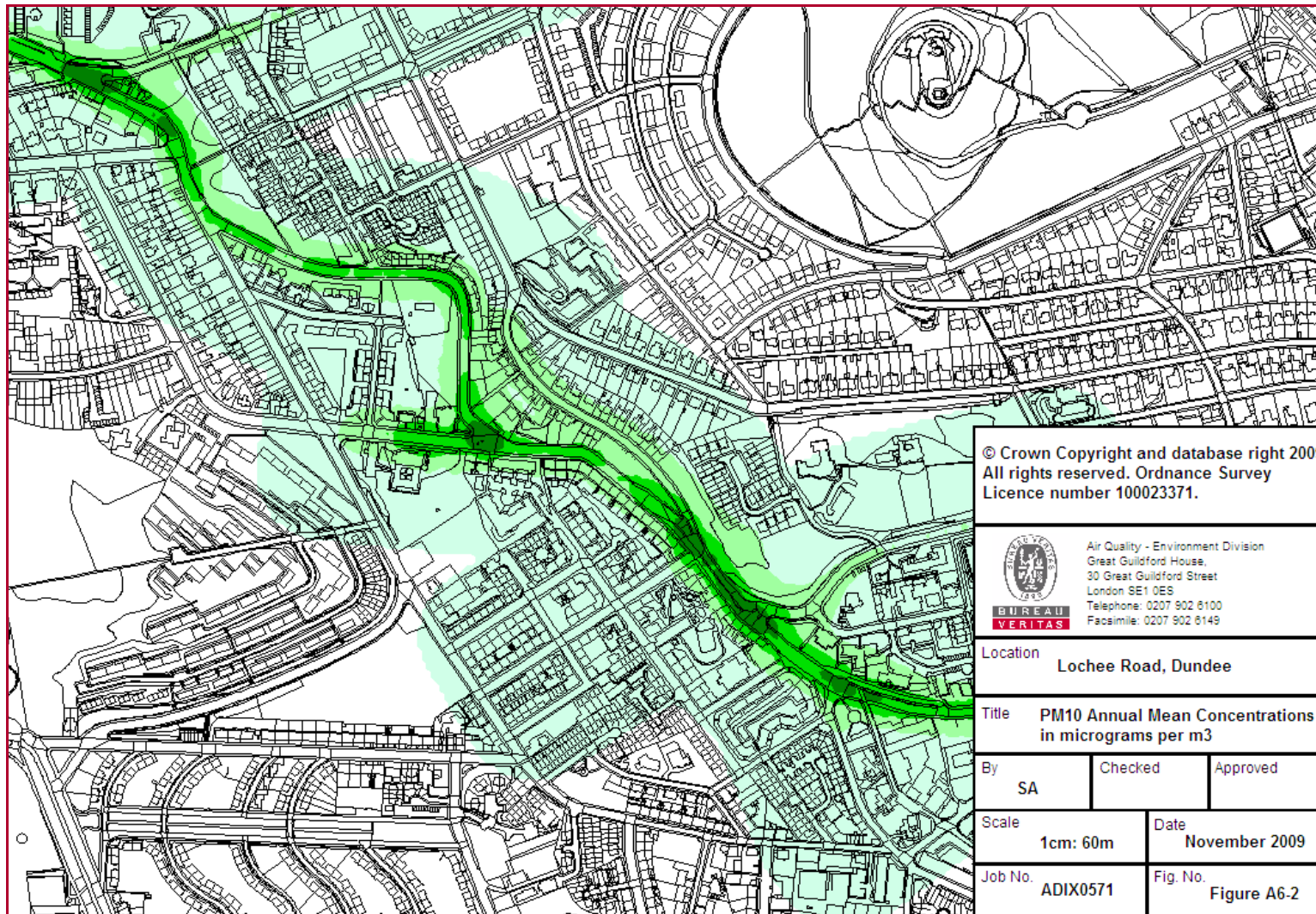
By	Checked	Approved
SA		

Scale	Date
1cm: 100m	November 2009

Job No.	Fig. No.
ADIX0571	Figure A6-1b



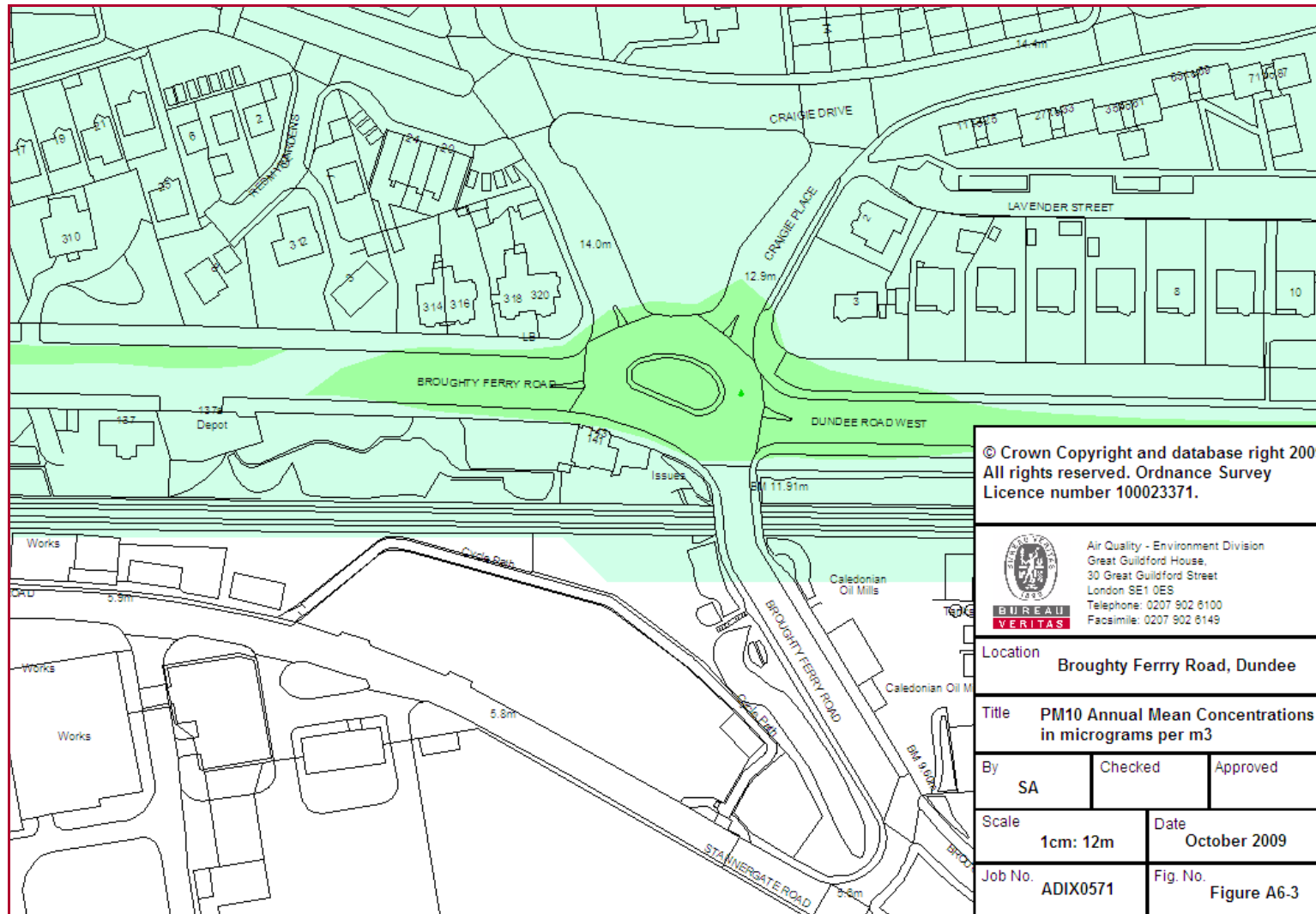
Figure 6.2 Lochee Road and Logie Street PM<sub>10</sub> Annual Mean 2007 Contour



PM<sub>10</sub> Annual Mean  
in micrograms per m<sup>3</sup>

- 12 to 14
- 14 to 16
- 16 to 18
- 18 to 20
- 20 to 22

Figure 6.3 Broughty Ferry PM<sub>10</sub> Annual Mean 2007 Contour



PM<sub>10</sub> Annual Mean  
 in micrograms per m<sup>3</sup>

- 12 to 14
- 14 to 16
- 16 to 18
- 18 to 20
- 20 to 22