2011 Air Quality Progress Report for *Dundee City Council*

In fulfillment of Part IV of the Environment Act 1995
Local Air Quality Management

October, 2011

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Executive Summary

This document is the 2011 Progress Report on air quality for the Dundee City Council area. The report focuses on each of the pollutants listed in Air Quality Regulations that were monitored within the council area during 2010, these were; nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and fine particulate matter (PM_{10}).

The review and assessments of air quality are carried out to determine if the pollutant levels that the public are exposed to will meet the National Air Quality Standards by the set target dates, or if additional local measures will need to be taken to address identified polluted areas.

Previous assessments of air quality established that there was no problem with the levels of some of the seven pollutants namely; benzene, carbon monoxide, 1,3-butadiene, sulphur dioxide and lead. However, exceedences of the annual mean standard for nitrogen dioxide have been identified and an Air Quality Management Area was declared for this pollutant in July 2006.

The AQMA was amended in October 2010 to include small particulates PM_{10} as a result of potential exceedences of the PM_{10} (2010) standard that were identified in the Detailed Assessment of PM_{10} in 2009.

The council produced an Action Plan in January 2011, which contains 32 measures designed to help improve air quality through efforts to tackle traffic emissions, education and raising awareness.

This Progress Report presents the 2010 NO_2, PM_{10} and SO_2 monitoring results. Trends in pollutant concentrations are also examined within the report. It provides information to assist in other policy areas, such as transport and land use planning within the council. Each pollutant has been assessed in conjunction with the relevant guidance and the conclusions reached are:

Nitrogen dioxide (NO_2) – analysis of the 2010 data for nitrogen dioxide has reconfirmed the need for the AQMA and development of an Action Plan. One new area of potential exceedence of the annual mean has been identified at Strathmore Avenue.

Sixty-seven exceedences of the NO_2 hourly mean were recorded at the automatic monitoring station on Lochee Road; this breaches the NAQS objective as only 18 are allowed. Analysis suggests this may have occurred as a result of traffic congestion caused by severe winter weather at the end of 2010. The need for a detailed assessment / AQMA for the hourly NO_2 will be kept under review.

NO_2 annual mean concentrations throughout the city have increased since the AQMA was declared in 2006. The greatest increases in pollutant concentrations have been recorded along the city centre bus corridor, the north west arterial route and associated access roads, major junctions on the Kingsway and at Stannergate Junction, on Broughty Ferry Road.

Small Particulates (PM_{10}) - PM_{10} objectives for 2004 are being met at all monitoring locations within the city. However, the 2010 PM_{10} annual mean and 24 hour objective are being exceeded at roadside and kerbside Osiris sites. Osiris monitoring units are indicative only and the results should be treated with caution. The council have installed reference equivalent PM_{10} analysers in Lochee Road, Seagate and at the Victoria Rd / Meadowside junction, and the need for a detailed assessment or AQMA in relation to the daily mean will be kept under review. A detailed assessment undertaken in 2009 for PM_{10}, also identified a risk of exceedence of the 2010 objectives at receptors adjacent to busy roads and junctions in the city centre.

Generally PM_{10} concentrations between 2006 and 2009 levelled off or were decreasing slightly. Monitoring locations on the north-west arterial route (Logie Street and Lochee Road) showed a significant increase in PM_{10} concentrations in 2010.

Sulphur Dioxide (SO_2) -The monitoring results for 2010 indicate that all the NAQS objectives were met at monitoring locations in Dundee. A detailed assessment is not currently required for this pollutant.

SO_2 concentrations have declined at the Broughty Ferry Road monitoring station between 2002 and 2010, this is thought to be largely due to the introduction of low sulphur fuels at a nearby industrial process in the port. Occasional exceedences of the 15min mean objective have been recorded as a result of certain shipping activities/movements within the port.

Proposed Actions

Proposed actions arising from this Progress Report 2011 are as follows:

- Investigate further sources of domestic and commercial biomass/solid fuel combustion in the local authority area to enable appropriate screening, and report findings in subsequent LAQM reports as information becomes available;

- Report the results of new monitors installed at locations of relevant exposure for sites identified with potential exceedence of the hourly-mean NO_2 objective; and review the need for a detailed assessment / AQMA due to breaches of the hourly mean NO_2 objective once ratified 2011 monitoring data is available;

- Report the results from new reference equivalent PM_{10} analysers installed in potential problem areas;

- undertake the characterisation of the areas of exceedence at Strathmore Avenue and Broughty Ferry Road at the Stannergate junction, including additional NO_2 monitoring, as required to inform additional, appropriate action plan measures that will effectively target the pollution problems at those localities; and

- Complete the Updating and Screening Assessment in 2012 and report on Action Plan Progress.

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GLOSSARY OF ACRONYMS AND DEFINITIONS

AADT	Annual Average Daily Traffic Flow
ADMS	An atmospheric air pollution dispersion model
AEA	AEA Energy & Environment
annualise	the means of estimating an annual mean from a shorter study period mean by comparison with full datasets from background AURN sites
AQ Archive	UK Air Quality Archive
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
AURN	Automatic Urban and Rural Network (Defra funded air quality monitoring network)
CHP	Combined Heat and Power
CO	Carbon Monoxide
Defra	Department for Environment, Food and Rural Affairs
DERL	Dundee Energy Recycling Ltd
DMRB	Design Manual for Roads and Bridges
EC	European Community
EHTS	Environmental Health and Trading Standards Department
EPA	The Environmental Protection Act 1990
EPAQS	Expert Panel on Air Quality Standards
EU	European Union
GF	Ground floor
GIS	Geographical Information System
HDV	Heavy goods vehicles and buses
HGV	Heavy Goods Vehicle
IPC	Integrated Pollution Control
kerbside	0 to 1 metre from the kerb
LAQM.TG(09)	Local Air Quality Management: Technical Guidance (2009)
Limit Value	An EU definition for a mandatory air quality standard of a pollutant listed in the air quality directives
MW	Mega Watts
mg/kg	Milligrams per Kilogram
mg/m^3	Milligrams per cubic metre
NAEI	National Atmospheric Emission Inventory
NAQS	National Air Quality Standard
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_X	Oxides of nitrogen
ng/m^3	Nanograms per cubic metre
NRTF	National Road Traffic Forecast
OSIRIS	the brand name given by Turnkey Instruments Ltd. to their particle measuring nephalometer
P&T	Planning and Transportation
$PM_{2.5}$	Particulate Matter less than 2.5µm aerodynamic diameter
PM_{10}	Particulate Matter less than 10µm aerodynamic diameter
Pb	Lead

percentile	The percentage of results below a given value
ppb	Parts per billion
ppm	Parts per million
receptor	In this study, the relevant location where air quality is assessed or predicted (for example, houses, hospitals and schools)
roadside	1 to 5 m from the kerb
SCA	Smoke Control Area
SEPA	Scottish Environment Protection Agency
SO_2	Sulphur Dioxide
Street Canyon	A relatively narrow street with buildings on both sides, where the height of the buildings is generally greater than the width of the road
TEA	Triethanolamine
TEOM	Tapered Element Oscillating Microbalance
UKAS	United Kingdom Accreditation Service
$\mu g/m^3$	Micrograms per cubic metre
VOC	Volatile Organic Compound
vpd	Vehicles per day
WASP	Workplace Analysis Scheme for Proficiency

1 Introduction

1.1 Description of Local Authority Area

Dundee City is located on the north bank of the river Tay in the Tay valley. The Dundee City Council area covers 6,300 hectares (24 square miles) and is geographically the smallest local authority area in Scotland. It is bordered by Perth and Kinross Council to the west and by Angus Council to the north and east. The former Tayside Regional Council area previously covered all three councils and Dundee continues to serve as the regional centre for this area and north-east Fife, with an estimated catchment population of some 400,000 people.

Dundee is the fourth largest city in Scotland and the most recent estimate of Dundee's population is 144,290 (National Registers of Scotland (NRS) 2010 Mid Year Population Estimate). This equates to a population density of 2412 people per square kilometre.

Dundee is served by an airport which has daily flights to London City. Dundee also has a modern deep-water port and large harbour area. The port area has been a major industrial and commercial source of employment and wealth creation for Dundee and the Central Waterfront project is one of the key priorities in terms of re-connecting the city and its people with the river.

The City is almost entirely urban and suburban in character and is a hub for many routes. It is connected to Fife by the Tay road and rail bridges. The A92 crosses the Tay and emerges in the centre of Dundee. There is an inner ring road, the Marketgait, and five arterial routes - Broughty Ferry Road, Arbroath Road, Riverside Drive, Lochee Road and Forfar Road. There is an outer-ring road, the Kingsway, which consists of the A90(T), the main route from Edinburgh/Perth to Aberdeen, and the A972(T), the route to Arbroath. There are a significant number of busy road junctions across the City. A large proportion of roads in the City have a gradient due to a central topographical feature, The Law, the plug of an extinct volcano (height 174 metres above sea level). The main sources of pollution in the area are from the road traffic emissions from these routes, with additional emissions from industrial sources, most of which are located around the periphery of the city and in the port area

In common with many Scottish cities the architecture consists of a significant number of 4 or 5-storey tenemental properties creating numerous street canyons. In the commercial centres, a common feature of these tenemental properties is that commercial premises are located on the ground floor with residential premises on the floors above. The main shopping area in the city is pedestrianised.

1.2 Purpose of Progress Report

Progress Reports are required in the intervening years between the three-yearly Updating and Screening Assessment reports. Their purpose is to maintain continuity in the Local Air Quality Management (LAQM) process, and they are intended to assist local authorities by:

- providing a means for communicating air quality information to members and the public;
- maximising the usefulness and interpretation of the monitoring effort being carried out;
- maximising the value of the investment in monitoring equipment;
- helping local authorities respond to requests for up-to-date information on air quality;
- providing information to assist in other policy areas, such as transport and land use planning;
- providing a source of baseline data for strategic environmental assessments;
- providing a ready source of information on air quality for developers carrying out environmental assessments for new schemes;
- demonstrating progress with implementation of air quality Action Plans and/or air quality strategies; and
- providing a timely indication of the need for further measures to improve air quality, rather than delaying until the next full round of review and assessment.

They are not intended to be as detailed as Updating and Screening Assessment Reports. However, if the Progress Report identifies the risk of exceedence of an Air Quality Objective, the Local Authority (LA) should undertake a Detailed Assessment immediately, and not wait until the next round of Review and Assessment.

This report contains the minimum requirements for progress reports, regarding new monitoring data and new developments, to demonstrate to stakeholders the progress being made to address air quality issues within the council area. It does not include the recommended additional elements, regarding how other aspects of the council's work are contributing to air quality improvements.

1.3 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 micrograms per cubic metre, $\mu g/m^3$ (milligrams per cubic metre, mg/m^3 for carbon monoxide) with the number of exceedences in each year that are permitted (where applicable).

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

1.4 Summary of Previous Review and Assessments

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 for a number of pollutants. The process of review and assessment of air quality undertaken by local authorities is set out under the Local Air Quality Management (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 Air Quality Management Area (AQMA) – a geographic area defined by high levels of pollution and exceedences of health-based standards.

The LAQM regime was first set down in the 1997 National Air Quality Strategy (NAQS) and introduced the idea of local authority 'Review and Assessment'. The Government and Devolved Administrations subsequently published policy and technical guidance related to the review and assessment processes in 1998. This guidance has since been reviewed and the latest documents include Policy Guidance (LAQM.PGS (09)) and Technical Guidance (LAQM.TG (09)) . 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.

A summary of the conclusions of previous rounds of review and assessment are presented in **Table 1.2** below. A map of the boundary of the Air Quality Management Area for nitrogen dioxide (NO_2) and particulate matter (PM_{10}) is shown in **Figure 1.1** below.

Table 1.2 Summaries of Review and Assessment Reports

REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
Stage 1 (1998)	The principle conclusion of Dundee City Council's Stage 1 report was that it was necessary to proceed to the next stage of assessment for all seven of the key LAQM pollutants (nitrogen dioxide (NO_2), particulate matter (PM_{10}), lead, carbon monoxide (CO), benzene, 1,3-butadiene and sulphur dioxide(SO_2). The chief reasons for this conclusion were a lack of available information relating to potentially significant traffic and industrial pollution sources within the city.
Stage 2 (2000)	Additional monitoring was carried out and additional information was obtained concerning industrial and traffic sources. Screening assessments incorporating this new information were carried out in accordance with national guidance and concluded that the National Air Quality Standards and Objectives (NAQS) would be achieved in Dundee.

REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
Updating and Screening Assessment (2003)	The imposition of stricter pollutant thresholds, changes in the technical guidance and methodologies for assessment led to an investigation of new areas. This review concluded that the NAQS for carbon monoxide, benzene, 1,3-butadiene and lead would be achieved. It was also concluded that a detailed assessment would be required as a result of potential exceedences of the NAQS for NO_2 and PM_{10} at busy roads and junctions and to investigate the likelihood of exceedences of the NAQS for sulphur dioxide at new residential premises introduced close to an industrial source.
Detailed Assessment (2005)	The detailed assessment of NO_2 and PM_{10} from traffic sources identified exceedences of the NAQS annual mean standard for NO_2 at relevant receptors in the city centre and along the north- west arterial route. • **NO_2** - the detailed assessment established the need for Dundee City Council to declare an Air Quality Management Area (AQMA), carry out a further assessment of NO_2 and develop an Action Plan to try and reduce pollution levels in exceedence areas. • **PM_{10}** -there was insufficient confidence in the modelled results for 2010 and it was concluded that additional monitoring and modelling would be required to determine whether an AQMA was also required for PM_{10}. **SO_2** -the detailed assessment concluded that the NAQS would be achieved at new residential developments introduced close to an industrial source and that an AQMA was not required for this pollutant.
Progress Report (2005)	2004 monitoring data and new local developments with the potential to affect air quality were assessed in accordance with statutory guidance and the conclusions reached were: • **Benzene** - no AQMA required for Benzene, as a result monitoring was discontinued. • **NO_2 -** identified additional areas of exceedence of the NO_2 annual mean at relevant receptors on the north-west arterial route. 22 exceedences of the hourly mean NAQS for NO_2 were recorded at the Lochee Road monitoring site. 18 of the 22 occurred during water main rehabilitation works which caused traffic congestion in the vicinity of the monitor. The results were not thought to be representative of the ambient conditions in the area and no AQMA was considered necessary at that time. • **PM_{10}** - the results for 2004 indicated that the 2004 and 2010 NAQS for PM_{10} would be achieved at the Broughty Ferry Road and background monitoring sites. Exceedences of the 2010 annual mean and daily mean NAQS were recorded at the Union Street monitoring location. These were investigated and it was considered that low data capture, local demolition works and the temporary re-routing of buses along Union St during the construction of a bus-interchange in Whitehall St has contributed to these exceedences and the monitored concentrations did not represent the normal ambient concentrations. • **SO_2** - monitoring indicated that no AQMA was required.

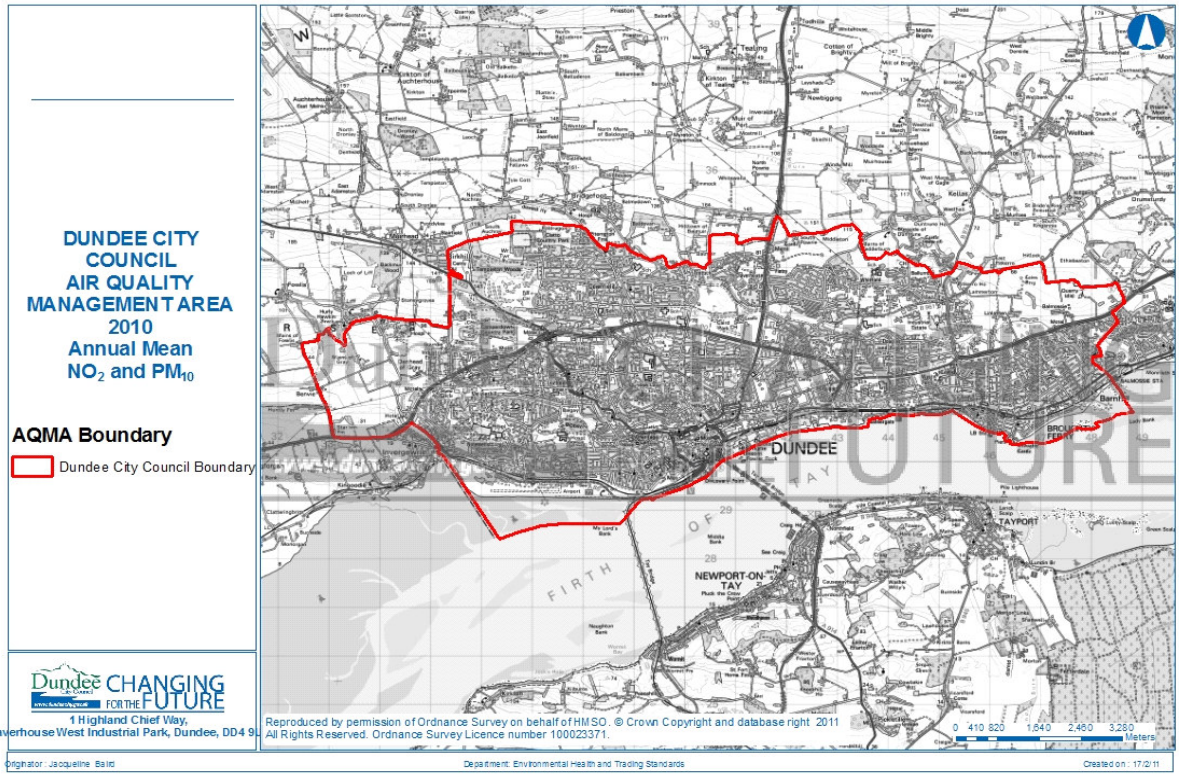
REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
Updating and Screening Assessment (2006)	The Updating and Screening Assessment (USA) 2006 marked the beginning of the third round of review and assessment and required the re-examination all of the seven LAQM pollutants. 2005 data and any significant changes in pollutant sources and public exposure to pollutants were examined in accordance with statutory guidance. The conclusions reached were: • that the NAQS for CO, benzene, 1,3-butadiene, lead and SO_2 would be achieved and hence no detailed assessment would be needed. • **NO_2** - the report confirmed the need for the AQMA for NO_2 (which was declared for the whole city in July 2006) and identified an additional exceedence area in the city centre, one of the main bus corridors (Meadowside). • **PM_{10}** - the report concluded that the only monitored PM_{10} concentrations predicted to breach the annual mean NAQS for 2010 was the monitoring location in Union Street this was investigated and it was determined that major construction projects in the vicinity might have had an influence on the levels recorded and these may not be truly represent ambient concentrations at this location.
Progress Report (2007)	2006 monitoring data and new local developments with the potential to affect air quality were assessed in accordance with statutory guidance and the conclusions reached were: • **NO_2** - analysis of the 2006 data re-confirmed the need for the AQMA and the development of an Action Plan. Two new areas of potential exceedence of the annual mean NAQS were identified on the north-east arterial route. (Kingsway/Forfar Road and Albert Street/Arbroath Road). • **PM_{10}** - Dundee City Council operate a local Partisol/TEOM co-location study which allows a local gravimetric correction factor to be calculated. This was used to correct TEOM and Osiris data in the monitoring network. Using this factor, exceedences of the 2010 PM_{10} NAQS were predicted at the following monitoring locations in the city centre and the north-west arterial route: • Victoria Road / Hilltown Junction, Seagate, Logie Street, and Lochee Road. • The Union Street site was also very close to exceeding the annual mean for 2010 and remains an area of concern due to increasing PM_{10} at this city centre location. There were also potential exceedences of the daily mean NAQS predicted at the OSIRIS monitoring locations. The 2006 PM_{10} monitoring results indicated that a detailed assessment would be required for PM_{10}. • **SO_2** - the monitoring results for 2006 indicate that all NAQS objectives were met at the monitoring locations in Dundee. Exceedences of the 15min mean NAQS occurred at the Broughty Ferry Road site, these were well below the 35 exceedences allowed and were thought to have been caused by certain shipping movements and activities. A detailed assessment of this pollutant was not required, but monitoring data would be kept under review.

REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
Further Assessment of Nitrogen Dioxide and Detailed Assessment of Particulate Matter PM_{10} (2009)(FA/DA)	The FA/DA combined the detailed assessment of PM_{10} with a further assessment of both NO_2 and PM_{10}. It examined the 2007 monitoring data and established the main sources of pollution in the exceedence areas and the reduction in pollutant levels necessary to meet the NAQS. The report confirmed the need for the existing AQMA for NO_2 and concluded that an AQMA should be declared for PM_{10}. The report also estimated that 4,600 people were living in areas at risk of exceeding the NAQS for NO_2 and PM_{10} and concluded that significant reductions in pollutant concentrations are required to meet the annual mean NAQS for both pollutants. The results of the source apportionment exercise are summarised below: • **Source apportionment of NOx**, indicates road traffic emissions of NOx are the main contribution to total NOx concentrations, as they account for 74 - 91% of the total NOx concentrations at receptors. Heavy-duty vehicles (HDVs) contribute around 38 - 77% to the total NOx 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_{10}**, indicates background sources of PM_{10} (e.g. sea salt) make a significant contribution to total PM_{10} concentrations, as they account for 28-59% of the total PM_{10} concentrations at receptors, with the majority of this being made up of secondary particulates, residual and salt contributions. Road traffic contributes 41% to 72% of the total 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 PM_{10} concentrations at receptors. Brake and tyre wear contribute around 13-29% to the total PM_{10} concentrations at receptors. HDV contributions are disproportionably 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. (HDV - is a collective term for heavy goods vehicles (HGV) and buses)
Updating and Screening Assessment 2009 (2010)	The Updating and Screening Assessment (USA) 2009 marked the beginning of the fourth round of review and assessment and required the re-examination all of the seven LAQM pollutants. This was carried out in accordance with revised statutory guidance and examined 2008 data and any significant changes in pollutant sources and public exposure to pollutants. The conclusions reached were: • that the NAQS for CO, benzene, 1,3-butadiene, lead and SO_2 would be achieved and hence no detailed assessment would be needed. **NO_2** - the report re-confirmed the need for the AQMA for NO_2 (which was declared for the whole city in July 2006) and identified an additional potential annual mean exceedence area in Strathmore Avenue. Diffusion tube monitoring also indicated potential exceedences of the hourly mean NAQS in the vicinity of Victoria Road / Meadowside junction and informed the need for automatic monitoring to investigate whether an additional AQMA is required for hourly mean NAQS for NO_2. Monitoring programmed to begin in 2011.

REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
	• **PM_{10}** - the report noted that monitored PM_{10} concentrations at Lochee Road and Seagate breach the annual mean NAQS for 2010. Combined with the predicted exceedences of the 2010 PM_{10} annual mean in the FA/DA, it was concluded that an AQMA should be declared. Consequently, the 2006 AQMA order was amended in October 2010 to include PM_{10}. • the revised statutory guidance contained a new requirement to review and assess biomass combustion sources. The review did not identify any sources within the local authority area that met the criteria for assessment. However, it was considered there was insufficient information available to adequately assess these sources. This will be reported in subsequent review and assessment reports as information becomes available.
Progress Report 2010	2009 monitoring data and new local developments with the potential to affect air quality were assessed in accordance with statutory guidance and the conclusions reached were: **SO_2** - New monitoring data for 2010 show the objectives for SO_2 are being achieved. Sulphur dioxide concentrations measured at the Broughty Ferry Road monitoring location remained low and achieved the objectives during 2009. **PM_{10}** - PM_{10} objectives for 2004 are being met at all monitoring locations within the city. However, there is a risk of exceedence of the 2010 PM_{10} annual mean objective being exceeded at roadside sites. The 2010 PM_{10} daily mean was also exceeded at the monitoring location in Seagate using the VCM corrected data, but not when the local gravimetric correction factor was applied to the data. Osiris monitoring units have a tendency to over-estimate the number of exceedences compared to TEOMs. The council intend to install a reference equivalent PM_{10} analyser in this area, and the need for a detailed assessment or AQMA in relation to the daily mean will be kept under review. A detailed assessment undertaken in 2009 for PM_{10}, also identified a risk of exceedence of the 2010 objectives at receptors adjacent to busy roads and junctions in the city centre **NO_2** - Exceedences of the nitrogen dioxide annual mean objective continued to occur within the existing AQMA in 2009 and, after façade projections were calculated, concentrations at fourteen sites failed to meet the annual mean standard. Uncertainties associated with the distance calculator tool used to estimate pollutant concentrations at façade suggest that Strathmore Avenue may be a new potential area of exceedence; this will be kept under review.

REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
	With respect to the hourly NO_2 objective, none of the diffusion tube monitoring sites in the city recorded annual mean concentrations above 60µg/m^3 –The diffusion tube site at the junction of Victoria Road/Hilltown measured a NO_2 concentration of 59.5µg/m^3. Members of the public are not regularly present for more than 1-hour in these locations, however there are nearby ground floor residences on Meadowside. When projected to façade the concentrations calculated are below 60µg/m^3. Keeping in view the uncertainties associated with façade projection methodology, the Council intend to monitor at sites of relevant exposure close to the identified locations to confirm if the hourly-mean of NO_2 is being exceeded. There were 23 exceedences of the hourly NO_2 objective recorded at the automatic monitoring station on Lochee Road during 2009, an examination of the distribution of these exceedences, concluded that they occurred mostly at peak times, on Mondays and Fridays, and during the winter months. Severe weather (snow and ice) during December 2009 may have contributed to some of the exceedences: the monitoring station is located on the main north-west arterial route into the city, which can become increasingly congested during adverse weather when alternative routes are difficult to for drivers to negotiate. The need for a detailed assessment of this location in relation to exceedences of the hourly NO_2 objective is re-assessed in the 2011 Progress Report.

Figure 1.1 Map Showing Boundary of AQMA for NO_2 and PM_{10}.



2 New Monitoring Data

2.1 Summary of Monitoring Undertaken

2.1.1 Automatic Monitoring Sites

Dundee utilise several methods for monitoring particulate matter (PM_{10}) within the city. The Partisol is a reference equivalent method and is used to determine a local correction factor for the TEOMs, which were designated as non-equivalent in 2006. In addition, five sites are monitored with Osiris analysers; these are also non-equivalent and are only indicative of particulate concentrations. Details of these monitoring locations can be found in **Table 2.1** and their locations are shown in **Figure 2.1**. Siting automatic monitoring sites in urban areas is problematic and compromises mean that monitors cannot always be situated in the worst case location. Dundee commenced a yearly study in 2005 to compare the PM_{10} data measured using an Osiris analyser with that from a TEOM; determining that the Osiris generally exaggerates peak values compared to the TEOM.

Nitrogen dioxide chemiluminescence 'Monitor Labs 9841A' analysers are employed at four locations within the city. Sulphur dioxide is monitored by UV fluorescence using a 'Monitor Labs 9850A' at Broughty Ferry Road. All analysers are audited twice yearly by an external consultant, AEA. The gas analysers at Union Street and Broughty Ferry Road have on-site gases traceable to the National Physical Laboratory (NPL) standards (provided under contract by AEA) and are calibrated automatically every 4 days and daily respectively. The remaining gas analysers do not have on-site gases and are manually calibrated every 3 weeks by AEA using NPL traceable gas.

Dundee City Council secured funding from the Scottish Executive to commission AEA to assist with data management and ratification procedures. Dundee joined the 'Calibration Club' run by AEA at the end of 2006 and AEA have ratified all the real-time monitoring data reported from 2006 onwards (excluding the OSIRIS units), and have provided the VCM - corrections used in this report. TEOM PM_{10} data presented in this report is corrected using both the local gravimetric correction factor and the VCM method.

Further details and data for those monitors that are part of the 'Calibration Club' can be found at www.scottishairquality.co.uk.

Figure 2.1 Map of Automatic Monitoring Sites in Dundee in 2010

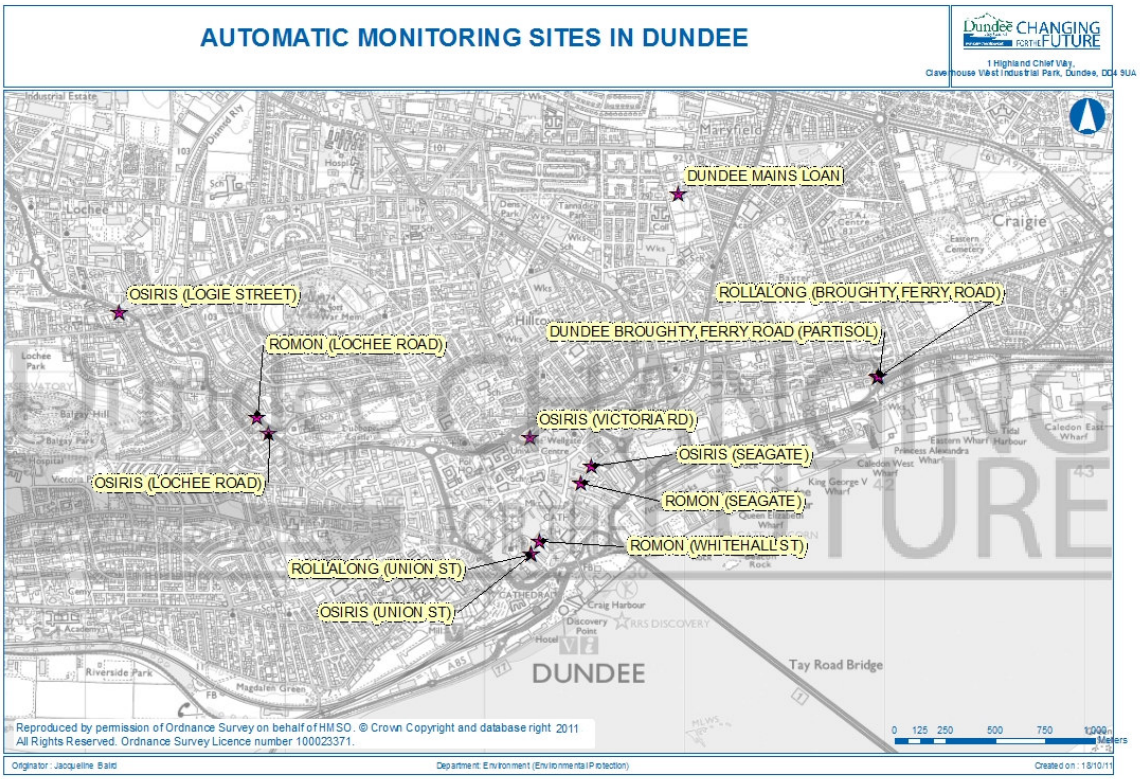


Table 2.1 Details of Automatic Monitoring Sites

Site Name	Site Type	OS Grid Ref (x,y)	Pollutants Monitored	In AQMA?[1]	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*[3]	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location?[2]
Broughty Ferry Road Rollalong	Urban Industrial	x=341970, y=730977	SO_2, PM_{10} (TEOM)	Yes	Y - 0m	N/A	No
Broughty Ferry Road Partisol	Urban Industrial	x=341971, y=730978	PM_{10} (Gravimetric - Partisol)	Yes	Y - 0m	N/A	No
Lochee Road Romon	Kerbside	x=338861, y=730773	NO_2	Yes	Y - 2.25m	0.6m	No
Lochee Road Osiris	Kerbside	x=338920, y=730694	PM_{10} (Osiris)	Yes	Y - 2.2	0.6m	Yes
Logie Street Osiris	Kerbside	x=338176, y=731298	PM_{10} (Osiris)	Yes	Y- 1.65m	0.57m	Yes
Mains Loan	Urban Background	x=340972, y=731893	PM_{10} (TEOM)	Yes	N - 0m	n/a	No
Seagate Romon	Kerbside	x=340487, y=730446	NO_2	Yes	Y - 2.0m	0.2m	No
Seagate Osiris	Kerbside	x=340539, y=730528	PM_{10} (Osiris)	Yes	Y - 1.64m	0.63m	No
Union Street Rollalong	Roadside	x=340235, y=730091	NO_2, PM_{10} (TEOM)	Yes	Y - 3.3m	1m	Yes
Union Street Osiris	Roadside	x=340235, y=730090	PM_{10} (Osiris)	Yes	Y - 3.1m	1.12m	Yes
Victoria Road Osiris	Kerbside	x=340230, y=730673	PM_{10} (Osiris)	Yes	Y - 2.7m	0.3m	No
Whitehall Street Romon	Roadside	x=340278, y=730156	NO_2	Yes	Y - 1.25m	3.26m	No

[1] The whole of Dundee is an AQMA for NO_2 and PM_{10}

[2] Explanation provided in Box 3.1 of LAQM.TG(09): *Where results are presented for new monitoring sites, then a description of the sites should be provided. This should include the reason they were set up, for example, to represent worst-case relevant exposure alongside a particular road.*

[3] Explanation provided in Box 3.1 of LAQM.TG(09), *When describing sites, it should be made clear whether they represent relevant exposure. For instance, if the site is kerbside, it would be appropriate to say that "the nearest relevant exposure is residential properties set back 5 m from the kerb."*

2.1.2 Non-Automatic Monitoring Sites

In addition to the continuous monitoring network, Dundee City Council operated 81 diffusion tube sites in 2010. Details of these monitoring locations can be found in **Table 2.2** and their locations are shown in **Figure 2.2**

The diffusion tubes are supplied by Gradko and analysed by Tayside Scientific Services utilising the 20% Triethanolamine (TEA) in water preparation method. Tayside Scientific Services participate in the Workplace Analysis Scheme for Proficiency (WASP) for NO_2 diffusion tube analysis, and the Annual Field Inter-Comparison Exercise. These provide strict performance criteria for participating laboratories to meet, thereby ensuring NO_2 concentrations reported are robust. The lab' follows the procedures set out in the Working Group on Harmonisation of Diffusion Tubes Practical Guidance that was published in February 2008[1], and is UKAS accredited for the analysis of nitrogen dioxide. Tayside Scientific Services has demonstrated satisfactory performance over the past five quarterly WASP rounds.

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 2010, which generated the following bias adjustment factors:

- Dundee Lochee Road - 0.85
- Dundee Seagate - 0.8 (insufficient data capture, i.e. less than 75%)
- Dundee Union Street - 0.78
- Dundee Whitehall Street - 0.79

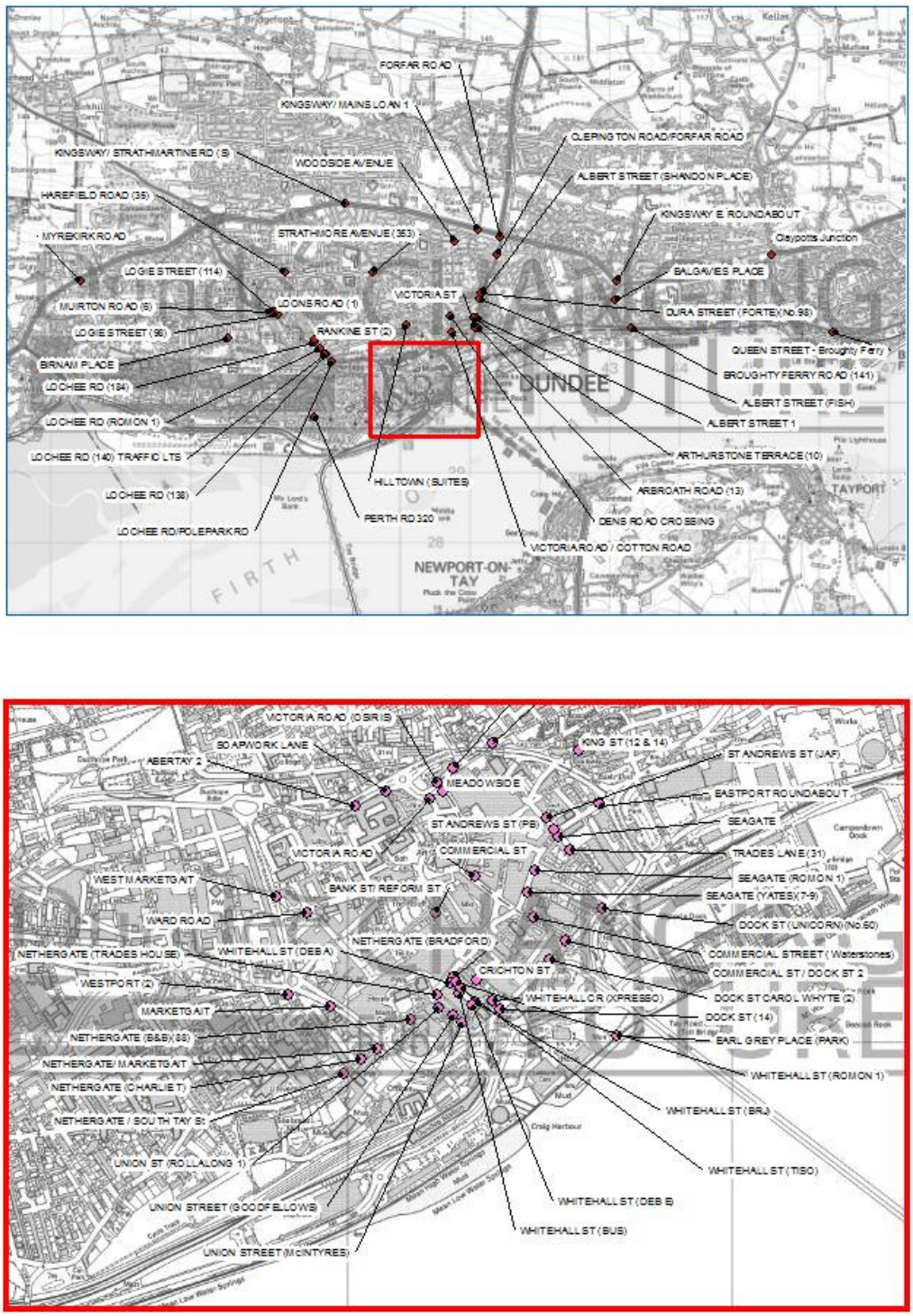
These were provided to the National Physical Laboratory, who calculated the overall local bias from the three sites with sufficient data capture as:

- Dundee City Council - 0.79

The national bias correction factor for Tayside Scientific Services was 0.79 (based on the above studies and one other (version 4/11)). The individual calculations of bias adjustment for the roadside local co-location studies in 2010 are shown in **Appendix 1**.

[1] AEA Energy & Environment (2008), Diffusion Tubes for Ambient NO_2 Monitoring : Practical Guidance for Laboratories and Users

Figure 2.2 Maps of Non-Automatic Monitoring Sites (NO_2 Diffusion Tubes) in Dundee



0 425 850 1,700 2,550 3,400
Meters

Table 2.2 Details of Non- Automatic Monitoring Sites

Location	Site Type	X	Y	Pollutant monitored	In AQMA (Y/N)?[1]	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to kerb of nearest road (m) (N/A if not applicable)	Worst-case Location (Y/N)?
Abertay	K	340047	730629	NO_2	Y	N	0.66	N
Abertay 2	R	340019	730612	NO_2	Y	N	1.95	N
Albert Street (Fish)	K	341139	731476	NO_2	Y	2.27	0.57	Y
Albert Street (Shandon Place)	R	341171	731574	NO_2	Y	7.57	1.09	N
Albert Street 1	K	341104	731210	NO_2	Y	2.14	0.91	N
Arbroath Road (13)	K	341111	731070	NO_2	Y	2.52	0.73	Y
Arthurstone Terrace (10)	K	341051	731203	NO_2	Y	1.75	0.89	Y
Balgavies Place	UB	343082	731465	NO_2	Y	n/a	n/a	N
Bank St/ Reform St	K	340228	730337	NO_2	Y	1.31	0.51	Y
Birnam Place	UB	337531	730914	NO_2	Y	n/a	n/a	N
Brook Street (B.F.)	K	346293	730872	NO_2	Y	1.26	0.84	Y
Broughty Ferry Road (141)	R	343322	731073	NO_2	Y	1.98	1.32	Y
Claypotts Junction	R	345315	732103	NO_2	Y	12	8	N
Clepington Road/Forfar Road	K	341385	732121	NO_2	Y	8.28	0.78	Y
Commercial St	K	340328	730431	NO_2	Y	2.9	0.6	Y
Commercial St / Dock St 2	R	340565	730263	NO_2	Y	0.17	2.78	Y
Commercial Street (Waterstones)	R	340481	730325	NO_2	Y	2	2.6	Y
Crichton St	K	340331	730162	NO_2	Y	4.08	0.53	Y
Dens Road Crossing	R	340725	731238	NO_2	Y	2.49	1.2	Y
Dock St (14)	K	340395	730086	NO_2	Y	3.24	0.78	Y
Dock St (Unicorn)(No.60)	R	340659	730348	NO_2	Y	1.74	3.86	Y
Dock St Carol Whyte (2)	R	340524	730216	NO_2	Y	0.34	5.13	Y
Dura Street (Forte) (No.98)	K	341150	731576	NO_2	Y	1.65	0.57	N
Earl Grey Place (Park)	UB	340699	730019	NO_2	Y	n/a	n/a	N
Forfar Road	K	341437	732360	NO_2	Y	7.68	0.67	Y
Eastport Roundabout	R	340651	730623	NO_2	Y	1.56	1	Y
Harefield Road (35)	K	338360	731855	NO_2	Y	11.75	0.53	Y
Hilltown (Suites)	R	340088	731116	NO_2	Y	0.5	1.66	N

Location	Site Type	X	Y	Pollutant monitored	In AQMA (Y/N)?[1]	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to kerb of nearest road (m) (N/A if not applicable)	Worst-case Location (Y/N)?
King St (12 & 14)	K	340598	730757	NO_2	Y	1.84	0.6	Y
Kingsway E. Roundabout	R	343107	731740	NO_2	Y	14.3	2.9	N
Kingsway/ Mains Loan 1	R	341124	732468	NO_2	Y	15.4	6.2	Y
Kingsway/ Pitkerro Rd	R	341963	732303	NO_2	Y	18	6.7	N
Kingsway/ Strathmartine Rd (S)	K	339221	732836	NO_2	Y	16.8	0.64	N
Lochee Rd (138)	K	338936	730680	NO_2	Y	2.06	0.44	N
Lochee Rd (140) Traffic Lts	R	338927	730685	NO_2	Y	0.25	2.22	Y
Lochee Rd (184)	K	338767	730856	NO_2	Y	3.19	0.73	Y
Lochee Rd (Romon Ave)	K	338861	730773	NO_2	Y	2.25	0.6	Y
Lochee Rd/Polepark Rd	K	339016	730586	NO_2	Y	9.21	0.95	Y
Logie Street (114)	R	338184	731293	NO_2	Y	0.53	1.73	Y
Logie Street (98)	K	338252	731258	NO_2	Y	1.26	0.86	N
Loons Road (1)	R	338211	731293	NO_2	Y	0.5	1.9	Y
Marketgait	R	339953	730094	NO_2	Y	3.5	1.3	Y
Meadowside	R	340245	730651	NO_2	Y	1.26	1	Y
Muirton Road (6)	R	338152	731293	NO_2	Y	0.3	1.11	Y
Myrekirk Road	K	335420	731733	NO_2	Y	16.4	0.95	N
Nethergate (B&B)(88)	K	340163	730061	NO_2	Y	5	0.86	Y
Nethergate (Bradford)	R	340274	730171	NO_2	Y	2.51	1.25	Y
Nethergate (Charlie T)	K	340033	729957	NO_2	Y	1.84	0.86	Y
Nethergate (Trades House)	R	340230	730124	NO_2	Y	2.72	1.26	Y
Nethergate / South Tay St	R	339987	729919	NO_2	Y	0.38	2.24	Y
Nethergate/ Marketgait	R	340074	729984	NO_2	Y	3.6	1.33	Y
Perth Rd / Hawkhill	K	338742	729828	NO_2	Y	4	0.55	Y
Perth Rd 320	K	338776	729798	NO_2	Y	3.78	0.42	Y
Queen St B/F	R	346207	731007	NO_2	Y	0	2.85	Y
Rankine St (2)	R	338768	730900	NO_2	Y	0.4	1.76	Y
Seagate	R	340545	730532	NO_2	Y	0.19	1.94	N
Seagate (Romon Ave)	K	340487	730446	NO_2	Y	1.76	0.66	Y
Seagate (Yates)(7-9)	R	340467	730388	NO_2	Y	0.9	1.7	N
Soapwork Lane	R	340099	730650	NO_2	Y	Façade	3.51	Y

Location	Site Type	X	Y	Pollutant monitored	In AQMA (Y/N)?[1]	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to kerb of nearest road (m) (N/A if not applicable)	Worst-case Location (Y/N)?
St Andrews St (JAF)	K	340516	730584	NO_2	Y	1.77	0.71	Y
St Andrews St (PB)	K	340532	730551	NO_2	Y	2.38	0.5	Y
St Mary Flats	R	339039	730624	NO_2	Y	15	3	N
Strathmore Avenue (353)	K	339609	731871	NO_2	Y	1.45	0.67	Y
Trades Lane (31)	K	340575	730500	NO_2	Y	1.82	0.44	Y
Union St (Rollalong 1)	R	340235	730091	NO_2	Y	3.25	1.2	Y
Union Street (Goodfellows)	K	340274	730069	NO_2	Y	1.6	0.46	Y
Union Street (Mcintyres)	K	340293	730051	NO_2	Y	1.6	0.73	Y
Victoria Road	R	340212	730633	NO_2	Y	3	1.22	Y
Victoria Rd(10)	R	340255	730667	NO_2	Y	2.11	1.14	Y
Victoria Road (60)	R	340375	730779	NO_2	Y	0.56	2.18	Y
Victoria Road (osiris)	K	340230	730673	NO_2	Y	2.7	0.3	Y
Victoria Road / Cotton Road	K	340740	730996	NO_2	Y	1.3	0.82	Y
Victoria Road/Hilltown	R	340274	730714	NO_2	Y	2.01	1.15	N
Victoria Street	K	340071	731072	NO_2	Y	1.7	0.75	Y
Ward Rd	R	339893	730336	NO_2	Y	0.64	2.24	Y
West Bell St	R	339815	730395	NO_2	Y	0.84	2.48	Y
West Marketgait	K	339814	730380	NO_2	Y	2.34	0.67	Y
Westport (2)	R	339842	730122	NO_2	Y	2.5	0.46	Y
Whitehall Cr (Xpresso)	K	340376	730109	NO_2	Y	3	0.88	Y
Whitehall St (Brj)	K	340330	730106	NO_2	Y	3.57	0.78	Y
Whitehall St (Bus)	R	340289	730128	NO_2	Y	3.17	2.51	N
Whitehall St (Deb A)	K	340265	730153	NO_2	Y	5.57	0.88	N
Whitehall St (Deb E)	K	340322	730098	NO_2	Y	4.55	0.75	Y
Whitehall St (Romon 1)	R	340278	730156	NO_2	Y	1.7	3.26	N
Whitehall St (Tiso)	R	340293	730142	NO_2	Y	2.67	3	Y
Woodside Avenue	UB	340776	732307	NO_2	Y	n/a	n/a	Y

[1] The whole of Dundee is an AQMA for NO_2 and PM_{10+}
2 K= Kerbside, R = Roadside, UB = Urban background

2.2 Comparison of Monitoring Results with Air Quality Objectives

2.2.1 Nitrogen Dioxide

Automatic Monitoring Data

The results of the automatic monitoring stations for nitrogen dioxide are shown in **Table 2.3**. Exceedences of the annual mean NAQS for nitrogen dioxide were recorded at three stations in 2010: Lochee Road, Seagate and Union Street. These are known hotspot locations and are located within an AQMA declared as a result of exceedences of the annual mean.

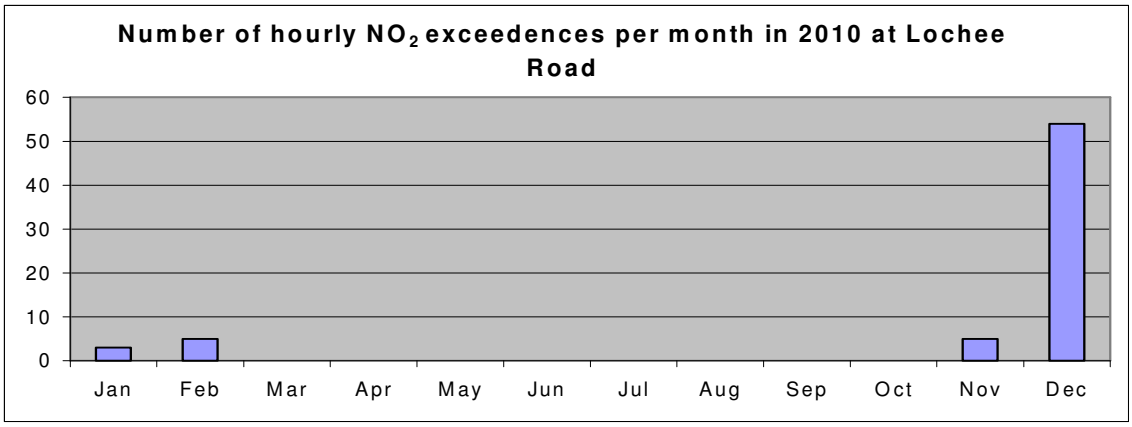
Table 2.3 - Results of Automatic Monitoring for Nitrogen Dioxide: Comparison with Annual Mean Objective and Hourly Objective

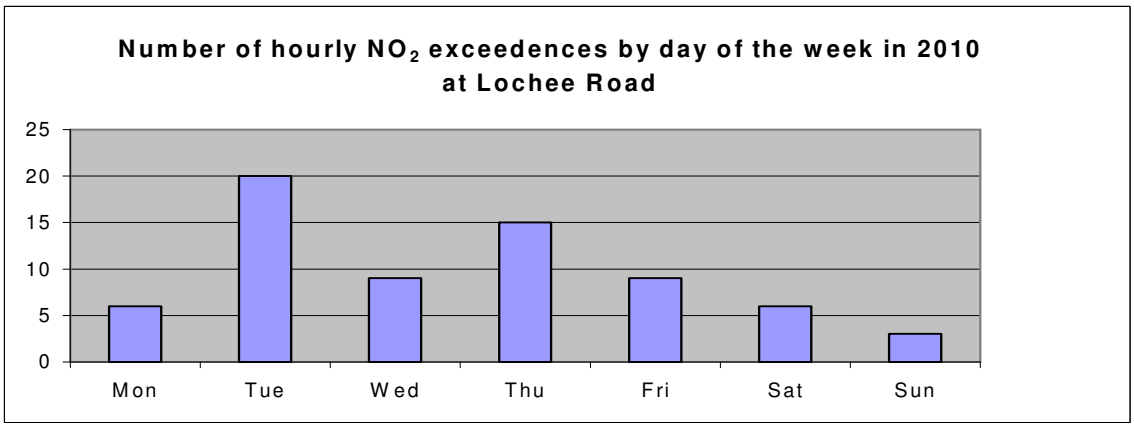
Location	Within AQMA ?[a]	NAQS NO_2 Objectives & annual data statistics	Annual Results [b,c]				
			2006	2007	2008	2009	2010
Lochee Road	Yes	Annual mean (Objective 40µg/m^3) (ug/m^3)	**49**	**52.8**	**52.9**	**54.2**	**55**
		Data capture (%)	63.4*	93.0	92.0	87.5*	94.7
		No. of exceedences of the hourly mean (200ug/m^3), not to be breached >18 times per year	0	0	4	**23**	**67**
		99.8thPercentile of the hourly means (ug/m^3)	141	157.5	175.6	206.2	242.6
Seagate	Yes	Annual mean (Objective 40µg/m^3) (ug/m^3)	**43**	**49.1**	**51.4**	**48.4**	**51.0**
		Data capture (%)	60.7*	93.9	81.6*	74.3*	80
		No. of exceedences of the hourly mean (200ug/m^3), not to be breached >18 times per year	0	1	0	1	0
		99.8thPercentile of the hourly means (ug/m^3)	119	141.2	141.3	152.8	134.8
Union Street	Yes	Annual mean (Objective 40µg/m^3) (ug/m^3)	39	35.8	**42.9**	**45.2**	**40**
		Data capture (%)	59.9*	99.3	99.7	99.7	90.7
		No. of exceedences of the hourly mean (200ug/m^3), not to be breached >18 times per year	0	0	11	2	0
		99.8thPercentile of the hourly means (ug/m^3)	133	132.1	182.3	165.2	141.9
Whitehall Street	Yes	Annual mean (Objective 40µg/m^3) (ug/m^3)	39.8	**42.0**	**46.7**	37.8	36
		Data capture (%)	85.1	90.6	75.6*	93.2	88.9
		No. of exceedences of the hourly mean (200ug/m^3), not to be breached >18 times per year	0	0	0	0	0
		99.8thPercentile of the hourly means (ug/m^3)	106	136.8	139.4	111.3	101.1

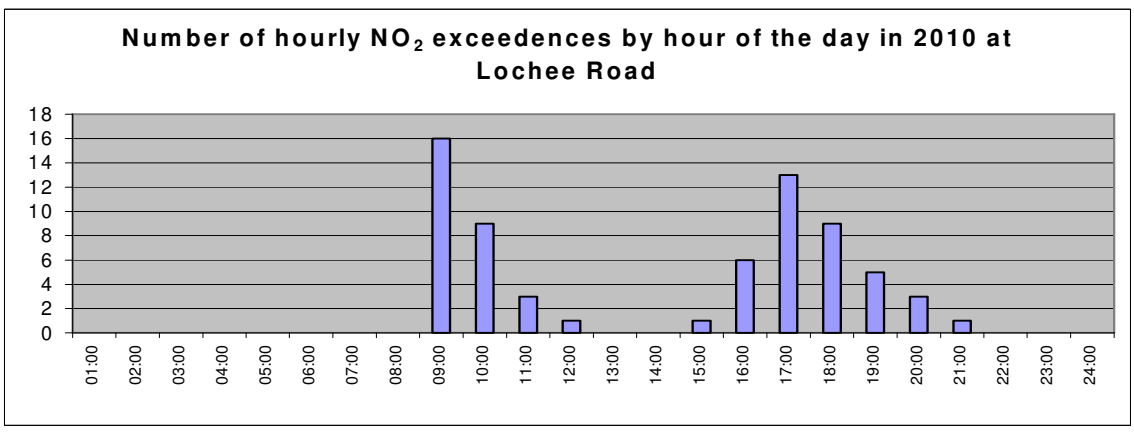
[a] All monitoring sites are located within an AQMA for NO_2 and PM_{10} annual mean.
[b] Monitoring period and data capture percentage is for the full calendar year.
[c] Exceedences of the air quality objectives are shown in bold.
* Data capture less than the recommended 90%
Results in the shaded cells have been period adjusted according to the methodology outlined in Box 3.2 of LAQM TG(09) .

The monitoring station on Lochee Road also recorded 67 exceedences of the hourly mean in 2010; only 18 are permitted in any calendar year. An analysis of the frequency of these exceedences is shown in **Figure 2.3**. This showed that all of the exceedences occurred during the winter months, during the morning and evening peak traffic periods and on weekdays. Severe weather (snow and ice) during December 2010 may have contributed to many of the exceedences, the monitoring station is located on the main north-west arterial route into the city, which can become increasingly congested during adverse weather when alternative routes are difficult for drivers to negotiate. The Rankine Street and Dudhope Terrace junctions with Lochee Road are being studied to determine if improvements to the Urban Traffic Management Control (UTMC) systems and the possible re-allocation of road space will help to alleviate congestion. The need for a detailed assessment or new AQMA for exceedences of the hourly NO_2 objective will be kept under review.

Figure 2.3 Analysis of the Frequency of Exceedences of the Hourly NO_2 Objective at Automatic Monitoring Site on Lochee Road







Diffusion Tube Monitoring Data

The nitrogen dioxide diffusion tube data for 2010 are summarised in the **Table 2.4** below. The full dataset (monthly mean values) is included in **Appendix 2**. None of the diffusion tube locations had less than 9 months data in 2010 and hence the results did not require to be annualised. The local bias- correction factor (0.79) derived for the Dundee sites by the National Physical Laboratory was used for the 2010 results; the Seagate co-location site was omitted from the overall local correction factor in 2010 due to low data capture.

The 2010 data show that concentrations measured at 27 diffusion tube sites exceeded the annual mean NO_2 Standard. As the Dundee AQMA encompasses the whole local authority area, all these locations are within the existing AQMA. Further consideration of these sites was made with regard to the likely exposure at nearest residential receptors using the LAQM distance calculator tool. Of these, the predicted concentrations were estimated to exceed the NAQS at receptors at 11 sites. All of these locations are in known areas of exceedence. Uncertainties associated with the distance calculator tool suggest that there are at least a further 7 locations where the objective may be exceeded. The Strathmore Avenue tube measured an NO_2 concentration of 39.9 $\mu g/m^3$ this area will also be kept under review.

Table 2.4 Results of Nitrogen Dioxide Diffusion Tubes

Location	X	Y	Site Type	2006 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.78)	2007 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.86)	2008 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.87)	2009 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.83	2010 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.79)	2010 Data Capture %	2010 Annual mean NO2 at receptor ($\mu g/m^3$)
Abertay	340047	730629	kerbside	**42.5**	**46.5**	**48.5**				
Abertay 2	340019	730612	roadside				**47.2**	**42.5**	100.0	n/a
Albert Street (Fish)	341139	731476	kerbside	30.0	30.7	32.8	34.7	33.9	100.0	29.8
Albert Street (Shandon Place)	341171	731574	roadside	32.3	34.3	**39.0**	**39.0**	**38.2**	100.0	**30.4**
Albert Street 1	341104	731210	kerbside	32.1	33.0	**37.9**	**37.4**	**36.0**	91.7	**32.1**
Arbroath Road (13)	341111	731070	kerbside	**37.4**	**38.0**	**40.2**	**45.4**	**40.8**	100.0	**34.9**
Arthurstone Terrace (10)	341051	731203	kerbside	22.6	23.1	25.4	25.2	24.9	100.0	23.8
Balgavies Place	343082	731465	urban background	15.3	17.6	18.9	18.6	19.1	100.0	n/a
Bank St/ Reform St	340228	730337	kerbside	26.4	29.4	28.2	30.9	27.7	100.0	25.9
Birnam Place	337531	730914	urban background	9.6	10.8	11.7	11.0	11.4	100.0	n/a
Brook Street (B.F.)	346293	730872	kerbside	21.8	22.9	23.1				
Broughty Ferry Road (141)	343322	731073	roadside	35.6	**40.4**	**45.3**	**46.9**	**44.2**	100.0	**39.4**
Claypotts Junction	345315	732103	roadside	22.7	24.6	28.0	27.5	29.0	91.7	27.8
Clepington Road/ Forfar Road	341385	732121	kerbside	33.5	**36.8**	**38.5**	**40.7**	**39.8**	100.0	**30.4**
Commercial St	340328	730431	kerbside	31.3	33.5	**36.2**	34.2	31.2	100.0	27.6
Commercial St/Dock St 2	340565	730263	roadside	35.6	**38.6**	**41.9**	**42.2**	**41.3**	100.0	**41.0**
Commercial Street (Waterstones)	340481	730325	roadside	34.9	**40.2**	**47.4**	**43.2**	**43.3**	100.0	**40.0**
Crichton St	340331	730162	kerbside	28.6	31.6	34.0	33.7	31.3	100.0	26.9

Location	X	Y	Site Type	2006 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.78)	2007 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.86)	2008 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.87)	2009 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.83	2010 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.79)	2010 Data Capture %	2010 Annual mean NO2 at receptor ($\mu g/m^3$)
Dens Road Crossing	340725	731238	roadside	30.2	35.2	36.0	36.6	34.9	100.0	31.4
Dock St (14)	340395	730086	kerbside	37.1	46.7	43.8	43.1	42.0	91.7	35.0
Dock St (Unicorn)(No.60)	340659	730348	roadside	33.3	37.6	40.8	39.6	42.2	100.0	39.9
Dock St Carol Whyte (2)	340524	730216	roadside	36.3	37.8	37.5	38.2	38.3	100.0	37.9
Dura Street (Forte) (No.98)	341150	731576	kerbside	34.0	39.4	41.6	43.0	41.1	100.0	35.9
Earl Grey Place (Park)	340699	730019	urban background	20.2	20.6	20.7	21.8	23.2	100.0	n/a
Eastport Roundabout	340651	730623	roadside	30.5	35.5	35.9	35.2	34.4	100.0	31.7
Forfar Road	341437	732360	kerbside	40.2	45.7	50.2	52.6	49.1	100.0	35.4
Harefield Road (35)	338360	731855	kerbside	29.2	32.6	36.0	32.5	29.8	100.0	24.2
Hilltown (Suites)	340088	731116	roadside	31.0	33.2	35.4	35.6	34.2	100.0	33.4
King St (12 & 14)	340598	730757	kerbside	26.4	28.7	30.1	31.1	29.1	100.0	26.7
Kingsway E. Roundabout	343107	731740	roadside	33.9	40.0	42.6	44.9	40.7	100.0	31.2
Kingsway/ Mains Loan 1	341124	732468	roadside	29.9	34.1	37.8	35.1	36.7	100.0	30.0
Kingsway/ Pitkerro Rd	341963	732303	roadside	26.6	30.7	26.7				
Kingsway/ Strathmartine Rd (S)	339221	732836	kerbside	37.4	43.3	45.0	43.2	46.3	100.0	30.2
Lochee Rd (138)	338936	730680	kerbside	45.5	52.6	57.4	56.9	56.9	100.0	45.8
Lochee Rd (140) Traffic Lts	338927	730685	roadside	45.3	53.4	57.0	57.2	57.4	91.7	56.4
Lochee Rd (184)	338767	730856	kerbside	31.9	38.1	39.1	40.2	39.7	100.0	33.4
Lochee Rd (Romon) mean of 3 tubes	338861	730773	kerbside	39.2	49.2	51.4	51.2	50.4	94.4	41.7

Location	X	Y	Site Type	2006 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.78)	2007 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.86)	2008 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.87)	2009 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.83	2010 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.79)	2010 Data Capture %	2010 Annual mean NO2 at receptor ($\mu g/m^3$)
Lochee Rd/Polepark Rd	339016	730586	kerbside	26.8	30.9	32.3	33.9	33.4	100.0	27.0
Logie Street (114)	338184	731293	roadside	46.9	52.2	58.2	57.0	56.9	91.7	54.7
Logie Street (98)	338252	731258	kerbside	32.7	35.2	34.5	35.0	33.4	83.3	31.0
Loons Road (1)	338211	731293	roadside	36.1	39.1	45.3	43.9	44.8	100.0	43.5
Marketgait	339953	730094	roadside	29.3	33.0	35.8	34.7	32.5	100.0	29.0
Meadowside	340245	730651	roadside	52.1	61.4	63.5	55.8	57.2	100.0	51.1
Muirton Road (6)	338152	731293	roadside	26.1	28.4	29.2	30.4	30.4	100.0	29.9
Myrekirk Road	335420	731733	kerbside	27.5	32.9	32.3	35.1	34.9	100.0	26.2
Nethergate (B&B)(88)	340163	730061	kerbside	40.0	43.1	49.1	48.6	48.1	100.0	37.5
Nethergate (Bradford)	340274	730171	roadside	35.8	37.4	43.2	41.9	38.7	100.0	34.3
Nethergate (Charlie T)	340033	729957	kerbside	34.8	39.1	38.4	38.2	37.5	100.0	33.6
Nethergate (Trades House)	340230	730124	roadside	34.5	39.6	44.6	41.8	38.9	100.0	34.3
Nethergate/South Tay St	339987	729919	roadside	25.4	29.6	30.1	29.3	29.8	91.7	29.4
Nethergate/ Marketgait	340074	729984	roadside	29.8	36.0	35.2	35.4	33.9	100.0	30.0
Perth Rd / Hawkhill	338742	729828	kerbside	23.5	25.0	22.9				
Perth Rd 320	338776	729798	kerbside			36.5	39.9	37.6	100.0	30.6
Queen St B/F	346207	731007	roadside			29.8	31.3	30.1	100.0	30.1
Rankine St (2)	338768	730900	roadside	31.7	39.9	42.6	44.9	45.5	91.7	44.3
Seagate	340545	730532	roadside	39.0	42.3	45.9	44.9	42.3	100.0	41.8
Seagate (Yates)(7-9)	340487	730446	roadside	35.1	40.5	38.3	41.5	39.4	100.0	34.7
Seagate(Romon) mean of 3 tubes	340467	730388	kerbside	42.3	47.5	50.8	51.4	48.9	100.0	46.1

Location	X	Y	Site Type	2006 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.78)	2007 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.86)	2008 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.87)	2009 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.83	2010 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.79)	2010 Data Capture %	2010 Annual mean NO2 at receptor ($\mu g/m^3$)
Soapwork Lane	340099	730650	roadside	29.6	35.0	35.8	36.9	35.4	100.0	35.4
St Andrews St (JAF)	340516	730584	kerbside	32.7	34.8	40.4	36.9	36.7	100.0	32.7
St Andrews St (PB)	340532	730551	kerbside	35.0	41.5	41.6	41.5	40.4	100.0	34.1
St Mary Flats	339039	730624	roadside	18.4	20.6	19.8				
Strathmore Avenue (353)	339609	731871	kerbside	35.0	38.0	42.6	40.3	39.9	100.0	35.6
Trades Lane (31)	340575	730500	kerbside	29.2	36.3	33.3	32.8	32.6	100.0	29.0
Union St (Rollalong) mean of 3 tubes	340235	730091	roadside	39.1	43.4	44.7	45.3	40.7	100.0	35.0
Union Street (Goodfellows)	340274	730069	kerbside	28.2	32.4	34.1	32.6	32.1	100.0	28.9
Union Street (Mcintyres)	340293	730051	kerbside	29.0	32.7	33.2	33.5	32.8	100.0	30.0
Victoria Road	340212	730633	roadside	32.1	36.7	38.4	37.5	36.2	100.0	32.0
Victoria Road (10)	340225	730667	roadside	29.7	32.9	34.0				
Victoria Road (60)	340375	730779	roadside	35.2	41.1	43.8	44.0	40.8	91.7	39.7
Victoria Road (OSIRIS)	340230	730673	kerbside				38.5	37.5	100.0	30.9
Victoria Road / Cotton Road	340740	730996	kerbside	31.3	36.6	37.4	38.1	36.5	100.0	33.4
Victoria Road/Hilltown	340274	730714	roadside	47.8	55.8	60.9	59.5	57.9	100.0	49.9
Victoria St	341071	731072	kerbside	31.7	34.1	35.2	36.5	35.2	100.0	31.7
Ward Rd	339893	730336	roadside			34.5	35.7	33.3	100.0	32.5
West Bell St	339815	730395	roadside			36.0				
West Marketgait	339814	730380	kerbside				44.1	38.2	100.0	33.1
Westport (2)	339842	730122	roadside	33.6	38.9	41.3	42.1	37.5	91.7	31.8
Whitehall Cr (Xpresso)	340376	730109	kerbside	27.2	30.3	30.6	30.4	29.5	91.7	26.7
Whitehall St (Brj)	340330	730106	kerbside	32.2	36.3	37.8	35.8	35.5	100.0	30.4

Location	X	Y	Site Type	2006 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.78)	2007 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.86)	2008 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.87)	2009 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.83	2010 Annual mean NO_2 conc ($\mu g/m^3$) adjusted for bias (0.79)	2010 Data Capture %	2010 Annual mean NO2 at receptor ($\mu g/m^3$)
Whitehall St (Bus)	340289	730128	roadside	**42.8**	**48.6**	**51.7**	**48.6**	**43.4**	100.0	**38.7**
Whitehall St (Deb A)	340265	730153	kerbside	**38.5**	**43.4**	**50.3**	**46.9**	**42.5**	91.7	**33.7**
Whitehall St (Deb E)	340322	730098	kerbside	32.2	**36.9**	**39.6**	**38.3**	**37.1**	100.0	**30.7**
Whitehall St (Romon) mean of 3 tubes	340278	730156	roadside	33.2	**38.5**	**42.7**	**38.9**	**36.5**	100.0	**34.7**
Whitehall St (Tiso)	340293	730142	roadside	34.8	**38.8**	**42.6**	**40.2**	**37.1**	91.7	**34.3**
Woodside Avenue	340776	732307	urban background	15.6	18.1	18.5	17.7	17.5	100.0	n/a

[a] All diffusion tube are located within an AQMA for NO_2 and PM_{10} annual mean.
[b] Monitoring period and data capture percentage is for the full calendar year.
[c] The means shown in the highlighted cells have been "annualised" as in Box 3.2 of TG(09), the methodology was detailed in the USA 2009.
[d] Exceedences of the air quality objectives are shown in bold & red. Orange values denote those at risk of exceeding the objective.
e Definitions and siting criteria for each site type can be found in Box A1.2 (LAQM TG:09)

The diffusion tubes monitoring sites where NO_2 concentrations exceeded the annual mean objective were assessed, using the procedures set out in LAQM.TG(09) (Box2.3) and the tool available from the Review and Assessment website, to see whether exceedences are likely to occur at the nearest relevant receptor. The average of three urban-background monitoring locations (Balgavies Place, Earl Grey Place (Park) and Woodside Avenue) was used to provide the background concentration (19.9µg/m^3) for these comparisons. Background sites were selected in accordance with the selection criteria contained in Box A1.2 of LAQM (TG:09). Of the 27 sites, which recorded an exceedence in 2010, all were located within the AQMA.

There is considerable uncertainty associated with the use of the distance calculator tool. An example of this can be illustrated using two of the diffusion tube sites on Lochee Road. Lochee Rd (138) is located at kerbside and Lochee Rd (140) is located close to (25cm) the residential at the same location. When the distance calculator is used to predict the drop-off in pollutant concentrations between the two tubes it calculates that pollution levels will drop from 56.9µg/m^3 to 46.5µg/m^3, i.e. a drop off of 10.4µg /m^3. The actual monitored value at the façade tube was 57.4µg/m^3, an increase of 0.5µg/m^3.

The following 11 sites exceeded the NAQS annual mean when the distance calculator tool was used to estimate concentrations at relevant receptors:

Table 2.5 Predicted Exceedences of NO_2 Annual Mean at Façade of Receptors

Tube location	x	y	Bias Corrected 2010 Annual mean NO_2 concentration (µg/m^3)	2010 Predicted annual mean NO_2 concentration at Receptor (µg/m^3)
COMMERCIAL ST / DOCK ST 2	340565	730263	**41.3**	**41.0**
LOCHEE RD (138)	338936	730680	**56.9**	**45.8**
LOCHEE RD (140) TRAFFIC LTS	338927	730685	**57.4**	**56.4**
LOCHEE RD (ROMON average of 3)	338861	730773	**50.4**	**41.7**
LOGIE STREET (114)	338184	731293	**56.9**	**54.7**
LOONS ROAD (1)	338211	731293	**44.8**	**43.5**
MEADOWSIDE	340245	730651	**57.2**	**51.1**
RANKINE ST (2)	338768	730900	**45.5**	**44.3**
SEAGATE	340545	730532	**42.3**	**41.8**
SEAGATE (YATES)(7-9)	340467	730388	**48.9**	**46.1**
VICTORIA ROAD/HILLTOWN	340274	730714	**57.9**	**49.9**

A further 7 sites were close to exceeding the NAQS annual mean when the distance calculator tool was used to estimate concentrations at relevant receptors:

Table 2.6 Locations at risk of Exceeding NO_2 Annual Mean at Façade of Receptors

Tube location	x	y	Bias Corrected 2010 Annual mean NO_2 concentration ($\mu g/m^3$)	2010 Predicted annual mean NO_2 concentration at Receptor ($\mu g/m^3$)
BROUGHTY FERRY ROAD (141)	343322	731073	**44.2**	39.4
COMMERCIAL STREET (WATERSTONES)	340481	730325	**43.3**	40.0
DOCK ST (UNICORN)(No.60)	340659	730348	**42.2**	39.9
DOCK ST CAROL WHYTE (2)	340524	730216	38.3	37.9
NETHERGATE (B&B)(88)	340163	730061	**48.1**	37.5
VICTORIA ROAD (60)	340375	730779	**40.8**	39.7
WHITEHALL ST (BUS)	340289	730128	**43.4**	38.7

The Technical Guidance considers that there could be a potential risk of breaching the hourly NO_2 standard, where the annual mean NO_2 concentration is greater than (>) 60µg/m^3. There were no diffusion tubes with an annual mean NO_2 concentration >60µg/m^3 in 2010.

2.2.2 PM_{10}

Dundee City Council undertook automatic monitoring of PM_{10} at seven sites in the city in 2010. These are all located within the Dundee AQMA (NO_2 and PM_{10} annual mean) with one at an urban background location and the rest either at busy roads and junctions in the city centre or by main arterial routes.

Dundee City Council uses three types of measurement methods for PM_{10} 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_{10} 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 nephalometer, 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.

Details and locations of these monitoring stations can be found in **Table 2.1** and **Figure 2.1**, respectively.

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. Prior to the introduction of the LAQM.TG(09) recommended methodology of applying the volatile correction model; Dundee City Council derived local factors from co-location studies to enable adjustment of both TEOM and Osiris data. AEA were commissioned by the Scottish Government to provide VCM correction for TEOMs; from 2008, hence the 2010 dataset is also corrected using the AEA VCM correction factors.

Comparison of the equivalent daily averages in 2010 for the Partisol and TEOM co-location study at Broughty Ferry Road showed locally that TEOMs under-read compared to the Partisol and so all TEOM results have been factored by the local factor of **1.044**.

Comparing equivalent daily averages in 2010 for the TEOM and OSIRIS at Union Street found that the OSIRIS was under-reading compared to the TEOM. This meant the OSIRIS had to be multiplied by a factor of **1.11** 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. The factored monitoring results for 2010 are shown in **Table 2.7** and **Table 2.7a**.

All of the automatic monitoring stations had greater than 9 months data in 2010, therefore the results did not require to be annualised according to the methodology outlined in Box 3.2 of LAQM.TG(09).

Table 2.7 Results of PM_{10} Automatic Monitoring: Comparison with Annual Mean Objective

Location (Monitor type)	Within AQMA ?	Correction factor	Data Capture for 2010 (%)	Annual mean concentrations (µg/m^3)
		VCM/*Local*		2010
Broughty Ferry Rd (Partisol)	Y	N/A	93.7	14.1
Broughty Ferry Rd (TEOM)	Y	VCM	99.0	15.6
		Local *(2010 - 1.044)*	*99.2*	*14.1*
Mains Loan (TEOM)	Y	VCM	99.1	12.6
		Local *(2010 - 1.044)*	*99.3*	*11.1*
Union St (TEOM)	Y	VCM	90.5	17.0
		Local *(2010 - 1.044)*	*90.7*	*15.7*
Union St (OSIRIS)	Y	VCM	92.9	16.8
		Local *(2010 - 1.044)*	*93.2*	*14.8*
Victoria Rd (OSIRIS)	Y	VCM	91.1	**21.0**
		Local *(2010 - 1.044)*	*91.9*	***18.8***
Logie St (OSIRIS)	Y	VCM	93.0	**22.1**
		Local *(2010 - 1.044)*	*93.2*	***19.9***
Lochee Rd (OSIRIS)	Y	VCM	93.0	**24.8**
		Local *(2010 - 1.044)*	*93.2*	***22.5***
Seagate (OSIRIS)	Y	VCM	93.0	**20.5**
		Local *(2010 - 1.044)*	*93.2*	*18.4*

Notes

Monitoring period & data capture percentage is for the full calendar year

Exceedences of the air quality objectives are shown in bold

* denotes where data capture is less than the recommended 90%. Results with data capture below 75% have been annualised as in Box 3.2 of TG(09)

Table 2.7a Results of PM_{10} Automatic Monitoring: Comparison with 24-hour Mean Objective

Location (Monitor type)	Within AQMA ?	Correction factor	Data Capture for 2010 (%)	Number of Exceedences of daily mean objective (50 µg/m^3) (7 allowed)
		VCM/*Local*		2010
Broughty Ferry Rd (Partisol)	Y	N/A	93.7	0 (36.8)
Broughty Ferry Rd (TEOM)	Y	VCM	98.9	0 (39.8)
		Local *(2010 - 1.044)*	*99.5*	*0 (35.9)*
Mains Loan (TEOM)	Y	VCM	99.5	0 (30.0)
		Local *(2010 - 1.044)*	*100*	*0 (26.0)*
Union St (TEOM)	Y	VCM	89.3	0 (37.7)
		Local *(2010 - 1.044)*	*89.6*	*0 (34.1)*
Union St (OSIRIS)	Y	VCM	92.6	0 (38.8)
		Local *(2010 - 1.044)*	*93.2*	*0 (33.0)*
Victoria Rd (OSIRIS)	Y	VCM	91.0	7 (47.7)
		Local *(2010 - 1.044)*	*91.0*	*4 (42.8)*
Logie St (OSIRIS)	Y	VCM	92.6	**12 (62.7)**
		Local *(2010 - 1.044)*	*93.2*	***11 (58.5)***
Lochee Rd (OSIRIS)	Y	VCM	92.6	**16 (62.5)**
		Local *(2010 - 1.044)*	*93.2*	***13 (57.3)***
Seagate (OSIRIS)	Y	VCM	92.6	**9 (52.7)**
		Local *(2010 - 1.044)*	*93.2*	*7 (49.6)*

Notes

Monitoring period & data capture percentage is for the full calendar year

Exceedences of the air quality objectives are shown in bold

* denotes where data capture is less than the recommended 90%.

The 98th percentile is shown in brackets .

Monitoring results indicate the 2004 PM_{10} Objectives are being met. However, there were exceedences of the 2010 PM_{10} annual mean and daily mean objectives recorded at roadside Osiris units. An analysis of the frequency of these exceedences is shown in **Table 2.7b**. This showed that the majority of the exceedences occurred during light westerly winds, with most occurring during March and April. A comparison of Dundee daily PM_{10} concentrations with urban background monitoring locations in Scotland for each of the identified exceedence episodes is shown in **Figures 2.4 to 2.9**. These figures show that the majority of exceedences recorded at the Osiris monitoring sites coincided with raised background concentrations, some of which were during the eruption of the Icelandic volcano.

Table 2.7b Comparison of Exceedence Events with Wind Speed and Direction and Urban Background Sites

	Dates of exceedences of the NAQS 24hr PM_{10} in Dundee		Average wind direction & speed (m/s)		Urban background					Downwind of Port		Roadside					
					North Lanarkshire Coatbridge Whilet	West Lothian Whitburn	Aberdeen Errol Place	Edinburgh St Leonards	Dundee Mains Loan VCM	Dundee Broughty Ferry Rd VCM	Dundee Broughty Ferry Rd PARTISOL	Dundee Union St VCM	Dundee Victoria Rd OSIRIS VCM	Dundee Logie St OSIRIS VCM	Dundee Union St OSIRIS VCM	Dundee Lochee Rd OSIRIS VCM	Dundee Seagate OSIRIS VCM
1	05/02/2010	Fri	E	2.3	22.7	*no data*	**41.0**	33.3	30.0	35.0	38.3	34.1	**61.9**	**47.5**	**47.7**	**50.7**	**61.9**
2	22/02/2010	Mon	E	1.8	23.4	31.2	17.2	23.0	19.9	**43.1**	**40.8**	36.4	35.1	**74.5**	27.5	**60.4**	28.7
	23/02/2010	Tues	E	1.7	23.8	23.4	19.0	22.4	24.1	**43.5**	37.1	38.1	**43.0**	**72.9**	27.6	**98.8**	39.6
3	01/03/2010	Mon		2.2	21.5	12.8	11.8	19.8	13.9	27.3	30.0	26.7	31.6	37.4	22.2	**56.8**	25.5
	02/03/2010	Tues		1.9	23.2	20.5	14.4	25.4	18.6	34.0	32.1	38.5	34.7	**52.4**	31.5	**69.3**	**60.0**
	03/03/2010	Wed	W	0.7	31.4	29.3	24.6	32.6	38.7	**43.7**	**44.2**	**46.7**	**54.1**	**79.7**	39.2	**78.1**	**77.9**
	04/03/2010	Thu	W	1.2	**42.2**	38.1	27.2	**46.5**	29.6	**43.4**	**44.2**	**45.5**	**41.8**	**50.2**	**41.6**	**69.6**	**51.9**
	08/03/2010	Mon	SW	0.7	33.3	**40.5**	20.0	**46.2**	32.6	**44.8**	**44.0**	39.8	**48.4**	**67.3**	34.4	**64.3**	**65.0**
	09/03/2010	Tues	W	0.9	38.8	38.5	26.0	*no data*	25.6	**40.0**	36.5	**45.2**	39.6	**85.6**	38.3	**79.7**	**57.7**
	10/03/2010	Wed	WSW	1.0	**41.6**	36.3	22.2	28.3	25.5	39.8	32.3	**41.3**	31.4	**63.9**	33.0	**92.2**	**66.3**
	11/03/2010	Thu	WSW	2.0	26.3	21.6	16.8	19.5	15.5	21.3	19.4	24.4	20.5	**41.0**	21.8	**50.2**	31.2
	16/03/2010	Tues	WSW	1.5	16.1	11.5	18.2	12.3	12.4	23.1	21.5	*no data*	20.2	**54.8**	25.6	**49.6**	**44.5**
	20/03/2010	Sat	WSW	1.3	21.2	20.9	13.5	16.8	14.0	24.2	20.8	26.5	28.6	**47.3**	25.7	**50.6**	38.6
4	09/04/2010	Fri	WSW	1.2	*no data*	18.3	18.8	15.3	19.5	22.5	19.4	30.7	28.2	**69.1**	28.9	**52.7**	39.5
	10/04/2010	Sat	WSW	1.1		20.2	22.0	21.0	18.2	22.1	24.0	27.6	32.3	**51.4**	26.5	**47.2**	36.3
	13/04/2010	Tues	ENE	1.6		24.5	21.9	22.1	24.3	28.4	27.7	24.5	**44.4**	**43.1**	32.7	**54.1**	**44.7**
	16/04/2010	Fri	WSW	2.0		32.1	37.1	21.1	23.3	24.5	18.3	30.3	27.0	**61.4**	25.9	39.8	28.3
	22/04/2010	Thu	WSW	1.9	23.9	22.2	14.5	19.4	14.9	15.1	12.9	18.8	18.3	24.3	15.1	23.1	**53.5**
	24/04/2010	Sat	E	1.4	30.5	39.7	32.2	**40.0**	33.8	33.1	33.8	34.5	**50.8**	**41.5**	35.1	**43.4**	**44.2**
	25/04/2010	Sun	SW	1.0	23.4	32.9	**51.9**	34.7	30.2	31.4	34.2	33.6	**50.6**	**40.8**	**41.0**	**46.8**	**48.1**
5	08/10/2010	Fri	E	2.6	21.0	25.8	20.9	21.2	17.9	22.2	22.3	24.2	**53.6**	36.0	**46.7**	**45.4**	**51.7**
	10/10/2010	Sun	NE	1.9	34.8	**40.4**	25.0	**42.5**	33.8	33.1	30.2	33.8	**52.9**	39.8	39.5	**43.8**	**41.7**
6	12/12/2010	Sun	WNW	0.8	*no data*	*no data*	10.8	28.0	22.2	28.8	19.8	27.1	**43.8**	**40.4**	37.4	**59.6**	**41.4**
	14/12/2010	Tues	WNW	0.8	**41.2**	23.2	4.2	20.2	14.5	20.0	10.2	*no data*	29.9	29.2	25.2	**52.4**	25.0
7	31/12/2010	Fri	W	1.1	13.2	7.6	3.7	14.0	10.5	14.4	13.8		**125.4**	18.2	15.8	23.9	16.3
No. of exceedences					**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**7**	**12**	**0**	**16**	**9**

Notes - Average wind speed & direction is derived from the Broughty Ferry Road & Mains Loan monitoring sites. It was not possible to determine an average wind direction for the 1st and 2nd of March 2010.

Values shown in bold and red are exceedences of the daily mean objective for PM_{10} (50µg/m^3), values shown in orange are between 40 & 50µg/m^3 and indicate raised PM_{10} concentrations.

Osiris monitoring units are indicative only and the results should be treated with caution. The council have installed reference equivalent PM_{10} analysers in Lochee Road, Seagate and at the Victoria Rd / Meadowside junction, and the need for a detailed assessment or AQMA in relation to the daily mean objective will be kept under review. A detailed assessment undertaken in 2009 for PM_{10}, also identified a risk of exceeding both the daily and annual objectives (2010) at receptors adjacent to busy roads and junctions in the city centre.

Figure 2.4 Comparison of Dundee PM_{10} Monitoring Sites and Urban Background Locations from 1/2/2010 to 8/2/2010

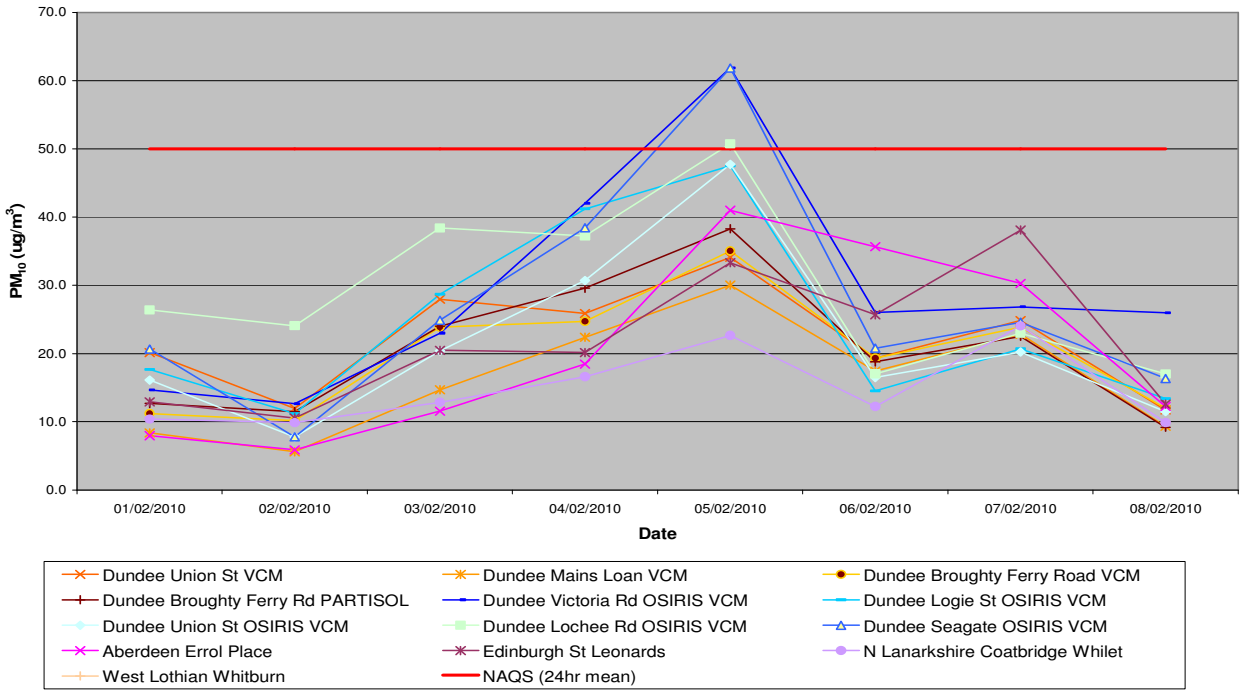


Figure 2.5 Comparison of Dundee PM_{10} Monitoring Sites and Urban Background Locations from 19/2/2010 to 26/2/2010

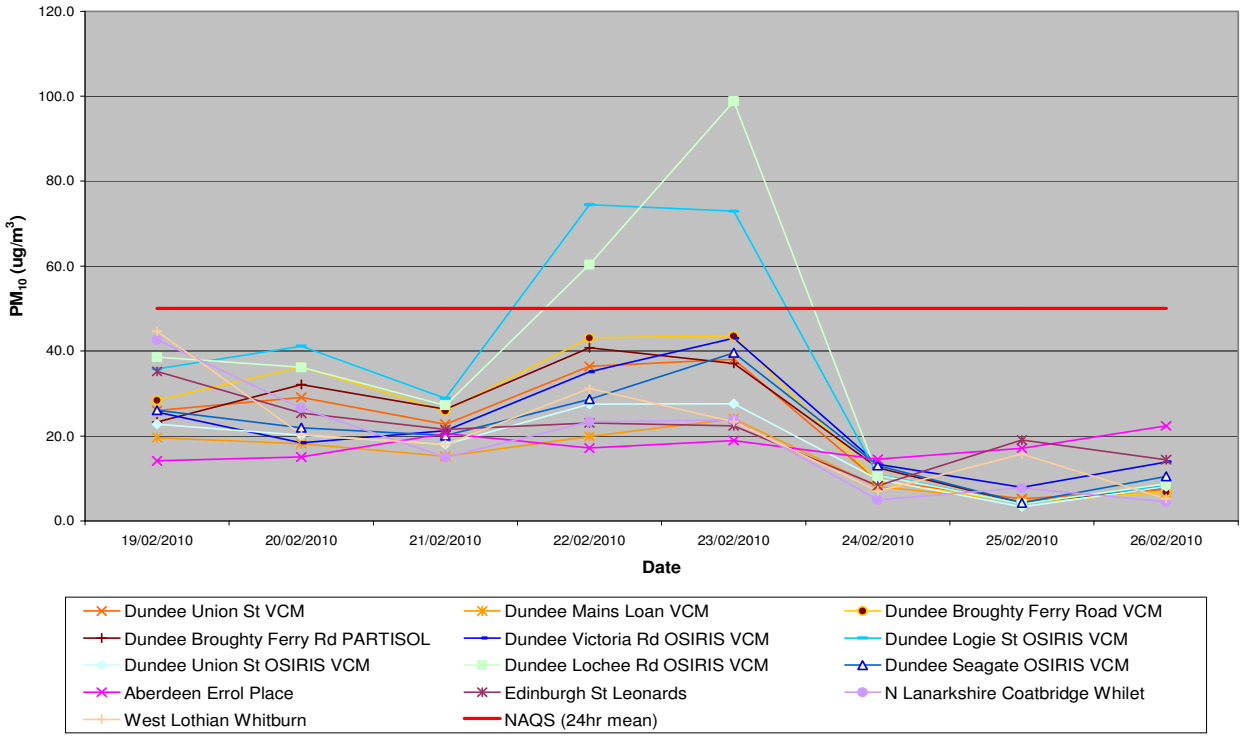


Figure 2.6 Comparison of Dundee PM_{10} Monitoring Sites and Urban Background Locations from 28/2/2010 to 21/3/2010

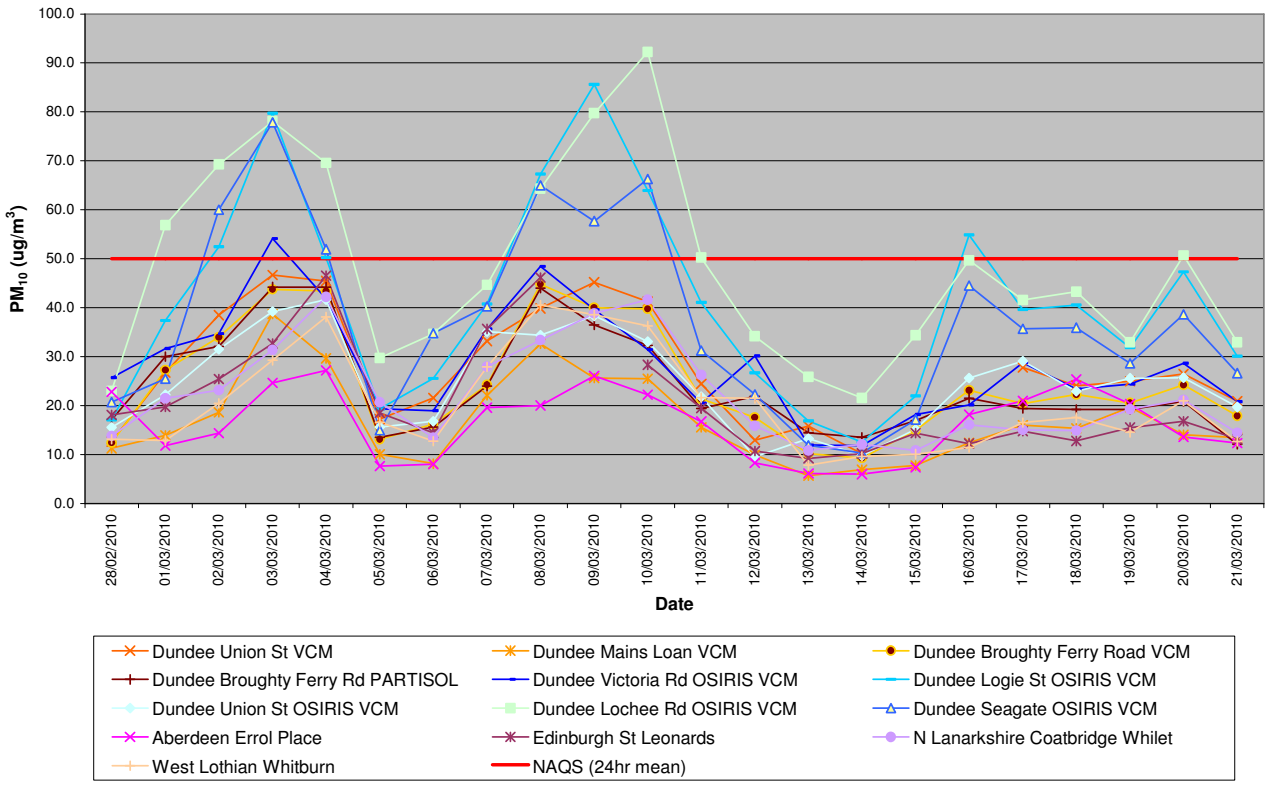


Figure 2.7 Comparison of Dundee PM_{10} Monitoring Sites and Urban Background Locations from 7/4/2010 to 27/4/2010

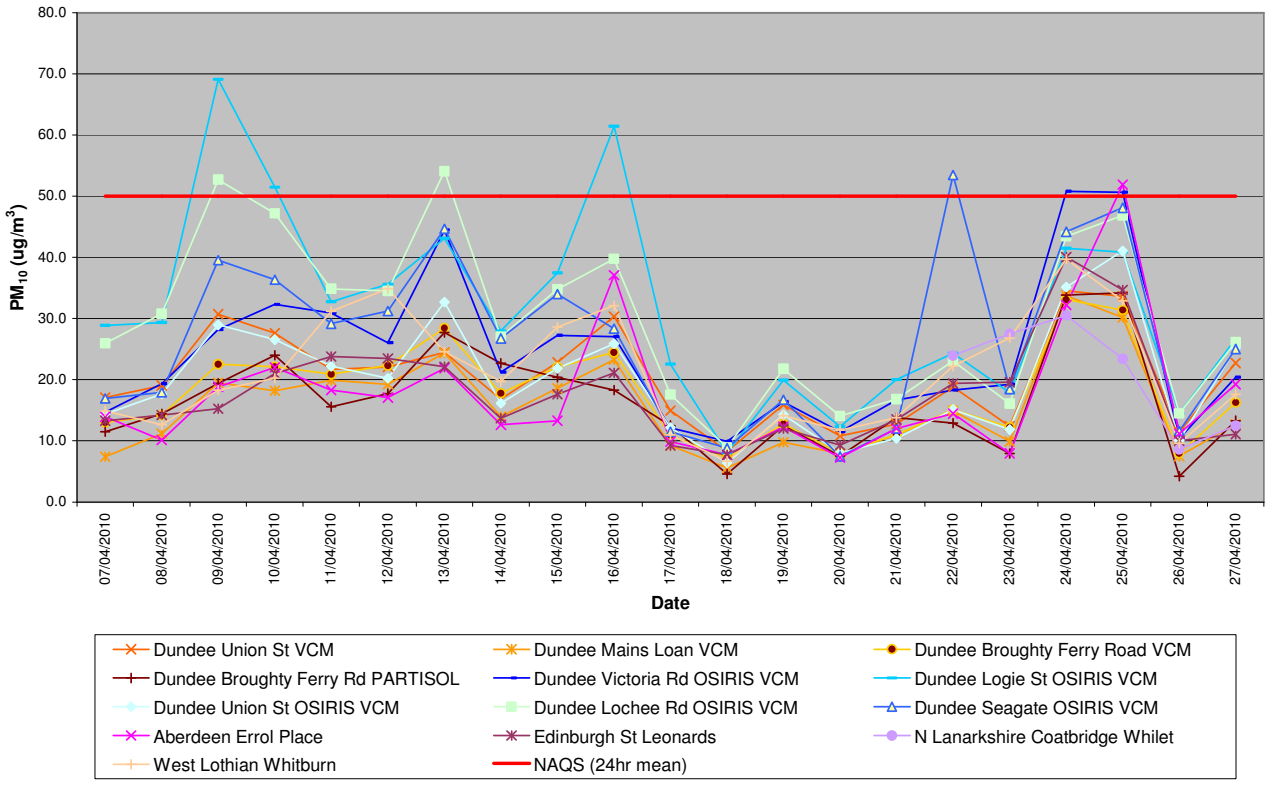


Figure 2.8 Comparison of Dundee PM_{10} Monitoring Sites and Urban Background Locations from 6/10/2010 to 12/10/2010

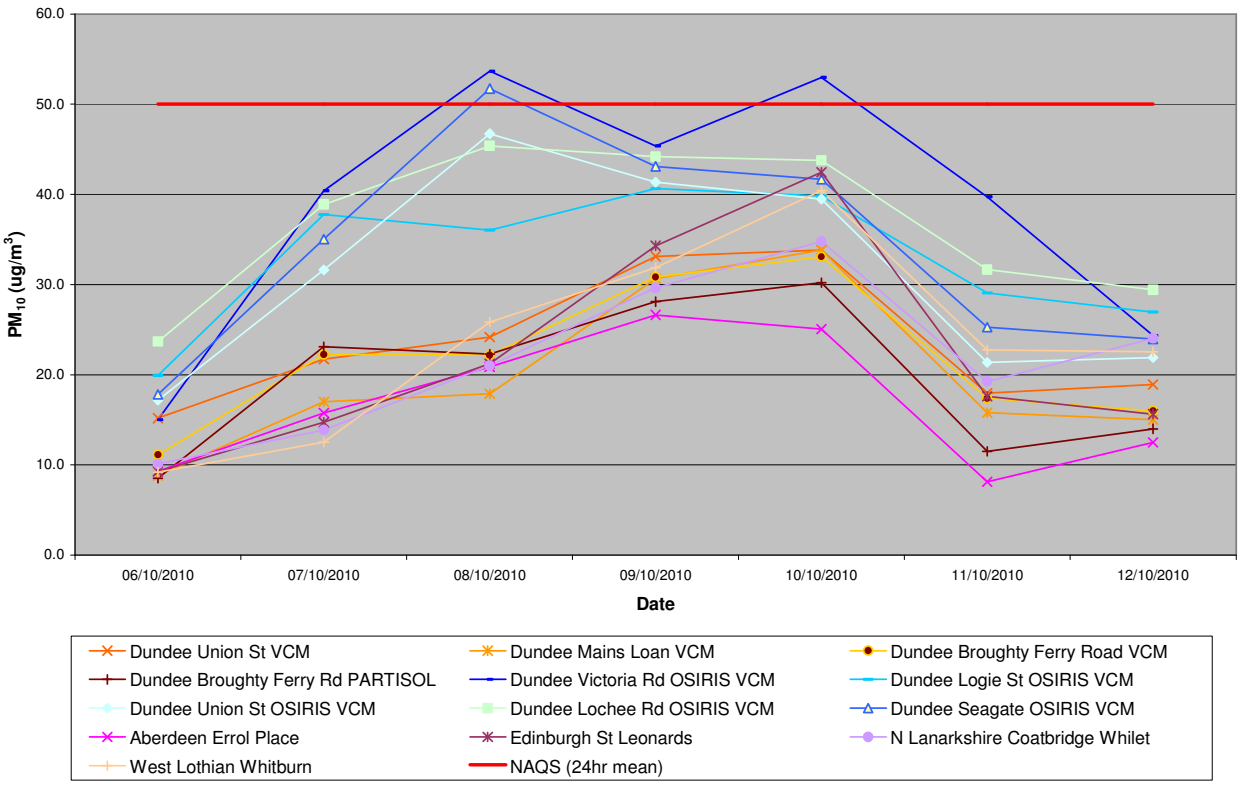
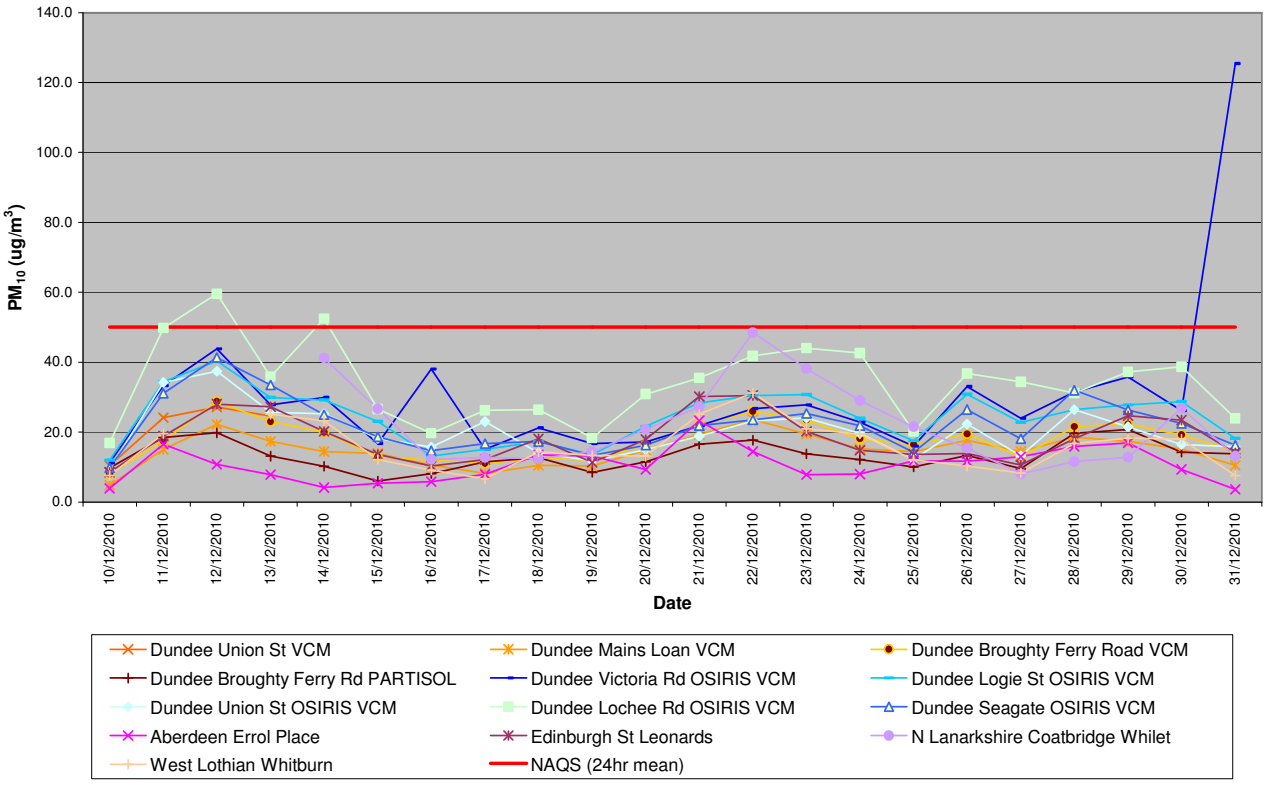


Figure 2.9 Comparison of Dundee PM_{10} Monitoring Sites and Urban Background Locations from 10/12/2010 to 31/12/2010



2.2.3 Sulphur Dioxide

Dundee City Council measures SO_2 at one location within the city, at Broughty Ferry Road. The monitor is located close to residential receptors located downwind of an urban industrial facility and the port. The UV fluorescence analyser is operated under similar protocols to the AURN stations and the unit is audited twice yearly by AEA. Data are ratified with reference to the Technical Guidance (LAQM.TG09).

Data for 2010 are shown in **Table 2.8** below. Concentrations of SO_2 are very low and the objectives were met. The number of exceedences of each objective is given alongside the relevant percentile value.

Table 2.8 Results of SO_2 Automatic Monitoring at Broughty Ferry Road: Comparison with Objectives

NAQS Objective		2002	2003	2004	2005	2006	2007	2008	2009	2010
daily average	No. of exceedences (>125ug/m^3)	0	0	0	0	0	0	0	0	0
	Max (ug/m^3)	69.7	53.7	33.3	54	50.1	19.6	24.5	17.4	27.4
	99.2nd percentile (ug/m^3)	37.6	27.2	18.3	21.3	23.3	15.7	16.8	15.6	19.8
	data capture %	92.1	97.3	100	94.8	96.2	99.7	97.5	93.4	96.4
hourly average	No. of exceedences (>350ug/m^3)	0	0	0	0	0	0	0	0	0
	Max (ug/m^3)	208	267	294	235	277.5	68.8	137.8	119.8	92.3
	99.7th percentile (ug/m^3)	100	61	39	54	46	36	36	35	44
	data capture %	92	97.5	100	95	96.6	99.6	97.5	93.4	96.5
15min average	No. of exceedences (>266ug/m^3)	1	6	5	2	5	0	0	0	0
	Max (ug/m^3)	288	392	395	281	572	104	215	205	101
	99.9th percentile (ug/m^3)	165	117	57	90	72	51	56	53	69
	data capture %	90.4	95.4	97.9	93	94.5	97.5	95.6	91.5	94.5

*Data for all years has been fully ratified, data capture percentages are for a full calendar year.

Exceedences are highlighted in bold. Percentiles 99.9th for 15min, 99.7th for hourly and 99.2nd percentile for 24-hour means in brackets next to exceedences. The monitoring station is located within an AQMA for NO_2 and PM_{10} (annual means) only.

2.1.3 Summary of Compliance with AQS Objectives

Dundee City Council has measured concentrations of NO_2 above the annual mean objective at relevant locations within the AQMA, previously declared for NO_2 and PM_{10} annual mean (i.e. the whole council area). However, uncertainties associated with the distance calculator tool used to estimate NO_2 concentrations at façade suggest that the number of locations where the objective is breached at façade will exceed the number estimated (11).

Dundee City Council has measured concentrations of NO_2 above the 1-hour objective at one location (Lochee Road). This is thought to have occurred as a result of traffic congestion caused by the impact of the severe winter weather on the road network. The need for a detailed assessment / AQMA will be reviewed in subsequent review and assessment reports.

Dundee City Council has measured concentrations of PM_{10} above the annual mean and 24-hour objective at roadside and kerbside Osiris units. Osiris monitoring units are indicative only and the results should be treated with caution. The council have installed reference equivalent PM_{10} analysers in Lochee Road, Seagate an at the Victoria Rd / Meadowside junction, and the need for a detailed assessment or AQMA in relation to the daily mean will be reviewed as data becomes available.

3 Trends in Pollutant Concentrations 2006-2010

3.1 Trends in Nitrogen Dioxide Concentrations

3.1.1 Trends in Nitrogen Dioxide Annual Mean Concentrations

Figure 3.1 shows the trend in NO_2 concentrations at real time monitoring locations between 2006 and 2010. NO_2 concentrations have increased at the monitoring locations in Lochee Road and Seagate. NO_2 concentrations have remained relatively stable at Union Street (with year to year fluctuations) and have decreased slightly at the Whitehall Street monitor.

Figure 3.1 Annual Mean Nitrogen Dioxide Concentrations at Real-time Monitors from 2006 to 2010

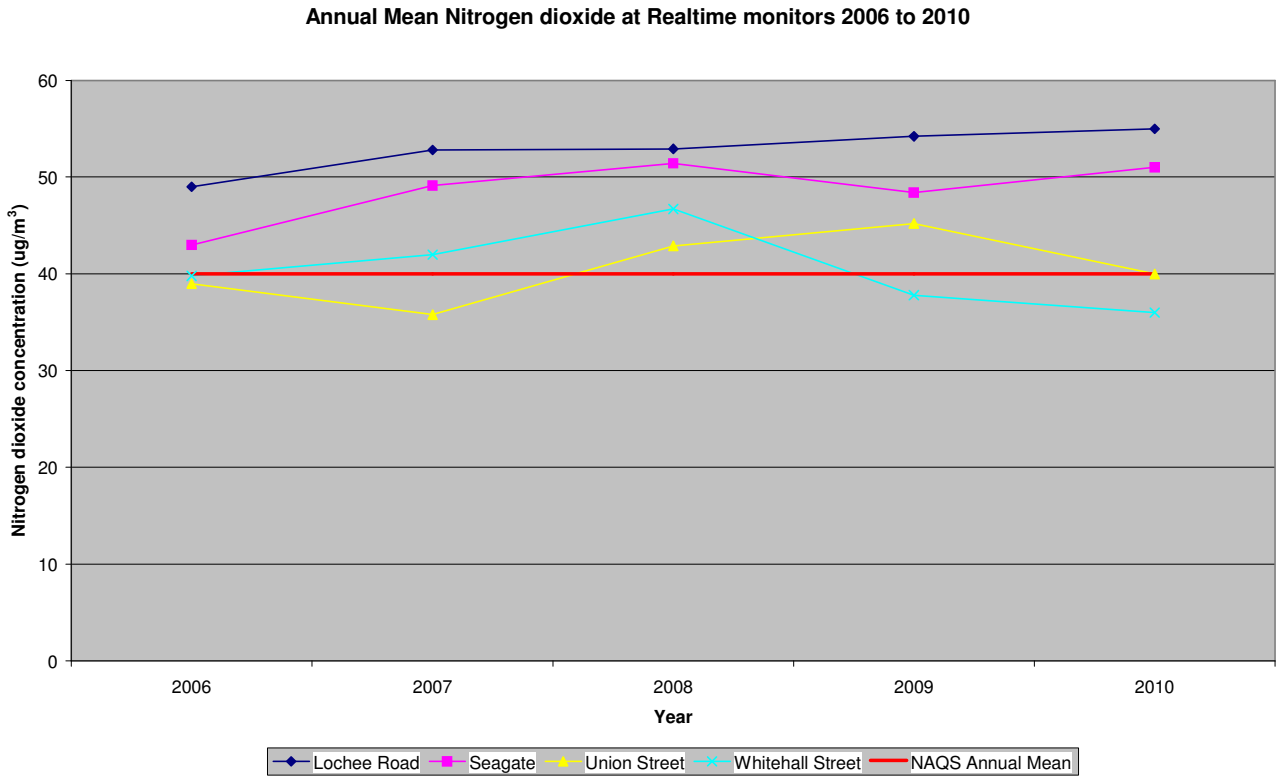


Figure 3.2 shows the difference between 2006 and 2010 bias corrected diffusion tube annual mean results for those tube sites that have been present for 5 years. All tubes apart from one (Commercial Street), have shown an increase in NO_2 concentrations over this time. The greatest increases in pollutant concentrations have been recorded along the city centre bus corridor, the north west arterial route and associated access roads, major junctions on the Kingsway and at Stannergate Junction, on Broughty Ferry Road. These are shown in **Figures 3.3 and 3.4**.

Figure 3.2 Change in Nitrogen Dioxide Concentrations at Diffusion Tube Monitoring Locations between 2006 and 2010

Change in Nitrogen dioxide concentration at 73 diffusion tube monitoring locations between 2006 and 2010 (Red columns are locations where the 2010 annual mean concentration exceeded the Air Quality Std & Orange columns are locations at risk of exceeding).

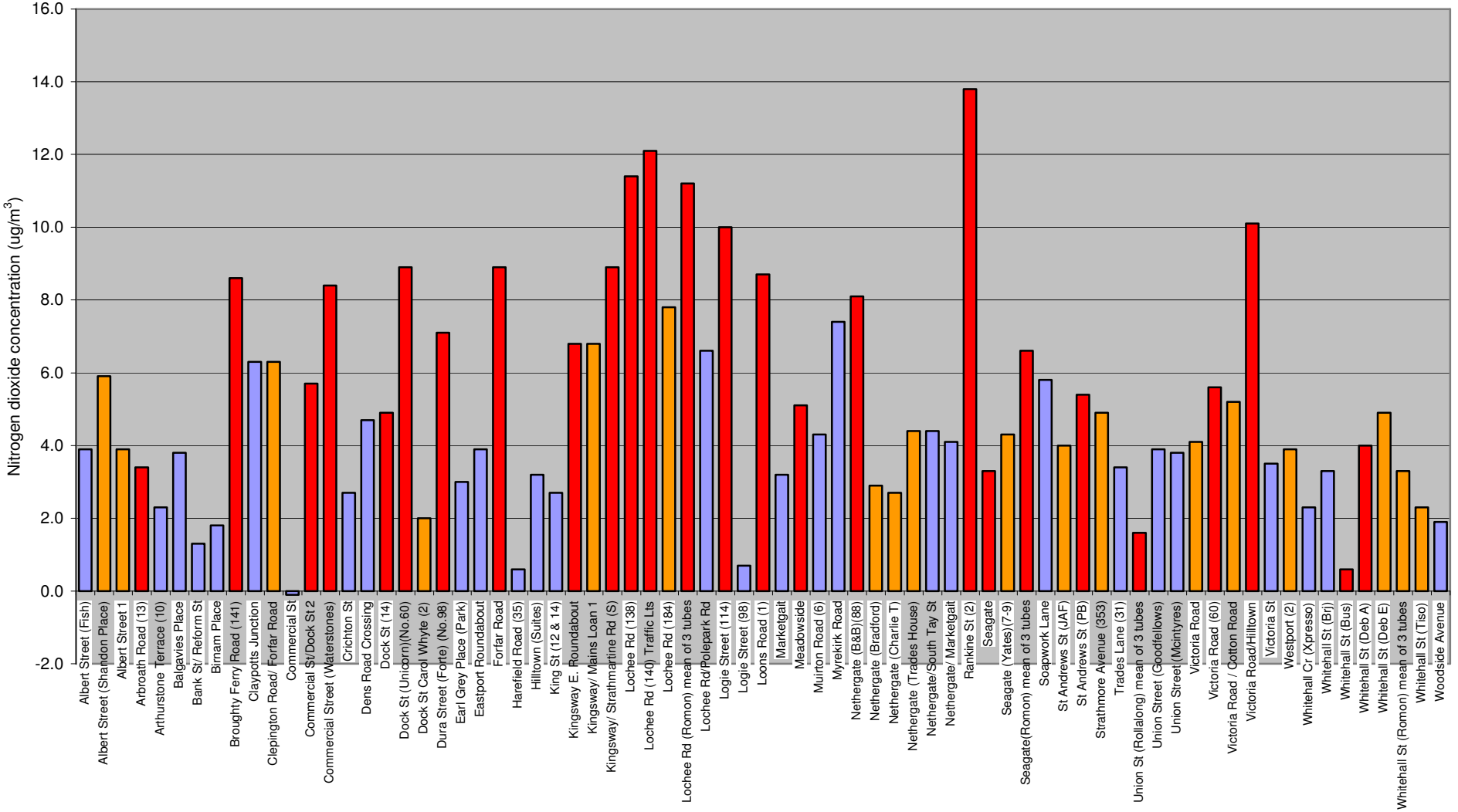


Figure 3.3 Change in Nitrogen Dioxide Diffusion Tube Concentrations between 2006 and 2010 (City Centre)

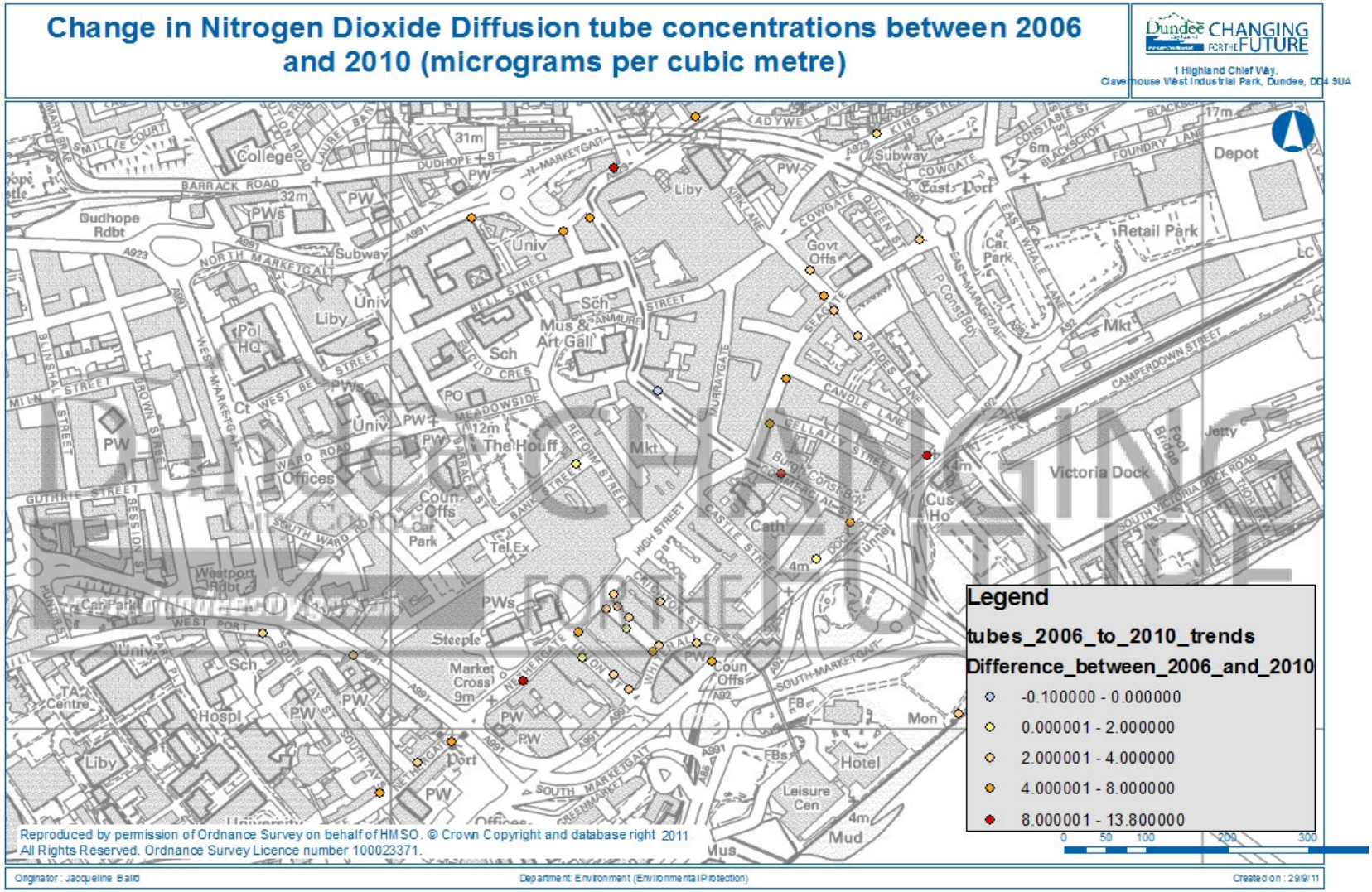
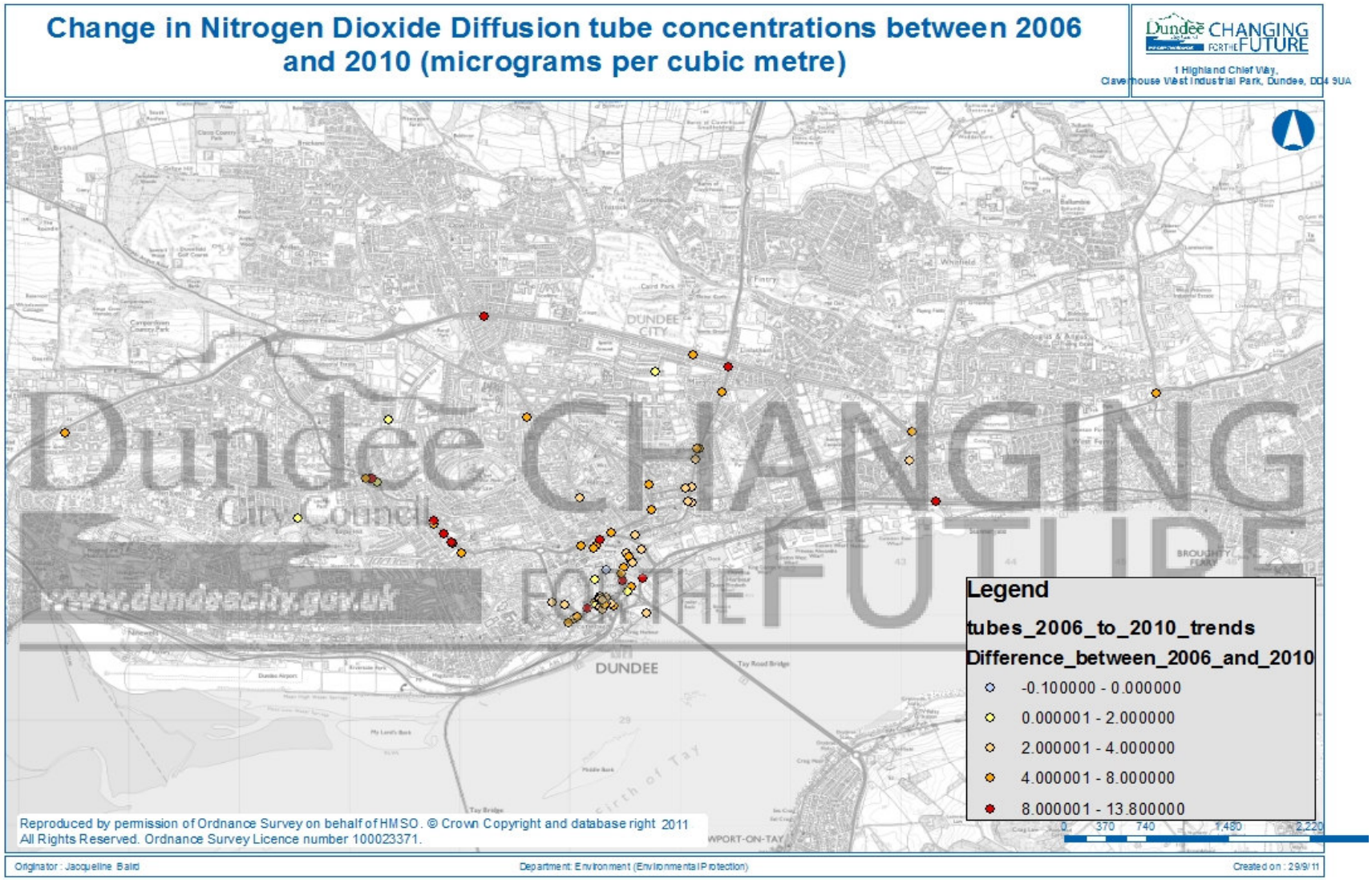


Figure 3.3a Change in Nitrogen Dioxide Diffusion Tube Concentrations between 2006 and 2010 (City-Wide)



3.1.1.1 Trends in Real-time Monitor and Diffusion Tube NO_2 Concentrations at Hotspot Locations

The **Figures 3.4 to 3.28** below show the detailed trends in real-time monitor and bias-corrected diffusion tube NO_2 concentrations between 2006 and 2010 at hotspot locations throughout the city. These include:

- Union Street
- Seagate
- Victoria Rd / Meadowside
- Lochee Road
- Albert St. / Arbroath Rd.
- Main Bus Corridor
- Stannergate Junction
- Whitehall Street
- Nethergate
- Albert St / Dura St.
- Logie St
- Kingsway / Forfar Rd.
- Inner Ring Road

All of these locations have been described previously in the Dundee City Council Progress Report 2007, except for the Stannergate Junction, which is located on one of the main routes into the city from the east, and forms part of the eastern access to the port. It is evident from the figures presented below that NO_2 concentrations are not decreasing across the city and in some cases have shown a considerable increase since the AQMA was declared in 2006.

Union Street & Whitehall Street

Figure 3.4 NO_2 Monitoring Locations in Union Street and Whitehall Street

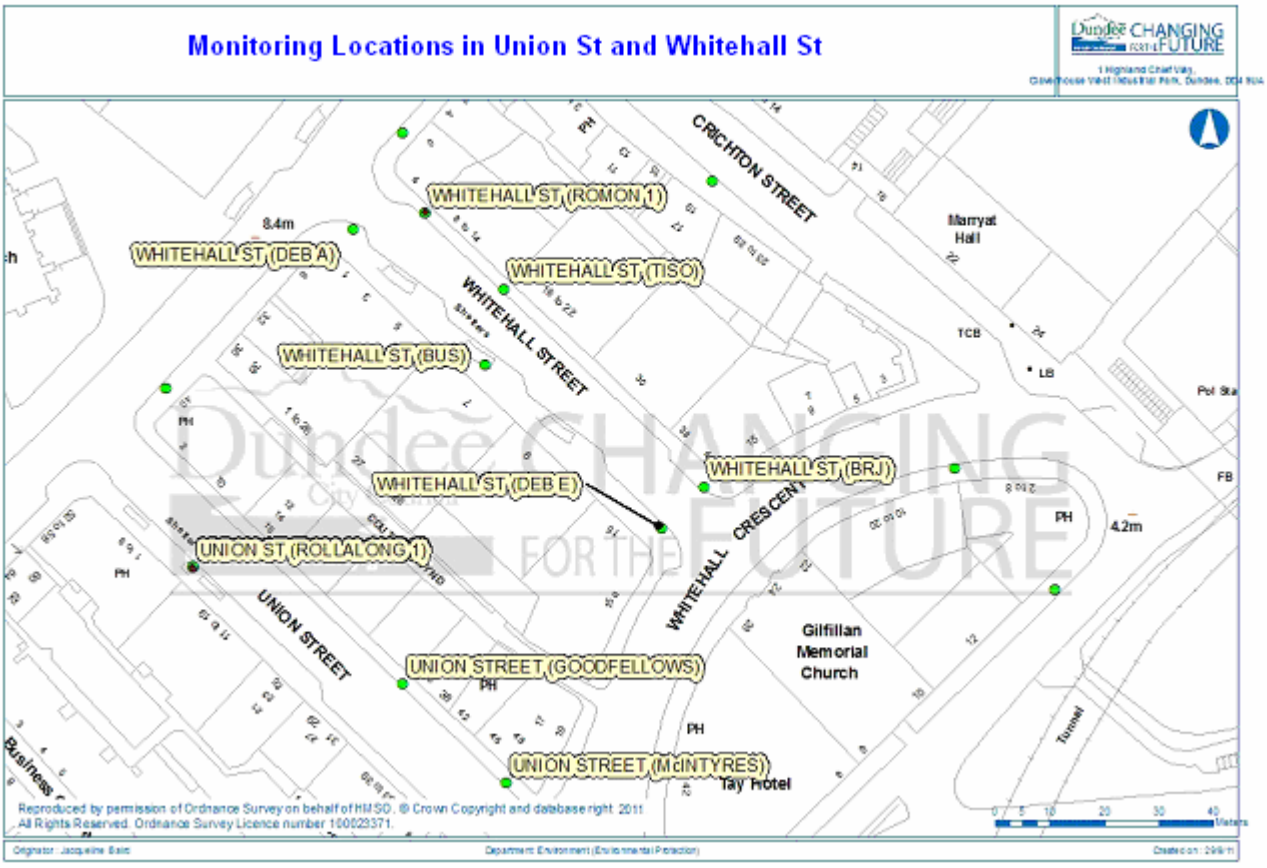


Figure 3.5 Trends in NO_2 Concentrations in Union St.

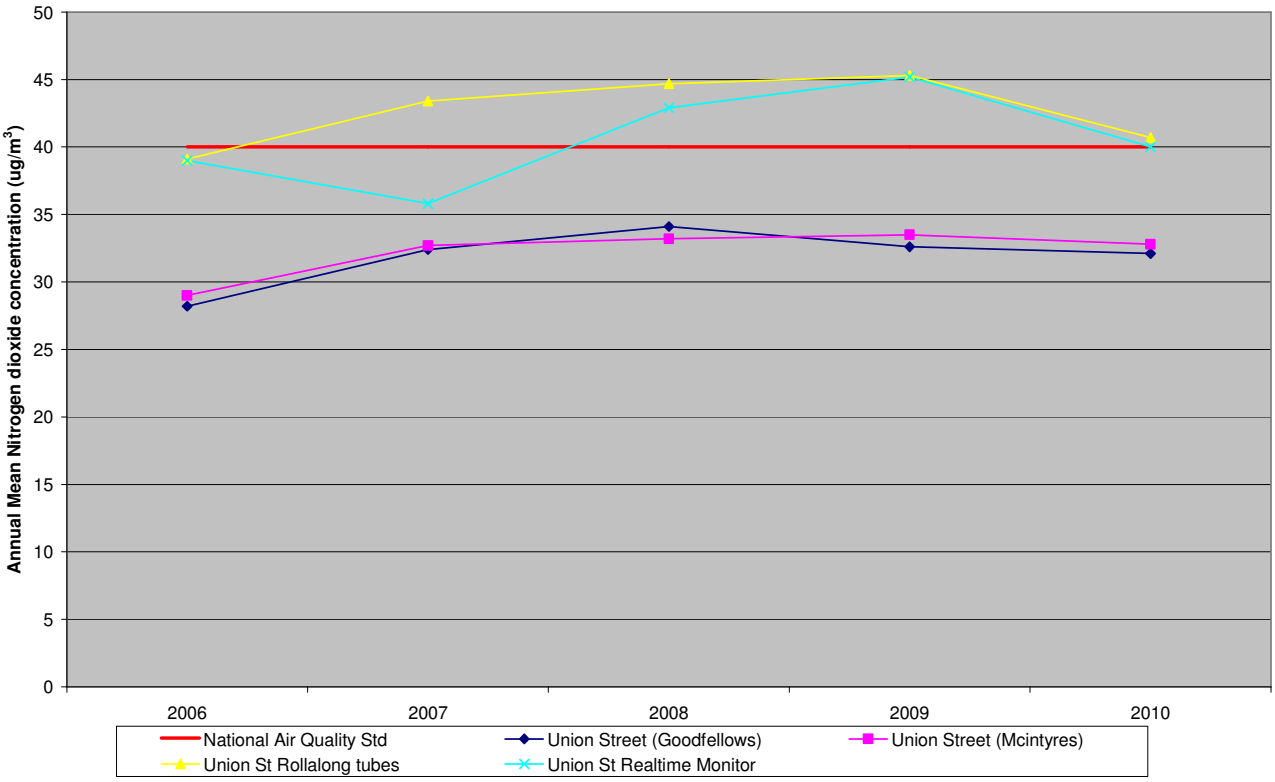
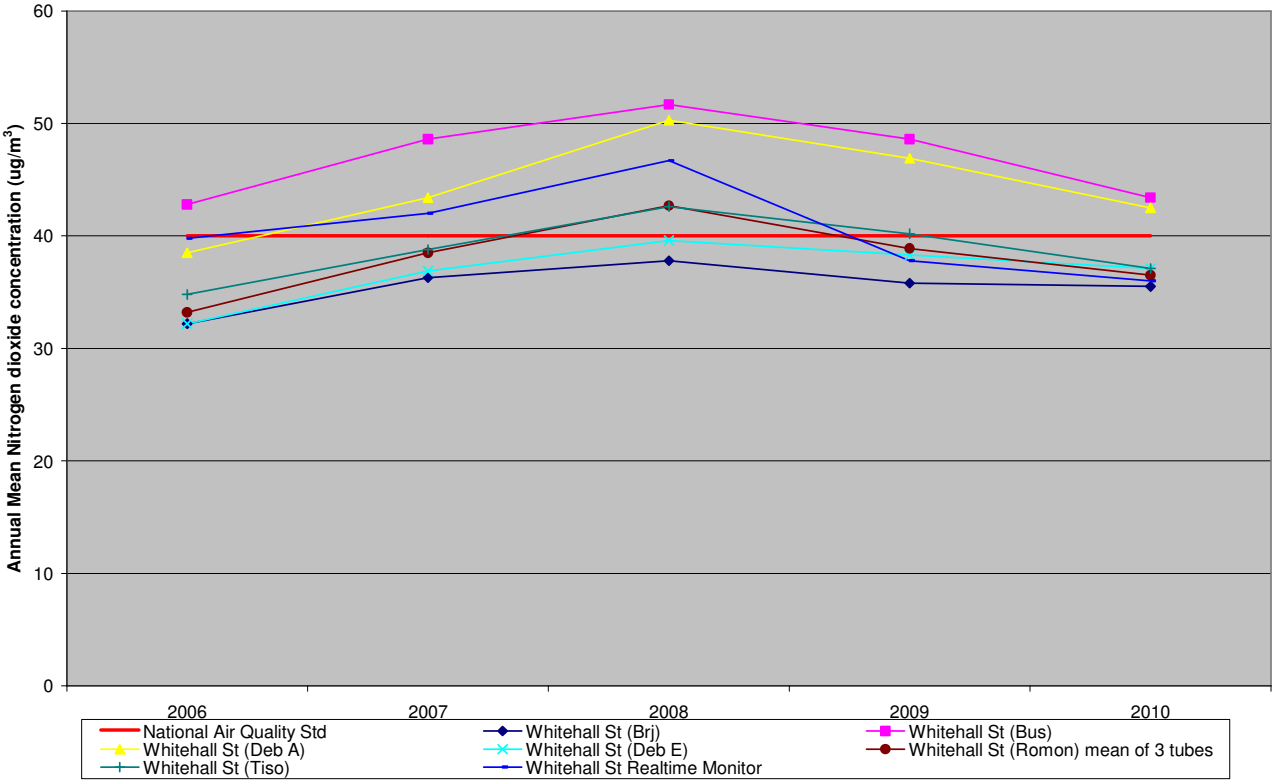


Figure 3.6 Trends in NO_2 Concentrations in Whitehall St.



Seagate

Figure 3.7 NO_2 Monitoring Locations in Seagate

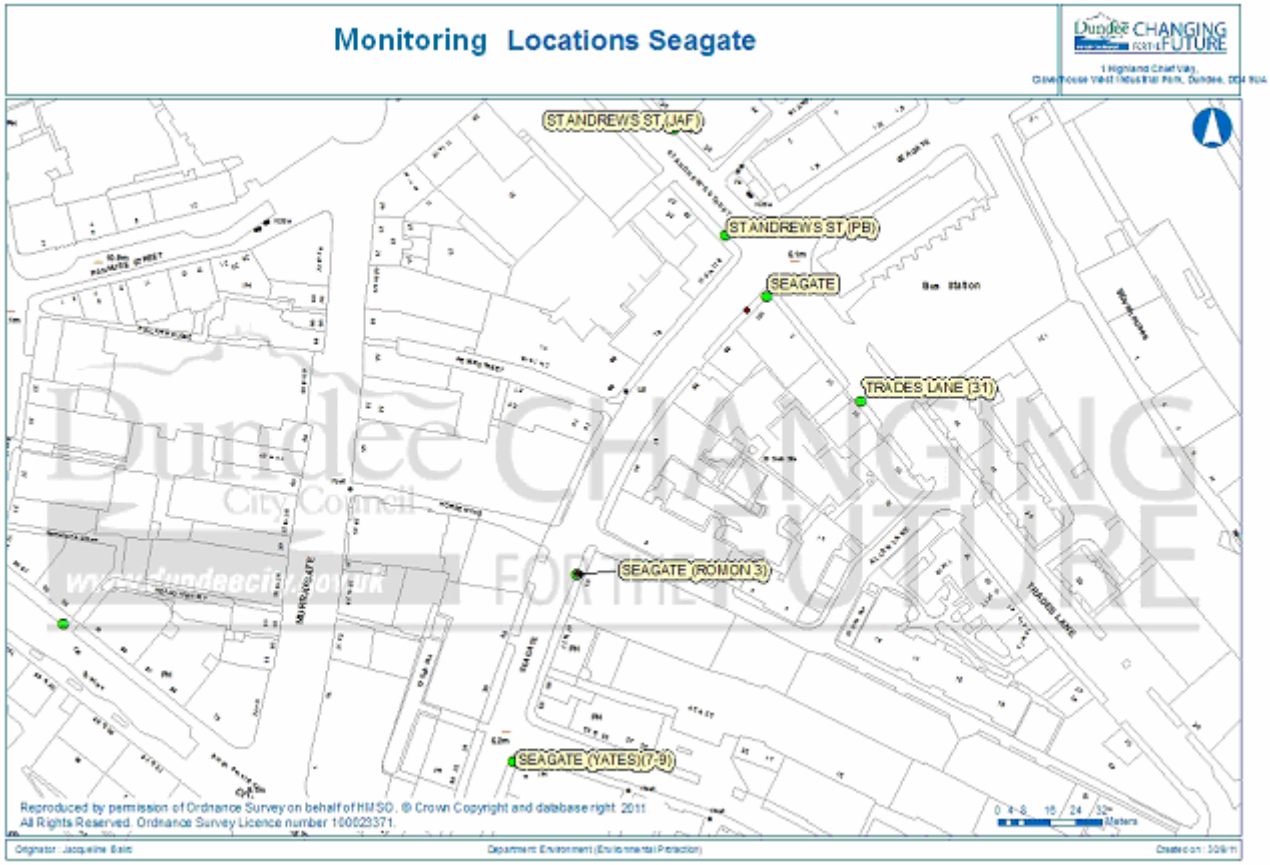
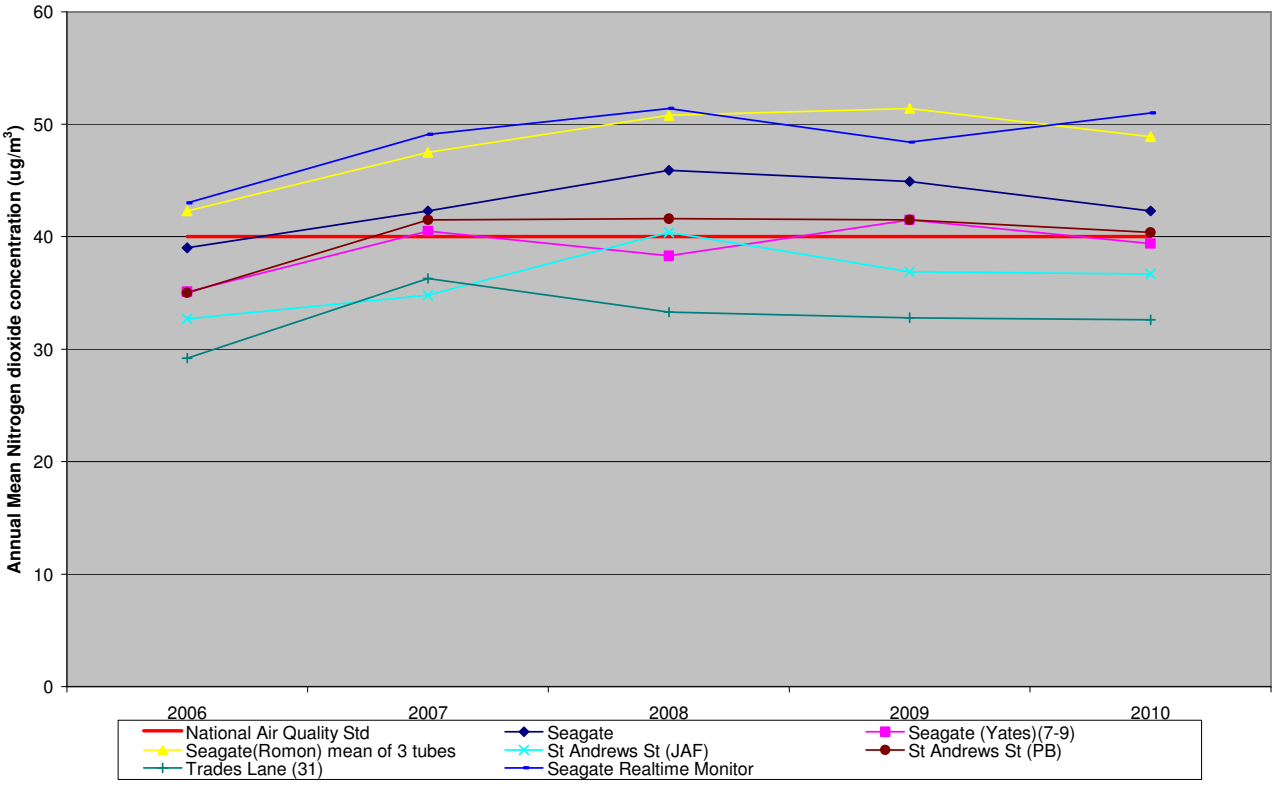


Figure 3.8 Trends in NO_2 Concentrations in Seagate.



Nethergate

Figure 3.9 NO_2 Diffusion Tube Locations in Nethergate

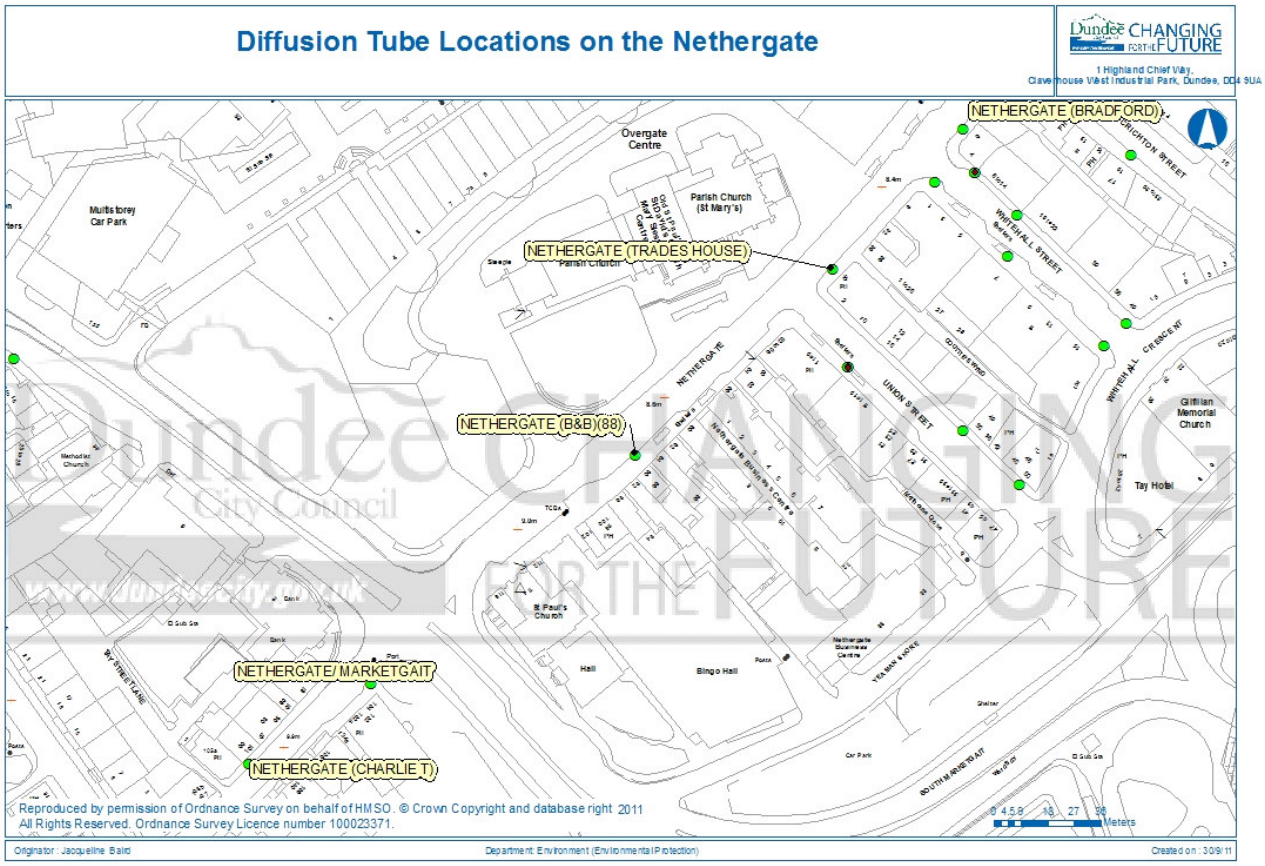
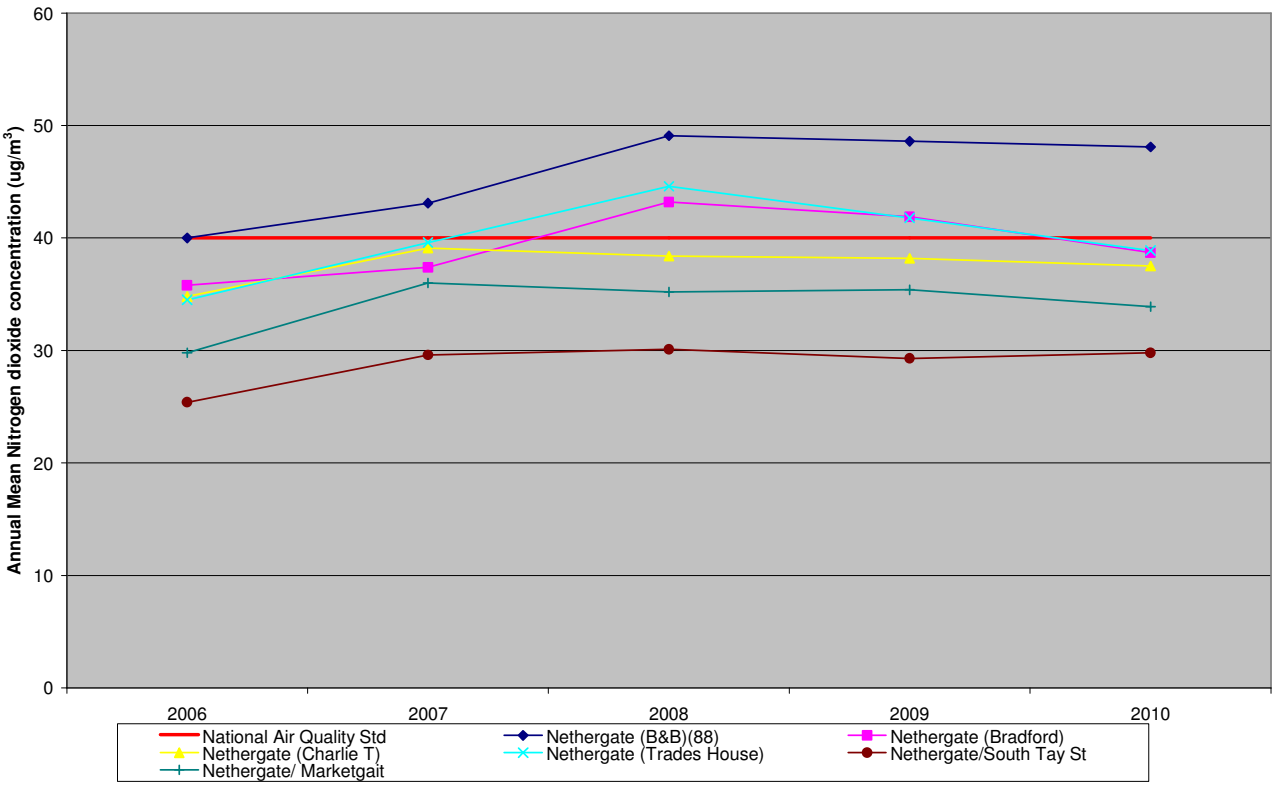


Figure 3.10 Trends in NO_2 Diffusion Tube Concentrations in Nethergate.



Victoria Road / Meadowside

Figure 3.11 NO_2 Diffusion Tube Locations in Victoria Road / Meadowside

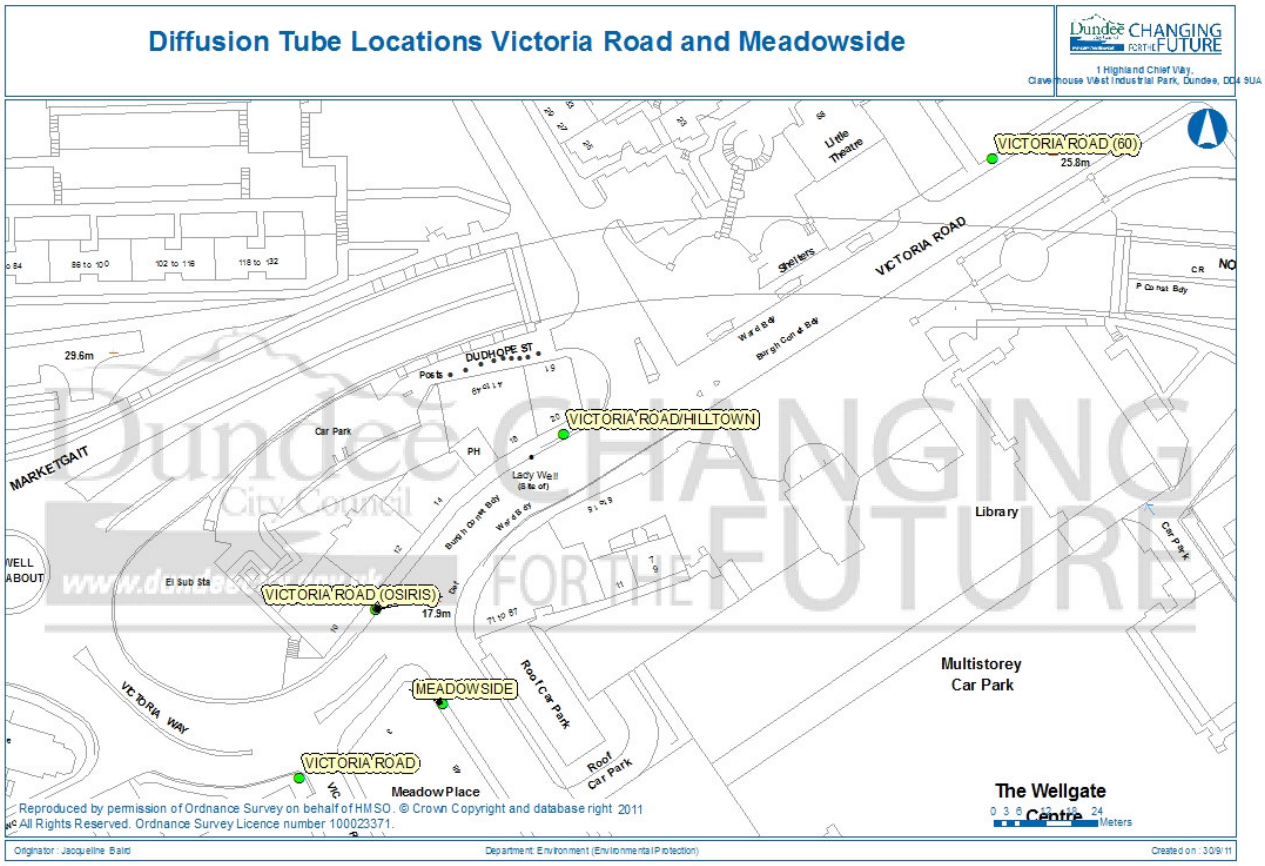
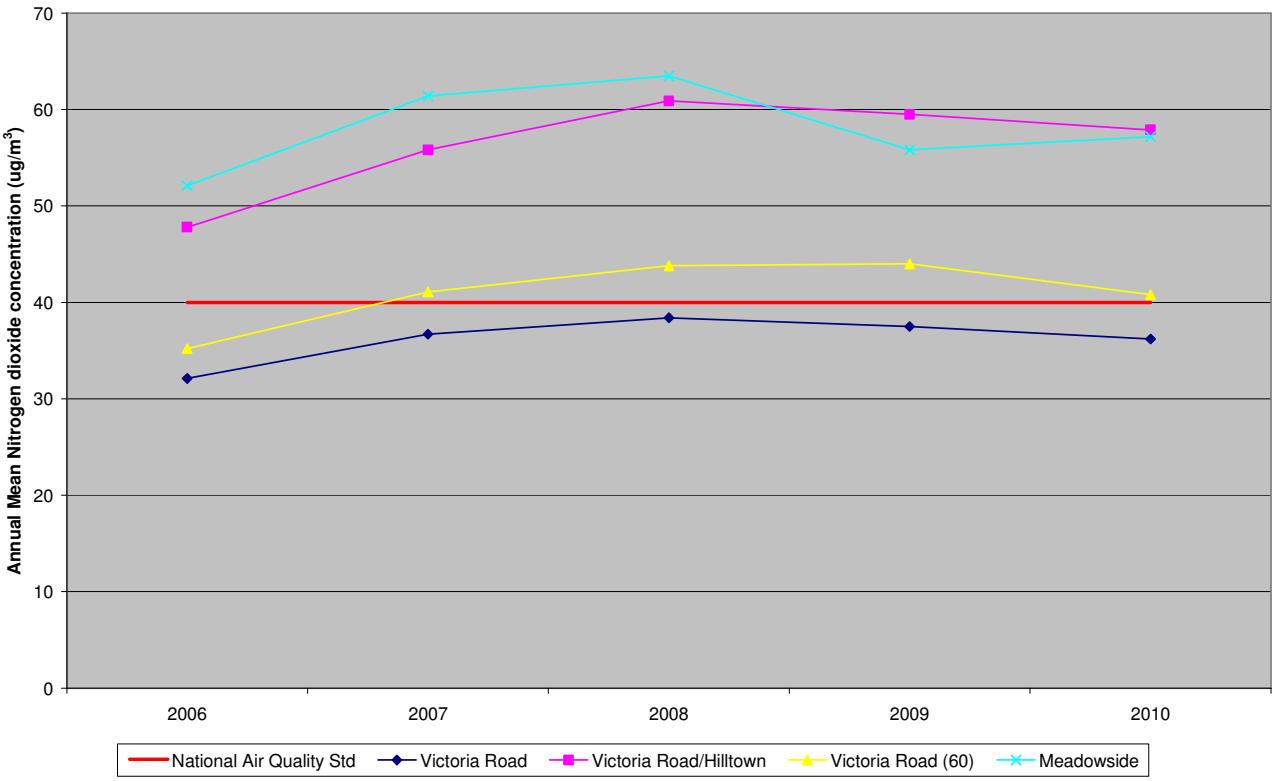


Figure 3.12 Trends in NO_2 Diffusion Tube Concentrations in Victoria Road / Meadowside.



Albert Street / Dura Street

Figure 3.13 NO_2 Diffusion Tube Locations in Albert Street / Dura Street

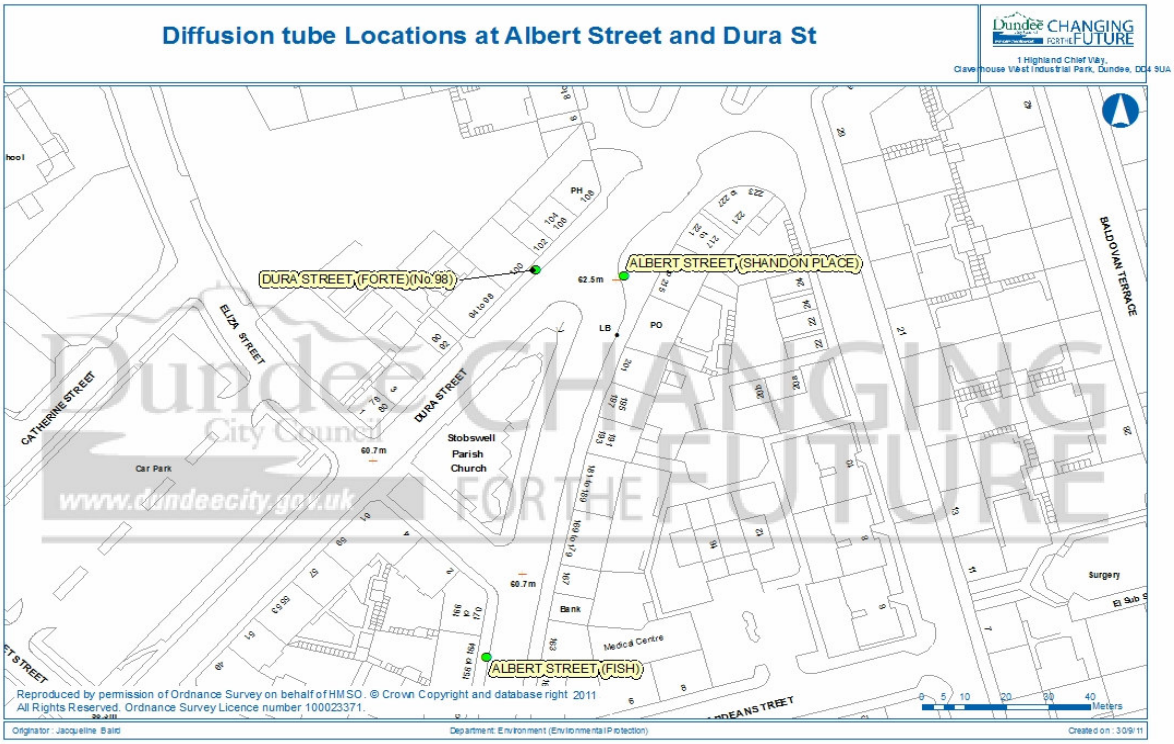
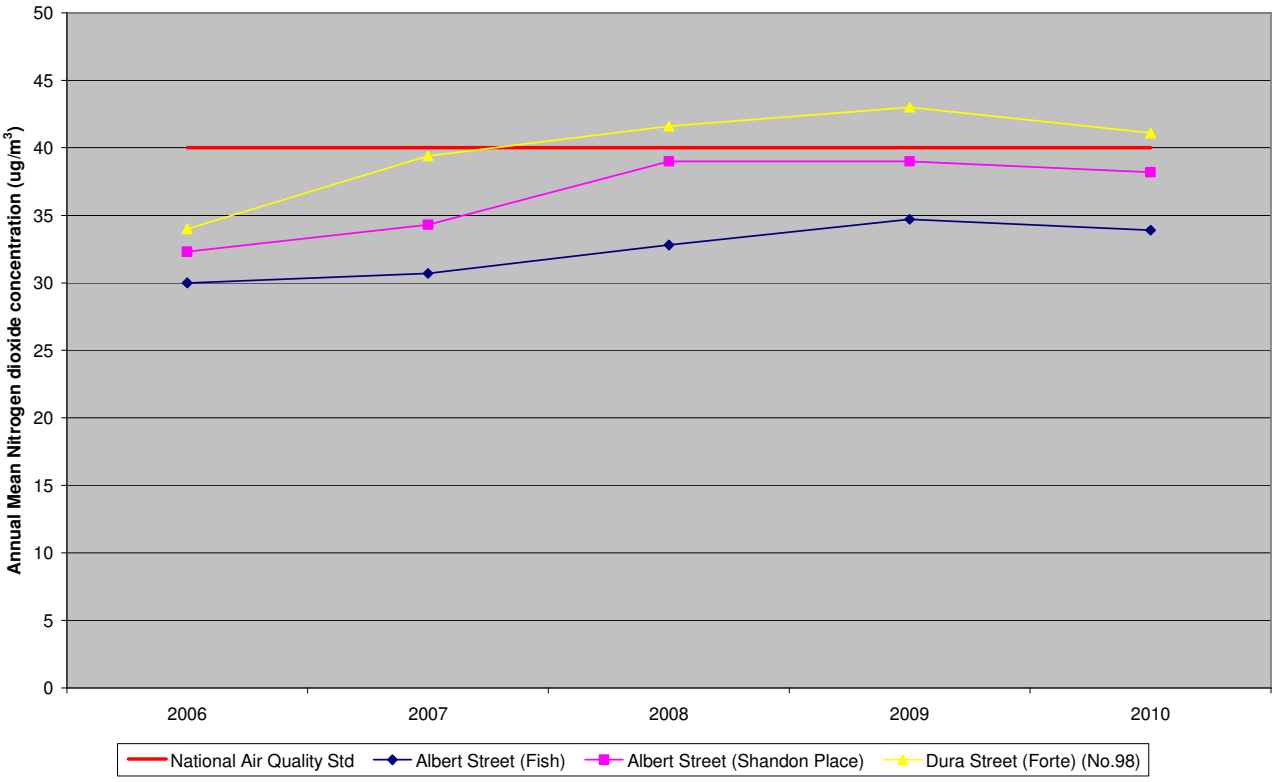


Figure 3.14 Trends in NO_2 Diffusion Tube Concentrations in Albert Street / Dura Street.



Lochee Road

Figure 3.15 NO_2 Monitoring Locations in Lochee Road

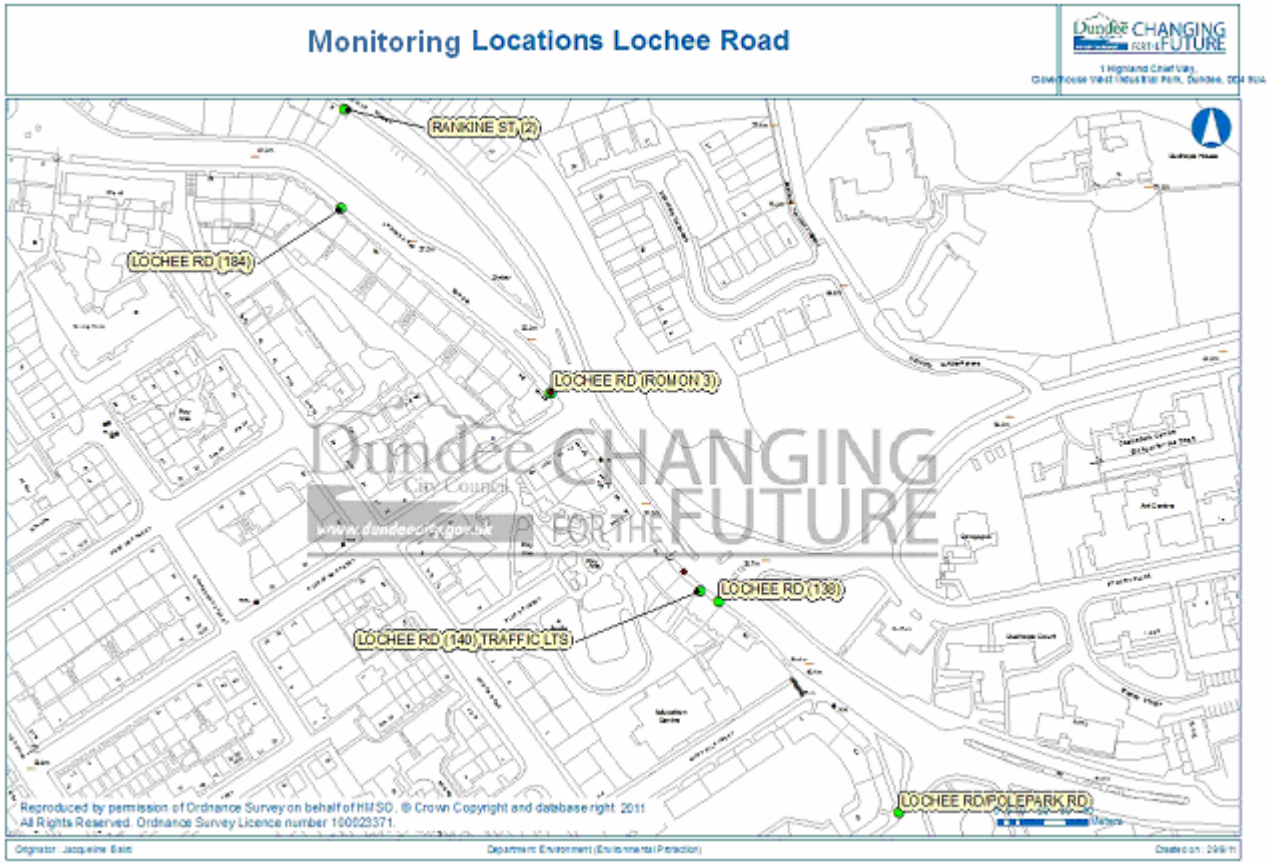
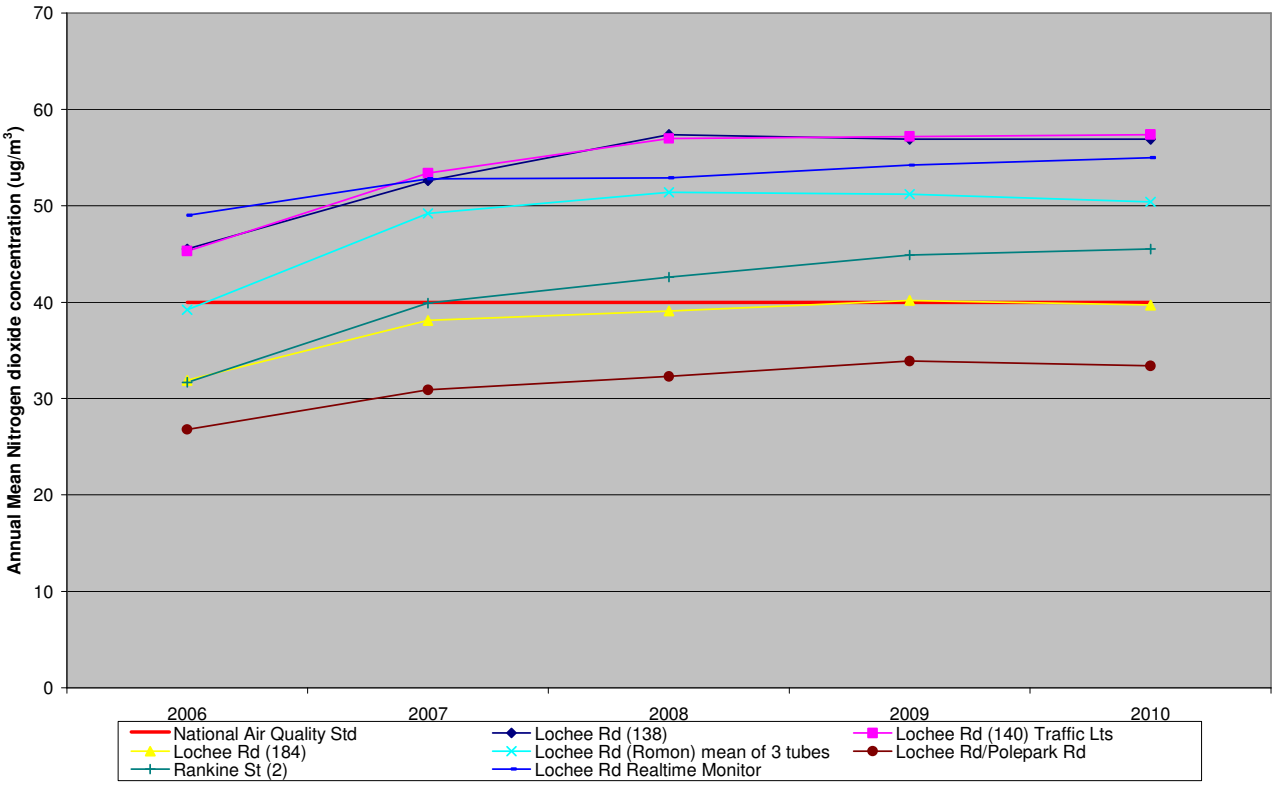


Figure 3.16 Trends in NO_2 Concentrations in Lochee Road



Logie Street

Figure 3.17 NO_2 Diffusion Tube Locations in Logie Street

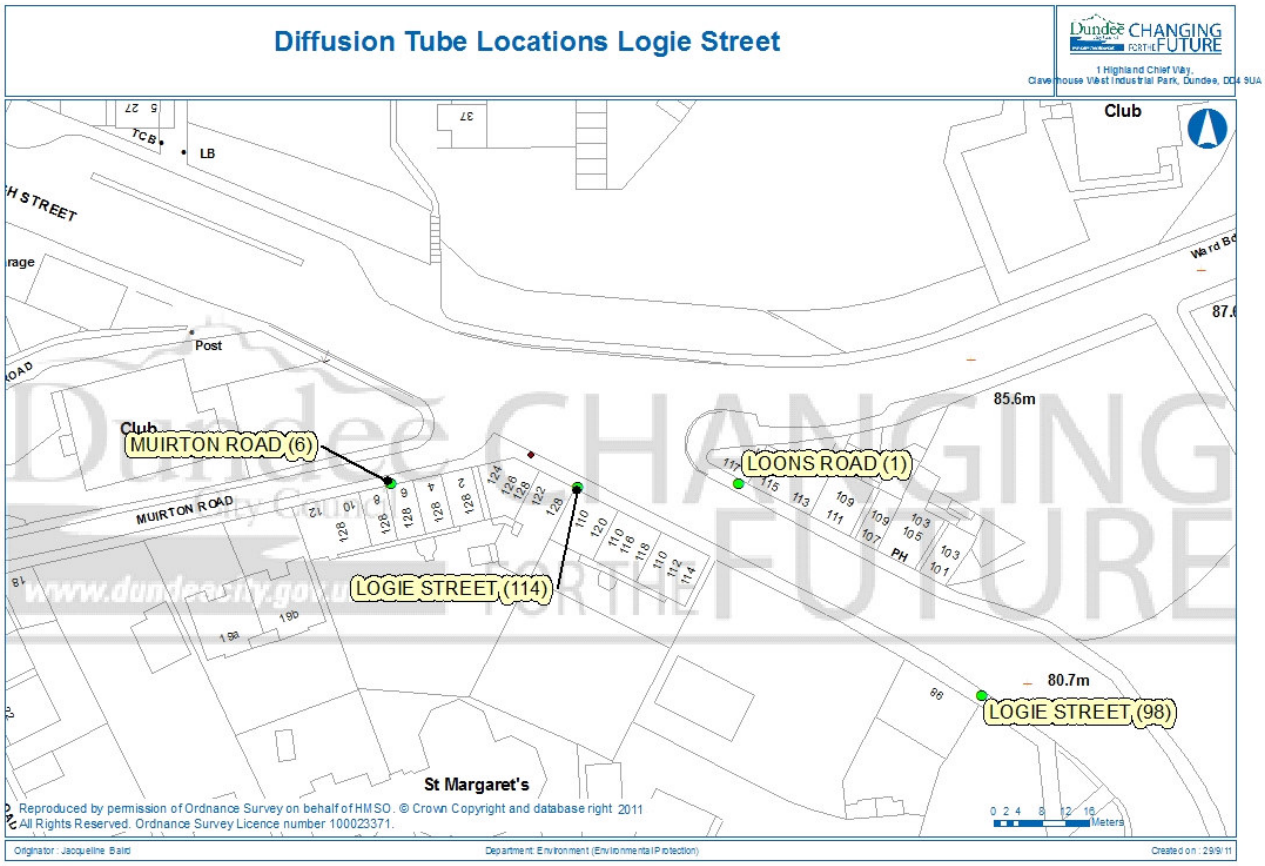
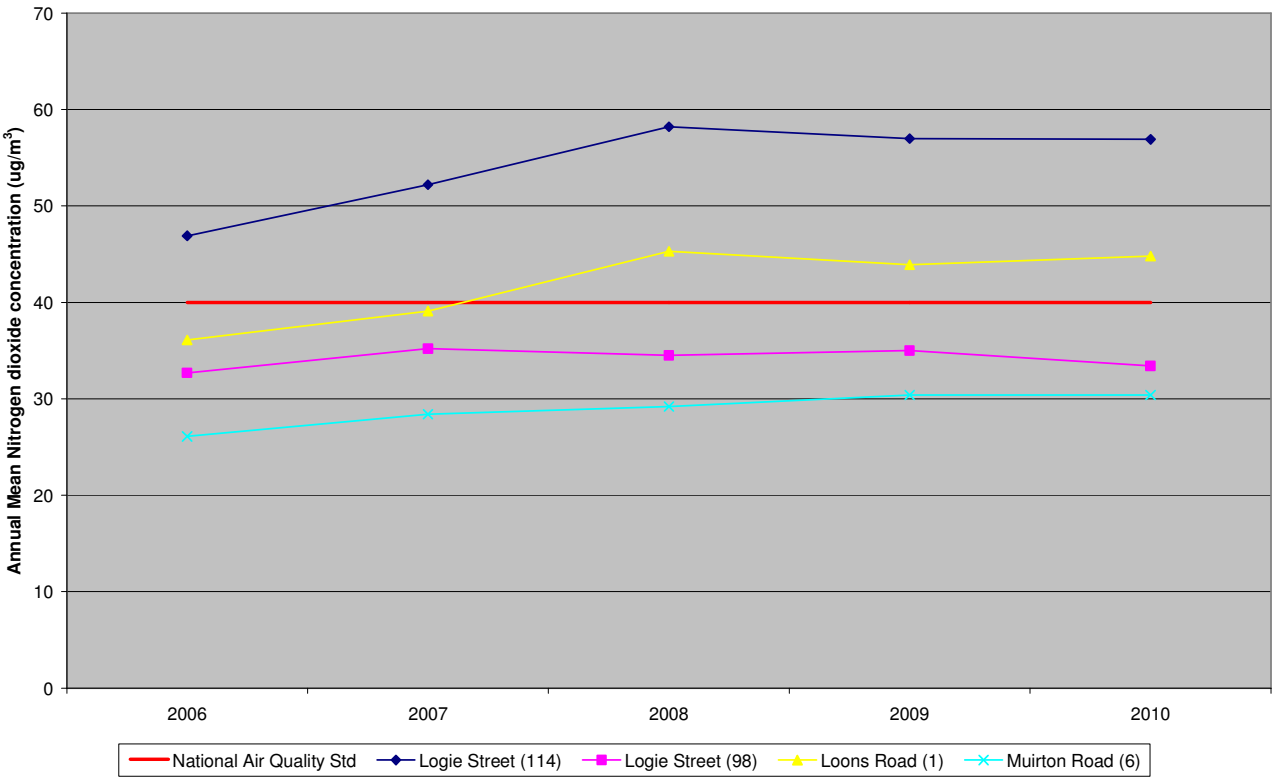


Figure 3.18 Trends in NO_2 Diffusion Tube Concentrations in Logie St.



Albert Street / Arbroath Road

Figure 3.19 NO_2 Diffusion Tube Locations in Albert St. / Arbroath Road

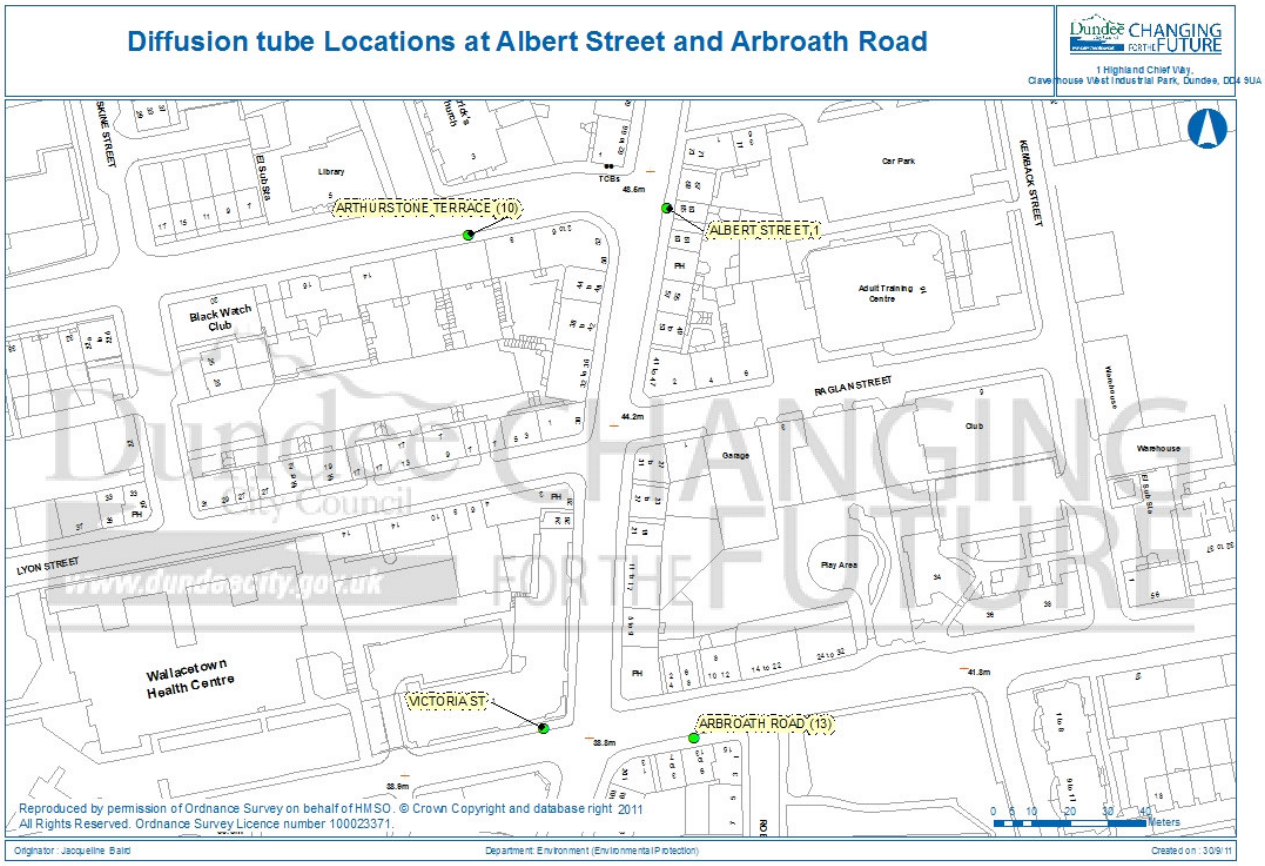
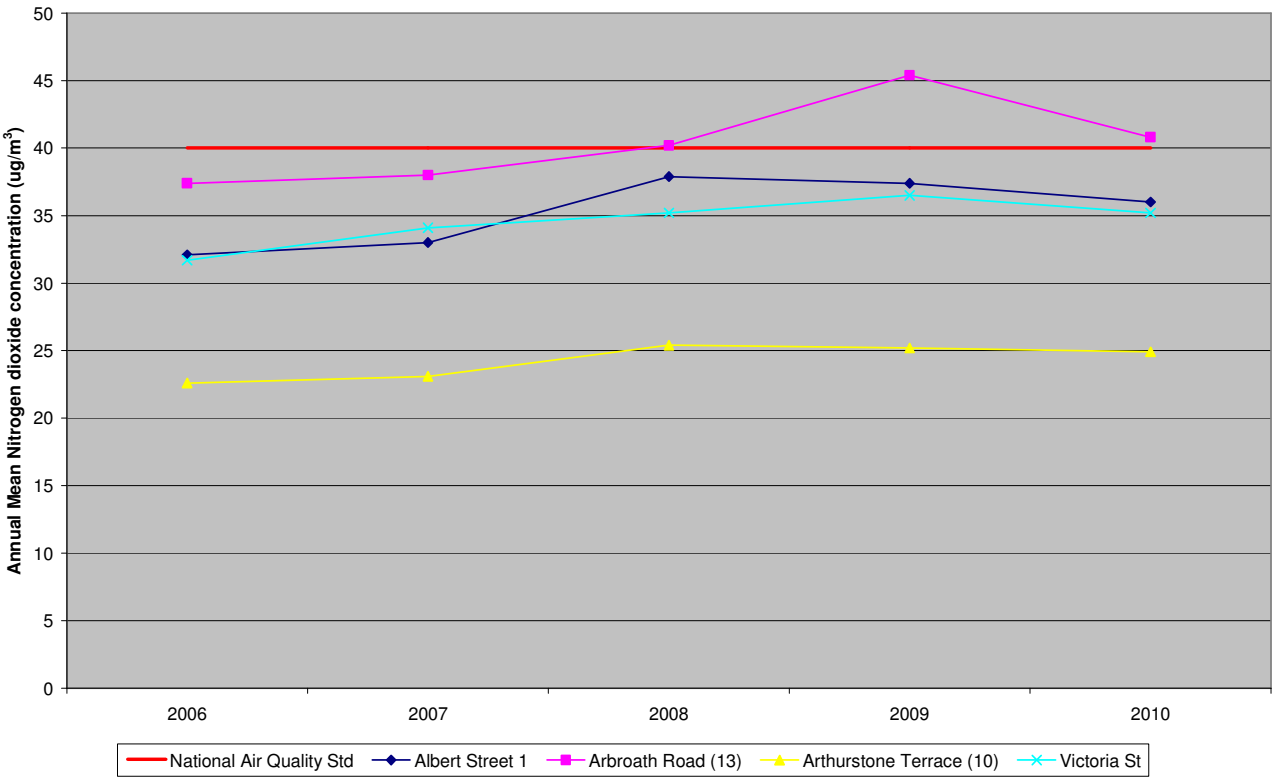


Figure 3.20 Trends in NO_2 Diffusion Tube Concentrations in Albert St. / Arbroath Road



Kingsway / Forfar Road.

Figure 3.21 NO_2 Diffusion Tube Locations on/near the Kingsway

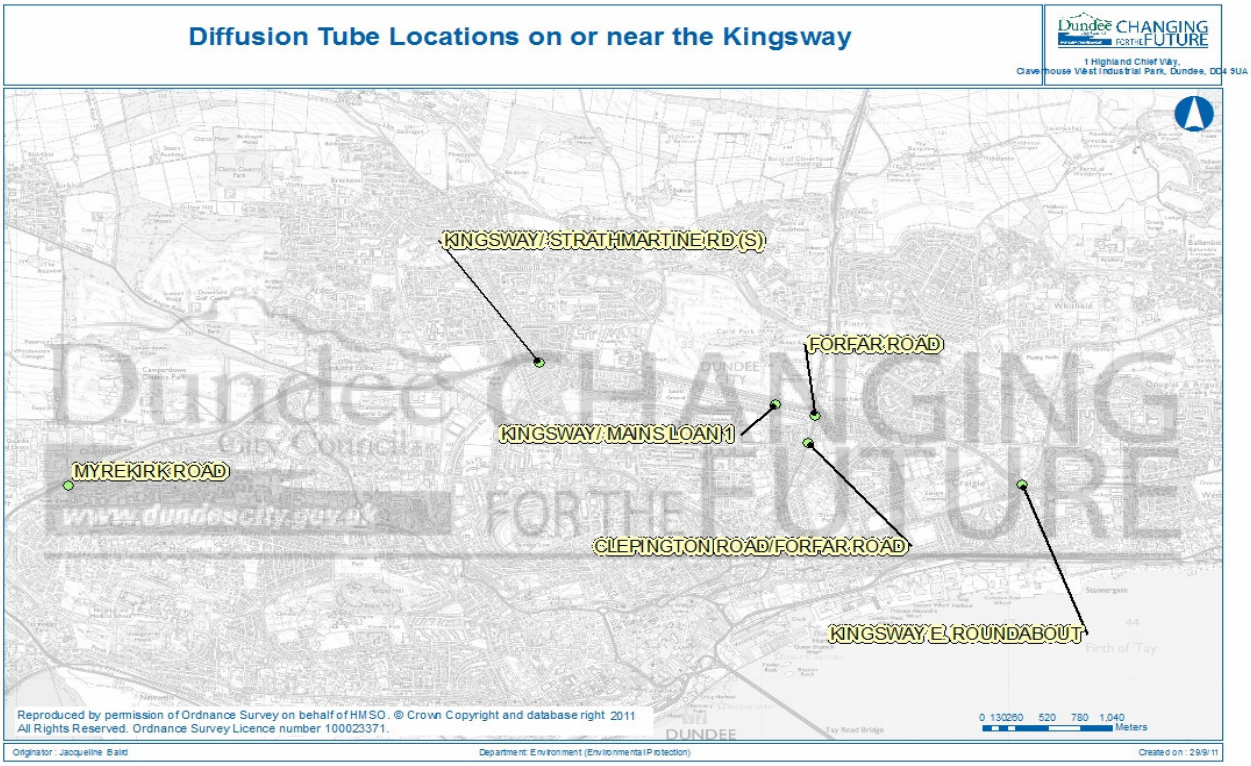
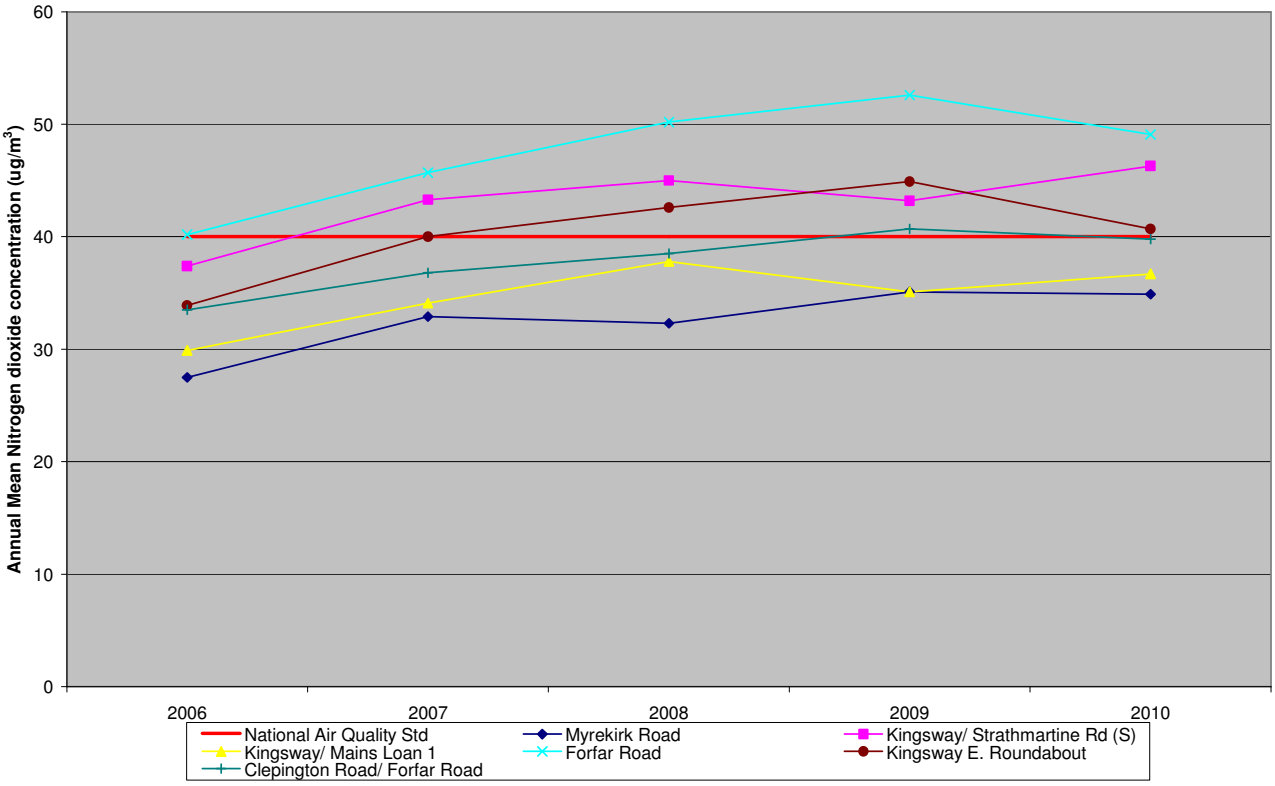


Figure 3.22 Trends in NO_2 Diffusion Tube Concentrations on/near the Kingsway



Bus Corridor

Figure 3.23 NO_2 Diffusion Tube Locations on Bus Corridor

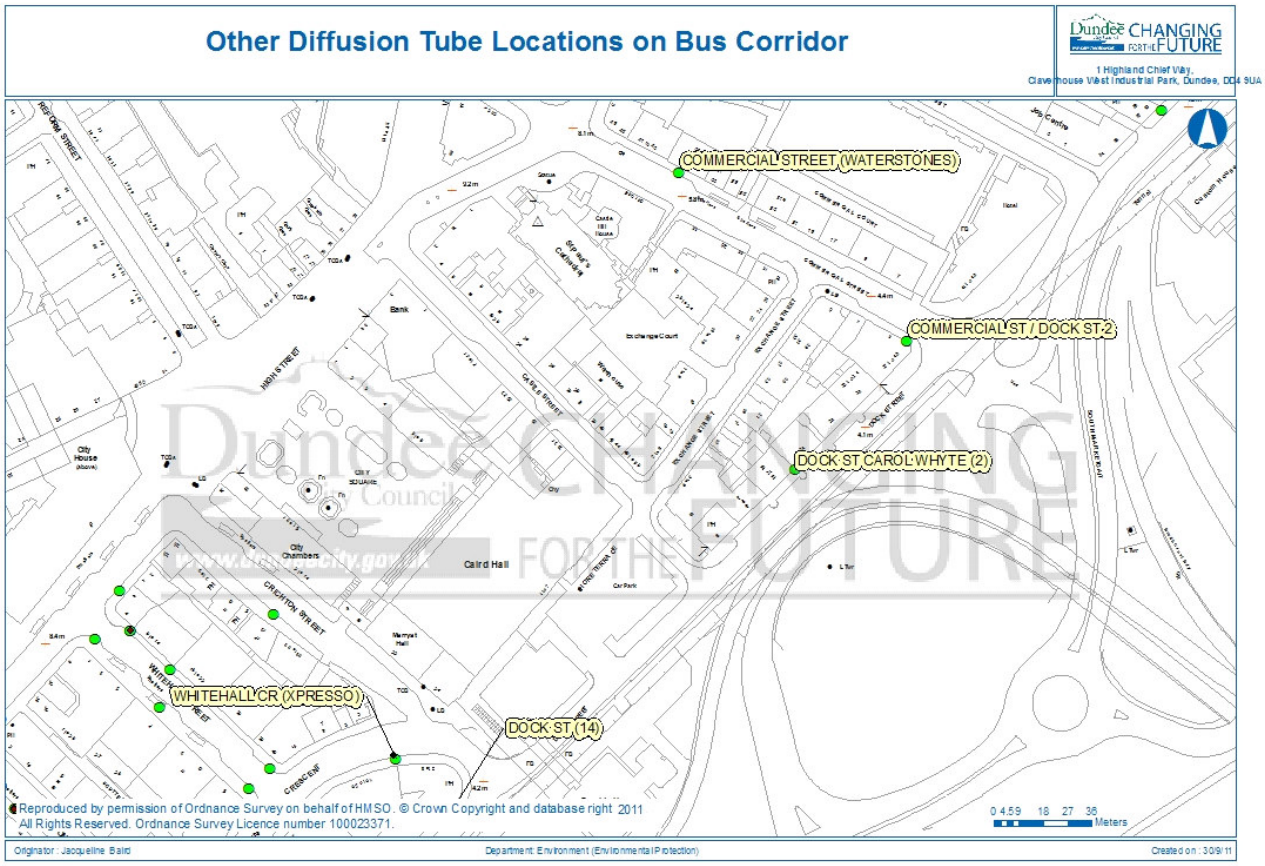
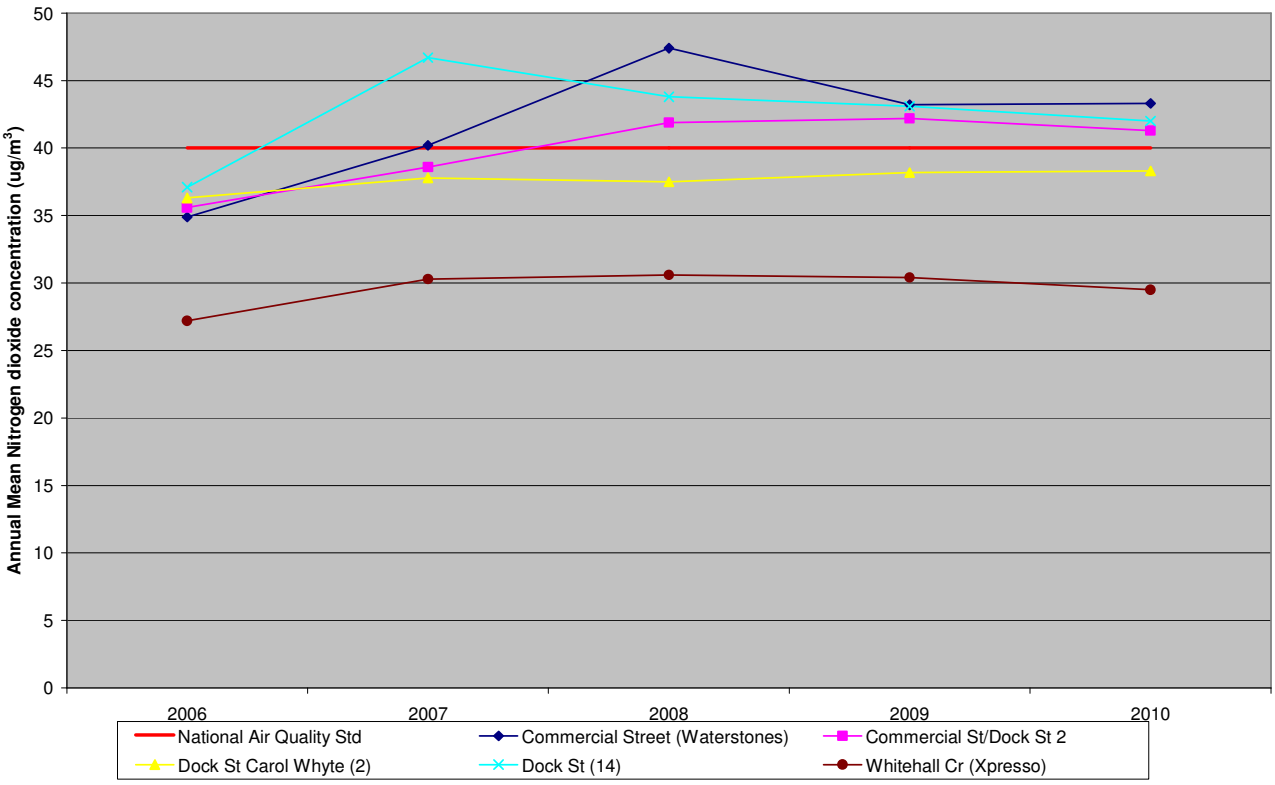


Figure 3.24 Trends in NO_2 Diffusion Tube Concentrations on Bus Corridor



Inner Ring Road

Figure 3.25 NO_2 Diffusion Tube Locations on Inner Ring Road

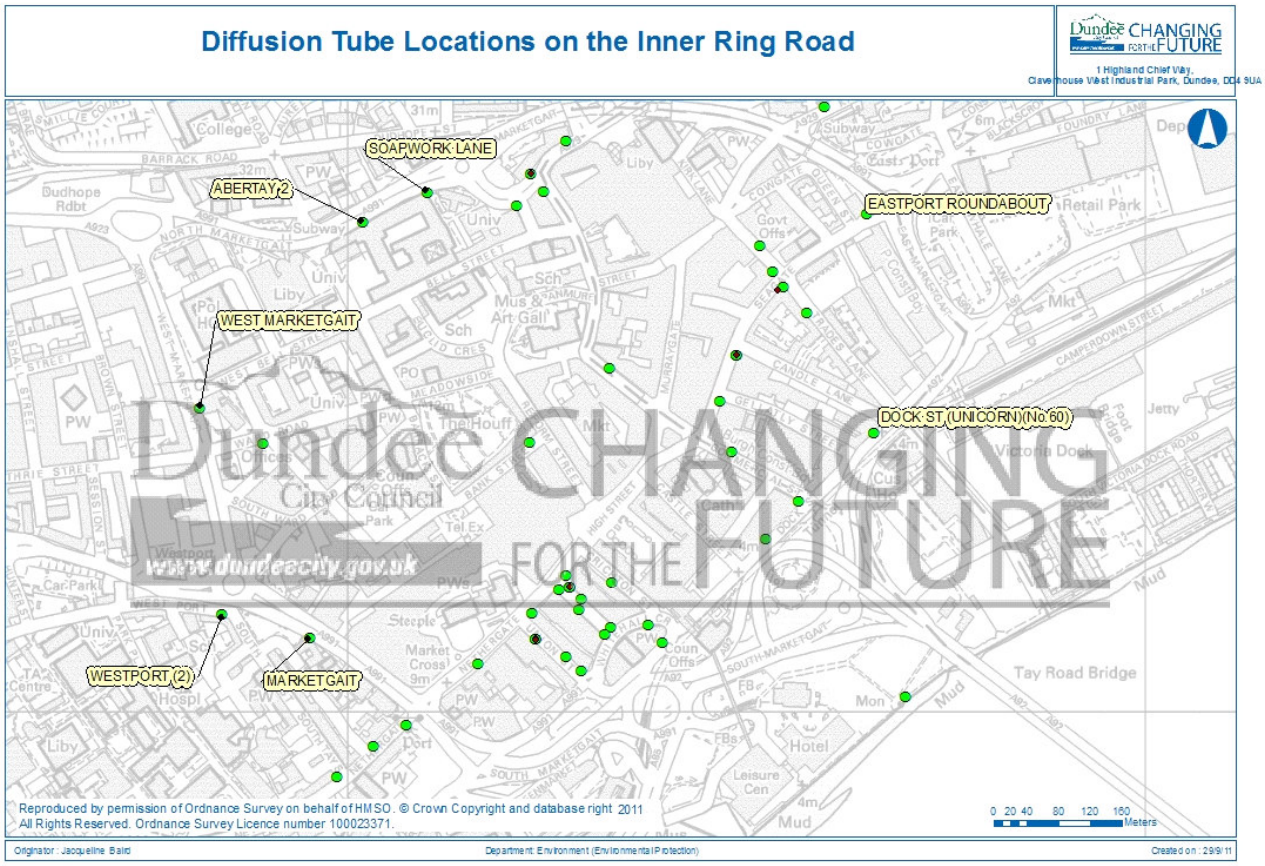
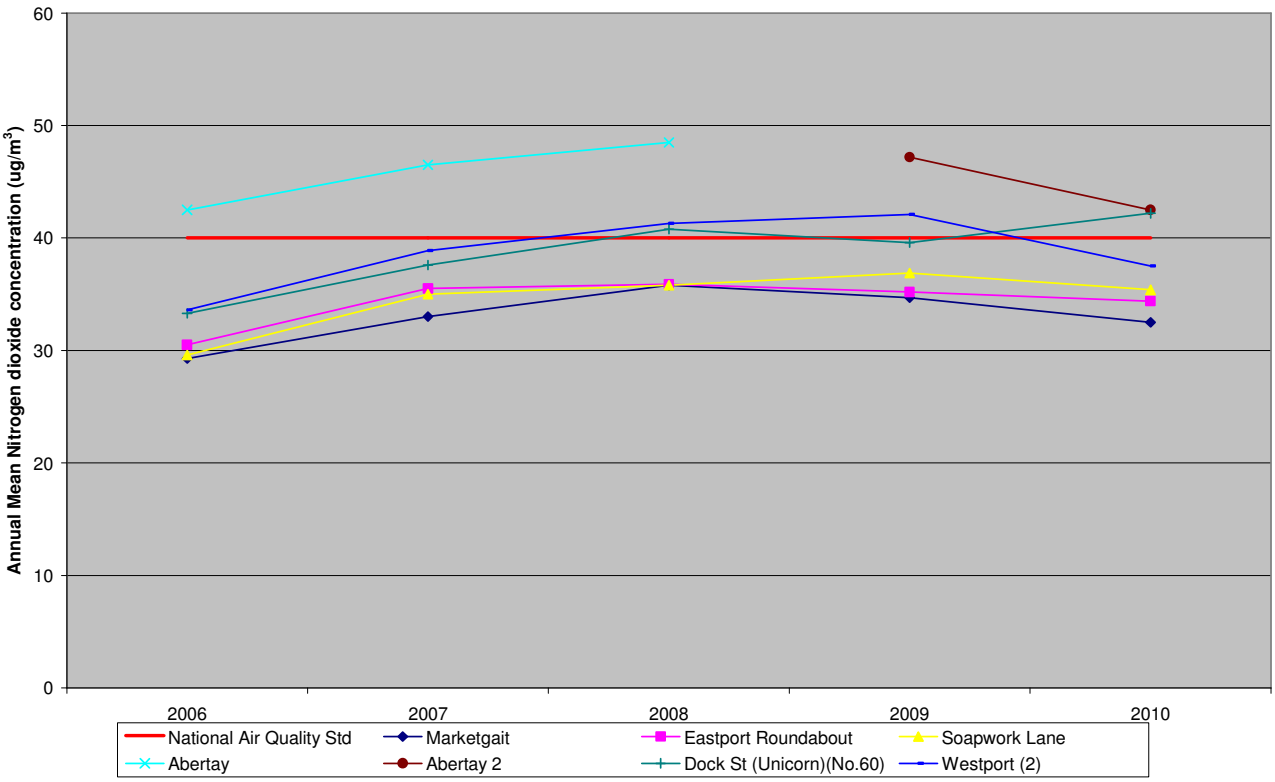


Figure 3.26 Trends in NO_2 Diffusion Tube Concentrations on Inner Ring Road



Stannergate Junction

Figure 3.27 NO_2 Diffusion Tube Location at Stannergate Junction 2010

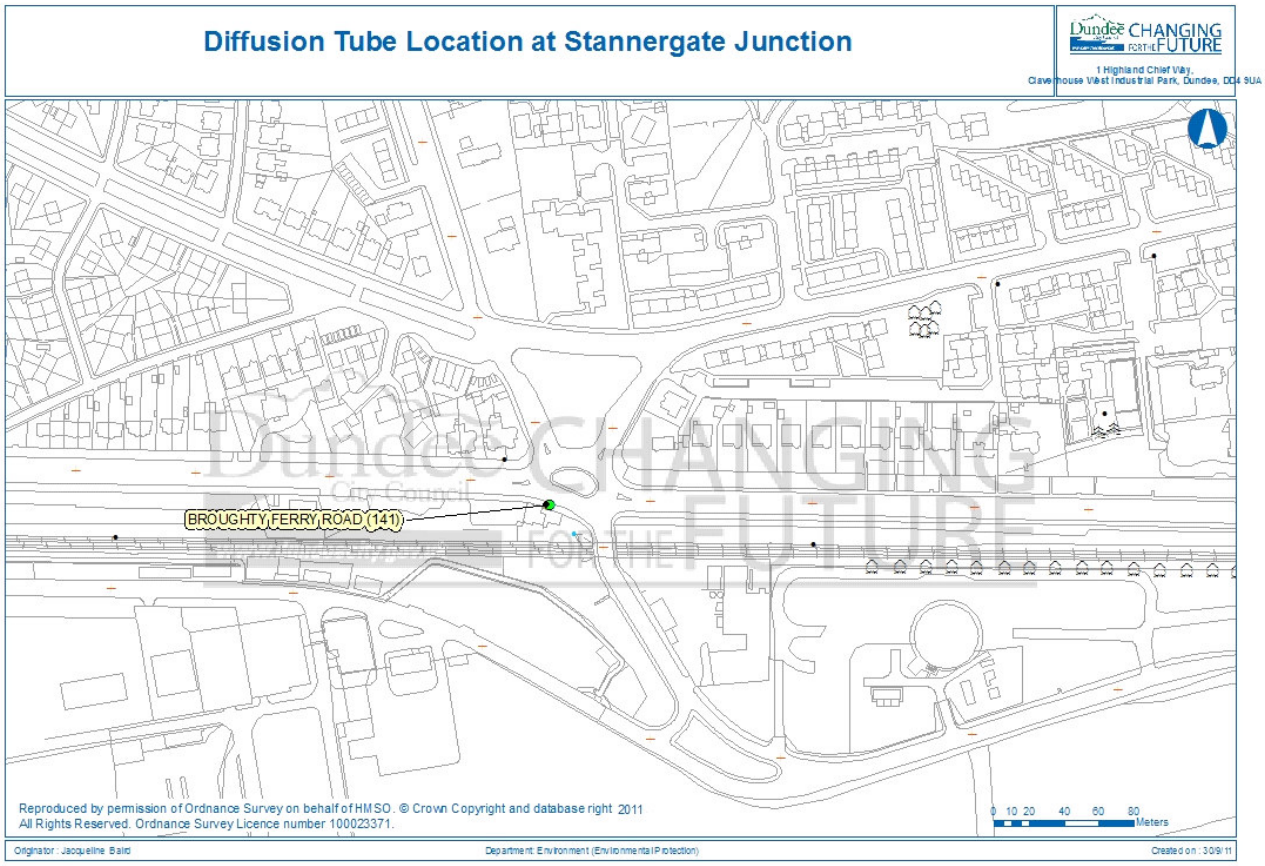
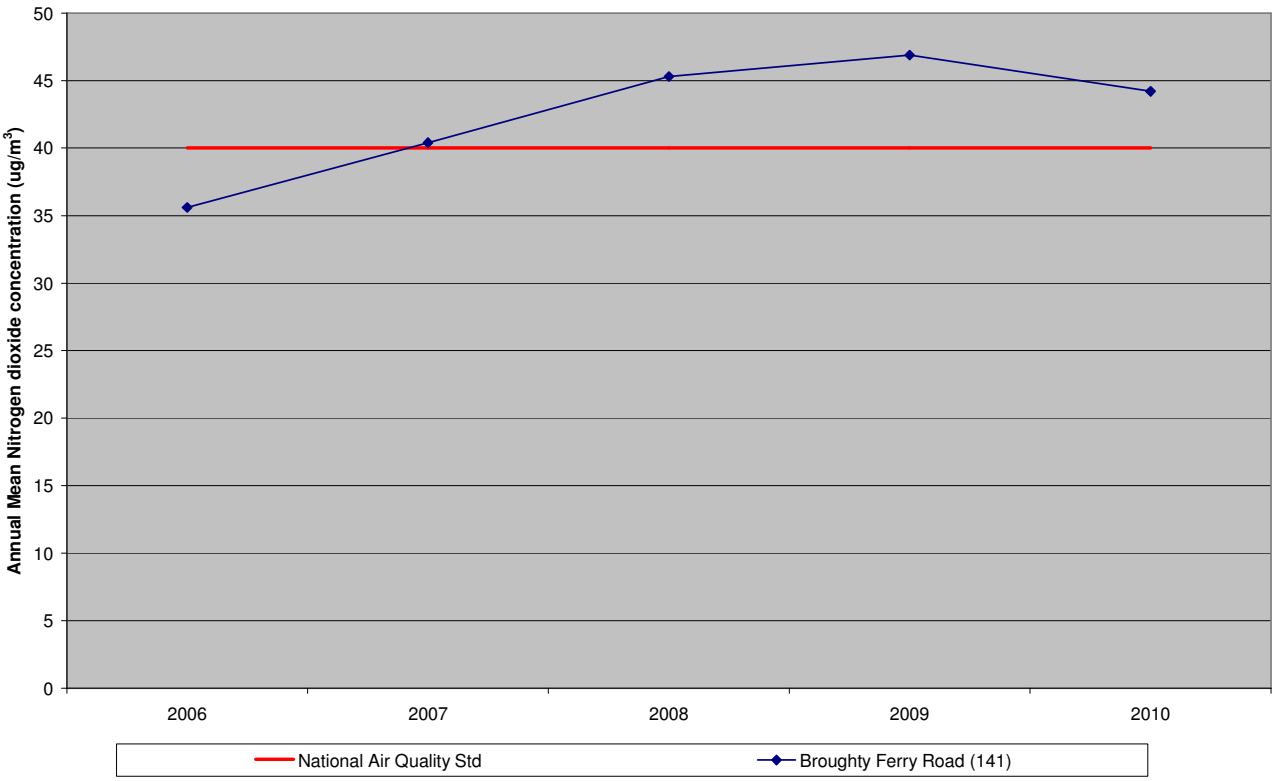


Figure 3.28 Trends in NO_2 Diffusion Tube Concentration at Stannergate Junction



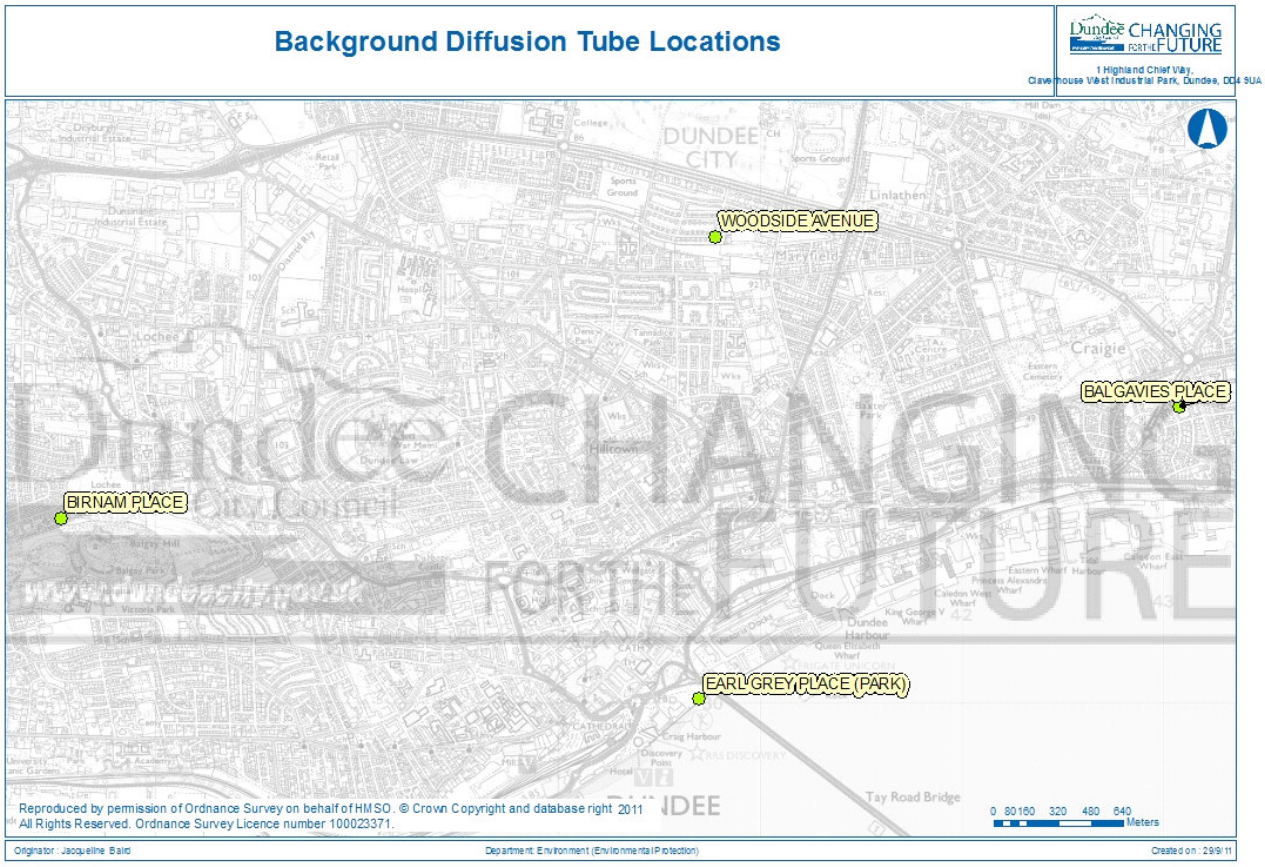
3.1.1.2 Trends in NO_2 Diffusion Tube Concentrations at Urban Background Locations

Dundee City Council operated 4 urban background diffusion tube sites, these are shown in **Figure 3.29**. The 2010 NO_2 annual mean diffusion tube concentrations at urban background sites were generally in good agreement with the Scottish Government modelled background pollutant concentration (1km x 1km) maps[2] (see **Table 3.1**).

Table 3.1 Comparison of Measured Background NO_2 Results for 2010 with Scottish Government Background Map Data

Location	Grid Square	Measured Annual Mean (bias 0.79) (µg/m^3)	Scottish Government Mapped Concentration (µg/m^3)
Birnam Place	337500 : 730500	11.4	13.5
Woodside Avenue	340500 : 732500	17.5	19.2
Balgavies Place	343500 : 731500	19.1	17.1
Earl Grey Place	340500 : 730500	23.2	23.3

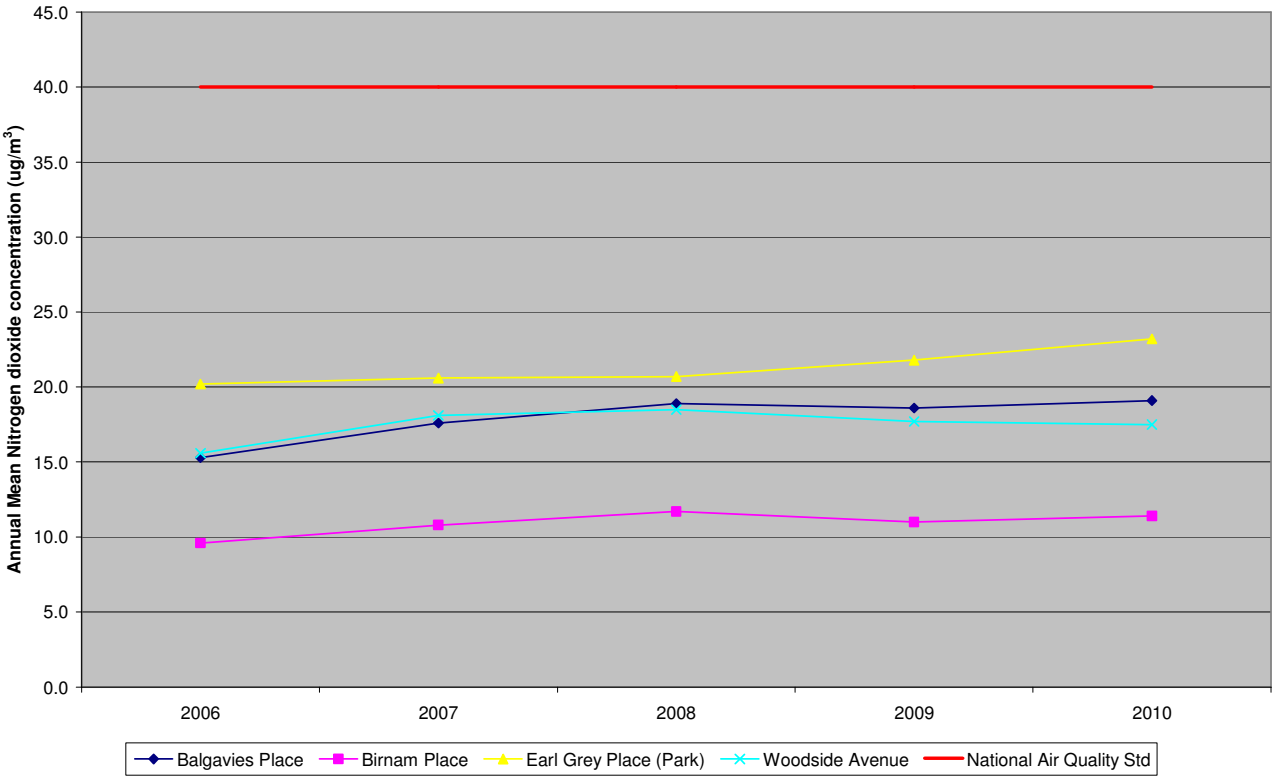
Figure 3.29 Urban Background NO_2 Diffusion Tube Locations 2010



NO_2 concentrations at urban background locations have increased at all sites over the past 5 years. This is illustrated in **Figure 3.30**.

[2] http://www.scottishairquality.co.uk/maps.php?n_action=data

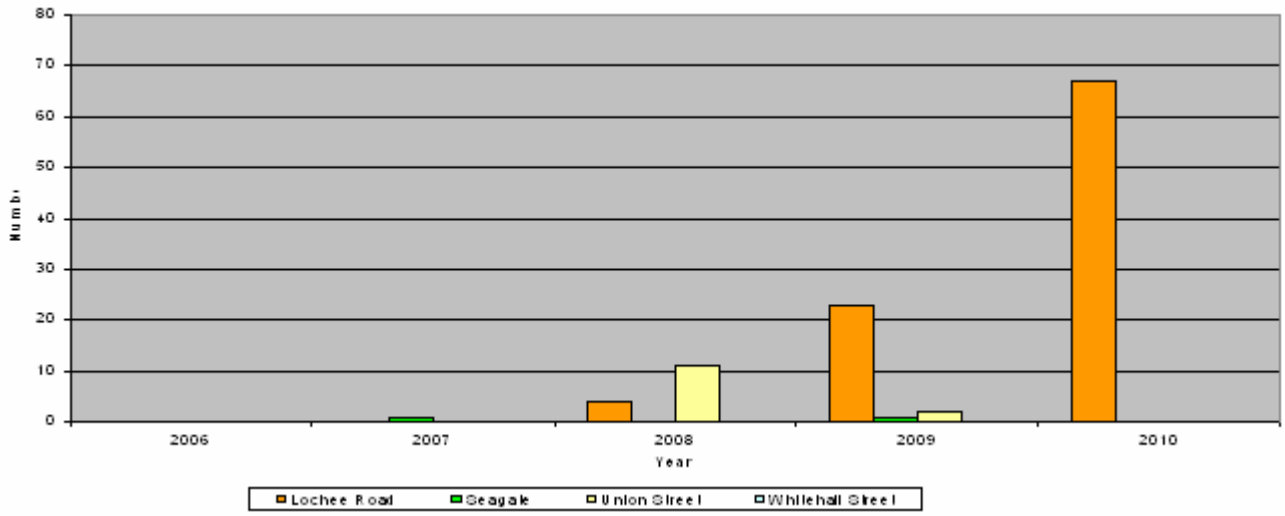
Figure 3.30 Trends in NO_2 Diffusion Tube Concentrations at Urban Background Locations



3.1.2 Trends in Nitrogen Dioxide Hourly Mean Concentrations

Figure 3.31 shows the number of exceedences of the NO_2 hourly mean objective (200µg/m^3) (18 allowed) at each of the real time monitoring locations in Dundee between 2006 and 2010. This shows that the objective was met at all the monitoring locations except Lochee Road in 2009 and 2010. Severe winter weather in 2009 and 2010 is thought to have contributed significantly to the number of exceedences recorded in both these years. The monitoring site is located on the north-west arterial route which can become increasingly congested during severe adverse weather when alternative routes are difficult for drivers to negotiate.

Figure 3.31 Number of Exceedences of the NO_2 Hourly Mean Objective (200µg/m^3) (18 Allowed) at Real Time Monitoring Locations in Dundee between 2006 and 2010



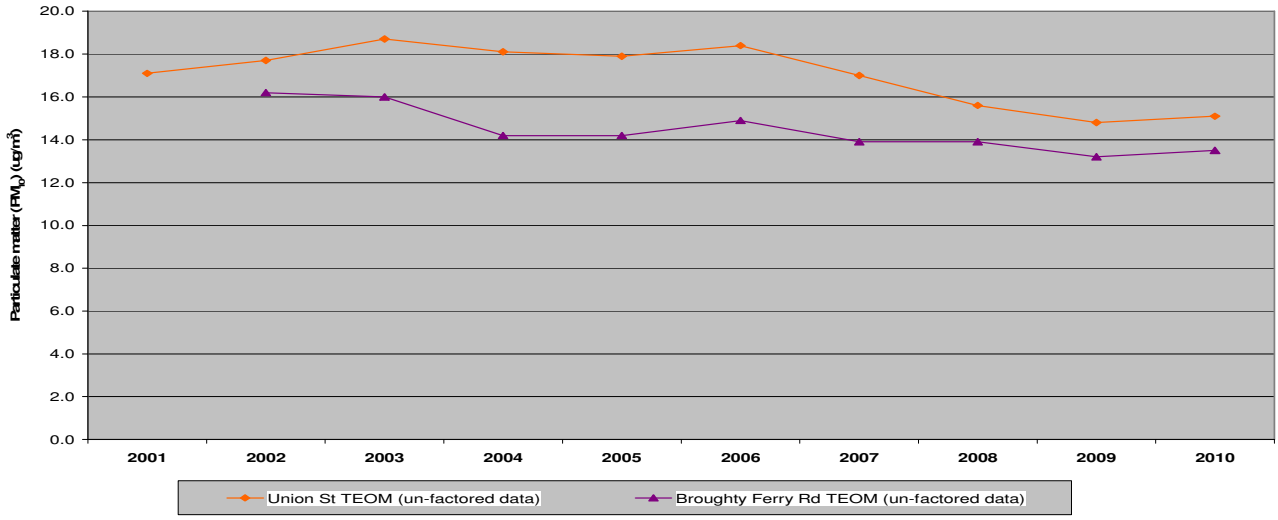
3.2 Trends in PM_{10} Concentrations

A minimum of 5 years data is required to show a reliable trend. VCM adjusted concentrations are only available for the last 3 years, therefore the following examination of trends in PM_{10} concentrations is based on either un-factored data or data adjusted by Dundee City Council's locally derived gravimetric factors (The data and derivation of local factors have been reported in previous LAQM reports). Concentrations at roadside and kerbside sites are known to be affected by localised or short -term factors such as roadworks and traffic flow changes. Year on year fluctuations are also possible as a consequence of climatic effects, and trans-boundary pollution episodes.

3.2.1 Trends in Annual Mean PM_{10} Concentrations

Trends in un-factored TEOM monitored concentrations between 2001 and 2010 are shown in **Figure 3.32**, for the two long-term TEOM sites, Union Street (Roadside) and Broughty Ferry Road (Urban Industrial). A slight decline in PM_{10} concentrations is evident at both sites.

Figure 3.32 Trend in Un-factored PM_{10} Concentrations at Long Term TEOM Monitoring Sites



Trends in local-factored TEOM and Osiris monitored concentrations between 2006 and 2010 are shown in **Table 3.2** and **Figure 3.33**, along with results from the Partisol (gravimetric equivalent). A slight decline in PM_{10} concentrations is evident across the monitoring locations except at Victoria Road and Seagate. 2010 showed large increases in PM_{10} concentrations at Victoria Road, Logie Street and Lochee Road, which are located on busy commuter routes.

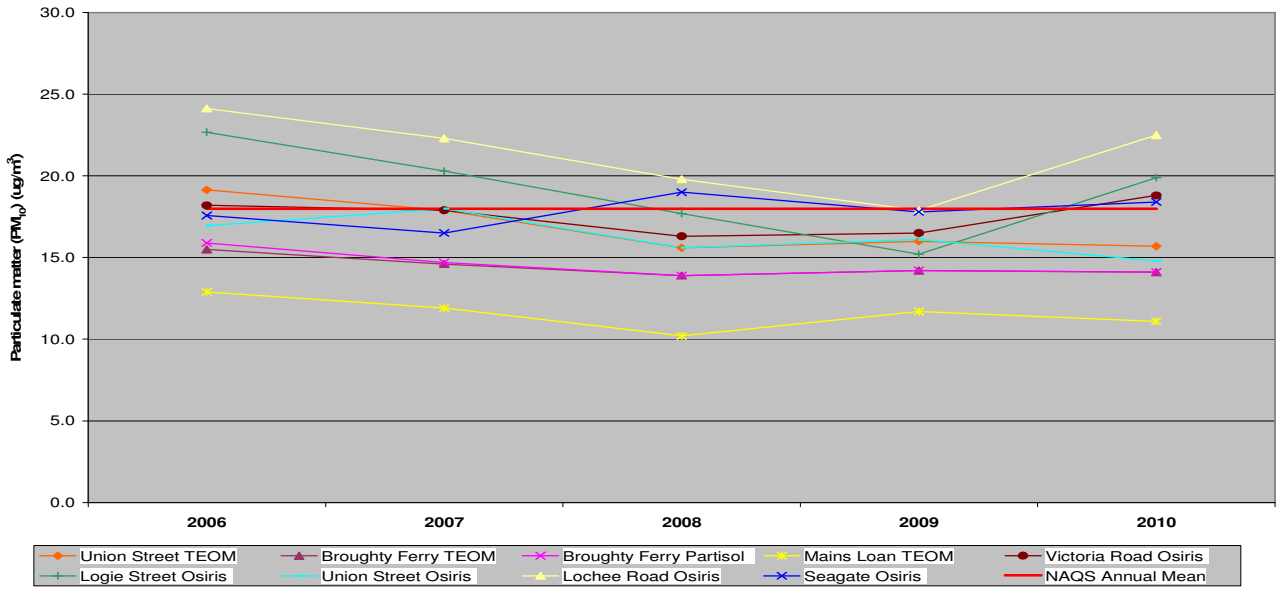
Table 3.2 Annual Mean PM_{10} Concentrations 2006-2010 adjusted by local gravimetric factors and VCM method

Location/Monitor		2006	2007	2008	2009	2010
Union Street TEOM	Local	**19.1**	17.9	15.6	16.0	15.7
	VCM	n/a	n/a	16.9	16.5	17.0
Broughty Ferry Rd TEOM	Local	15.5	14.6	13.9	14.2	14.1
	VCM	n/a	n/a	15.2	14.8	15.6
Broughty Ferry Rd Partisol	Grav.	15.9*	14.7	14.0	14.2	14.1
Mains Loan TEOM	Local	12.9*	11.9	10.2	11.7	11.1
	VCM	n/a	n/a	11.4	12.6	12.6
Victoria Road Osiris	Local	**18.2**	17.9	16.3	16.5	**18.8**
	VCM	n/a	n/a	17.6	17.1	**21.0**
Logie Street Osiris	Local	**22.7***	**20.3**	17.7	15.2	**19.9**
	VCM	n/a	n/a	**19.0**	15.8	**22.1**
Union Street Osiris	Local	17.0	18.0	15.6	16.1	14.8
	VCM	n/a	n/a	16.9	16.6	16.8
Lochee Road Osiris	Local	**24.1**	**22.3**	**19.8**	17.9	**22.5**
	VCM	n/a	n/a	**21.1**	**18.3**	**24.8**
Seagate Osiris	Local	17.6	16.5	**19.0**	17.8*	**18.4**
	VCM	n/a	n/a	**20.3**	**18.1***	**20.5**

NB: Concentrations in bold are greater than the NAQS Annual mean (18ug/m^3)

* denotes less than 75% data capture, mean has been annualised - described in previous reports

Figure 3.33 Trends in Annual Mean PM_{10} Concentrations 2006-2010 adjusted by local gravimetric factors



The 2010 PM_{10} annual mean concentrations at the urban background site was generally in good agreement with the Scottish Government estimated background pollutant concentration (1km x 1km) maps[3] (see **Table 3.3**).

[3] http://www.scottishairquality.co.uk/maps.php?n_action=data

Table 3.3 Comparison of Measured Background PM_{10} Results for 2010 with Scottish Government Background Map Data.

Location	Grid Square	Measured Annual Mean PM_{10} (µg/m^3)	Scottish Government Mapped Concentration (µg/m^3)
Mains Loan (VCM)	340500:731500	12.6	11.8
Mains Loan (Local)	340500:731500	11.1	11.8

3.2.2 Trends in Daily Mean PM_{10} Concentrations

Trends in the number of exceedences of the daily mean local-factored TEOM and Osiris monitored concentrations between 2006 and 2010 are shown in **Table 3.4** and **Figure 3.34**, along with results from the Partisol (gravimetric equivalent). A decline in the number of exceedences of the daily mean PM_{10} objective is evident across all of the monitoring locations between 2006 and 2009, but in 2010 the number of exceedences at Logie Street ,Lochee Road increased significantly. Logie Street and Lochee Road are located on the north-west arterial route.

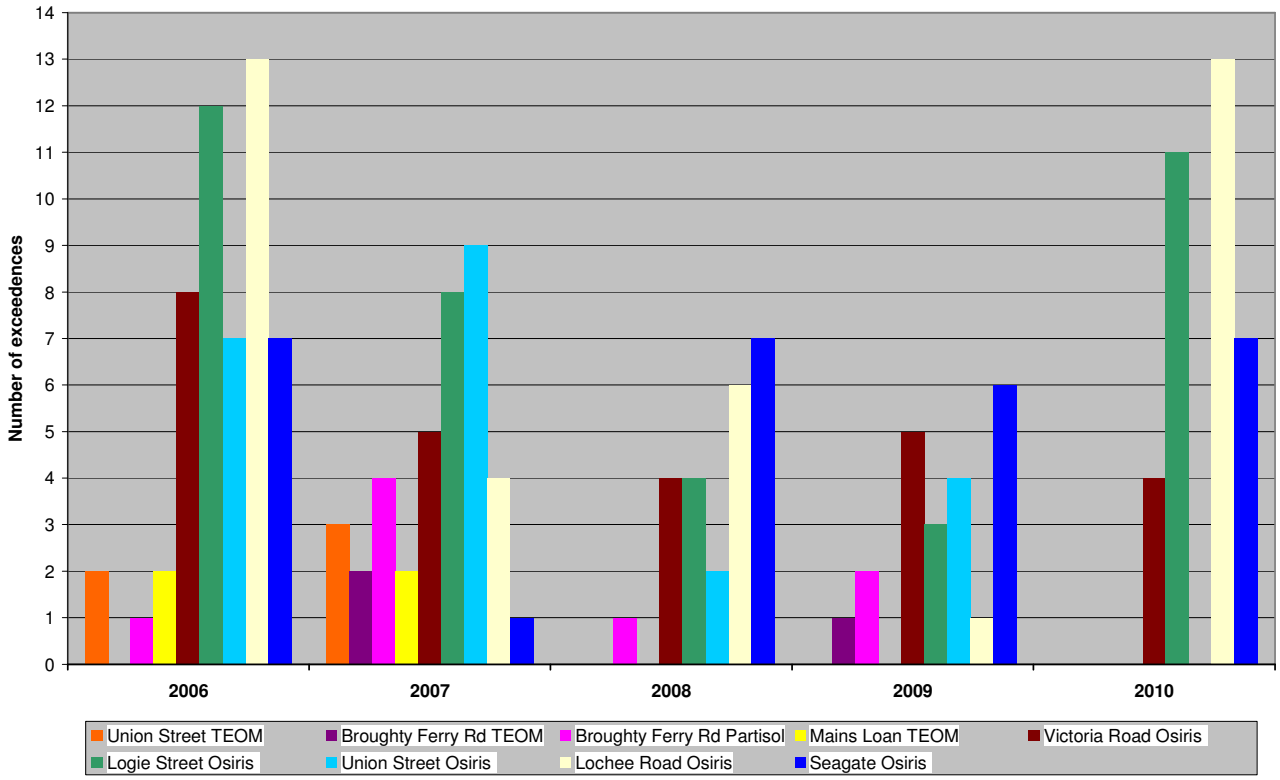
Table 3.4 Number of Exceedences of PM_{10} Daily Mean Objective 2010 (50µg/m^3- 7 allowed) 2006-2010 adjusted by local gravimetric factors and VCM method

Location/Monitor		2006	2007	2008	2009	2010
Union Street TEOM	Local	2	3	0	0	0
	VCM	n/a	n/a	0	2	0
Broughty Ferry Rd TEOM	Local	0	2	0	1	0
	VCM	n/a	n/a	0	2	0
Broughty Ferry Rd Partisol	Grav.	1*	4	1	2	0
Mains Loan TEOM	Local	2*	2	0	0	0
	VCM	n/a	n/a	0	0	0
Victoria Road Osiris	Local	**8**	5	4	5	4
	VCM	n/a	n/a	7	6	7
Logie Street Osiris	Local	**12***	**8**	4	3	**11**
	VCM	n/a	n/a	9	0	**12**
Union Street Osiris	Local	7	**9**	2	4	0
	VCM	n/a	n/a	4	6	0
Lochee Road Osiris	Local	**13**	4	6	1	**13**
	VCM	n/a	n/a	**10**	4	**16**
Seagate Osiris	Local	7	1	7	6*	7
	VCM	n/a	n/a	**12**	**8***	**9**

NB: 'bold' means the number of 24hr averages greater than 50ug/m^3 has breached that allowed (i.e. 7)

* denotes less than 75% data capture

Figure 3.34 Trends in Number of Exceedences of PM_{10} Daily Mean Objective 2010 (50µg/m^3- 7 allowed) 2006-2010 adjusted by local gravimetric factors



In certain circumstances, where the measured data capture is less than 90%, it may be more appropriate to express short-term concentrations as percentile values that approximate to the permitted number of exceedences. Generally, if the value of the 98.08th percentile is above 50 µg/m^3 then it is likely that the allowed number of daily mean exceedences will have been breached. Trends in the 98.08th Percentile of the daily mean local-factored TEOM and Osiris monitored concentrations between 2006 and 2010 are shown in **Table 3.5** and **Figure 3.35**, along with results from the Partisol (gravimetric equivalent). PM_{10} concentrations have remained relatively stable at the background site (Mains Loan) and the urban industrial site (Broughty Ferry Road) and at Seagate (main bus corridor). A general downward trend has been shown at other locations, although Logie Street and Lochee Road saw a significant increase in 2010.

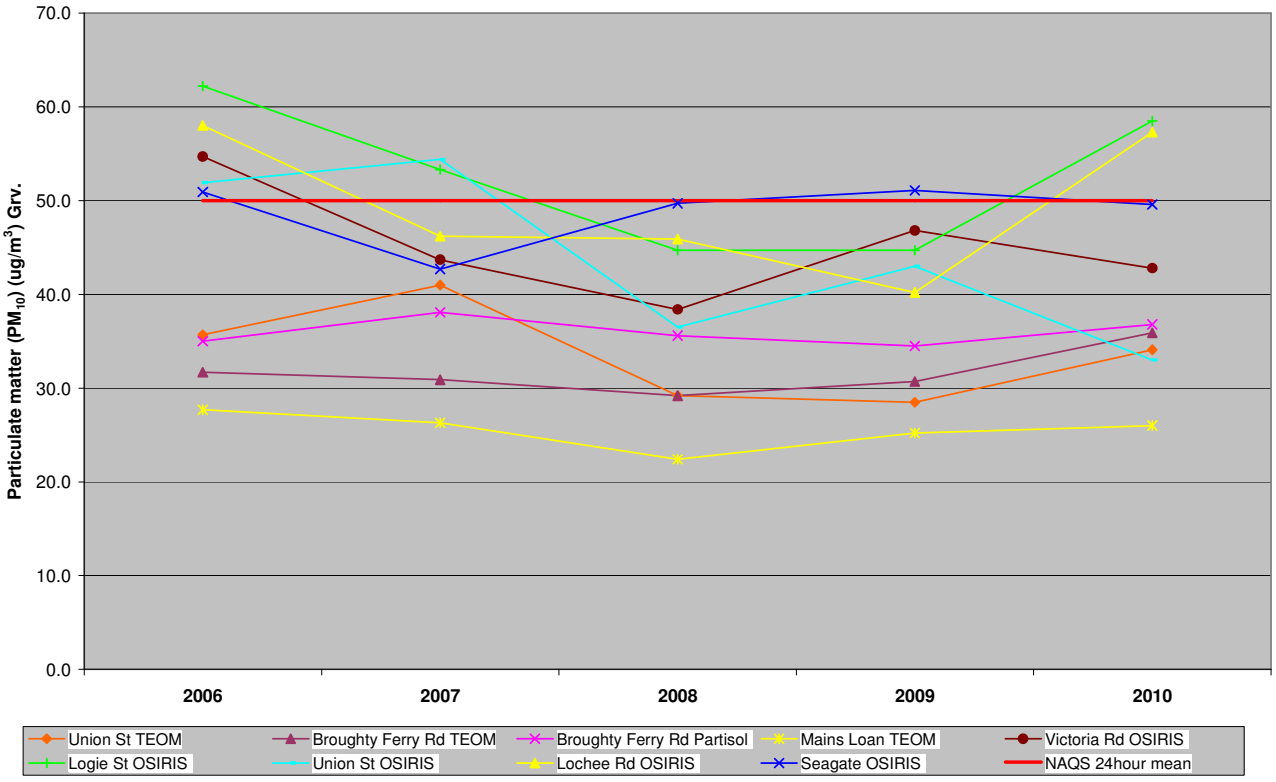
Table 3.5 98.08th Percentile of PM_{10} Daily Mean Objective 2010 (50µg/m^3) 2006-2010 adjusted by local gravimetric factors and VCM method

Location/Monitor		2006	2007	2008	2009	2010
Union St TEOM	Local	35.7	41.0	29.2	28.5	34.1
	VCM	n/a	n/a	40.3	33.4	37.7
Broughty Ferry Rd TEOM	Local	31.7	30.9	29.2	30.7	35.9
	VCM	n/a	n/a	37.8	35.3	39.8
Broughty Ferry Rd Partisol	Grav.	35.0*	38.1	35.6	34.5	36.8
Mains Loan TEOM	Local	27.7*	26.3	22.4	25.2	26.0
	VCM	n/a	n/a	30.7	31.3	30.0
Victoria Rd OSIRIS	Local	**54.7**	43.7	38.4	46.8	42.8
	VCM	n/a	n/a	**50.4**	47.7	49.8
Logie St OSIRIS	Local	**62.2***	**53.3**	44.7	44.7	**58.5**
	VCM	n/a	n/a	**54.9**	38.7	**62.7**
Union St OSIRIS	Local	**51.9**	**54.4**	36.5	43.0	33.0
	VCM	n/a	n/a	47.0	47.9	38.8
Lochee Rd OSIRIS	Local	**58.0**	46.2	45.9	40.2	**57.3**
	VCM	n/a	n/a	**57.9**	44.0	**62.5**
Seagate OSIRIS	Local	**50.9**	42.7	49.7	**51.1***	49.6
	VCM	n/a	n/a	**56.6**	**53.5***	**52.7**

NB: Concentrations in bold are greater than the NAQS 24hour mean (50ug/m^3)

* denotes less than 75% data capture

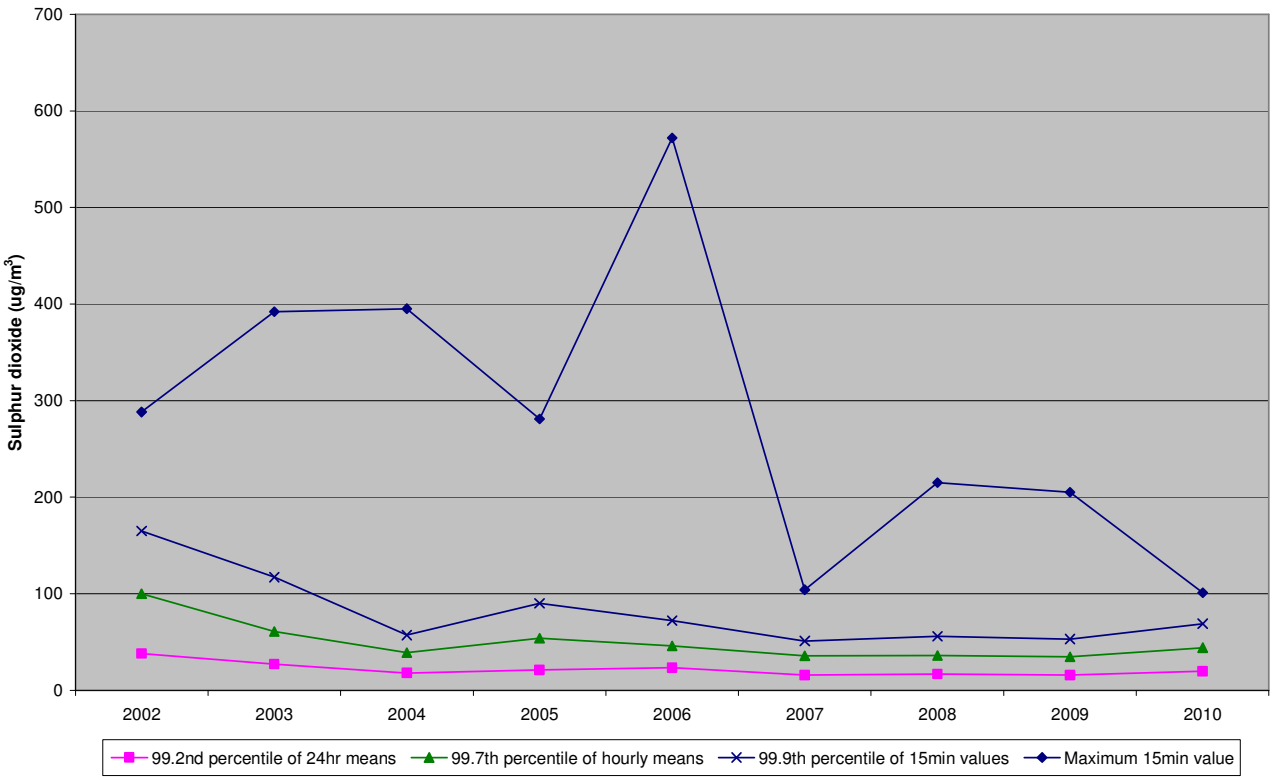
Figure 3.35 Trends in 98.08th Percentile of PM_{10} Daily Mean Objective 2010 (50µg/m^3) 2006-2010 adjusted by local gravimetric factors



3.3 Trends in Sulphur Dioxide (SO_2) Concentrations

Figure 3.36 shows the trend in maximum (15min) SO_2 concentrations and each of the relevant percentiles for each of the SO_2 objectives, i.e. 99.9th for 15min, 99.7th for hourly and 99.2nd for 24-hour means (see **Table 2.8** for a description of each of the objectives). This shows an overall decline in SO_2 concentrations between 2002 and 2011. This is largely consistent with the introduction of lower-sulphur fuel at the nearby industrial facility. Some exceedences of the 15min objective were recorded in 2006, but these were well below the 35 allowed. These exceedences were investigated previously and were associated with certain shipping activites/movements within the port.

Figure 3.36 Trends In Maximum (15min) SO_2 Concentrations and Relevant Percentiles from 2002 to 2010



4 New Local Developments

4.1 Road Traffic Sources

Under this section the Council is required to identify any of the following which are new since the last Updating and Screening Assessment:

- Narrow congested streets with residential properties close to the kerb.
- Busy streets where people may spend one hour or more close to traffic.
- Roads with a high flow of buses and/or HGVs.
- Junctions.
- New roads constructed or proposed since the last Updating and Screening Assessment.
- Roads with significantly changed traffic flows.
- Bus or coach stations.

Since the last USA (2009) work has begun on a new link road as part of the Whitfield Regeneration Programme. Traffic on this road is not expected to exceed 5,000 vehicles per day and hence no further assessment is required. In addition alterations to the Kingsway / Myrekirk Road roundabout, which forms part of the trunk road network through the city, are included as part of a new superstore development. The air quality assessment that accompanied the proposals predicted a new exceedence of the PM_{10} annual mean standard as a result of the development[4]. A condition requiring post development pollution monitoring has been applied to the planning consent. A strategic transport project to improve access to the port may result in an increase in HGVs entering the port from the east. The eastern port access is close to the existing hotspot at Stannergate junction. New junctions and roads have been constructed and others are proposed as part of the Central Waterfront Development Masterplan 2001 - 2031, described previously in the Progress Report 2005. There are currently no relevant receptors near the locations of these recent road network changes. However the urban background nature of the diffusion tube "Earl Grey Place Park" may have been compromised by the changes in October 2011 and will need to be relocated. The need for review and assessments of these roads and junctions will be examined in subsequent reports as necessary.

4.2 Other Transport Sources

Under this section the Council is required to identify any of the following which are new since the last Updating and Screening Assessment:

- Airports.
- Locations where diesel or steam trains are regularly stationary for periods of 15 minutes or more, with potential for relevant exposure within 15m.
- Locations with a large number of movements of diesel locomotives, and potential long-term relevant exposure within 30m.
- Ports for shipping.

There are no new developments since the last USA (2009) that meet the above description/criteria.

[4] http://idoxwam.dundeecity.gov.uk/WAM133/doc/Report-345111.PDF?extension=.PDF&id=345111&location=VOLUME2&contentType=application/pdf&pageCount=1

4.3 Industrial Sources

Under this section the Council is required to identify any of the following which are new since the last Updating and Screening Assessment:

- **Industrial installations:** new or proposed installations for which an air quality assessment has been carried out.
- **Industrial installations:** existing installations where emissions have increased substantially or new relevant exposure has been introduced.
- **Industrial installations:** new or significantly changed installations with no previous air quality assessment.
- Major fuel storage depots storing petrol.
- Petrol stations.
- Poultry farms.

A new petrol station is proposed as part of a supermarket development, however as there won't be any relevant receptors within 10m of the petrol pumps it does not meet the criteria for assessment. An existing Part B process has received a variation to its permit to allow the use of a waste wood fuelled heating system. An air quality assessment accompanied the application and no exceedences of the NAQS are predicted.

4.4 Commercial and Domestic Sources

Under this section the Council is required to identify any of the following which are new since the last Updating and Screening Assessment:

- Biomass combustion plant – individual installations.
- Areas where the combined impact of several biomass combustion sources may be relevant.
- Areas where domestic solid fuel burning may be relevant.

The USA concluded that there was insufficient information to adequately fulfil the requirements of this section. The Council has applied for funding from the Scottish Government under the LAQM grant scheme to take this forward, but have been unable to do so to date. Since the last USA, a mixed use building including a health centre and other community facilities has been granted planning permission as part of the Whitfield Regeneration Project. The building is being designed by the council architects and biomass has been identified as an option to meet CO_2 reduction targets.

4.5 New Developments with Fugitive or Uncontrolled Sources

Under this section the Council is required to identify any of the following which are new since the last Updating and Screening Assessment:

- Landfill sites.
- Quarries.
- Unmade haulage roads on industrial sites.
- Waste transfer stations etc.
- Other potential sources of fugitive particulate emissions.

There are no new developments since the last USA (2009) that meet the above description.

Dundee City Council has identified the following new or previously unidentified local developments which may impact on air quality in the Local Authority area.

- Proposed new superstore Kingsway / Myrekirk Junction
- Improved Port Access
- New Health Centre and Community Facilities, Whitfield

These will be taken into consideration in the next Updating and Screening Assessment, scheduled for 2012.

5 Implementation of Action Plans

Dundee City Council produced an Air Quality Action Plan for NO_2 and PM_{10} in January 2011, following the submission of a draft plan in June 2010.

Thirty two measures have been selected from the draft action plan to be taken forward; some measures have a number of separate actions within them. Actions that have been selected as high priority include:

- Introducing measures to improve bus services and reduce emissions, including investigation of Statutory Bus Quality Partnerships, Voluntary Bus Quality Partnerships, Fleet Renewal, Tackling Idling Bus Emissions, Low Emission Zones for buses

- Exploring means of reducing emissions from taxis and private car hire vehicles in AQMA

- Ensuring local air quality is fully integrated into the LDP process and development scenarios/planning applications are appropriately assessed with respect to the potential impacts on air quality

- Increase uptake and implementation of School and Workplace Travel Plans.

A copy of the Council's Air Quality Action Plan can be viewed our web-site at the following location:

http://www.dundeecity.gov.uk/dundeecity/uploaded_publications/publication_2166.doc

The Council will report on progress on implementing the action plan measures in 2012, but have been successful in obtaining funding from the Scottish Government for the 2011/12 financial year to help support the council's review and assessment work and take forward a variety of initiatives, targeting high pollution levels and congestion on the north-west arterial route. These include improvements to the urban traffic management system, and a behavioural change programme to try and reduce demand for travel by private vehicles through hotspot locations.

6 Conclusions and Proposed Actions

6.1 Conclusions from New Monitoring Data

New monitoring data for 2010 show the objectives for SO_2 are being achieved. Sulphur dioxide concentrations measured at the Broughty Ferry Road monitoring location remained low and achieved the objectives during 2010.

PM_{10} objectives for 2004 are being met at all monitoring locations within the city. However, the 2010 PM_{10} annual mean and 24 hour objective are being exceeded at roadside and kerbside Osiris sites. Osiris monitoring units are indicative only and the results should be treated with caution. The council have installed reference equivalent PM_{10} analysers in Lochee Road, Seagate and at the Victoria Rd / Meadowside junction, and the need for a detailed assessment or AQMA in relation to the daily mean will be kept under review. A detailed assessment undertaken in 2009 for PM_{10}, also identified a risk of exceedence of the 2010 objectives at receptors adjacent to busy roads and junctions in the city centre.

Exceedences of the nitrogen dioxide annual mean objective continued to occur within the existing AQMA in 2010 and, after façade projections were calculated, concentrations at eleven sites failed to meet the annual mean standard. Uncertainties associated with the distance calculator tool suggest that at least a further 7 locations may exceed the objective. These are located within the existing AQMA, and include Broughty Ferry Road at the Stannergate junction. The need for additional action plan measures to target this area and Strathmore Avenue will be kept under review.

With respect to the hourly NO_2 objective, none of the diffusion tube monitoring sites in the city recorded annual mean concentrations above 60µg/m^3. The diffusion tube site at the junction of Victoria Road/Hilltown measured the highest NO_2 concentration of 57.9µg/m^3. Members of the public are not regularly present for more than 1-hour in these locations, however there are nearby ground floor residences on Meadowside. When projected to façade the concentrations calculated are below 60µg/m^3. Keeping in view the uncertainties associated with façade projection methodology, the Council have installed a real-time monitor at sites of relevant exposure close to the identified locations to confirm if the hourly-mean of NO_2 is being exceeded.

There were 67 exceedences of the hourly NO_2 objective recorded at the automatic monitoring station on Lochee Road during 2010, an examination of the distribution of these exceedences, concluded that all of the exceedences occurred during the winter months, during the morning and evening peak traffic periods and on weekdays. Severe weather (snow and ice) during December 2010 may have contributed to many of the exceedences. The monitoring station is located on the main north-west arterial route into the city, which can become increasingly congested during adverse weather when alternative routes are difficult to for drivers to negotiate. The Rankine Street and Dudhope Terrace junctions with Lochee Road are being studied to determine if improvements to the Urban Traffic Management Control (UTMC) system and the possible re-allocation of road space will help to alleviate congestion. The need for a detailed assessment or new AQMA for exceedences of the hourly NO_2 objective will be kept under review.

6.2 Conclusions relating to trends in pollutant concentrations

NO_2 annual mean concentrations throughout the city have increased since the AQMA was declared in 2006. The greatest increase in pollutant concentrations have been recorded along the city centre bus corridor, the north-west arterial route and associated access roads, major junctions on the Kingsway and at Stannergate Junction. The hourly NO_2 objective was met at all the monitoring locations except Lochee Road in 2009 and 2010. Severe winter weather in 2009 and 2010 is thought to have contributed significantly to the number of exceedences recorded in each of these years. The monitoring site is located on the north-west arterial route which can become increasingly congested during adverse weather when alternative routes are difficult for drivers to negotiate.

Generally PM_{10} concentrations between 2006 and 2009 levelled off or were decreasing slightly. Monitoring locations on the north-west arterial route (Logie Street and Lochee Road) showed a significant increase in PM_{10} concentrations in 2010.

SO_2 concentrations have declined at the Broughty Ferry Road monitoring station between 2002 and 2010; this is thought to be largely due to the introduction of low sulphur fuels at a nearby industrial process in the port. Occasional exceedences of the 15min mean objective have been recorded as a result of certain shipping activities/movements within the port; these were well within the number allowed.

6.3 Conclusions relating to New Local Developments

Dundee City Council has identified the following new or previously unidentified local developments which may impact on air quality in the Local Authority area.

- Proposed new superstore Kingsway / Myrekirk Junction
- Improved Port Access
- New Health Centre and Community Facilities, Whitfield

These will be taken into consideration in the next Updating and Screening Assessment, scheduled for 2012.

It is considered that biomass combustion sources require further investigation, as that there is insufficient information at present to assess this adequately. This will be reported in subsequent LAQM reports as information becomes available.

6.4 Other Conclusions

Dundee City Council produced an Air Quality Action Plan for NO_2 and PM_{10} in January 2011. The Council have applied for funding to take forward some of the Action Plan measures this year (2011/12).

6.5 Proposed Actions

Proposed Actions

Proposed actions arising from the Progress Report 2011 are as follows:

- Investigate further sources of biomass/solid fuel combustion in the local authority area to enable appropriate screening, and report findings in subsequent LAQM reports as information becomes available;

- Report the results of new monitors installed at locations of relevant exposure for sites identified with potential exceedence of the hourly-mean NO_2 objective; and review the need for a detailed assessment / AQMA due to breaches of the hourly mean NO_2 objective once ratified 2011 monitoring data is available.

- Report the results from new reference equivalent PM_{10} analysers installed in potential problem areas;

- Characterisation of the areas of exceedence at Strathmore Avenue and Broughty Ferry Road at Stannergate junction, including additional NO_2 monitoring, as required to inform additional, appropriate action plan measures that will effectively target the pollution problems at those localities; and

- Complete the Updating and Screening Assessment in 2012 and report on Action Plan Progress.

7 References

This report includes references where appropriate throughout the text as footnotes.

Appendices

APPENDIX 1 - LOCAL BIAS CO-LOCATION STUDIES

APPENDIX 2 - MONTHLY DIFFUSION TUBE RESULTS 2009

APPENDIX 1 - LOCAL BIAS CO-LOCATION STUDIES

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements										Automatic Method		Data Quality Check	
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
1	05/01/2010	03/02/2010	63.0	66.0	65.4	65	1.6	2	3.9	55	99.9	Good	Good
2	03/02/2010	03/03/2010	69.2	71.7	71.2	71	1.3	2	3.3	62	99.7	Good	Good
3	03/03/2010	01/04/2010	71.8	68.9	67.6	69	2.2	3	5.3	56	99.9	Good	Good
4	01/04/2010	28/04/2010	60.6	56.8	62.8	60	3.0	5	7.5	50	55.5	Good	Poor Data Capture
5	28/04/2010	02/06/2010	53.2	56.8	56.0	55	1.9	3	4.7	43	52.7	Good	Poor Data Capture
6	02/06/2010	30/06/2010	58.5	59.8	64.8	61	3.3	5	8.3	-	0	Good	Poor Data Capture
7	30/06/2010	04/08/2010	51.1	53.3	52.9	52	1.2	2	2.9	43	72.9	Good	Poor Data Capture
8	04/08/2010	31/08/2010	54.5	55.6	57.4	56	1.5	3	3.6	44	95.7	Good	Good
9	31/08/2010	29/09/2010	59.7	60.8	62.4	61	1.4	2	3.4	44	95.6	Good	Good
10	29/09/2010	03/11/2010	62.8	63.6	65.8	64	1.6	2	3.9	50	95.7	Good	Good
11	03/11/2010	03/12/2010	55.7	58.2	59.4	58	1.9	3	4.7	47	95.7	Good	Good
12	03/12/2010	05/01/2011	70.3	69.9	72.3	71	1.3	2	3.2	55	94.2	Good	Good
13													

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey --> Good precision | Poor Overall DC

(Check average CV & DC from Accuracy calculations)

Site Name/ ID:	Dundee Seagate

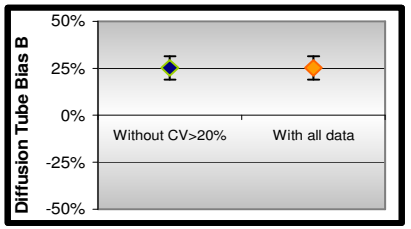
Precision: 12 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 8 periods of data

Bias factor A	0.8 (0.76 - 0.84)
Bias B	25% (18% - 31%)
Diffusion Tubes Mean:	64 μgm^{-3}
Mean CV (Precision):	2
Automatic Mean:	52 μgm^{-3}
Data Capture for periods used:	97%
Adjusted Tubes Mean:	51 (49 - 54) μgm^{-3}

Accuracy (with 95% confidence interval)
WITH ALL DATA
Bias calculated using 8 periods of data

Bias factor A	0.8 (0.76 - 0.84)
Bias B	25% (18% - 31%)
Diffusion Tubes Mean:	64 μgm^{-3}
Mean CV (Precision):	2
Automatic Mean:	52 μgm^{-3}
Data Capture for periods used:	97%
Adjusted Tubes Mean:	51 (49 - 54) μgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements										Automatic Method		Data Quality Check	
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
1	06/01/2010	03/02/2010	77.6	67.1	66.0	70	6.4	9	15.9	64	95.5	Good	Good
2	03/02/2010	03/03/2010	70.7	72.1	72.6	72	1.0	1	2.4	66	95.7	Good	Good
3	03/03/2010	01/04/2010	64.6	75.5		70	7.7	11	69.2	61	95.3	Good	Good
4	01/04/2010	28/04/2010	61.7	60.6	61.3	61	0.6	1	1.4	50	95.1	Good	Good
5	28/04/2010	02/06/2010	51.9	49.0		50	2.1	4	18.4	43	95.6	Good	Good
6	02/06/2010	30/06/2010	49.0	45.2	46.6	47	1.9	4	4.8	34	91.7	Good	Good
7	30/06/2010	04/08/2010	48.9	47.4	46.0	47	1.5	3	3.6	38	94.4	Good	Good
8	04/08/2010	31/08/2010	53.2	52.4	56.0	54	1.9	4	4.7	45	93.1	Good	Good
9	31/08/2010	29/09/2010	57.0	55.9	55.9	56	0.6	1	1.6	39	91.4	Good	Good
10	29/09/2010	03/11/2010	69.5	69.5	67.2	69	1.3	2	3.3	56	95.5	Good	Good
11	03/11/2010	03/12/2010	68.8	64.1	69.5	67	2.9	4	7.3	57	95.8	Good	Good
12	03/12/2010	05/01/2011	101.8	100.4	95.6	99	3.3	3	8.1	97	99.9	Good	Good
13													
											Overall survey -->	Good precision	Good Overall DC

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

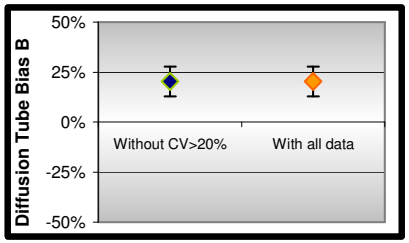
(Check average CV & DC from Accuracy calculations)

Site Name/ ID:	Dundee Lochee Road

Precision 12 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) without periods with CV larger than 20%	
Bias calculated using 12 periods of data	
Bias factor A	0.85 (0.8 - 0.91)
Bias B	17% (10% - 25%)
Diffusion Tubes Mean:	64 μgm^{-3}
Mean CV (Precision):	4
Automatic Mean:	54 μgm^{-3}
Data Capture for periods used:	95%
Adjusted Tubes Mean:	54 (51 - 58) μgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA	
Bias calculated using 12 periods of data	
Bias factor A	0.85 (0.8 - 0.91)
Bias B	17% (10% - 25%)
Diffusion Tubes Mean:	64 μgm^{-3}
Mean CV (Precision):	4
Automatic Mean:	54 μgm^{-3}
Data Capture for periods used:	95%
Adjusted Tubes Mean:	54 (51 - 58) μgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements										Automatic Method		Data Quality Check	
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
1	05/01/2010	03/02/2010	53.7	60.0	60.7	58	3.9	7	9.6	50	99.7	Good	Good
2	03/02/2010	03/03/2010	55.1	54.2	56.2	55	1.0	2	2.5	52	99.7	Good	Good
3	03/03/2010	01/04/2010	59.6	59.5	64.3	61	2.7	4	6.8	50	96.7	Good	Good
4	01/04/2010	28/04/2010	53.1	55.2	53.2	54	1.2	2	2.9	41	99.7	Good	Good
5	28/04/2010	02/06/2010	47.1	45.7	44.2	46	1.5	3	3.6	36	99	Good	Good
6	02/06/2010	30/06/2010	39.9	41.1	40.7	41	0.6	2	1.5	27	99.4	Good	Good
7	30/06/2010	04/08/2010	42.5	42.8	42.5	43	0.2	0	0.4	34	59	Good	Poor Data Capture
8	04/08/2010	31/08/2010	45.7	45.3	41.7	44	2.2	5	5.5	32	99.5	Good	Good
9	31/08/2010	29/09/2010	46.7	48.1	46.0	47	1.1	2	2.7	30	99.7	Good	Good
10	29/09/2010	03/11/2010	56.0	56.7	55.4	56	0.7	1	1.6	40	99.9	Good	Good
11	03/11/2010	01/12/2010	48.0	52.2	48.1	49	2.4	5	6.0	40	87.4	Good	Good
12	01/12/2010	05/01/2011	64.8	66.9	63.0	65	2.0	3	4.8	57	58.7	Good	Poor Data Capture
13													
											Overall survey -->	Good precision	Good Overall DC

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

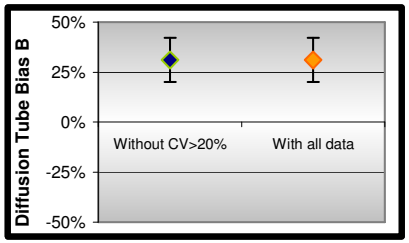
(Check average CV & DC from Accuracy calculations)

Site Name/ ID:	Dundee Union St

Precision 12 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) without periods with CV larger than 20%	
Bias calculated using 10 periods of data	
Bias factor A	0.78 (0.72 - 0.85)
Bias B	28% (17% - 39%)
Diffusion Tubes Mean:	51 μgm^{-3}
Mean CV (Precision):	3
Automatic Mean:	40 μgm^{-3}
Data Capture for periods used:	98%
Adjusted Tubes Mean:	40 (37 - 43) μgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA	
Bias calculated using 10 periods of data	
Bias factor A	0.78 (0.72 - 0.85)
Bias B	28% (17% - 39%)
Diffusion Tubes Mean:	51 μgm^{-3}
Mean CV (Precision):	3
Automatic Mean:	40 μgm^{-3}
Data Capture for periods used:	98%
Adjusted Tubes Mean:	40 (37 - 43) μgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements										Automatic Method		Data Quality Check	
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
1	05/01/2010	03/02/2010	52.1	50.8	49.2	51	1.5	3	3.6	41	89.8	Good	Good
2	03/02/2010	03/03/2010	51.8	52.6	52.8	52	0.5	1	1.3	44	76.8	Good	Good
3	03/03/2010	01/04/2010	47.7	50.8	50.4	50	1.7	3	4.2	38	99	Good	Good
4	01/04/2010	28/04/2010	41.9	49.6	47.1	46	3.9	9	9.8	37	95.4	Good	Good
5	28/04/2010	02/06/2010	35.7	37.5	40.2	38	2.3	6	5.6	32	94.8	Good	Good
6	02/06/2010	30/06/2010	41.6	43.0	42.9	43	0.8	2	1.9	31	91.1	Good	Good
7	30/06/2010	04/08/2010	36.9	37.4	39.2	38	1.2	3	3.0	29	95.4	Good	Good
8	04/08/2010	31/08/2010	39.8	38.6	41.3	40	1.4	3	3.4	32	95.7	Good	Good
9	31/08/2010	29/09/2010	46.3	44.8	46.7	46	1.0	2	2.5	34	95.4	Good	Good
10	29/09/2010	03/11/2010	44.6	47.4	47.8	47	1.7	4	4.3	37	95.6	Good	Good
11	03/11/2010	01/12/2010	44.3	49.8	46.2	47	2.8	6	6.9	39	89.7	Good	Good
12	01/12/2010	05/01/2011	56.6	60.8	58.5	59	2.1	4	5.2	48	56.8	Good	Poor Data Capture
13													
											Overall survey -->	Good precision	Poor Overall DC

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

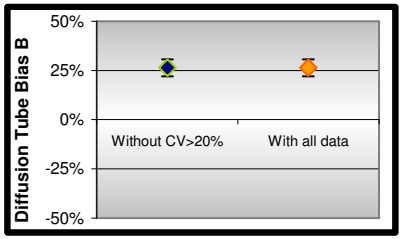
(Check average CV & DC from Accuracy calculations)

Site Name/ ID:	Dundee Whitehall St

Precision	12 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) without periods with CV larger than 20%	
Bias calculated using 11 periods of data	
Bias factor A	0.79 (0.77 - 0.82)
Bias B	26% (22% - 30%)
Diffusion Tubes Mean:	45 μgm^{-3}
Mean CV (Precision):	4
Automatic Mean:	36 μgm^{-3}
Data Capture for periods used:	93%
Adjusted Tubes Mean:	36 (35 - 37) μgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA	
Bias calculated using 11 periods of data	
Bias factor A	0.79 (0.77 - 0.82)
Bias B	26% (22% - 30%)
Diffusion Tubes Mean:	45 μgm^{-3}
Mean CV (Precision):	4
Automatic Mean:	36 μgm^{-3}
Data Capture for periods used:	93%
Adjusted Tubes Mean:	36 (35 - 37) μgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

APPENDIX 2 - MONTHLY DIFFUSION TUBE RESULTS 2010

LOCATION	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Mean	Bias corrected (0.79)	% Data
ABERTAY 2	57.1	63.3	56.3	51.8	55.0	46.6	41.7	48.4	50.6	59.5	48.7	66.4	53.8	42.5	100.0
ALBERT ST (SHANDON PL)	58.5	57.2	50.1	48.3	45.2	40.7	35.1	38.2	49.5	48.6	46.1	62.2	48.3	38.2	100.0
ALBERT ST (1)	57.4	58.6	49.2	42.8		43.8	31.0	33.3	37.7	46.3	43.0	58.3	45.6	36.0	91.7
ALBERT ST (FISH)	52.5	54.1	54.7	38.2	33.1	24.7	30.7	32.8	33.7	45.4	48.6	67.1	43.0	33.9	100.0
ARBROATH RD (13)	58.9	70.1	63.1	43.8	50.5	35.3	38.8	42.1	43.6	54.6	46.3	72.6	51.6	40.8	100.0
ARTHURSTONE TCE (10)	41.4	40.1	33.6	29.0	25.4	24.7	22.2	21.5	27.9	33.5	32.9	45.4	31.5	24.9	100.0
BALGAVIES PL	33.2	36.1	34.1	19.0	17.0	10.6	11.3	13.4	17.8	25.8	26.5	45.0	24.2	19.1	100.0
BANK ST/ REFORM ST	42.7	45.8	40.6	31.3	27.1	22.9	27.1	26.3	30.1	37.0	38.4	51.4	35.1	27.7	100.0
BIRNAM PL	23.4	21.4	15.0	11.0	8.5	7.4	7.2	8.0	13.1	14.9	17.9	25.2	14.4	11.4	100.0
BROUGHTY FERRY RD (141)	58.2	67.6	62.8	55.1	52.3	44.9	38.4	44.3	53.2	59.2	59.9	76.2	56.0	44.2	100.0
CLAYPOTTS JUNCTION	42.6	45.2	37.4	30.9	27.6	30.3	25.4	24.2		54.1	34.3	52.3	36.8	29.0	91.7
CLEPINGTON RD/ FORFAR RD	57.3	64.1	59.0	51.1	40.7	36.4	33.2	41.7	45.0	49.9	52.0	74.5	50.4	39.8	100.0
COMMERCIAL ST	45.1	53.4	43.7	41.4	35.4	31.2	29.2	29.8	35.4	41.4	40.1	47.3	39.5	31.2	100.0
COMMERCIAL ST (WATERSTONES)	60.9	67.6	53.9	52.0	43.0	54.5	42.7	49.7	57.2	54.2	60.7	61.0	54.8	43.3	100.0
COMMERCIAL ST /DOCK ST 2	56.3	62.4	63.9	53.7	47.2	38.2	41.4	43.5	47.0	52.3	55.3	65.8	52.3	41.3	100.0
CRICHTON ST	48.5	46.4	47.4	39.8	34.1	26.2	29.6	31.4	36.6	41.5	37.7	55.6	39.6	31.3	100.0
DENS RD (CROSSING)	51.7	56.4	50.1	42.4	36.0	31.5	31.8	36.5	37.2	46.7	45.7	64.5	44.2	34.9	100.0
DOCK ST (CAROL WHYTE) 2	53.4	64.2	58.2	45.4	42.3	31.3	35.4	37.9	45.0	49.2	54.0	65.5	48.5	38.3	100.0
DOCK ST (SHERIDANS)	54.2	62.4	64.7	57.3	45.6	42.3	40.5	45.7		51.4	50.2	69.9	53.1	42.0	91.7
DOCK ST (UNICORN)	53.9	63.6	65.8	56.5	44.6	37.7	39.9	47.3	48.7	57.0	57.2	69.0	53.4	42.2	100.0
DURA ST (FORTES)	58.2	63.5	58.3	47.2	45.7	42.0	36.4	44.9	49.8	52.3	56.5	70.1	52.1	41.1	100.0
EARL GREY PL (PARK)	43.3	40.0	35.4	23.1	20.2	13.7	15.1	20.8	23.0	30.0	38.6	48.7	29.3	23.2	100.0
EASTPORT ROUNDABOUT	50.1	58.6	48.2	42.3	35.7	30.4	27.9	34.2	40.3	46.6	47.0	60.9	43.5	34.4	100.0
FORFAR RD	63.9	69.2	72.4	56.4	54.7	50.5	51.3	58.4	60.5	65.4	66.8	76.1	62.1	49.1	100.0
HAREFIELD RD (35)	48.9	50.2	39.2	34.5	29.7	27.6	23.4	26.9	37.1	38.5	39.5	57.1	37.7	29.8	100.0

LOCATION	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Mean	Bias corrected (0.79)	% Data
HILLTOWN (SUITES)	49.6	55.2	52.0	39.1	37.4	33.5	33.4	34.4	38.5	45.5	42.7	58.0	43.3	34.2	100.0
KING ST (12/14)	43.8	43.5	47.2	33.8	28.2	22.8	26.5	29.1	33.7	41.2	38.5	54.2	36.9	29.1	100.0
KINGSWAY EAST ROUNDABOUT	58.7	51.6	65.5	47.8	49.1	40.6	40.0	42.3	47.9	54.9	40.1	80.3	51.6	40.7	100.0
KINGSWAY/ MAINS LOAN	55.1	65.6	46.2	46.3	38.4	44.0	30.6	37.1	46.5	46.1	46.7	54.8	46.5	36.7	100.0
KINGSWAY/ STRATHMARTINE RD (S)	64.6	72.7	66.3	51.6	47.7	43.1	39.6	52.7	56.2	61.6	64.6	82.7	58.6	46.3	100.0
LOCHEE RD (138)	78.8	79.2	71.5	67.1	61.4	60.5	52.1	63.9	65.4	74.0	74.0	115.7	72.0	56.9	100.0
LOCHEE RD (140 TRAFFIC LTS)	79.5	78.2	78.8	70.7	60.0		55.3	64.0	65.6	75.5	73.7	97.3	72.6	57.4	91.7
LOCHEE RD (184)	61.6	55.7	57.6	46.6	40.0	35.5	35.1	40.3	39.1	54.9	51.9	84.9	50.3	39.7	100.0
LOCHEE RD (ROMON 1)	77.6	70.7	64.6	61.7	51.9	49.0	48.9	53.2	57.0	69.5	68.8	101.8	64.6	51.0	100.0
LOCHEE RD (ROMON 2)	67.1	72.1	75.5	60.6	49.0	45.2	47.4	52.4	55.9	69.5	64.1	100.4	63.3	50.0	100.0
LOCHEE RD (ROMON 3)	66.0	72.6		61.3		46.6	46.0	56.0	55.9	67.2	69.5	95.6	63.7	50.3	83.3
AVERAGE Lochee Rd ROMON													63.8	50.4	
LOCHEE RD/POLEPARK RD	53.7	57.2	44.1	38.3	30.7	30.5	27.8	28.7	38.0	43.8	45.1	70.0	42.3	33.4	100.0
LOGIE ST (114)	80.9	74.5	74.5	69.6	63.0	63.3	60.5	64.6	70.7	77.9		92.1	72.0	56.9	91.7
LOGIE ST (98)	51.8	51.0			32.3	29.6	29.4	31.2	37.7	44.5	45.6	69.5	42.3	33.4	83.3
LOONS RD (1)	68.2	66.0	59.9	52.2	49.5	54.1	41.2	42.9	56.6	58.1	59.5	72.9	56.8	44.8	100.0
MARKETGAIT (PALAIS COURT)	47.0	52.0	44.5	41.1	36.3	36.6	32.8	34.0	38.2	44.0	38.2	49.1	41.2	32.5	100.0
MEADOWSIDE	74.5	76.6	84.2	77.8	67.7	64.7	55.9	65.7	70.9	77.4	69.0	84.4	72.4	57.2	100.0
MUIRTON RD (6)	49.9	49.9	34.4	40.4	31.6	35.0	25.8	30.3	39.1	39.2	38.0	47.6	38.4	30.4	100.0
MYREKIRK RD	51.3	53.8	50.5	41.9	36.6	30.3	29.7	37.0	39.3	45.9	43.5	69.8	44.1	34.9	100.0
NETHERGATE (B&B)	64.6	65.0	64.3	65.9	59.1	65.1	51.1	51.5	59.0	61.8	56.4	66.4	60.9	48.1	100.0
NETHERGATE (BRADFORD)	55.0	51.8	54.4	43.9	42.1	41.9	43.7	42.7	47.4	53.2	46.1	66.4	49.1	38.7	100.0
NETHERGATE (CHARLIE T)	54.2	64.4	54.3	42.0	41.7	36.7	33.1	37.6	45.9	47.6	52.9	59.7	47.5	37.5	100.0
NETHERGATE (TRADES HOUSE)	54.8	56.0	50.4	51.2	43.2	49.8	42.1	43.8	47.7	49.5	43.2	59.1	49.2	38.9	100.0
NETHERGATE/ MARKETGAIT	46.8	59.6	49.9	39.5	38.5	33.1	28.7	33.9	41.5	42.5	45.9	55.1	42.9	33.9	100.0
NETHERGATE/SOUTH TAY ST	46.5	47.9	38.5	37.3		33.0	23.1	30.0	32.8	37.7	37.8	50.3	37.7	29.8	91.7
PERTH RD 320	57.1	53.1	47.0	44.9	42.2	40.8	34.3	40.5	47.9	50.7	47.7	64.3	47.5	37.6	100.0

LOCATION	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Mean	Bias corrected (0.79)	% Data
QUEEN ST B/F	53.0	50.2	45.2	30.7	30.2	25.0	21.5	29.6	32.0	37.1	42.3	59.9	38.1	30.1	100.0
RANKINE ST (2)	70.1	72.8		56.5	46.0	41.2	36.8	40.6	50.3	58.1	67.0	93.9	57.6	45.5	91.7
SEAGATE	56.8	60.2	60.9	53.1	45.6	50.7	48.1	44.8	50.4	56.8	49.9	65.2	53.5	42.3	100.0
SEAGATE (ROMON 1)	63.0	69.2	71.8	60.6	53.2	58.5	51.1	54.5	59.7	62.8	55.7	70.3	60.9	48.1	100.0
SEAGATE (ROMON 2)	66.0	71.7	68.9	56.8	56.8	59.8	53.3	55.6	60.8	63.6	58.2	69.9	61.8	48.8	100.0
SEAGATE (ROMON 3)	65.4	71.2	67.6	62.8	56.0	64.8	52.9	57.4	62.4	65.8	59.4	72.3	63.2	49.9	100.0
AVERAGE Seagate ROMON													61.9	48.9	100.0
SEAGATE (YATES)	55.5	57.4	57.1	48.8	43.2	45.8	36.4	44.6	47.2	50.8	51.5	59.5	49.8	39.4	100.0
SOAPWORK LANE	54.3	56.5	52.8	42.8	36.6	30.5	29.7	33.4	40.6	50.9	46.4	63.8	44.9	35.4	100.0
ST ANDREWS ST (JAF)	55.1	62.2	48.7	45.4	37.5	42.4	35.8	31.6	43.1	50.2	45.0	60.1	46.4	36.7	100.0
ST ANDREWS ST (PB)	59.4	57.9	62.4	49.9	45.6	43.2	43.5	41.0	46.3	55.2	44.4	64.8	51.1	40.4	100.0
STRATHMORE AVE (353)	66.0	66.6	52.0	50.4	43.3	51.2	35.7	39.7	45.6	40.6	46.6	68.3	50.5	39.9	100.0
TRADES LANE (31)	50.8	53.4	49.9	41.1	32.2	28.6	30.4	31.1	35.1	44.0	40.2	58.8	41.3	32.6	100.0
UNION ST (GOODFELLOWS)	47.3	51.7	43.5	38.7	33.3	35.1	28.8	34.5	39.0	41.5	40.9	52.8	40.6	32.1	100.0
UNION ST (McINTYRES)	47.8	53.8	44.1	40.2	34.0	35.9	29.1	33.0	38.5	42.7	43.7	55.5	41.5	32.8	100.0
UNION ST (ROLLALONG 1)	53.7	55.1	59.6	53.1	47.1	39.9	42.5	45.7	46.7	56.0	48.0	64.8	51.0	40.3	100.0
UNION ST (ROLLALONG 2)	60.0	54.2	59.5	55.2	45.7	41.1	42.8	45.3	48.1	56.7	52.2	66.9	52.3	41.3	100.0
UNION ST (ROLLALONG 3)	60.7	56.2	64.3	53.2	44.2	40.7	42.5	41.7	46.0	55.4	48.1	63.0	51.3	40.6	100.0
AVERAGE Union St (ROLLALONG)													51.6	40.7	100.0
VICTORIA RD	55.1	64.1	47.9	41.6	38.2	35.8	29.6	32.6	41.2	51.5	49.5	62.2	45.8	36.2	100.0
VICTORIA RD (10)	51.3	64.4	53.0	46.2	41.4	39.7	31.8	39.5	44.4	47.3	49.6	60.3	47.4	37.5	100.0
VICTORIA RD (60)	55.3		57.6	52.3	46.9	50.4	40.8	42.9	50.6	54.4	54.7	61.9	51.6	40.8	91.7
VICTORIA RD / COTTON RD	50.6	51.9	59.0	40.5	37.5	36.6	34.7	38.6	41.9	52.3	42.7	68.2	46.2	36.5	100.0
VICTORIA RD / HILLTOWN	80.9	73.4	89.0	72.3	61.8	57.1	57.8	63.2	65.3	77.1	77.2	104.4	73.3	57.9	100.0
VICTORIA ST / ALBERT ST	55.0	47.1	44.8	41.7	36.0	37.6	29.4	39.0	44.0	46.9	50.0	63.5	44.6	35.2	100.0
WARD RD	47.1	47.5	50.3	42.5	34.6	35.5	36.2	33.7	39.2	46.9	38.7	53.9	42.2	33.3	100.0
WESTPORT (2)	54.2	56.9	58.2	43.3	38.6	35.9	35.3		42.4	50.9	47.4	58.8	47.4	37.5	91.7
WEST MARKETGAIT (SA)	50.3	58.5	54.2	50.4	41.7	40.9	35.9	36.8	43.7	51.0	49.6	67.6	48.4	38.2	100.0

LOCATION	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Mean	Bias corrected (0.79)	% Data
WHITEHALL CR (XPRESSO)		49.2	42.5	35.7	30.1	27.6	26.9	28.6	33.6	39.6	42.4	54.2	**37.3**	29.5	**91.7**
WHITEHALL ST (BRJ)	50.9	57.9	44.4	44.2	36.2	33.8	34.3	38.5	45.9	48.6	48.5	55.9	**44.9**	35.5	**100.0**
WHITEHALL ST (BUS)	58.5	63.0	51.4	59.3	42.9	45.3	47.7	50.9	67.5	56.4	51.1	64.5	**54.9**	**43.4**	**100.0**
WHITEHALL ST (DEB A)	51.0	66.3	55.8	54.5	47.2	44.9	45.7	49.2	53.2	56.7		67.1	**53.8**	**42.5**	**91.7**
WHITEHALL ST (DEB E)	54.4	55.6	49.1	46.0	35.4	34.3	37.2	40.4	45.6	51.9	49.8	63.3	**46.9**	37.1	**100.0**
WHITEHALL ST (ROMON 1)	52.1	51.8	47.7	41.9	35.7	41.6	36.9	39.8	46.3	44.6	44.3	56.6	**44.9**	35.5	**100.0**
WHITEHALL ST (ROMON 2)	50.8	52.6	50.8	49.6	37.5	43.0	37.4	38.6	44.8	47.4	49.8	60.8	**46.9**	37.1	**100.0**
WHITEHALL ST (ROMON 3)	49.2	52.8	50.4	47.1	40.2	42.9	39.2	41.3	46.7	47.8	46.2	58.5	**46.9**	37.0	**100.0**
AVERAGE Whitehall St ROMON													**46.2**	36.5	**100.0**
WHITEHALL ST (TISO)	53.4	54.4	48.6	47.0		44.0	36.3	41.2	47.2	46.1	45.3	53.3	**47.0**	37.1	**91.7**
WOODSIDE AVE	30.6	33.4	21.6	18.2	15.0	12.9	12.1	14.3	17.5	22.8	25.8	41.1	**22.1**	17.5	**100.0**