2014 Further Assessment
Cardiff City Centre AQMA

In fulfillment of Section 84(2) of the Environment Act 1995
Local Air Quality Management

March 2014

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Executive Summary

Following the declaration of the Cardiff City Centre Air Quality Management Area (AQMA) in April 2013, Cardiff Council is required by Section 84(2) of the Environment Act 1995 to carry out a "Further Assessment" of air quality within the AQMA.

This report focuses exclusively on the Westgate Street area of the AQMA, this being the area that was added to the existing St Mary Street AQMA by varying that AQMA Order on 1st April 2013.

This Further Assessment concludes that the declaration of the AQMA was justified and provides an elementary assessment with regard to source apportionment for road traffic. The conclusions in respect of the primary source of NOx emissions and the required emissions reductions are clear.

The conclusions of this report will assist in the development of an Action Plan to address air quality in the AQMA.

Contents

1 Introduction

1.1 This report sets out the Further Assessment of air quality within the Cardiff City Centre Air Quality Management Area (AQMA). It forms part of the air quality Review and Assessment process prescribed by DEFRA and the Devolved Administrations (including the Welsh Assembly Government). The AQMA is shown in Figure 1 and was declared because of exceedences of the annual mean nitrogen dioxide objective.

1.2 This Report focuses exclusively on the Westgate Street area of the AQMA, this being the area that was added to the formerly existing St Mary Street AQMA by varying that AQMA Order on 1st April 2013.

Introduction to the Review and Assessment Process

1.3 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (DEFRA and the Devolved Administrations, 2007) sets out a framework for air quality management, which includes a number of air quality objectives. National and international measures are expected to achieve these objectives in most locations, but where areas of poor air quality remain, air quality management at a local scale has a particularly important role to play. Part IV of the Environment Act 1995 requires local authorities to periodically review and assess air quality in their areas. The role of this process is to identify areas where it is unlikely that the air quality objectives will be achieved. These locations must be designated as AQMAs and a subsequent Air Quality Action Plan developed in order to reduce pollutant emissions in pursuit of the objectives.

1.4 Review and Assessment is a long-term, ongoing process, structured as a series of 'rounds'. Local Authorities in England, Scotland and Wales have now completed four rounds of Review and Assessment, with the fifth due to be completed this year.

1.5 Technical Guidance for Local Air Quality Management (LAQM.TG(09)) (DEFRA and the Devolved Administrations, 2009) sets out a phased approach to the Review and Assessment process. This prescribes an initial Updating and Screening Assessment (USA), which all local authorities must undertake. It is based on a checklist to identify any matters that have changed since the previous round. If the USA identifies any areas where there is a risk that the objectives may be exceeded, which were not identified in the previous round, then the Local Authority should progress to a Detailed Assessment (DA).

1.6 The purpose of the DA is to determine whether there is an exceedence of an air quality objective and the geographical extent of that exceedence. If the outcome of the DA is that one or more of the air quality objectives are likely to be exceeded, then an Air Quality Management Area (AQMA) must be declared. Subsequent to the declaration of an AQMA, a Further Assessment must be carried out to confirm that the AQMA declaration is justified and that the appropriate geographical area has been included; to ascertain the sources contributing to the exceedence; and to calculate the magnitude of reduction in emissions required to achieve the objective. This information can be used to inform the Air Quality Action Plan (AQAP), which will identify measures to improve local air quality.

The Air Quality Objectives

1.7 The Government's Air Quality Strategy (DEFRA and the Devolved Administrations, 2007) provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment. It also sets out how the different sectors: industry, transport and local government, can contribute to achieving the air quality objectives. The objectives are prescribed within The Air Quality (Wales) Regulations 2000 (Stationery Office, 2000) and The Air

Quality (Wales) (Amendment) Regulations 2002 (Stationery Office, 2002). Table 1 summarises the objectives which are relevant to this report. Appendix 1 provides a brief summary of the health effects of nitrogen dioxide.

Table 1: Air Quality Objectives for Nitrogen Dioxide

Pollutant	Concentration	Measured as	Date to be achieved by
Nitrogen dioxide	200μg/m^3 not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
	40μg/m^3	Annual mean	31.12.2005

1.8 The air quality objectives only apply where members of the public are likely to be regularly present for the averaging time of the objective (i.e. where people will be exposed to pollutants). For annual mean objectives, relevant exposure is limited to residential properties, schools and hospitals. The 1-hour objective applies at these locations and also at any outdoor location where a member of the public might reasonably be expected to stay for 1 hour or more, such as shopping streets, parks and sports grounds, as well as bus stations and railway stations that are not fully enclosed.

1.9 Measurements across the UK have shown that the 1-hour nitrogen dioxide objective is unlikely to be exceeded unless the annual mean nitrogen dioxide concentration is greater than 60µgm^{-3} (Laxen and Marner, 2003). Thus, potential exceedences of the 1-hour mean nitrogen dioxide objective need only be considered where the annual mean is predicted to be above 60µgm^{-3}.

1.10 The European Union has also set limit values for nitrogen dioxide. Achievement of these values is a national obligation rather than a local one. The limit values for nitrogen dioxide are the same level as the UK objectives and were to have been achieved by 2010.

Scope

1.11 Guidance explains that a Further Assessment report allows authorities:

- to confirm their original assessment of air quality against the prescribed objectives, and thus ensure that they were right to designate the AQMA;
- to calculate more accurately how much of an improvement in air quality would be needed to deliver the air quality objectives within the AQMA;
- to refine their knowledge of the sources of pollution so that air quality action plans can be properly targeted;
- to take account of national policy developments that may come to light after the AQMA declaration;
- to take account, as far as possible, of any local policy developments that are likely to affect air quality by the relevant date, and which were not fully factored into earlier calculations;
- to carry out real-time monitoring where this has not been done previously;
- to carry out further monitoring in problem areas to check earlier findings;

- to corroborate other assumptions on which the designation of the AQMA has been based, and to check that the original designation is still valid, and does not need amending in any way;
- to respond to any comments made by statutory consultees in respect of local authorities' previous reports, particularly where these have highlighted that insufficient attention has been paid to, for example, the validation of modelled data.

Report Structure and Issues Addressed

1.12 Section 2 of this report introduces the Cardiff City Centre AQMA, and hence defines the study area.
Section 3 describes new developments since the AQMA was declared in April 2013.
Section 4 comprises a review of new monitoring data.
Section 5 estimates the relative contribution of the most significant pollution sources to pollutant concentrations.
Section 6 sets out the Air Quality Improvements required to meet the objectives
Section 7 presents the Summary and Conclusions

Key Findings of Previous Review and Assessment Reports

1.13 Version 2 of the Council's 2011 Progress Report was published in February 2012, the initial report having been submitted in June 2011.

This report concluded that a Detailed Assessment of nitrogen dioxide in the Westgate Street area of the City Centre was necessary.

The Council's 2012 USA confirmed that a preparation of a Detailed Assessment was underway. The Detailed Assessment dated June 2012 was consulted upon during the autumn of 2012. The Cardiff City Centre AQMA came into force on 1st April 2013; this was declared by variation of the existing St Mary Street AQMA to include Westgate Street.

The Council's 2013 Progress Report was submitted in June 2013.

2 AQMA Location

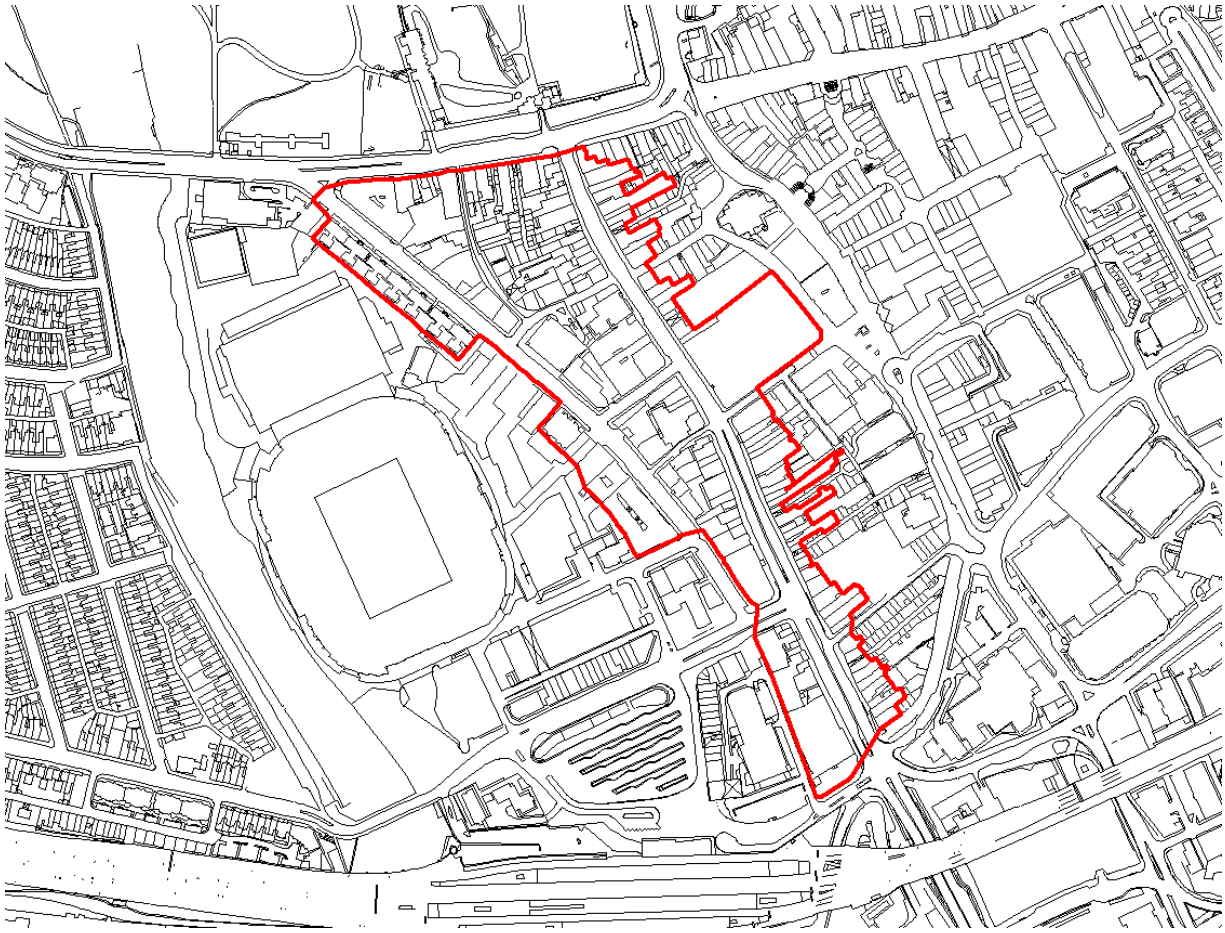
2.1 The Cardiff City Centre AQMA encompasses the area indicated in Figure 1. This includes the whole of the area covered by the former St Mary Street AQMA and residential accommodation in Westgate Street.

2.2 The air quality objectives only apply where members of the public are likely to be regularly present for the averaging time of the objective (i.e. where people will be exposed to pollutants). For annual mean objectives, relevant exposure is limited to residential properties, schools and hospitals. In terms of relevant locations on Westgate Street, the vast majority is towards its northern junction with Castle Street/Cowbridge Road East. This includes the seven apartment blocks collectively known as Castle Court and the apartments in the former Grand Hotel. There are two flats (for the Manager and Assistant Manager) above The Queens Vaults public house and rear-access to flats at 91-92 St Mary Street.

2.3 The Detailed Assessment for Westgate Street (October 2012) quoted a residential population for Castle Court flats of 140. During the Consultation, an estimate of 300 was provided by one respondent.

2.4 There are no major point sources of emissions within this AQMA nor any point sources significantly impacting upon it. The principal source of NOx emissions within the AQMA is road traffic.

Figure 1: Cardiff City Centre AQMA



3 Developments Since the Declaration of the AQMA

New/Proposed Local Developments

3.1 Whilst there have been no new road or significant housing developments proposed within the AQMA, planning consent has recently been granted for residential accommodation at former office/commercial premises at Northgate House on Kingsway.

3.2 The development is now underway and will introduce residential exposure to an area where previously there was none. As a result the Council's diffusion tube network was expanded at the beginning of 2014 to include a new site outside of Northgate House and also on Duke Street and Castle Street.

3.3 If the predicted exceedence of the nitrogen dioxide annual mean objective at relevant locations is found to be a reality then it might be that the boundary of the Cardiff City Centre AQMA has to be varied to include these areas.

3.4 Within the Cardiff City Centre AQMA, proposal to develop a 46-bed hostel in an existing building on Westgate Street is not considered significant in air quality terms; it will neither prompt a review of the AQMA boundary, add significantly to existing emissions nor hinder the development of an Action Plan for the area.

3.5 At the time of writing there is no plan proposed or adopted for the development of Central Square and/or the associated Central Bus Station. Given the principal source of NOx emissions identified in Section 5 of this report, such plans will be crucial in the development of an Air Quality Action Plan for this area.

National Developments

3.6 The National Air Quality Strategy was last revised in July 2007, and this sets the statutory objectives for nitrogen dioxide, against which local authorities have to carry out their Reviews and Assessments.

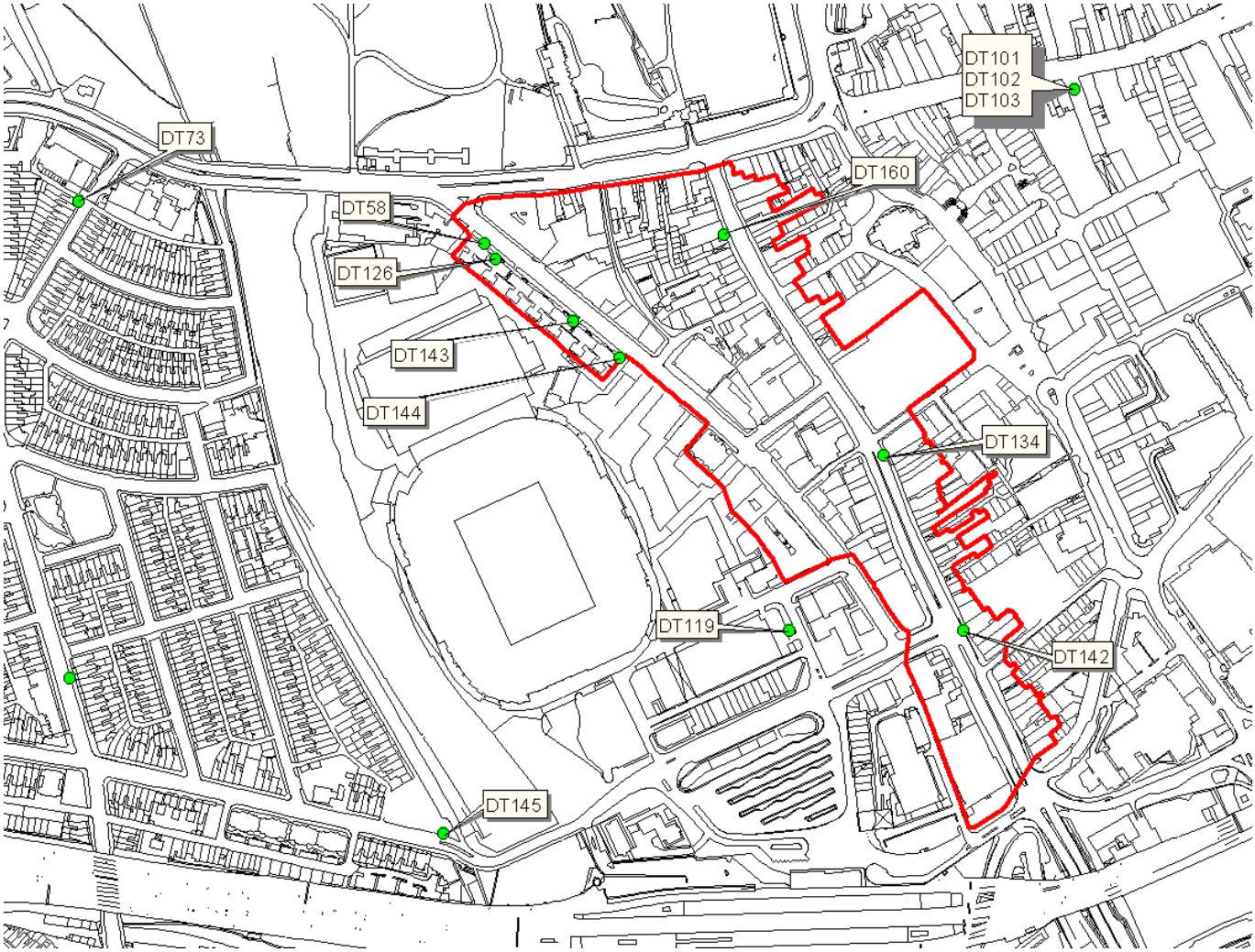
4 New Monitoring Data

4.1 Diffusion tubes are a type of passive sampler, which absorb the pollutant to be monitored from the surrounding air with no need for a power supply. Passive samplers are easy to use and relatively inexpensive. Cardiff Council uses nitrogen dioxide diffusion tubes prepared and analysed by Cardiff Scientific Services using the 50% TEA in acetone method.

4.2 Within the AQMA, Cardiff Council measures monthly average nitrogen dioxide concentrations at seven sites using diffusion tubes. Three of these are on the façades of residential accommodation in Westgate Street and there is also a tube on the façade of a building in High Street close to residential accommodation. These locations are representative of relevant exposure. The other three diffusion tubes located within the AQMA are at kerbside locations. There is also a diffusion tube located outside the AQMA in Havelock Street.

4.3 A map showing the monitoring locations is given in Figure 2.

Figure 2: Cardiff City Centre AQMA Diffusion Tube Locations



4.4 Data of the diffusion tubes monitoring sites is presented in Table 2 and data from them is presented in Tables 3 and 4.

4.5 Triplicate diffusion tubes are collocated with the Cardiff Centre AURN monitoring site at Frederick Street to allow a local bias adjustment factor to be determined annually, and also to allow an indication of the precision of the diffusion tubes to be calculated. Ratified bias adjustment factors are given for 2008 – 2013 inclusive in Table 4.

4.5 The results indicate that the annual mean nitrogen dioxide objective is being consistently exceeded at two of the three façade-based monitoring locations in Westgate Street and that the inclusion of Westgate Street within an AQMA is therefore justified.

4.6 At the beginning of 2014 additional diffusion tube sites were commissioned near to the AQMA in Kingsway, Duke Street and Castle Street. An additional site was also commissioned at the junction of Westgate Street and Park Street. Results from these diffusion tubes will be presented in future reports.

Table 2 Details of Diffusion Tube Monitoring Sites in City Centre

Site ID	Site Name	Site Type	X OS Grid Reference	Y OS Grid Reference	Site Height (m)	Pollutants Monitored	In AQMA?	Is Monitoring Co-located with a Continuous Analyser (Y/N)	Relevant Exposure? (Y/N with distance (m) from monitoring site to relevant exposure)	Distance to Kerb of Nearest Road (m) (N/A if not applicable)	Does this Location Represent Worst-Case Exposure?
58	Westgate Street	Kerbside	317937	176400	2.5	NO_2	Y	N	N (5m)	0.5m	Y
119	Havelock Street	Kerbside	318184	176086	2.0	NO_2	N	N	N	1m	Y
126	Westgate Street Flats	Façade	317946	176387	1.5	NO_2	Y	N	Y (0.10m)	5m	Y
134	Sandringham Hotel	Façade	318261	176229	2.0	NO_2	Y	N	N (3m)	5m	Y
142	Pure Rugby	Kerbside	318326	176086	2.0	NO_2	Y	N	N (>25m)	0.25m	Y
143	Windsor House	Façade	318009	176337	1.5	NO_2	Y	N	Y (0.10m)	6.5m	Y
144	Marlborough House	Façade	318046	176307	1.5	NO_2	Y	N	Y (0.10m)	6.5m	Y
160	High Street Zizzi	Façade	318131	176407	2.0	NO_2	Y	N	Y (0.10m)	65m	Y

Table 3 Results from City Centre NO_2 Diffusion Tubes 2013

Site ID	Location	Site Type	Within AQMA?	Triplicate or Co-located Tube	Full Calendar Year Data Capture 2013 (Number of Months)	2013 Annual Mean Concentration (µg/m^3) - Bias Adjustment factor = 0.85
58	Westgate Street	Kerbside	Y	N	12	**52.4**
119	Havelock Street	Kerbside	N	N	11	33.2
126	Westgate Street Flats	Façade	Y	N	10	**44.0**
134	Sandringham Hotel	Façade	Y	N	3	39.1[a]
142	Pure Rugby	Kerbside	Y	N	10	**46.3**
143	Windsor House	Façade	Y	N	12	**42.1**
144	Marlborough House	Façade	Y	N	12	39.0
160	High Street Zizzi	Façade	Y	N	11	30.0

a = result is “as measured” – it has not been “annualised”

Table 4 Results from City Centre NO_2 Diffusion Tubes 2008 - 2013

Site ID	Site Type	Within AQMA?	Annual Mean Concentration (µg/m^3) - Adjusted for Bias					
			2008 (Bias Adjustment Factor = 0.84)	2009 (Bias Adjustment Factor = 0.89)	2010 (Bias Adjustment Factor = 0.92)	2011 (Bias Adjustment Factor = 0.88)	2012 (Bias Adjustment Factor = 0.86)	2013 (Bias Adjustment Factor = 0.85)
58	Kerbside	Y	39.7	**49.5**	**52.4**	**54.9**	**49.5**	**52.4**
119	Kerbside	N	31.3	34.3	37.6	**40.2**	33.7	33.2
126	Façade	Y	35.0	40.0	**48.7**	**45.4**	39.9	**44.0**
134	Façade	Y	**46.1**	**45.7**	**48.8**	**45.1**	36.2	39.1[a]
142	Kerbside	Y	-	-	**58.8**	**48.7**	**47.6**	**46.3**
143	Façade	Y	-	-	**48.6**	**43.8**	**41.5**	**42.1**
144	Façade	Y	-	-	**46.2**	**42.9**	39.5	39.0
160	Façade	Y	-	-	36.0	32.6	31.4	30.0

a = result is “as measured” – it has not been “annualised”

5 Source Apportionment

5.1 In order to develop an appropriate action plan it is necessary to identify the sources contributing to the objective exceedences at locations within an AQMA. The data presented here could be used to inform any future traffic management decisions.

5.2 At the time of writing, the latest available classified traffic counts were those measured on 3rd February 2011. This was shortly after High Street and St Mary Street were closed to through traffic. Currently permitted traffic movements are as they were at the time of the survey. However, it is possible that flows have altered since the survey was undertaken and additional surveys are planned in the near future primarily to inform plans for the redevelopment of Central Square and the Bus Station just to the south of the AQMA.

5.3 The traffic flows given in Table 5 below have been calculated from the 2-way peak-hour measurements made on 3rd February 2011. The calculated flows are the average of the a.m. and p.m. peak-hour flows multiplied by a factor of 13 to give the Annual Average Daily Traffic flow (AADT).

5.4 Classified vehicle counts were made for cars, taxis, "loading" and buses/coaches. For the purposes of this assessment it has been assumed that the vehicles classified as "loading" are light goods vehicles and vans as the majority of them will have been and there is no data available to enable the disaggregation of this classification into sub-groups.

5.5 For the purpose of this assessment the focus has been on traffic flows at the northern (Castle) end of Westgate Street as this is where the vast majority of relevant exposure occurs, i.e. at the residential accommodation known as Castle Court and in the former Grand Hotel.

Table 5: Classified traffic counts on Westgate Street (northern/Castle end)

Vehicle Type	Cars	Taxis	"Loading"	Buses/Coaches
Flow (AADT)	6578	1287	1170	2548
% of Total Flow	56.8	11.1	10.1	22.0

5.6 NOx emissions were calculated from the classified traffic count data in Table 5 using version 5.2c of the Emissions Factor Toolkit (EFT) made available by DEFRA and the Devolved Administrations here:

http://laqm.defra.gov.uk/documents/EFT2013_v5.2c.xls.zip

5.7 The EFT was run with inputs based on "Detailed Option 1" for Wales in 2013. The following parameters were input:

Total Flow:	11583	
% Cars:	67.9	(cars + taxis from Table 5)
% LGV:	10.1	("Loading" from Table 5)
% Buses & coaches:	22.0	(Buses/Caches from Table 5)

5.8 The EFT was run with vehicle speeds of 50, 40, 30, 20 and 10kph to assess the effect on both total and proportionate emissions of lower vehicle speeds.

5.9 Based upon these inputs the EFT was used to estimate:

- Petrol Cars
- Diesel Cars
- Petrol Light Goods Vehicles
- Diesel Light Goods Vehicles
- Buses & Coaches

5.10 On Westgate Street there is a well-used bus stop on the south-bound side of the road, close to the junction with Quay Street. Other bus stops on Westgate Street are located at the southern end of road in the vicinity of Cardiff County Court and the Junction with Park Street. These latter bus stops are on both sides of the road and can be associated with prolonged periods of waiting/idling.

5.11 With regard to the proximity of the bus stops to relevant locations, it is the bus stop near to the junction with Quay Street that may be significant with regard to emissions close to relevant locations. The bus stop is well-used, particularly for setting down passengers. It is the nature of the current road layout that other vehicles have to wait behind a stopped bus, resulting in queuing that can be significant at peak times.

5.12 Data output from the EFT for NOx is given in Tables 6 and 7.

5.13 The data show that:

- total NOx emissions (g/km) increase with decreasing speed
- emissions from buses and coaches, i.e. HDVs, become more significant with decreasing vehicle speeds
- buses/coaches are the largest single source of emissions at all speeds

5.14 Given the location of the bus stop at Quay Street, emissions from buses/coaches may be even more significant than shown by the output.

Table 6: Emission Factor Toolkit output, NOx by vehicle type at constant speed (g/km)

Vehicle Speed	All Vehicles	All LDV	All HDV	Light Duty Vehicles (LDV)				HDV
				Petrol Cars	Diesel Cars	Petrol LGV	Diesel LGV	Buses/Coaches
50	14476.51	2991.69	11484.82	453.78	1788.22	17.36	732.33	11484.82
40	16958.16	3300.32	13657.84	483.56	1994.84	16.89	805.03	13657.84
30	21024.05	3762.16	17261.88	528.46	2304.78	16.61	912.31	17261.88
20	28271.91	4404.00	23867.91	587.31	2745.62	16.53	1054.53	23867.91
10	42115.39	5307.92	36807.47	640.30	3418.21	16.40	1233.01	36807.47

Table 7: Emission Factor Toolkit output, NOx by vehicle type at constant speed (%)

Vehicle Speed	All LDV	All HDV	Light Duty Vehicles (LDV				HDV
			Petrol Cars	Diesel Cars	Petrol LGV	Diesel LGV	Buses/Coaches
50	20.67	79.33	3.13	12.35	0.12	5.06	79.33
40	19.46	80.54	2.85	11.76	0.10	4.75	80.54
30	17.89	82.11	2.51	10.96	0.08	4.34	82.11
20	15.58	84.42	2.08	9.71	0.06	3.73	84.42
10	12.60	87.40	1.52	8.12	0.04	2.93	87.40

6 Air Quality Improvements Required

6.1 The degree of improvement needed in order for the annual mean objective for nitrogen dioxide to be achieved can be considered as the difference between the highest monitored concentration and the objective level (40µg/m^{-3}). The highest monitored concentrations of nitrogen dioxide year-on-year on façades of residential accommodation on Westgate Street are at Site 126 (Westgate Street Flats). Excluding 2010 measurements, where concentrations have previously been shown to have been unusually elevated across the local and regional monitoring networks, the highest bias-adjusted annual mean concentration at this site was 45.4µgm^{-3} in 2011. This means that a worst-case reduction of 5.4µgm^{-3} of nitrogen dioxide will be needed.

6.2 For road-traffic sources, nitrogen dioxide is very much a secondary pollutant. Concentrations will be dependent not only on local and regional emissions but also on prevailing weather conditions and the availability of atmospheric oxidants. The relationship between emissions of nitrogen oxides (NOx) and concentrations of nitrogen dioxide is not linear. In terms of describing the improvement that is required it is more useful to consider emissions of NOx rather than concentrations nitrogen dioxide. DEFRA and the Devolved Administrations have made available a tool for estimating NOx concentrations from NO_2 measurements here:

http://laqm.defra.gov.uk/documents/NOx-NO2-Calculator-v3.2.xls

6.3 The tool allows the calculation of NOx concentrations from nitrogen dioxide (NO_2) concentrations. It has been used to calculate the road traffic contribution to total NOx (total minus background) and the reduction in NOx concentration needed for the NO_2 objective to be achieved. The background used is the annual mean NO_2 concentration measured at Site 73 (Green Street).

6.4 The Green Street site is approximately 340m from Westgate Street close to a barrier which prevents through traffic. The location is therefore relatively traffic-free despite being only 52m from the main Cowbridge Road East leading to/from the City Centre. It is considered to be an Urban Background site. The location can be seen in Figure 2, page 7.

Table 8: Road traffic contributions to NOx concentrations

Year	Site	Diffusion tube NO_2 µgm^{-3}	Background NO_2 µgm^{-3}	Traffic NO_x, µgm^{-3}	Required reduction %
2013	Site 126	44.0	24.9	43.45	23.0
	Objective	40.0	24.9	33.44	
2012	Site 126	39.9	25.6	31.63	-0.01
	Objective	40.0	25.6	31.88	
2011	Site 126	45.4	28.0	39.91	33.5
	Objective	40.0	28.0	26.54	

6.4 Considering the worst-case situation in Table 8, i.e. 2011, the year for which the greatest emissions reduction would have been necessary for the objective to have been achieved, the data indicates road traffic emissions would have needed to have been approximately 66.5% of what they were, i.e. a 33.5% NOx emissions reduction.

6.5 Considering the data in Tables 6 and 7 (Section 5) and taking the least extreme situation in terms of vehicle type responsible for a proportion of emissions, i.e. vehicles travelling at a constant 50kmh, then 66.5% of total emissions would be 9626.88 g/km.

6.6 For the objective to be met in 2011 road traffic emissions would have needed to be 4849.63 g/km lower than the total estimated in Table 5.

6.7 Removing all Light Duty Vehicles from the traffic mix would only reduce total emissions by 2991.69 g/km so this clearly isn't a viable solution on its own.

6.8 The required emission reduction could have been achieved by cutting emissions from buses and coaches by 42.2%.

6.9 An alternative would be to remove petrol and diesel cars from the Light Duty Vehicles (leaving petrol and diesel LGVs which are presumably essential for servicing local businesses) and making the balance of the emission cut from buses and coaches. This would mean a cut in bus and coach emissions of 22.7%

6.10 Given that emissions from buses and coaches account for at least 79.33% of total emissions, it is clear that significant cuts in emissions from buses and coaches will be required to achieve the desired total emissions.

6.11 It is important to remember that the above calculations assume constant vehicle speeds. In reality, NOx emissions within the AQMA will be influenced by vehicle flow patterns and varying speeds, including acceleration from the Quay Street junction into Westgate Street. Emissions in the vicinity of the residential accommodation will be adversely affected by the acceleration of buses using the bus stops and vehicles queuing behind them.

7 Summary and Conclusion

7.1 Nitrogen dioxide concentrations within and around the Westgate Street area of the Cardiff City Centre AQMA have been assessed using monitoring data. The results indicate that the annual mean nitrogen dioxide objective has been consistently exceeded over a number of years within the AQMA and in Westgate Street particularly. The exceedences encompass residential accommodation within the AQMA. Residential accommodation is considered a "relevant location" in respect of the annual mean Objective for nitrogen dioxide.

7.2 A simple source apportionment exercise with regard to local traffic emissions in Westgate Street has been undertaken. This shows that emissions from buses/coaches are the significant/dominant source of road traffic emissions of NOx gases and that significant reductions in emissions will be needed for the nitrogen dioxide objective to be achieved.

7.3 It is concluded that:

- the inclusion of the Westgate Street area into the former St Mary Street AQMA to form the Cardiff City Centre AQMA was justified.
- that buses/coaches account for at least 80% of total vehicle emissions in Westgate Street.
- a reduction in total vehicle emissions of 33.5% would have been required to achieve the annual mean air quality objective at the worst-case receptor location in 2011.
- emission reductions equivalent to 42.2% of total bus/coach emissions would have been needed for the nitrogen dioxide objective to have been achieved in 2011 were Action Plan measures to be targeted solely on this vehicle type.

7.4 It is recommended that:

- The Cardiff City Centre AQMA should remain in its present form and that monitoring of nitrogen dioxide within and around the AQMA should continue.
- the Council proceed to the development of an Air Quality Action Plan for this AQMA focused on vehicle emissions in Westgate Street
- the Action Plan be developed in conjunction with plans for the redevelopment of Central Square and the Central Bus Station

8 Uncertainties

8.1 All values presented in this report are the best possible estimates, but uncertainties in the results might cause over-or under-predictions. All of the measured concentrations presented have an intrinsic margin of error. DEFRA and the DAs suggest that this is of the order of plus or minus 20% for diffusion tube data and plus or minus 10% for automatic measurements.

8.2 It has been assumed that the vehicle fleet within the study area will conform to the national (UK) average composition; it has been assumed the emissions per vehicle conform to the factors included in the Emissions Factor Toolkit.

8.3 No vehicle speed data is available for travel through the AQMA. Vehicle speeds used to calculate NOx emissions (Section 5, Tables 6 and 7) are simple estimates of moving speed based on experience of travelling through the AQMA. These are estimates based on travelling through the AQMA during the normal working day. They may not be representative of average speeds over a 24-hour period.

8.4 It has been assumed that calculations made using the NO_2-to-NOx Converter are valid at the monitoring locations within the AQMA.

8.5 The UK Government's Air Quality Expert Group (AQEG) has published a report on trends in primary nitrogen dioxide in the UK (AQEG, 2007). This examines evidence that shows that while NOx emissions have fallen in line with predictions made a decade previously, the composition of NOx has, in some urban environments, changed. This may have caused nitrogen dioxide levels at some locations to fall less rapidly than was expected. The latest guidance from DEFRA and the DAs (2009) has been followed regarding NOx to NO_2 relationships.

8.6 The limitations to the assessment should be borne in mind when considering the results set out in preceding sections.

9 References

Air Quality Expert Group, 2007. Trends in Primary Nitrogen Dioxide in the UK. December 2007.

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10 Glossary

Standards:
A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal.

Objectives:
A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date, taking into account costs, benefits, feasibility and practicality. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides.

Exceedence:
A period of time where the concentration of a pollutant is greater than the appropriate air quality objective.

Relevant Exposure:
Members of the public who are likely to be regularly present and exposed over the averaging period of the objective.

AQMA:
Air Quality Management Area

PM10:
Small airborne particles, more specifically particulate matter less than 10 micrometers in aerodynamic diameter.

NOx:
Nitrogen oxides

NO_2:
Nitrogen dioxide.

mg/m-3:
Microgrammes per cubic metre of air.

Urban Background:
An urban location distanced from sources and therefore broadly representative of city-wide background conditions (DEFRA and the DAs, 2003).

Roadside:
A site sampling between 1m of the kerbside of a busy road and the back of the pavement. Typically this will be within 5m of the road, but could be up to 15m.

HGV:
Heavy Goods Vehicle

LGV:
Light Goods Vehicle

LDV:
Light Duty Vehicles (taken as all vehicles excluding HDVs)

HDV:
Heavy Duty Vehicle (HGVs + Buses)