2016 Air Quality Annual Status Report (ASR)
Carlisle City Council

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

June 2016

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Executive Summary: Air Quality in Our Area

Air Quality in Carlisle

Air pollution is associated with a number of adverse health impacts. It is recognised as a contributing factor in the onset of heart disease and cancer. Additionally, air pollution particularly affects the most vulnerable in society: children and older people, and those with heart and lung conditions. There is also often a strong correlation with equalities issues, because areas with poor air quality are also often the less affluent areas[1,2].

The annual health cost to society of the impacts of particulate matter alone in the UK is estimated to be around £16 billion[3]. Improving air quality can benefit those who may find their conditions are made worse through exposure to air pollution, for example people with heart or lung conditions or breathing problems.

Air quality has been monitored in Carlisle and the surrounding district as part of the local authority review and assessment process since 1996. In addition to nitrogen dioxide, other pollutants measured include particulate matter (in two size ranges; $PM_{2.5}$ and PM_{10}) and benzene (measured as part of Defra's Non-Automatic Hydrocarbon Network). However, as local authorities are no longer required to report benzene concentrations we are not reporting these in this Annual Summary Report.

Monitoring has shown that air quality within Carlisle City Council is generally good but there were small pockets within the city where the annual mean objective (40 μg m^{-3}) for nitrogen dioxide (NO_2) was regularly exceeded, mainly due to road traffic sources. To improve air quality the review and assessment process resulted in declaration of six Air Quality Management Areas (AQMA) between 2005 and 2008. One of these (AQMA 3) was later extended to incorporate more properties along Wigton Road.

Due to measures introduced by Carlisle City Council, nitrogen dioxide concentrations have tended to decrease at all locations throughout the local authority. However, current pollution concentrations suggest that the following AQMAs should remain:

[1] Environmental equity, air quality, socioeconomic status and respiratory health, 2010
[2] Air quality and social deprivation in the UK: an environmental inequalities analysis, 2006
[3] Defra. Abatement cost guidance for valuing changes in air quality, May 2013

- AQMA 2 (Currock Street);
- AQMA 4 (Bridge Street);
- AQMA 5 (Dalston Road);
- AQMA 6 (London Road).

Within AQMA 1 (A7) nitrogen dioxide concentrations have decreased sufficiently to suggest an amendment to the AQMA Order be considered. Only within AQMA 3 (Wigton Road) have nitrogen dioxide concentrations have decreased sufficiently to suggest that the AQMA Order can be fully revoked.

Actions to Improve Air Quality

Carlisle City Council has taken forward a number of measures during the current reporting year of 2015 in pursuit of improving local air quality. Key completed measures are:

- Completion of Carlisle Northern Development Route. This was expected to reduce the traffic through the city by up to twenty five percent and produce a corresponding decrease in the nitrogen dioxide concentrations.
- Effective traffic management leading to reduction in congestion and standing traffic. Carlisle City Council works closely with Cumbria County Council to monitor how improvements in traffic flow, through more effective traffic management, will produce benefits in air quality.
- Increased use of alternative transport including adoption of cycle ways including major section of Caldew Cycleway.

Carlisle City Council expects the following measures to be completed over the course of the next reporting year:

- Upgrade passenger transport infrastructure
- Provide underpass for cycle and pedestrian access under Castle Way

Carlisle City Council's priorities for the coming year are:

- Promote travel plans and introduction of green spaces for all new housing developments

- Continue to work with businesses to promote more widespread use of alternative transport.
- Promote joint parking policy

Local Priorities and Challenges

Carlisle City Council, in partnership with Cumbria County Council, has a number of ongoing projects which should have a positive impact on local air quality.

Cycle Network for Carlisle is an ongoing project which utilises developer funding through S106 agreements. The aim is to continuously upgrade and extend the network, encouraging alternative transport use and help to make cycling and walking a safer and more convenient option.

Work is underway on the new Bicycle and Foot Bridge connecting two residential areas of the city, Currock and Denton Holme. This should be completed this year. This was funded by a Cumbria County Council grant. There are a further 7 schemes ongoing to improve and extend the existing cycle network.

Consideration is being given to enhance the Carlisle Railway station into a central transport hub, with improved accessibility and enhanced parking arrangements.

It has been identified that some existing city centre road junctions may not be sufficient to cope with future development, given the number of current and planned new residential schemes within the city. Work has been undertaken to identify those junctions which require improvement in order to meet future demand. The following have been identified as a priority in terms of increasing the width and capacity:

- Warwick Road Tesco Junction.
- Warwick Road Eastern Way junction.
- Currock Road, Crown Street junction.
- The Hardwick Circus main roundabout has also been considered.

There is a long term aspiration over the next 20-30 years for a new southern bypass development scheme to complete the city ring road and link with the existing Carlisle Northern Development Route.

The main challenge with all of these projects is the issue of funding. Many rely on developer contributions through S106 agreements which can be unreliable and restrictive. There are other obvious restrictions and physical constraints on what can feasibly be undertaken, such as increasing junction capacity in some city centre locations. The overall costs of projects which can have a real impact on air quality are often prohibitively high. The Local Authority is currently investigating the use of

Community Infrastructure Levy (CIL) to increase the flexibility and ways in which developer contributions can be utilised.

How to Get Involved

There are a number of ways in which the public can get involved with improving air quality:

- Taking part in Green Travel Plan arrangements with their employer.
- Joining local cycle groups and walk to school/work groups.
- Become involved other community groups such as the Waverly Viaduct Trust which is currently working to reopen the Waverly Viaduct Bridge. The Local Enterprise Partnership (LEP) also works to secure government grant funding for local projects.
- The City council website can be used to view all previous air quality review and assessment reports as well as real time monitoring data and advice on how to reduce emissions to air.

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1 Local Air Quality Management

This report provides an overview of air quality in Carlisle City Council during 2015. It fulfils the requirements of Local Air Quality Management (LAQM) as set out in Part IV of the Environment Act (1995) and the relevant Policy and Technical Guidance documents.

The LAQM process places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether or not the air quality objectives are likely to be achieved. Where an exceedance is considered likely the local authority must declare an Air Quality Management Area (AQMA) and prepare an Air Quality Action Plan (AQAP) setting out the measures it intends to put in place in pursuit of the objectives. This Annual Status Report (ASR) is an annual requirement showing the strategies employed by Carlisle City Council to improve air quality and any progress that has been made.

The statutory air quality objectives applicable to LAQM in England can be found in Table E.1 in Appendix E.

2 Actions to Improve Air Quality

2.1 Air Quality Management Areas

Air Quality Management Areas (AQMAs) are declared when there is an exceedance or likely exceedance of an air quality objective. After declaration, the authority must prepare an Air Quality Action Plan (AQAP) within 12-18 months setting out measures it intends to put in place in pursuit of the objectives. A summary of AQMAs declared by Carlisle City Council can be found in Table 2.1.

Table 2.1 – Declared Air Quality Management Areas

AQMA Name	Pollutants and Air Quality Objectives	City / Town	One Line Description	Action Plan
AQMA 1	NO_2 annual mean	Carlisle	A7 between Hardwicke Circus and J44 of the M6, and Brampton Road for a distance of 100m from the Stanwix Bank junction	2012 Air Quality Action plan for Carlisle City Council http://www.carlisle.gov.uk/LinkClick.aspx?fileticket=r3R76WJIhuI%3d&tabid=729&portalid=0&mid=2838
AQMA 2	NO_2 annual mean	Carlisle	Currock Street and the properties immediately to the west of it, between the junction with James St/Water St and Crown St.	2012 Air Quality Action plan for Carlisle City Council http://www.carlisle.gov.uk/LinkClick.aspx?fileticket=r3R76WJIhuI%3d&tabid=729&portalid=0&mid=2838
AQMA 3	NO_2 annual mean	Carlisle	Wigton Road between Crummock Street and Caldewgate roundabout as well as properties on Caldcotes.	2012 Air Quality Action plan for Carlisle City Council http://www.carlisle.gov.uk/LinkClick.aspx?fileticket=r3R76WJIhuI%3d&tabid=729&portalid=0&mid=2838
AQMA 4	NO_2 annual mean	Carlisle	North side of the A595 at Bridge Street, northbound from the junction with Shaddongate.	2012 Air Quality Action plan for Carlisle City Council http://www.carlisle.gov.uk/LinkClick.aspx?fileticket=r3R76WJIhuI%3d&tabid=729&portalid=0&mid=2838
AQMA 5	NO_2 annual mean	Carlisle	Junction of Dalston Road and Junction Street	2012 Air Quality Action plan for Carlisle City Council http://www.carlisle.gov.uk/LinkClick.aspx?fileticket=r3R76WJIhuI%3d&tabid=729&portalid=0&mid=2838

AQMA Name	Pollutants and Air Quality Objectives	City / Town	One Line Description	Action Plan
AQMA 6	NO_2 annual mean	Carlisle	London Road and properties on either side near the junction with Blake Street	2012 Air Quality Action plan for Carlisle City Council http://www.carlisle.gov.uk/LinkClick.aspx?fileticket=r3R76WJIhuI%3d&tabid=729&portalid=0&mid=2838

Further information related to declared or revoked AQMAs, including maps of AQMA boundaries are available online at:

https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=48

A list of AQMAs are shown on the LAQM website and be accessed by clicking on a hyperlinks below:

AQMA 1: http://uk-air.defra.gov.uk/aqma/details?aqma_id=362

AQMA 2: http://uk-air.defra.gov.uk/aqma/details?aqma_id=363

AQMA 3: http://uk-air.defra.gov.uk/aqma/details?aqma_id=364

AQMA 4: https://uk-air.defra.gov.uk/aqma/details?aqma_id=365

AQMA 5: http://uk-air.defra.gov.uk/aqma/details?aqma_id=366

AQMA 6: http://uk-air.defra.gov.uk/aqma/details?aqma_id=367

2.2 Progress and Impact of Measures to address Air Quality in Carlisle City Council

Carlisle City Council has taken forward a number of measures during the current reporting year of 2015 in pursuit of improving local air quality. Details of all measures completed, in progress or planned are set out in Table 2.2. Key completed measures are:

- Completion of Carlisle Northern Development Route
- Effective traffic management leading to reduction in congestion and standing traffic

- Increased use of alternative transport including adoption of cycle ways including major section of Caldew Cycleway

Progress on the following measures has been slower than expected due to funding issues, resources available or physical restrictions in particular areas:

- Road junction and traffic management improvements
- Cycleway improvements
- Bus route improvements
- Publicity events

Carlisle City Council expects the following measures to be completed over the course of the next reporting year:

- Upgrade passenger transport infrastructure
- Provide new crossing for cycle and pedestrian access over Castle Way

Carlisle City Council's priorities for the coming year are:

- Promote travel plans and introduction of green spaces for all new housing developments
- Continue to work with businesses to promote more widespread use of alternative transport.
- Promote joint parking policy

Table 2.2 – Progress on Measures to Improve Air Quality

Measure No.	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
1	A new major bypass, the 'Carlisle Northern Development Route,' to the west of the City will remove up to 25% of through traffic. The traffic and Air Quality impacts will be closely monitored and investigation made as to further network improvements to maximise the benefits.	Traffic Management	Other	Cumbria County Council & Carlisle City Council	<2007	2007-2012. Further design work is ongoing to improve links with existing road network.	Reduced NO_2 levels at monitoring locations and within AQMA's.	Anticipate approx 25% reduction in NO_2 in city centre.	CNDR now opened. Additional monitoring at receptors on new road. Evidence of NO2 improvements in some areas. Several new cycle links from arterial routes now complete. Plans for further improvements.	Ongoing monitoring of NO_2 and traffic data. Further road improvement works expected.	
2	Effective traffic management measures will be implemented to improve the existing road network and incorporate new developments.	Traffic Management	UTC, Congestion management, traffic reduction	Cumbria County Council	ASDA and Sainsbury's only <2012	ASDA and Sainsbury's only 2012 - 13	Reduced NO_2 levels and standing traffic within AQMA's.	Not calculated	Sainsbury's junction complete in 2012. ASDA development junction complete in 2013.	Projects ongoing.	
3	Environmental Health will continue to work with the Planning Department with regard to new developments and ensure that air quality implications are taken into consideration in the planning process.	Policy Guidance and Development Control	Air Quality Planning and Policy Guidance	Carlisle City Council	Ongoing	Ongoing	Improved links between EH and Planning. AQIA's submitted as necessary. Early consultation with applicant.	Not calculated	Environmental Health is consulted on all proposed developments which may impact on air quality at an early planning stage.	Ongoing	

Measure No.	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
4	Work will continue to upgrade the passenger transport infrastructure to make it more convenient and widely accessible across the County. Arrangements for sustainable transport systems will be integrated into major new and proposed developments	Transport Planning and Infrastructure	Bus route improvements	Cumbria County Council	Ongoing	Ongoing	Improved bus service. Increased use of transport provided. Reduced NO_2 along main routes	Not calculated	Improved bus access with new shelters and raised kerbs. Proposed extension of real time bus info signs (PIP screens). Possibility of linking this to a new city broadband network. Plans for large new housing estates include public transport provision.	Ongoing	
5	Cycling and walking will be encouraged through reducing the impact of vehicle traffic in key areas of the city. New and improved pedestrian and cycle links including the Caldew and Lowry Hill Cycle ways and the River Petteril shared cycle/footway will be provided.	Transport Planning and Infrastructure	Cycle network	Cumbria County Council	Ongoing	Ongoing	Completion of proposed works and ongoing improvement of the cycle and pedestrian route network.	Not calculated	Plans to provide underpass for cycle and pedestrian access under Castle Way, financial Contribution made by new Sainsbury's. Funding is available for further Cycle links to the CNDR including Etterby Street. Planned improvement to pedestrian bridge connecting Currock to Denton Holme cycle ways. Major section of Caldew Cycleway now adopted. Further works planned on Petteril Valley cycleway and cycleway projects in the north of the city.	Expected to complete these detailed proposals during 2015 -16.	
6	Travel plans will be required to be implemented and monitored through S106 agreements for all new developments that meet the criteria. Existing businesses will be encouraged to implement, monitor and review travel plans.	Promoting Travel Alternatives	Workplace Travel Planning	Cumbria County Council & Carlisle City Council	Ongoing	Ongoing	Increased number of participant businesses and more widespread use of alternative transport.	Not calculated	New developments likely to result in increased highway usage must submit a travel plan for approval when making an application. All schools within the city now have travel plans.	Ongoing	

Measure No.	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
7	The City Council and the County Council will develop and implement a comprehensive 'Transport Overview and Joint Parking Policy'.	Policy Guidance and Development Control	Regional Groups Co-ordinating programmes to develop Area wide Strategies to reduce emissions and improve air quality	Cumbria County Council & Carlisle City Council	<2015	Date not yet confirmed	Approval and adoption of Transport Overview and Joint Parking Policy.	Not calculated	Mentioned as priority document in LTP (3). Ongoing discussions between authorities as to the future of the draft document.	Progress with the document and allocation of roles is ongoing.	
8	The City Council will continue to provide comprehensive control over emissions from all Part A2 and B Processes located within the local authority area.	Environmental Permits	Other measure through permit systems and economic instruments	Carlisle City Council	Ongoing	Ongoing	Risk based inspections showing that emission limits are being met and efforts are being made to improve on national objectives.	Not calculated	There are currently 71 part B & 2 A2 processes which are permitted by Carlisle CC. No enforcement action required during 2013 -14 in relation to emissions.	Ongoing	
9	The City Council will continue to investigate complaints of black smoke and smoke nuisance as well as managing smokeless zones. Enforcement action will be taken as necessary.	Public Information	Other	Carlisle City Council	Ongoing	Ongoing	Reduction in the number of complaints from members of the public. Reduction in repeat offenders.	Not calculated	Info on website advice and enforcement as required. No. smoke complaints responded to: 2007 - 67, 2008 - 48, 2009 - 47, 2010 - 53, 2011 - 52, 2012 - 32, 2013 - 51.	Ongoing	

Measure No.	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
10	Energy savings advice and subsidised home insulation improvements will continue to be provided to the public. Uptake will be monitored.	Public Information	Other	Carlisle City Council	Ongoing	Ongoing	Improved energy efficiency of residential properties.	Cumbria Warm Homes Project (CWHP) delivered a reduction of 317296 lifetime carbon tonnes. Oct 11-Mar 13	CWHP spent £4.9 million on subsidies and grants between Oct 11 – Mar 13. Carlisle CC no longer invest any funding in domestic energy projects such as cavity or loft insulation. Homelife team bid for a small amount of funding from private investment from Gas Safe, Npower, EON etc. for work such as boiler upgrade/repair and heating systems.	Expect to start installing new range of measures in September 2015.	
11	Environmental Health will work alongside the Neighbourhoods and Green Spaces team to investigate and implement the effective use of trees and green areas to offset traffic derived emissions in existing AQMA's and in new development areas.	Public Information	Other	Cumbria County Council & Carlisle City Council	Ongoing	Ongoing	Increase in trees and vegetation in visible locations. Increased public interest.	Not calculated	106 new trees plantd in parks and cemetery. 62 new trees planted on the roadsides and city centre from April 2012 - April 2014 by Carlisle City Council.	Highways claimed rights given back to County in March 2013. Plans for roadside tree planting are uncertain.	

Measure No.	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
12	Joint working will be extended in order to include air quality improvement in all relevant City Council and County Council policies and strategies.	Policy Guidance and Development Control	Air Quality Planning and Policy Guidance	Cumbria County Council & Carlisle City Council	Ongoing	Ongoing	Increased awareness of air quality issues and consideration given by more council departments.	Not calculated	Included air quality links within: Corporate Plan (2010-13) (Replaced by Carlisle Plan 2013-16) Local Transport Plan (LTP 3) (2011-26) The Local Plan (2001-2016) The Big Green City – The Green Infrastructure Strategy for Carlisle District (2011), The Cumbria Renewable Energy Capacity & Deployment Study (2011)	Ongoing	
13	The City Council will undertake regular publicity events and actively promote air quality and sustainable transport issues. Up to date air quality information and monitoring data will be provided to the public.	Public Information	via the Internet	Carlisle City Council	Ongoing	Ongoing	Increased public awareness and participation in improving air quality.	Not calculated	Previous partnership work with other Cumbrian authorities to promote alternative transport using adverts on busses. Air quality info and real time monitoring data is available on the website. Joint Cumbria bid (2013) to DFT Clean Bus Technology Fund was rejected.	Ongoing	

2.3 $PM_{2.5}$ – Local Authority Approach to Reducing Emissions and or Concentrations

As detailed in Policy Guidance LAQM.PG16 (Chapter 7), local authorities are expected to work towards reducing emissions and/or concentrations of $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5µm or less). There is clear evidence that $PM_{2.5}$ has a significant impact on human health, including premature mortality, allergic reactions, and cardiovascular diseases.

Carlisle City Council is taking the following measures to address $PM_{2.5}$:

- Carlisle City Council has monitored PM2.5 levels at Paddys Market since 2009 as part of the AURN. This is a busy city centre junction alongside one AQMA and adjacent to two others. The annual mean concentrations are consistently well below the objective at around 10-12 µg m^3 at this location, however ongoing efforts are being made to reduce these levels.
- Carlisle City Council will continue to work in partnership with Cumbria County Council as the Highways authority and also in relation to any planning applications with significant air quality implications. The Environmental Health department will continue to work with the City Council Planning Department with regard to new local developments and ensure that air quality implications and mitigation measures are taken into consideration in the planning process.
- We will continue to work alongside the Neighbourhoods and Green Spaces team to investigate and implement the effective use of trees and green areas to offset traffic derived emissions in existing AQMA's and in new development areas.
- The City Council will also continue to provide comprehensive control over emissions from all Part A2 and B Processes located within the local authority area. We will work closely with the operators of these installations to continuously monitor and improve on their emissions to air as part of the permitting process. In line with measures 2, 3, 6, 8, 11 and 12 of the above Action Plan.

3 Air Quality Monitoring Data and Comparison with Air Quality Objectives and National Compliance

3.1 Summary of Monitoring Undertaken

This section sets out what monitoring has taken place and how it compares with objectives.

3.1.1 Automatic Monitoring Sites

Carlisle City Council undertook automatic monitoring for nitrogen dioxide at two sites (Paddy's Market and Stanwix Bank) In addition PM_{10} and $PM_{2.5}$ hourly concentrations are measured at Paddy's Market. Stanwix Bank is located within AQMA 1 whereas Paddy's Market is not located within an AQMA.

Further details regarding the sites can found in Table A.1 within Appendix A. With wide scale improvements in pollutant concentrations such as 1,3 butadiene, benzene, carbon monoxide and lead local authorities do not have to report annually on these pollutants unless there is a localised problem. Up to date monitoring results for Paddy's Market (known as Carlisle Roadside on UK-AIR) and Stanwix Bank can be obtained from the respective web links:

https://uk-air.defra.gov.uk/data/site-data?f_site_id=CARL&view=last_hour

http://www.airqualityengland.co.uk/local-authority/?la_id=55

Maps showing the location of the monitoring sites are provided in Appendix D.

3.1.2 Non-Automatic Monitoring Sites

Carlisle City Council undertook non- automatic monitoring of NO_2 at fifty sites using diffusion tubes during 2015. Table A.2 within Appendix A shows the details of the sites. The full 2015 dataset of monthly mean values is provided in Appendix B. Further details on Quality Assurance/Quality Control (QA/QC) and bias adjustment for the diffusion tubes are included in Appendix C. Maps showing the location of the monitoring sites are provided in Appendix D.

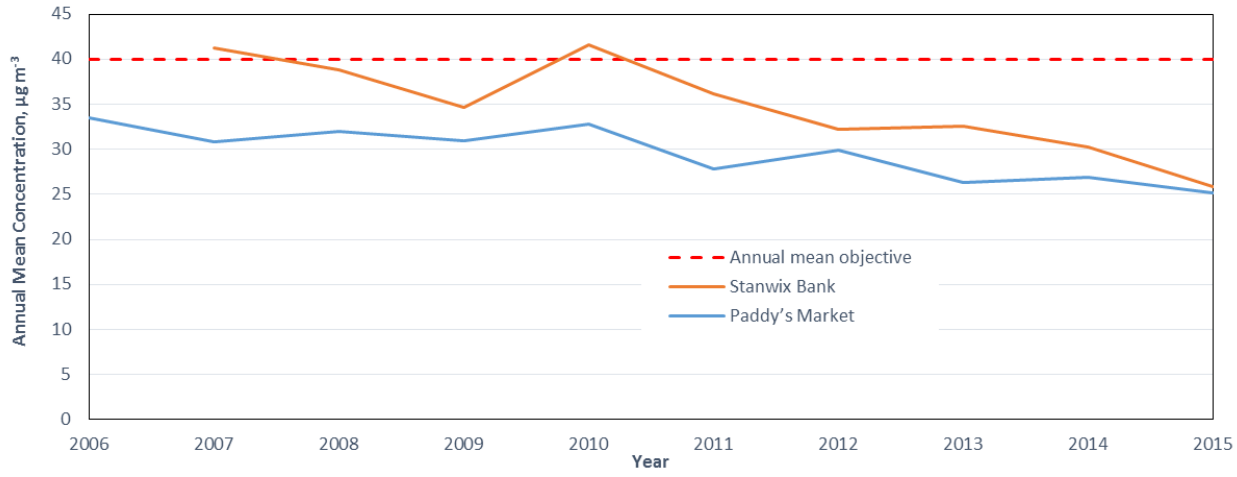
3.2 Individual Pollutants

The air quality monitoring results presented in this section are, where relevant, adjusted for "annualisation" and bias. Further details on bias corrections are provided in Appendix C.

3.2.1 Nitrogen Dioxide (NO_2)

With regards to the automatic monitoring nitrogen dioxide concentrations at Paddy's Market and Stanwix Bank began in 2006 and 2007, respectively. Figure 3-1 compares the annual mean concentration at both sites with the annual mean objective concentration (40 µg m^{-3}). At Paddy's Market concentrations have been consistently below the objective concentrations whereas at Stanwix Bank concentrations exceeded the annual objective concentration in 2007 and 2010 but since then concentrations have dropped to less than 26 µg m^{-3} in 2015. Monitoring data from these sites are also presented in Table A.3.

Figure 3-1 Annual mean nitrogen dioxide concentrations measured at Paddy's Market and Stanwix Bank.



Monitoring of nitrogen dioxide by diffusion tube within the Carlisle City Council has been organised according to eight geographical areas (Areas A, B, C, D, E, F, G and H). Table 3-1 lists which areas include the AQMAs.

Table 3-1- Location of areas monitored by diffusion tube and whether monitoring occurs within an AQMA

Area	Location	Are sites in an Air Quality Management Area?	Figure in Appendix D
A	A7	Yes, some sites in AQMA1	D.3
B	Currock Street Dalston Road	Yes, some sites in AQMA 2 Yes, some sites in AQMA 5	D.4
C	City centre	No	D.5
D	A69 Warwick Road	No	D.6
E	Wigton Road Bridge Street	Yes, some sites in AQMA 3 Yes, some sites in AQMA 4	D.7
F	A6 London Road/Botchergate	Yes, some sites in AQMA 6	D.8
G	Carlisle Northern Development Route	No	D.9
H	Mix of high population centres and outskirts of city	No	D.10

Some of these areas are included within air quality management areas while others are used to assess air quality within specific areas like the city centre or in areas that were previously border line for inclusion in a AQMA or areas in the outskirts of the city where it has been useful to measure the impact of the Carlisle Northern Development Route.

For consistency will previous progress, updating and screening reports all annual mean concentrations measured by diffusion tube within the local authority since 2006 are presented in Table A.3 within Appendix A. However, the format of the annual summary report implies that consideration should be given the most recent five years of data. Table 3-2 presents the annual mean concentrations measured at those fourteen monitoring stations within the six AQMAs.

Based on this monitoring data the following recommendations can be made regarding the future of each AQMA:

AQMA 1 (A7)	Consider amendment
AQMA 2 (Currock Street)	Keep
AQMA 3 (Wigton Road)	Revoke
AQMA 4 (Bridge Street)	Keep
AQMA 5 (Dalston Road)	Keep
AQMA 6 (London Road)	Keep

For those thirty six monitoring stations in non-AQMA locations there has been no exceedance on the annual objective concentration of 40 μg m^{-3} since 2012 so no additional AQMAs are required within the local authority.

Table A.4 in Appendix A compares the ratified continuous monitored NO_2 hourly mean concentrations for the past 5 years with the air quality objective of 200μg/m^3, not to be exceeded more than 18 times per year. There were no exceedancs of the 200 μg/m^{-3} at any point during the last five years or indeed since 2006.

Table 3-2 Nitrogen dioxide concentrations measured by diffusion tube within the six air quality management areas. Concentrations in brackets have been readjusted for distance to sensitive receptor.

Site ID	Site Name	NO_2 Annual Mean Concentration ($\mu g/m^3$)						Recommendation
		AQMA	2011	2012	2013	2014	2015	
A1	45 SCOTLAND RD	1	**44.6** (34.6)	39.8 (31.8)	37.1 (29.7)	36.4 (28.9)	35.6 (27.9)	While there has been no exceedance of annual objective within last three years in AQMA 1 concentrations at Brampton Road are sufficiently high to suggest there may be a risk of exceedance in future years ***Consider amendment of AQMA to include just Brampton Road***
A10	STANWIX BANK		**48 (42.9)**	**46.1 (41.5)**	**43.9** (39.6)	**40.9** (36.8)	37.4 (33.6)	
A5	37 KINGSTOWN RD		**41.3**	34.8	35	32.4	32.8	
A7	282 KINGSTOWN RD		30.7 (25.4)	27.5 (23.4)	27.7 (23.3)	24.6 (20.8)	25.4 (21.5)	
A9	BRAMPTON RD		**43.0**	**42.9**	36.7	36.5	35.9	
B4	DALSTON RD	5	**50.2**	**53.7**	**43.6**	**44.8**	**41.0**	Still exceeding air quality objective ***Keep AQMA***
B7	12 CURROCK ST	2	36.9	39.8	38.7	36.8	36.5	While no exceedances measured in last five year concentrations are sufficiently high to suggest there may be a risk of exceedance in future years ***Keep AQMA***
E12	3 WIGTON RD	3	**42.4** (39.9)	**41.8** (39.6)	37.1 (35.5)	36.1 (33.4)	34.0 (31.3)	No exceedance within last three years Clear downward trend ***Revoke AQMA***
E15	22 WIGTON RD		38.9	35.8	33.1	31	29.8	
E16	JOVIAL SAILOR		35.7	37.6	35	34.9	30.4	
E19	49 WIGTON RD		**45.4**	**42.5**	39.7	38.2	33.0	
E20	44 WIGTON RD		36.5	36.3	33.2	32	28.8	
E8	BRIDGE ST	4	**49.2**	**47**	**44.3**	**44.5**	**41.2**	Still exceeding air quality objective ***Keep AQMA***
F7	24 LONDON RD	6	39.3	**42.3**	37.8	35.3	35.5	While no exceedance within last three years concentrations are sufficiently high to suggest there may be a risk of exceedance in future years ***Keep AQMA***

3.2.2 Particulate Matter (PM_{10})

Figure 3-2 below and Table A.5 in Appendix A shows that concentrations have decreased slightly since 2006. As data capture was less than 75 % in 2013 and 2014 concentrations were adjusted or 'annualised' using methods described in Box 3.2 of LAQM.TG(09) (identical to method described in the updated guidance in Box 7.7 of LAQM.TG(16)). The calculations for 2013 and 2014 adjustments were presented in Appendix A of the USA 2015 report.

Concentrations are significantly below the annual mean objective of 40µg/m^3.

Figure 3-2 Annual mean PM_{10} concentrations measured at Paddy's Market

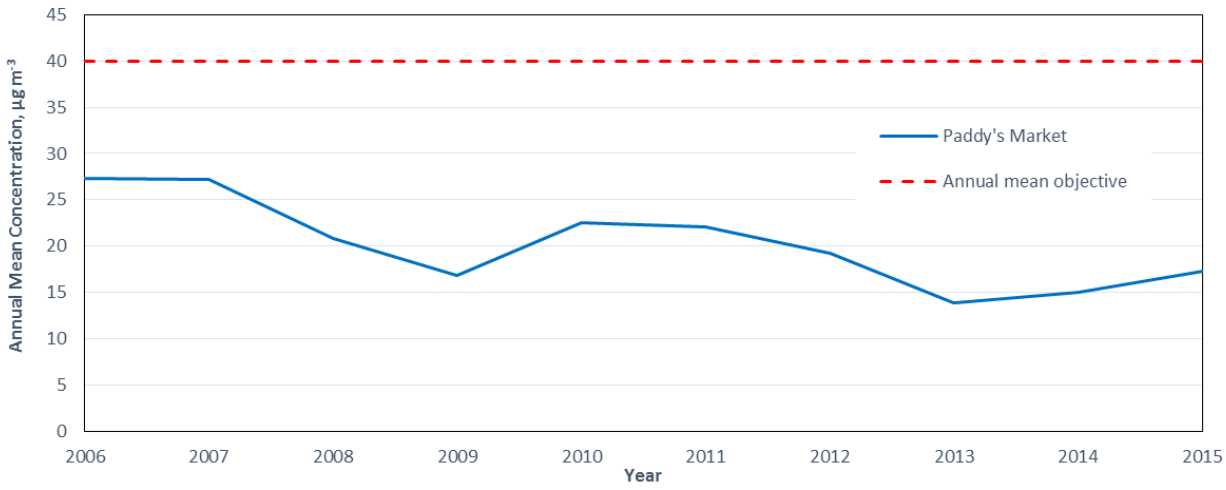
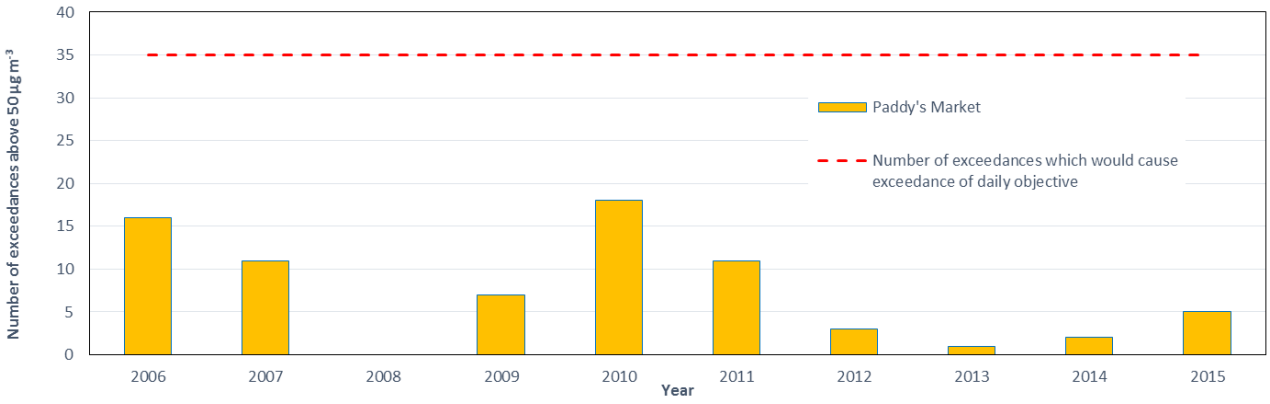


Table A.6 in Appendix A compares the ratified continuous monitored PM_{10} daily mean concentrations with the air quality objective of 50µg/m^3, not to be exceeded more than 35 times per year. The number of daily exceedances above 50 µg m^{-3} has been consistently less than than the 35 required for exceedance of the daily mean objective (see Figure 3-3).

Figure 3-3 Number of exceedances of daily mean objective of 50 µg m^{-3} at Paddy's Market since 2006

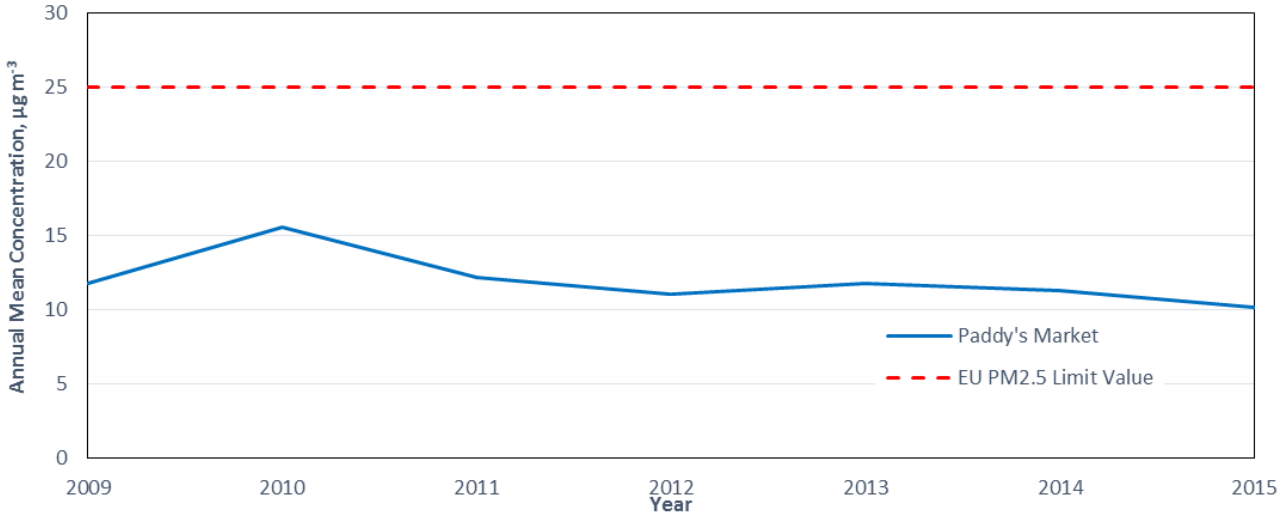


3.2.3 Particulate Matter ($PM_{2.5}$)

While there are no LAQM regulations to monitor $PM_{2.5}$ concentrations, local authorities are expected to work towards reducing $PM_{2.5}$ emissions and concentrations. $PM_{2.5}$ has been measured at Paddy's Market since March 2009 and as an affiliated site of Defra's Automatic Urban and Rural Network (AURN) provides a useful reference against which to assess measures to reduce emissions and concentrations.

Table A.7 in Appendix A presents the ratified monitored $PM_{2.5}$ annual mean concentrations since 2009. These data are presented in Figure 3-4 which shows that the annual average concentration has remained or level around 10 to 12 µg m^{-3} with the exception of 2010 when the concentrations reached a peak of 15.5 µg m^{-3}.

Figure 3-4 Annual mean $PM_{2.5}$ concentrations measured at Paddy's Market



Appendix A: Monitoring Results

Table A.1 – Details of Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA?	Monitoring Technique	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Inlet Height (m)
PM1	Paddy's Market(3)	Roadside	339467	555974	NO_2	N	Chemiluminescence	42	4	3
					PM_{10}	N	TEOM FDMS			2.9
					$PM_{2.5}$	N	TEOM FDMS			3
SB1	Stanwix Bank	Roadside	340018	557044	NO_2	Y	Chemiluminescence	32	3	2.2

(1) 0m if the monitoring site is at a location of exposure (e.g. installed on the façade of a residential property).

(2) N/A if not applicable.

(3) Site is known as Carlisle Roadside within the AURN

Table A.2 – Details of Non-Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA (AQMA ID)	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?	Height (m)
A1	45 SCOTLAND RD	Roadside	339995	557188	NO_2	Y (1)	N (4.5)	1.5	N	3.05
A10	STANWIX BANK	Roadside	340008	556842	NO_2	Y (1)	N (1.5)	1.5	N	2.95
A12	14 ETTERBY ST	Roadside	339935	557125	NO_2	N	Y (0)	3	N	2.8
A5	37 KINGSTOWN RD	Roadside	339758	558059	NO_2	Y (1)	Y (0)	4	N	2.8
A7	282 KINGSTOWN RD	Roadside	339526	559285	NO_2	Y (1)	N (7.5)	4	N	2.7
A9	BRAMPTON RD	Roadside	340028	556833	NO_2	Y (1)	Y (0)	1.5	N	2.75
B12	DENTON ST	Kerbside	339921	555406	NO_2	N	N (10)	0.5	N	2.65
B4	DALSTON RD	Roadside	339434	555638	NO_2	Y (5)	Y (0)	3.5	N	2.8
B5	8 JUNCTION ST	Roadside	339613	555587	NO_2	N	Y (0)	2.5	N	2.7
B6	41 CHARLOTTE ST	Roadside	339731	555526	NO_2	N	Y (0)	2.5	N	2.75
B7	12 CURROCK ST	Roadside	340205	555198	NO_2	Y (2)	Y (0)	3	N	3.05
C1	LOWTHER ST	Roadside	340216	556131	NO_2	N	Y (0)	3	N	2.85
C2	TOURIST INFO	Urban Centre	340069	555955	NO_2	N	N	N/A	N	2.7
C3	DEVONSHIRE ST	Roadside	340218	555768	NO_2	N	Y (0)	3	N	2.85
C4	BAR SOLO	Roadside	340286	555622	NO_2	N	Y (0)	9	N	2.7
C5	GRIFFIN	Roadside	340298	555589	NO_2	N	Y (0)	3	N	3
D10	368 WARWICK RD	Roadside	342044	555907	NO_2	N	Y (0)	5	N	2.75
D11	CARTREF	Roadside	340426	556040	NO_2	N	Y (0)	4.5	N	2.7
D12	POST OFFICE	Kerbside	340307	555718	NO_2	N	N	5	N	2.95
D5	215 WARWICK RD	Roadside	341310	555914	NO_2	N	Y (0)	9	N	2.4
D7	282 WARWICK RD	Roadside	341593	555893	NO_2	N	Y (0)	7	N	2.8
D9	251 WARWICK RD	Roadside	341426	555910	NO_2	N	Y (0)	8.5	N	2.7
E22	FINKLE ST	Roadside	339834	556137	NO_2	N	Y (0)	12	N	2.8
E12	3 WIGTON RD	Roadside	339225	555821	NO_2	Y (3)	N (2)	2.5	N	2.95
E15	22 WIGTON RD	Roadside	339091	555736	NO_2	Y (3)	Y (0)	4.5	N	3.9
E16	JOVIAL SAILOR	Roadside	339141	555900	NO_2	Y (3)	Y (0)	2.5	N	2.7
E19	49 WIGTON RD	Roadside	338953	555610	NO_2	Y (3)	Y (0)	2.5	N	3.1

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA (AQMA ID)	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?	Height (m)
E20	44 WIGTON RD	Roadside	339023	555692	NO_2	Y (3)	Y (0)	5.5	N	2.5
E4	JOHN ST	Roadside	339396	555947	NO_2	N	N (3)	3	N	2.75
E6	PADDYS MARKET 1	Roadside	339467	555974	NO_2	N	N (42)	9	Y	3
E6	PADDYS MARKET 2	Roadside	339467	555974	NO_2	N	N (42)	9	Y	3
E6	PADDYS MARKET 3	Roadside	339467	555974	NO_2	N	N (42)	9	Y	3
E8	BRIDGE ST	Roadside	339516	556024	NO_2	Y (4)	Y (0)	4	N	3.05
E21	BURGH RD	Roadside	337730	556118	NO_2	N	N (8)	3	N	2.9
F1	3 TAIT ST	Roadside	340482	555489	NO_2	N	Y (0)	3.5	N	2.7
F10	155 BOTCHERGATE	Roadside	349597	555351	NO_2	N	Y (0)	3	N	2.7
F5	STANLEY HALL	Roadside	340534	555409	NO_2	N	Y (0)	3	N	2.7
F7	24 LONDON RD	Roadside	340708	555240	NO_2	Y (6)	Y (0)	4.5	N	2.7
F9	129 LONDON RD	Kerbside	341099	554931	NO_2	N	Y (0)	0.5	N	2.95
G1	SPA HOUSE	Rural	338109	557841	NO_2	N	Y (0)	85	N	2.8
G2	KNOCKUPWORTH COTTAGE	Rural	337093	556785	NO_2	N	Y (0)	22	N	2.9
G3	CORNHILL FARM	Roadside	336338	556311	NO_2	N	Y (0)	3	N	2.9
G4	THE HOBBIT	Rural	336905	554036	NO_2	N	Y (0)	19	N	2.85
H1	BRAMPTON	Roadside	352824	561039	NO_2	N	N (0.5)	2.5	N	2.75
H3	LONGTOWN	Roadside	338052	568478	NO_2	N	N (0.5)	2.5	N	2.8
H4	WARWICK BRIDGE	Roadside	347411	556881	NO_2	N	N (0.5)	2.5	N	2.6
H5	WIGTON RD	Roadside	337643	554100	NO_2	N	Y (0)	1.5	N	2.4
H6	PETER LANE	Roadside	337962	553220	NO_2	N	Y (0)	4	N	2.4
H7	DALSTON RD	Roadside	338282	553396	NO_2	N	Y (0)	6.5	N	2.4
H8	AIRPORT	Other	347874	561254	NO_2	N	Y (0)	2	N	2.4

(1) 0m if the monitoring site is at a location of exposure (e.g. installed on the façade of a residential property).

(2) N/A if not applicable.

Table A.3 – Annual Mean NO_2 Monitoring Results

Site ID	Site Type	Monitoring Type	Valid Data Capture 2015 (%) [2]	NO_2 Annual Mean Concentration ($\mu g/m^3$) [3]									
				2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PM1	Paddy's Market	Chemilumine scence	80.1	33.5	30.8	32	30.9	32.8	27.8	29.9	26.3	26.9	25.1
SB1	Stanwix Bank	Chemilumine scence	95.6	-	**41.3**	38.8	34.6	**41.6**	36.2	32.2	32.6	30.3	25.9
A1	45 SCOTLAND RD	DT	100	**47.3**	**52.1**	**46.1 (43.4)**	**46.3 (35.8)**	**45.7 (35.6)**	**44.6** (34.6)	39.8 (31.8)	37.1 (29.7)	36.4 (28.9)	35.6 (27.9)
A10	STANWIX BANK	DT	100	**51.4**	**58.1**	**56.4**	**49.9 (44.8)**	**59.2 (52.5)**	**48 (42.9)**	**46.1 (41.5)**	**43.9** (39.6)	**40.9** (36.8)	37.4 (33.6)
A12	14 ETTERBY ST	DT	100	-	24.5	21.6	21	25.5	23.8	22.3	18.6	19.9	15.8
A5	37 KINGSTOWN RD	DT	100	**47.3**	**46.1**	**42.4**	**41.4**	**43.6**	**41.3**	34.8	35	32.4	32.8
A7	282 KINGSTOWN RD	DT	100	36.2	33.8	**30.7 (28.3)**	**31.4 (26.4)**	**34.1 (27.1)**	30.7 (25.4)	27.5 (23.4)	27.7 (23.3)	24.6 (20.8)	25.4 (21.5)
A9	BRAMPTON RD	DT	100	**44.2**	**47.5**	**42.6**	**41.9**	**48.5**	**43.0**	**42.9**	36.7	36.5	35.9
B12	DENTON ST	DT	100	-	**46.1**	**40.9 (25.9)**	**38.3 (35.0)**	**43.2 (33.6)**	35.2 (29.5)	36.9 (31.3)	37.3 (31.0)	33.5 (24.9)	30.3 (22.3)
B4	DALSTON RD	DT	92	**47.2**	**51.7**	**51**	**42.8**	**52.6**	**50.2**	**53.7**	**43.6**	**44.8**	**41.0**
B5	8 JUNCTION ST	DT	100	32.5	34.3	29.4	29.1	35.4	27.6	31.5	28.4	29	27.3
B6	41 CHARLOTTE ST	DT	100	38.1	38.3	33.2	32.3	38.6	33.5	34.9	32.2	30.8	29.9
B7	12 CURROCK ST	DT	100	**41.2**	**41.9**	**41.6**	39.8	**43.3**	36.9	39.8	38.7	36.8	36.5
C1	LOWTHER ST	DT	100	33.9	39.1	37.3	32.1	38.1	34.1	**42.6**	33.4	31.8	27.6
C2	TOURIST INFO	DT	92	15.9	20.5	16.2	17.6	19.9	18.2	18.5	19.2	24	17.9
C3	DEVONSHIRE ST	DT	100	35.1	**43.2**	37.6	35.2	39.4	36.5	39	36.6	31.8	29.3
C4	BAR SOLO	DT	100	36.2	**40.2**	39.1	33.8	37	34.6	36.2	33.2	32.8	27.8
C5	GRIFFEN	DT	100	39	**47.3**	**40.5**	**46.2**	**43.3**	40	39.7	38.3	34.9	33.6
D10	368 WARWICK RD	DT	100	33.2	34.5	31.6	28.9	35.5	31.1	32.8	30	28.1	27.0
D11	CARTEF	DT	100	-	38.4	35.6	29.4	37.4	31.5	34.4	32.7	31.9	28.9
D12	POST OFFICE	DT	100	**45.1**	**48.7**	**42.6**	**40.1**	**42.8**	**41.7**	**41.6**	39.1	38.6	36.1
D5	215 WARWICK RD	DT	100	24.4	27.2	24.1	22.5	28	22.3	25.5	23.3	23.2	21.9
D7	282 WARWICK RD	DT	100	35.8	**40.7**	37.9	33.1	37.1	37.3	36.8	33.6	32.2	33.2
D9	251 WARWICK RD	DT	100	30.6	32.1	27.7	27.1	34.4	27.6	29.8	29.7	28.2	25.7
E22	FINKLE ST	DT	100	37.9	**42.7**	37.6	37.1	**40.4**	38.4	36.4	34.6	33.4	30.9
E12	3 WIGTON RD	DT	67	**40.1**	**49.3**	**46.9 (41.5)**	**44.4 (41.8)**	**47.4 (44.2)**	**42.4** (39.9)	**41.8** (39.6)	37.1 (35.5)	36.1 (33.4)	34.0 (31.3)
E15	22 WIGTON RD	DT	100	38.8	**45.3**	**42.5**	39.1	**45.5**	38.9	35.8	33.1	31	29.8
E16	JOVIAL SAILOR	DT	100	37.8	**42.3**	**44.7**	36	39.3	35.7	37.6	35	34.9	30.4
E19	49 WIGTON RD	DT	100	**43.9**	**51.7**	**46.9**	**46.7**	**51.2**	**45.4**	**42.5**	39.7	38.2	33.0
E20	44 WIGTON RD	DT	100	33.8	**44.9**	**41.6**	37.1	**43.4**	36.5	36.3	33.2	32	28.8
E4	JOHN ST	DT	100	38.8	**42.2**	**42.9 (37.8)**	**35.7 (34.1)**	**43.7 (40.4)**	37.5 (35.2)	37.7 (35.7)	36.9 (34.9)	37.7 (34.1)	34.2 (30.8)
E6_1	PADDYS MARKET 1	DT	100	29	36.1	31.6	31.5	36.8	31.2	30.6	29.8	31.3	29.3
E6_2	PADDYS MARKET 2	DT	100	29.6	34.4	32.8	33.3	39.2	31.1	29.7	31.8	30.9	29.1
E6_3	PADDYS MARKET 3	DT	100	26.5	34.8	34.5	31.6	36.9	30.5	30.6	30.8	29.7	29.8
E8	BRIDGE ST	DT	100	**50.3**	**63.6**	**55.8**	**50.6**	**56.6**	**49.2**	**47**	**44.3**	**44.5**	**41.2**
E21	BURGH RD	DT	92	15.7	22.4	16.2 (15.5)	18.7 (16.1)	21.8 (17.9)	18.7 (15.7)	19.5 (16.7)	18.4 (15.8)	18.3 (14.8)	15.5 (12.9)
F1	3 TAIT ST	DT	100	33.2	33.8	32.6	31.2	35.1	30.5	33.8	30.3	29.1	30.1

Site ID	Site Type	Monitoring Type	Valid Data Capture 2015 (%) (2)	NO_2 Annual Mean Concentration ($\mu g/m^3$) (3)									
				2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
F10	155 BOTCHERGATE	DT	100	34.4	38.7	35.2	33	39.1	33	36	34	37.3	34.7
F5	STANLEY HALL	DT	92	34.9	33.2	38.1	33	39.7	35.5	34.5	32.5	33.4	29.2
F7	24 LONDON RD	DT	100	**43.3**	**41.4**	39.4	36.3	**45.5**	39.3	**42.3**	37.8	35.3	35.5
F9	129 LONDON RD	DT	100	32.6	36.8	32.7	31.5	37.7	33.9	35.1	33.4	32.1	29.0
G1	Spa House	DT	100	-	-	-	-	-	-	13.2	12.9	12.6	11.9
G2	Knockupworth Cottage	DT	100	-	-	-	-	-	-	12	14.6	13.5	12.7
G3	Cornhill Farm	DT	100	-	-	-	-	-	-	11.2	10.8	11.2	9.2
G4	The Hobbit	DT	100	-	-	-	-	-	-	15.2	14.1	14.6	12.5
H1	BRAMPTON	DT	92	19.3	23.9	20.9 (20.3)	18.7 (18.2)	23.2 (22.4)	18.8 (18.3)	19.9 (19.3)	18.5 (17.9)	17.2 (16.7)	16.7 (16.2)
H3	LONGTOWN	DT	100	20.7	26.9	23.1 (22.4)	21.5 (20.8)	26.0 (24.9)	22.4 (21.7)	24.0 (23.2)	21.9 (21.2)	22.1 (21.4)	19.8 (19.2)
H4	WARWICK BRIDGE	DT	92	-	-	35.7 (34.5)	31.8 (30.8)	37.2 (35.9)	30.9 (29.8)	33.2 (32)	30.8 (29.8)	29.6 (28.5)	27.0 (26.1)
H5	WIGTON RD	DT	92	-	-	27.3	20	26.8	22	20.5	16.8	17.5	15.7
H6	PETER LANE	DT	100	-	-	11.3	10.2	14.2	11.5	12.6	12.3	11.4	9.8
H7	DALSTON RD	DT	100	-	-	15.8	15.7	20	16.9	17.8	18.1	16.8	15.4
H8	AIRPORT	DT	100	-	-	9.8	9.1	11	9.5	9.7	8.6	8.4	7.7

Notes: Exceedances of the NO_2 annual mean objective of 40µg/m^3 are shown in **bold**.

NO_2 annual means exceeding 60µg/m^3, indicating a potential exceedance of the NO_2 1-hour mean objective are shown in **bold and underlined.**

(1) data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) Means for diffusion tubes have been corrected for bias. All means have been "annualised" as per Technical Guidance LAQM.TG16 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Table A.4 – 1-Hour Mean NO_2 Monitoring Results

Site ID	Site Type	Valid Data Capture 2015 (%) (2)	NO_2 1-Hour Means > 200µg/m^3 (3)									
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PM1	Paddy's Market	80.1	0	0	0	0	0	0	0	0	0	0
SB1	Stanwix Bank	95.6	0	0	0	0	0	0	0	0	0	0

Notes: Exceedances of the NO_2 1-hour mean objective (200µg/m^3 not to be exceeded more than 18 times/year) are shown in **bold.**

(1) data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) If the period of valid data is less than 85%, the 99.8th percentile of 1-hour means is provided in brackets.

Table A.5 – Annual Mean PM_{10} Monitoring Results

Site ID	Site Type	Valid Data Capture 2015 (%) (2)	PM_{10} Annual Mean Concentration (µg/m^3) (3)									
			2006	2007	2008	2009	2010	2011	2012	2013 (Estimated)	2014 (Estimated)	2015
PM1	Paddy's Market	85.5	27.3	27.2	20.8	16.8	22.5	22.1	19.2	13.9	15.0	17.3

Notes: Exceedances of the PM_{10} annual mean objective of 40µg/m^3 are shown in **bold.**

(1) data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) All means have been "annualised" as per Technical Guidance LAQM.TG16, valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Table A.6 – 24-Hour Mean PM_{10} Monitoring Results

Site ID	Site Type	Valid Data Capture 2015 (%) (2)	PM_{10} Annual Mean Concentration (µg/m^3) (3)									
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PM 1	Paddy's Market	85.5	16	11	0	7	18	11	3	1 (20)	2 (25)	5

Notes: Exceedances of the PM_{10} 24-hour mean objective (50µg/m^3 not to be exceeded more than 35 times/year) are shown in **bold.**

(1) data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) If the period of valid data is less than 85%, the 90.4th percentile of 24-hour means is provided in brackets.

Table A.7 – $PM_{2.5}$ Monitoring Results

Site ID	Site Type	Valid Data Capture 2015 (%) (2)	$PM_{2.5}$ Annual Mean Concentration ($\mu g/m^3$) (3)						
			2009	2010	2011	2012	2013	2014	2015
PM1	Paddy's Market	85.4	11.8	15.54	12.21	11.04	11.70	11.32	10.16

(1) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(2) All means have been "annualised" as per Technical Guidance LAQM.TG16, valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Appendix B: Full Monthly Diffusion Tube Results for 2015

Table B.1 – NO_2 Monthly Diffusion Tube Results -2015

Site ID	NO_2 Mean Concentrations ($\mu g/m^3$)												Annual Mean	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Raw Data	Bias Adjusted (1)
A1	44.28	51.27	37.55	32.90	35.90	39.05	33.61	34.17	39.70	43.23	34.89	42.70	39.10	35.59
A10	35.52	44.68	45.59	32.34	37.72	45.44	40.98	37.67	51.71	61.72	29.45	29.97	41.07	37.37
A12	15.47	23.64	20.14	16.69	12.72	15.05	11.84	14.78	19.55	27.74	13.76	17.56	17.41	15.85
A5	34.04	47.14	36.54	31.29	29.81	39.14	34.30	33.27	37.81	42.18	35.46	31.20	36.02	32.77
A7	30.66	32.89	30.14	24.54	24.15	27.84	23.81	26.42	30.63	32.93	24.19	26.45	27.89	25.38
A9	39.66	47.01	36.75	49.38	34.65	45.26	37.72	36.77	44.10	45.98	30.64	25.67	39.47	35.91
B12	32.93	38.69	31.45	27.69	25.81	32.64	29.83	28.34	40.41	48.45	31.71	31.15	33.26	30.26
B4	52.04	48.62	44.15	37.23	41.47	48.01	41.40	38.97	a	54.37	44.81	43.94	45.00	40.95
B5	34.67	34.52	30.49	27.37	24.92	27.51	25.77	24.06	28.99	37.21	33.93	30.20	29.97	27.27
B6	34.63	40.91	29.75	27.77	29.46	26.64	29.58	29.05	35.41	46.07	33.46	31.69	32.87	29.91
B7	39.31	49.09	41.44	33.05	32.68	40.84	35.64	37.09	44.52	51.39	34.67	41.00	40.06	36.45
C1	31.25	35.94	27.55	25.13	23.42	29.42	26.78	26.60	30.34	37.22	34.10	35.54	30.28	27.55
C2	23.59	25.18	21.67	16.06	12.60	14.51	14.12	18.80	20.82	25.53	a	23.13	19.64	17.87
C3	32.01	37.33	34.18	30.81	32.30	34.05	28.27	28.27	33.75	38.97	27.07	29.95	32.25	29.34
C4	28.55	31.19	33.44	27.52	28.01	30.96	27.49	27.06	34.57	39.99	25.96	32.45	30.60	27.85
C5	41.82	42.79	37.28	32.46	34.38	37.77	34.67	32.41	37.74	41.83	32.90	36.54	36.88	33.56
D10	31.44	39.23	33.13	25.65	24.98	26.16	25.15	25.81	27.82	35.86	31.07	29.85	29.68	27.01
D11	34.55	38.07	26.85	32.52	29.12	31.82	30.28	28.86	36.19	39.67	28.12	25.52	31.80	28.94
D12	42.50	45.20	41.24	30.13	38.63	36.06	39.67	31.78	37.28	48.16	38.24	46.63	39.63	36.06
D5	26.05	27.34	29.32	25.35	19.35	22.22	20.32	21.55	26.64	28.52	22.04	19.89	24.05	21.88
D7	41.64	44.46	38.21	29.59	34.68	33.33	37.49	32.05	36.87	38.87	37.26	33.80	36.52	33.23

Site ID	NO_2 Mean Concentrations (µg/m^3)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean	
													Raw Data	Bias Adjusted (1)
D9	30.52	37.81	31.24	24.91	24.04	26.28	24.03	28.32	31.88	36.17	21.29	23.05	28.29	25.75
E22	34.54	40.30	33.48	31.66	26.64	30.51	32.25	30.54	37.59	40.30	34.30	35.00	33.92	30.87
E12	34.70	a	38.11	a	33.62	34.83	35.94	a	a	54.81	37.64	29.39	37.38	34.02
E15	35.22	41.93	39.41	26.30	21.68	31.92	33.34	29.85	32.82	40.32	34.01	25.84	32.72	29.78
E16	31.70	37.05	41.02	27.63	28.13	28.68	28.78	27.38	40.51	47.81	29.62	32.83	33.43	30.42
E19	35.04	43.15	39.02	29.11	27.39	32.74	34.28	30.77	39.15	55.13	32.55	36.64	36.25	32.98
E20	34.20	35.03	38.30	26.79	25.39	32.37	29.45	27.92	31.03	41.29	28.96	28.85	31.63	28.78
E4	38.36	41.91	41.48	36.60	30.90	34.02	34.13	33.91	37.97	46.92	38.63	36.18	37.58	34.20
E6_1	34.71	38.92	34.97	28.88	25.81	28.93	28.67	30.50	31.28	42.36	34.96	26.67	32.22	29.32
E6_2	35.15	37.87	35.11	29.61	26.66	29.03	28.26	28.27	34.34	43.98	28.85	26.87	32.00	29.12
E6_3	32.92	37.43	38.49	29.03	27.48	29.37	29.30	32.14	32.12	44.05	33.65	27.26	32.77	29.82
E8	43.45	49.94	46.56	37.23	41.78	44.64	51.32	40.25	46.37	53.71	49.29	39.28	45.32	41.24
E21	20.42	25.01	19.87	15.61	11.44	15.19	14.00	13.38	16.72	a	14.82	20.53	17.00	15.47
F1	36.42	34.81	35.53	27.36	25.85	30.90	24.58	30.40	32.91	31.95	58.53	28.22	33.12	30.14
F10	39.45	41.50	41.77	43.03	31.27	38.11	36.60	33.50	40.46	50.35	26.68	35.27	38.17	34.73
F5	29.99	34.38	39.41	30.08	25.09	34.49	32.26	30.39	39.51	a	25.52	31.73	32.08	29.19
F7	42.69	42.71	45.35	35.17	34.23	38.46	40.85	35.53	40.22	42.40	35.09	35.24	38.99	35.49
F9	32.44	38.35	36.85	26.58	22.80	32.67	26.46	28.82	39.77	44.34	21.67	31.88	31.88	29.01
G1	13.33	17.53	13.93	12.02	8.25	12.56	10.85	10.60	15.89	19.62	10.08	12.22	13.07	11.90
G2	17.20	18.54	9.84	12.03	10.13	13.81	11.83	11.92	13.18	20.28	14.76	13.78	13.94	12.69
G3	10.48	13.61	11.64	9.38	6.59	8.91	7.37	8.25	10.61	14.65	8.57	11.55	10.13	9.22
G4	12.47	16.03	15.23	14.64	8.64	12.90	11.19	11.29	17.43	24.33	9.01	12.21	13.78	12.54
H1	23.46	21.50	21.15	a	13.31	16.56	14.61	15.02	22.39	22.10	14.92	16.89	18.36	16.70
H3	27.10	29.41	20.93	23.95	17.58	20.76	19.59	19.26	20.33	27.94	16.21	18.08	21.76	19.80
H4	27.12	32.50	36.48	29.34	26.67	26.96	30.63	27.96	a	38.19	27.62	23.39	29.71	27.04

Site ID	NO_2 Mean Concentrations (µg/m^3)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean	
													Raw Data	Bias Adjusted (1)
H5	a	25.03	19.14	17.90	12.95	13.84	12.73	13.20	15.71	24.53	18.05	16.88	17.27	15.71
H6	10.16	12.87	11.38	10.81	6.75	10.63	10.09	7.89	11.86	17.23	8.45	11.03	10.76	9.80
H7	17.31	22.61	17.67	13.72	11.21	15.66	15.34	15.52	18.76	26.92	11.45	17.14	16.94	15.42
H8	11.71	11.13	8.26	5.83	6.05	6.63	6.00	6.04	8.28	12.69	6.85	12.12	8.46	7.70

(1) See Appendix C for details on bias adjustment

Appendix C: Supporting Technical Information / Air Quality Monitoring Data QA/QC

QA/QC of automatic monitoring data
Both of our automatic stations are subject to stringent QA/QC procedures.

Paddy's Market, which monitors PM_{10}, NO_2 and $PM_{2.5}$, is part of the AURN and the network quality assurance and control procedures are implemented.

To ensure optimum data quality and capture, a three-tier system of calibration and analyser test procedures is employed in the AURN. The major components of this system are briefly described below.

a) Daily automatic IZS checks - these allow instrumental drifts to be examined, and act as a daily check on instrument performance.

b) Fortnightly manual calibrations - these are performed by the local site operators and are used by management unit to scale raw pollution data.

c) 6 – monthly network inter calibrations – These exercises are performed by the QA/Qc Unit every 6 months to ensure that all measurements from all network stations are completely representative and intercomparable. The inter calibrations will also act as an independent audit of the system at the site.

Data ratification is undertaken at 3 monthly intervals. This involves a critical review of all information relating to the data set to verify, amend or reject the data. The ratified data represents the final data set in the review & assessment process.

The NO_2 monitoring data from the Stanwix Bank monitoring unit was collected Ricardo Energy and Environment during 2015. The site is due to close summer 2016.

Diffusion Tube Bias Adjustment Factors
Diffusion tube precision can be described as the ability of a measurement to be consistently reproduced, i.e. how similar the results of duplicate or triplicate tubes are to each other. Accuracy represents the ability of the measurement to represent the 'true' value, which, in this case, is defined as the result from the automatic analyser. When averaged over a number of sets of results bias can be evident. This represents the overall tendency of the diffusion tubes to depart from the 'true' value, i.e. to systematically over or under-read when compared against the reference method. Once identified, bias can be adjusted for in order to improve the accuracy of diffusion tube results. This is done using bias adjustment factors, which have been found to be specific to a laboratory and tube preparation method.

As a result of the considerable difference in the performance of tubes prepared by different labs, government guidance recommends that a bias adjustment factor is determined and applied to the data. Technical guidance gives a method for this, which involves the co-location of these tubes with a chemiluminescent NOx analyser.

Authorities are asked to report the adjustment factor from their own co-location study, where available. The national bias adjustment factor is then determined by collating and assessing data from NO_2 co-location studies across the UK. Full details of both

the national and local bias adjustment factors used to adjust data and details of data precision are provided below.

Factor from Local Co-location Study

Carlisle City Council utilises NO_2 diffusion tubes prepared with 20% TEA in water, these are prepared and analysed by Gradko Environmental Ltd.

A local bias adjustment factor of **0.77** was derived from the diffusion tubes co-located at the Paddy's Market monitoring station for 2015. This is a roadside location, not representative of public exposure, located close to two air quality management areas.

The local bias adjustment factor was calculated using the RICARDO-AEA Spreadsheet for checking the precision and accuracy of triplicate tubes, found on the Defra Local Air Quality Management (LAQM) website. The following screen print shows the results of the data that was input into the spreadsheet:

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements

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	Automatic Method: Period Mean	Automatic Method: Data Capture (% DC)	Data Quality Check: Tubes Precision Check	Data Quality Check: Automatic Monitor Data
1	01/01/2015	31/01/2015	34.7105	35.15	32.9154	34	1.2	3	2.9	25.217	97.04	Good	Good
2	01/02/2015	28/02/2015	38.9163	37.866	37.4252	38	0.8	2	1.9	29.9601	95.24	Good	Good
3	01/03/2015	31/03/2015	34.9702	35.105	38.4869	36	2.0	6	4.9	27.4713	48.39	Good	Poor Data Capture
4	01/04/2015	30/04/2015	28.8796	29.607	29.0275	29	0.4	1	1.0	29.0392	93.61	Good	Good
5	01/05/2015	31/05/2015	25.8074	26.663	27.4814	27	0.8	3	2.1	18.3356	99.73	Good	Good
6	01/06/2015	30/06/2015	28.9349	29.03	29.3659	29	0.2	1	0.6	20.3868	99.72	Good	Good
7	01/07/2015	31/07/2015	28.6725	28.256	29.2968	29	0.5	2	1.3	19.8721	87.23	Good	Good
8	01/08/2015	31/08/2015	30.4975	28.27	32.1395	30	1.9	6	4.8	23.0556	77.82	Good	Good
9	01/09/2015	30/09/2015	31.28	34.34	32.12	33	1.6	5	3.9	28.0106	59.03	Good	Poor Data Capture
10	01/10/2015	31/10/2015	42.3624	43.982	44.0506	43	1.0	2	2.4	34.0193	94.62	Good	Good
11	01/11/2015	30/11/2015	34.9616	28.847	33.6499	32	3.2	10	8.0	24.3414	95.28	Good	Good
12	01/12/2015	31/12/2015	26.6658	26.873	27.2552	27	0.3	1	0.7	19.2049	15.86	Good	Poor Data Capture
13													

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

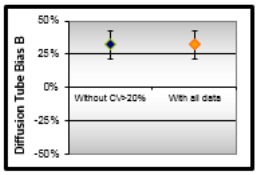
Overall survey --> Good precision | Poor Overall

(Check average CV & DC from Accuracy calculations)

Site Name/ ID:

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

Accuracy (with 95% confidence interval) without periods with CV larger than 20%		Accuracy (with 95% confidence interval) WITH ALL DATA	
Bias calculated using 9 periods of data		Bias calculated using 9 periods of data	
Bias factor A	0.77 (0.71 - 0.83)	Bias factor A	0.77 (0.71 - 0.83)
Bias B	30% (20% - 41%)	Bias B	30% (20% - 41%)
Diffusion Tubes Mean:	32 µgm^{-3}	Diffusion Tubes Mean:	32 µgm^{-3}
Mean CV (Precision):	3	Mean CV (Precision):	3
Automatic Mean:	25 µgm^{-3}	Automatic Mean:	25 µgm^{-3}
Data Capture for periods used:	93%	Data Capture for periods used:	93%
Adjusted Tubes Mean:	25 (23 - 27) µgm^{-3}	Adjusted Tubes Mean:	25 (23 - 27) µgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

Tube precision is separated into two categories good or poor. Tubes are considered to have good precision where the coefficient of variation (CV) of duplicate or triplicate diffusion tubes for eight or more periods during the year is less than 20%, and the average CV of all monitoring periods is less than 10%. Tubes are considered to have poor precision where the CV of four or more periods is greater than 20% and/or the average CV is greater than 10%. All of the 12 diffusion tube study periods shown above had a CV of below 20% (good precision).

The data capture from the automatic analyser for 2015 was poor overall. As a result the local bias adjustment factor was calculated using 9 months of valid data and the outcome is summarised as follows:

Diffusion tubes annual mean: **32µg/m^3**
Automatic monitoring station mean: **25 µg/m^3**
Local bias adjustment factor: **0.77**

Factor from National Co-location Studies

A national bias adjustment factor of **0.91** was calculated using the bias adjustment factor spreadsheet version 03/16 from the Defra LAQM website. This adjustment factor is based on 29 other co-location studies nationwide. All of the studies were analysed by Gradko for the method 20% TEA in water during 2015.

Discussion of Choice of Factor to Use

It was decided that the national bias adjustment factor would be the most appropriate to use. This factor is the higher of the two so it would give the worst case results when multiplied with the raw monitoring data. It was also considered that a correction factor derived from 29 co-location studies would incorporate variation from many different types of monitoring site. This would reflect the wide range of locations in which we expose our 50 diffusion tubes across the district, some of which differ considerably from our own co-location site. In addition to this the data capture from our Paddys Market automatic analyser was about 80 % for 2015, this is shown as poor overall in the data quality check on the above screen print. **The annual mean for each diffusion tube location has therefore been adjusted using the national bias adjustment factor of 0.91**.

Appendix D: Map(s) of Monitoring Locations

Figure D.1 Maps of Automatic Monitoring Site: Paddy's Market

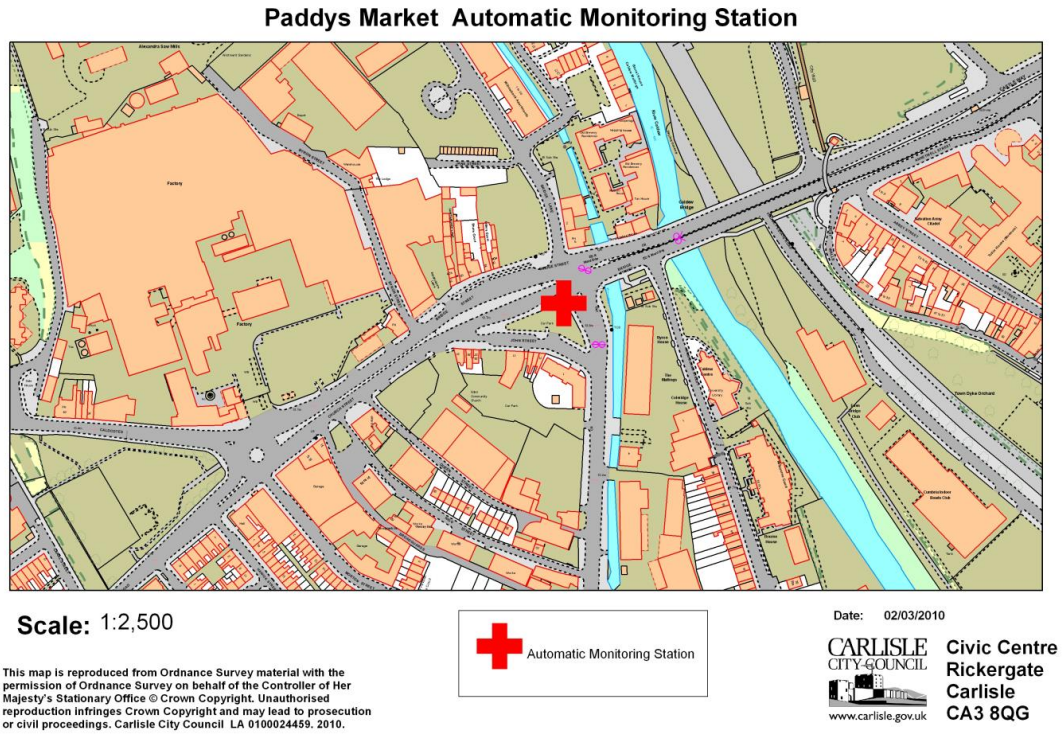
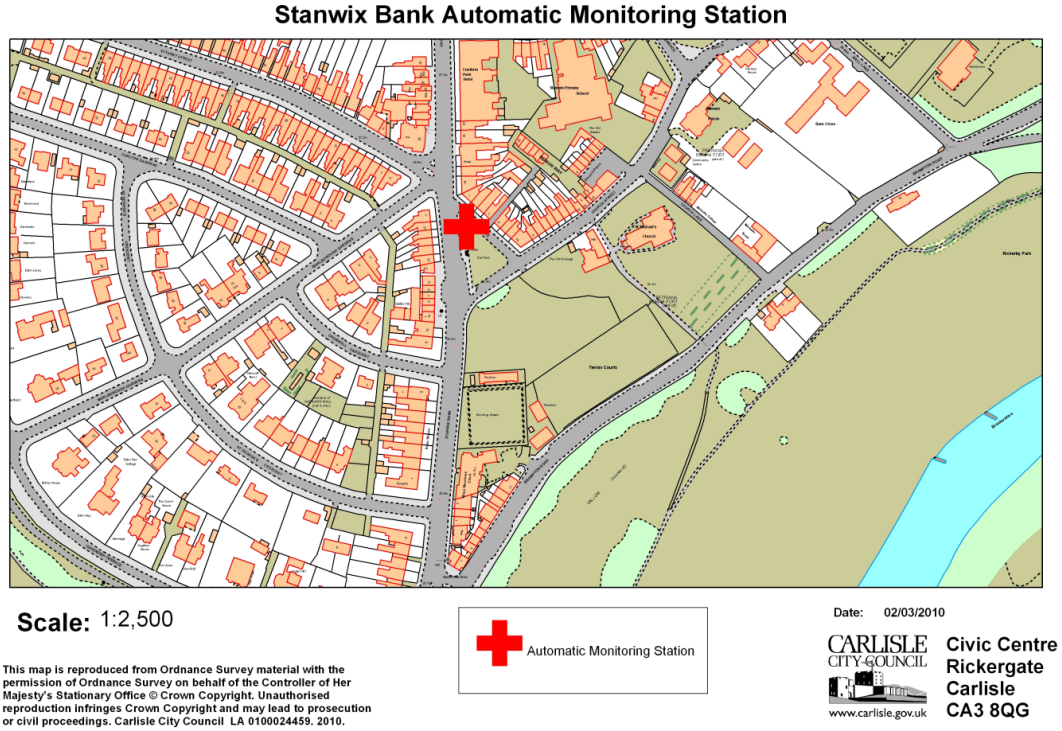


Figure D.2 Maps of Automatic Monitoring Site: Stanwix Bank

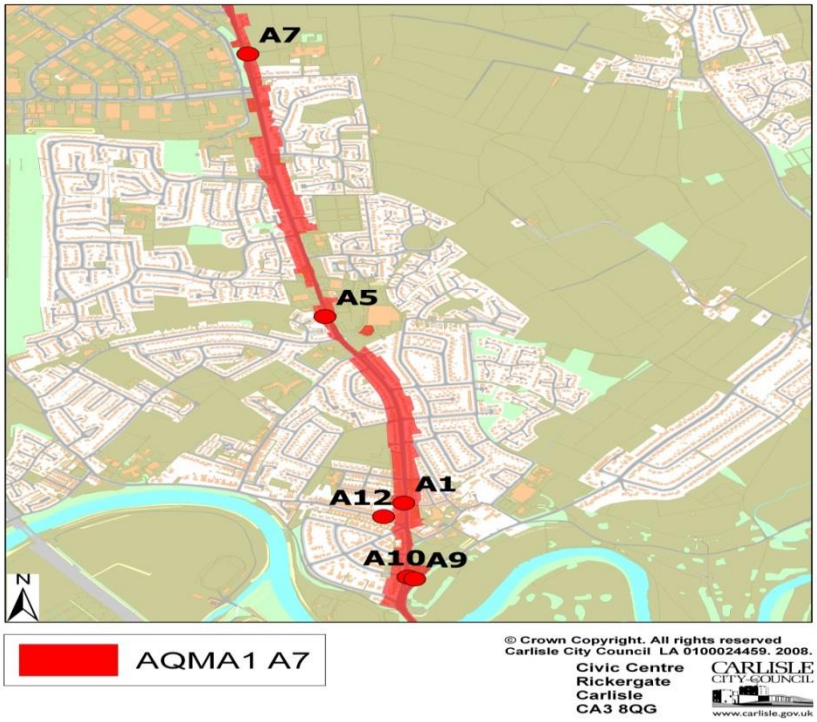


Non- automatic nitrogen dioxide monitoring

Area A – A7 Stanwix Bank, Scotland Rd and Kingstown Rd (AQMA No1)

Figure D.3 Map of diffusion tube locations in area A.

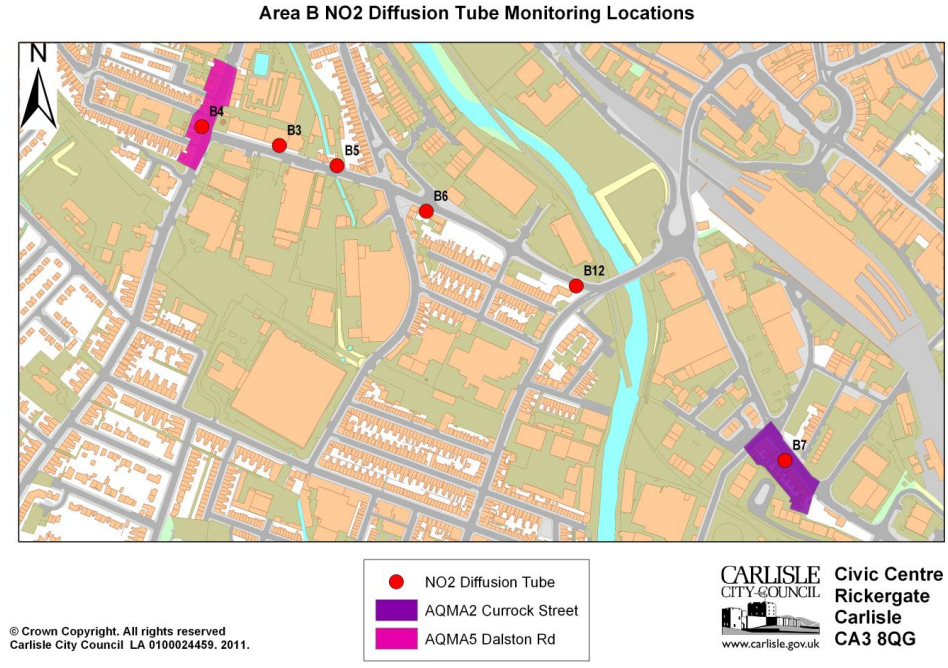
Area A NO2 Diffusion Tube Monitoring Locations



Area B – Currock St, Victoria Viaduct, Charlotte St, Junction St and Dalston Rd (Includes AQMA No.2 and No.5)

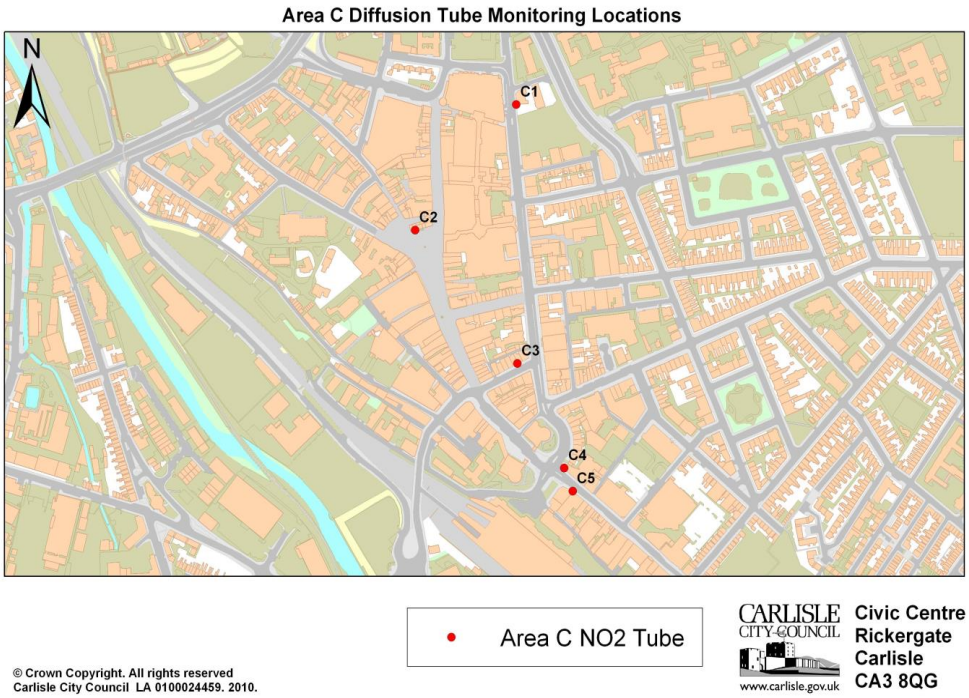
Figure D.4:Map of diffusion tube locations in area B

Area B NO2 Diffusion Tube Monitoring Locations



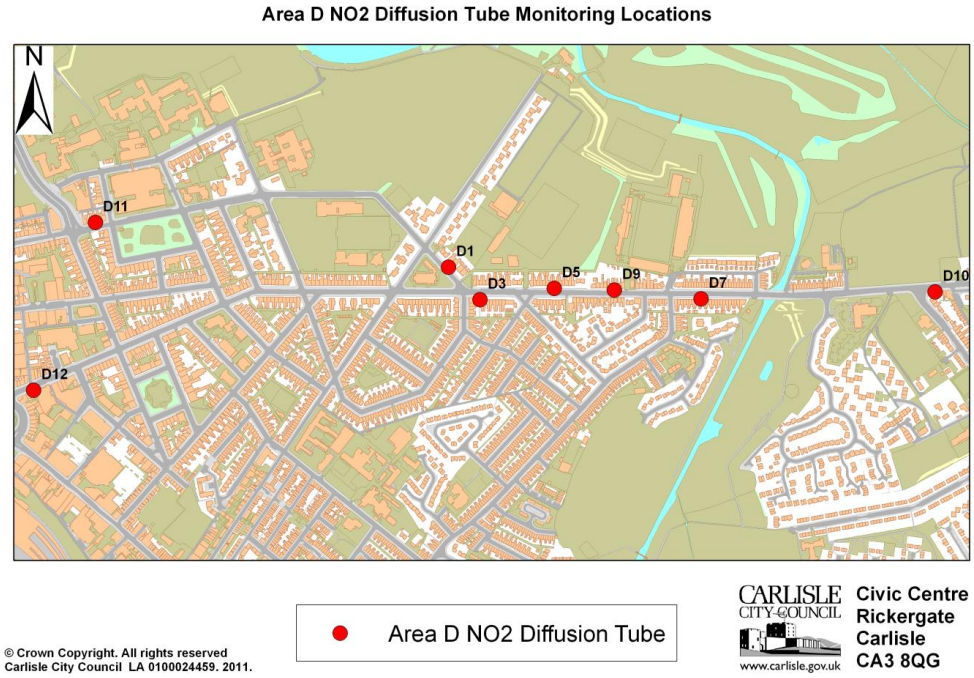
Area C – City Centre Locations

Figure D.5: Map of diffusion tube locations in area C



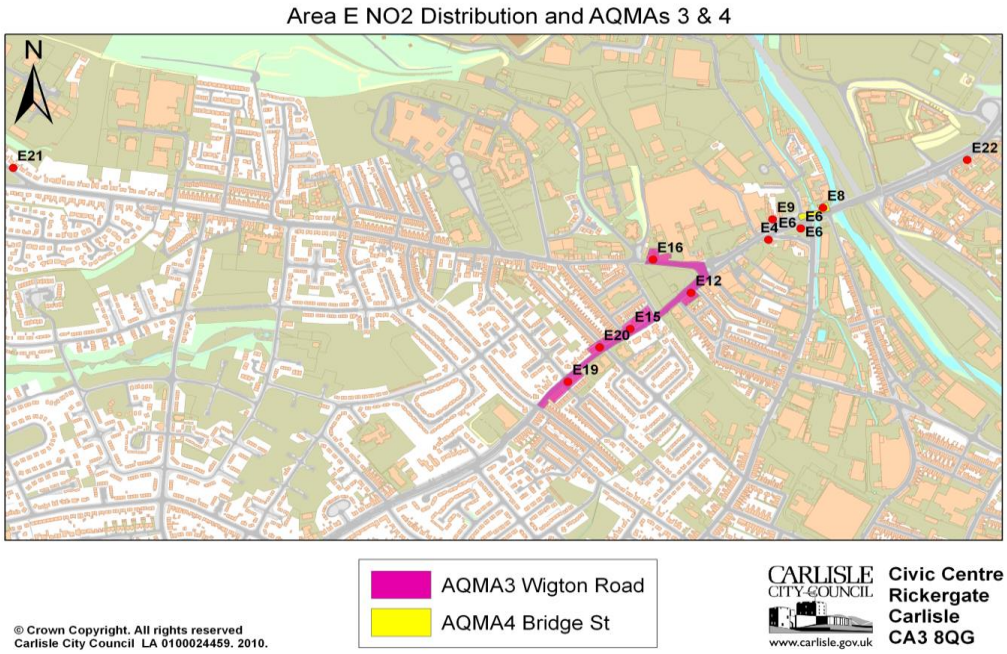
Area D A69 – Warwick Rd

Figure D.6: Map of diffusion tube locations in area D.



Area E - A595 Caldewgate, Wigton Rd and Newtown Rd (includes AQMA No3 and AQMA No4)

Figure D.7: Map of diffusion tube locations in area E.



Area F – A6 London Road / Botchergate (AQMA No6)

Figure D.8: Map of diffusion tube locations in area F.

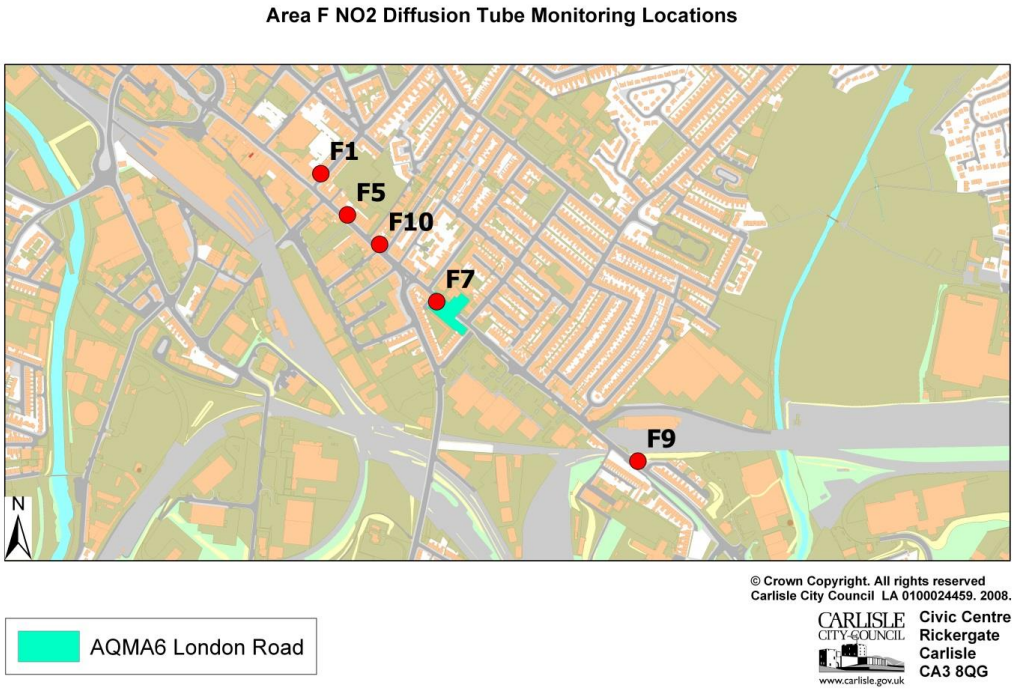
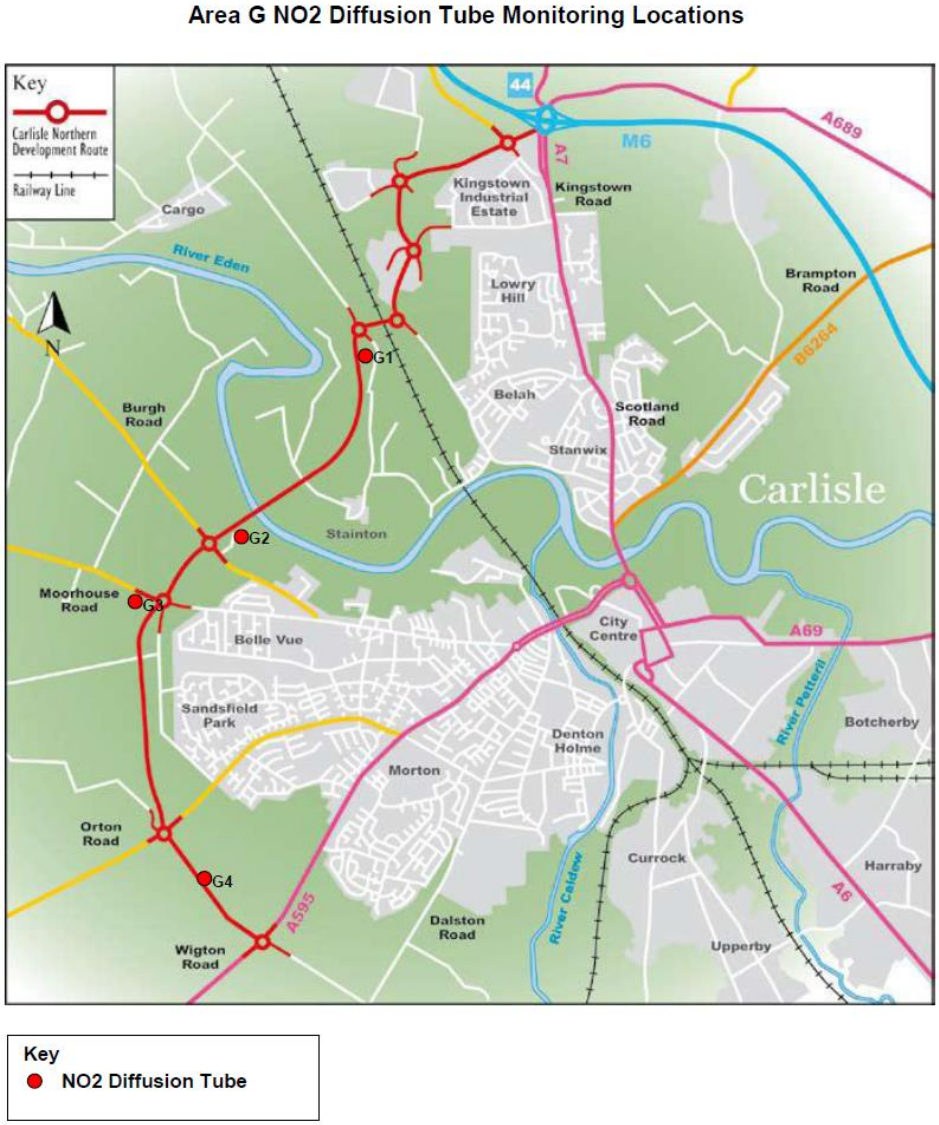
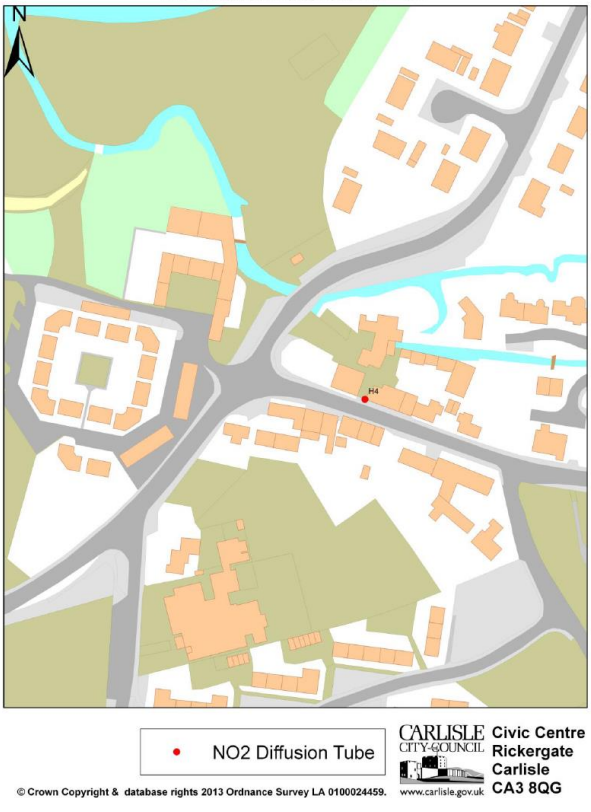


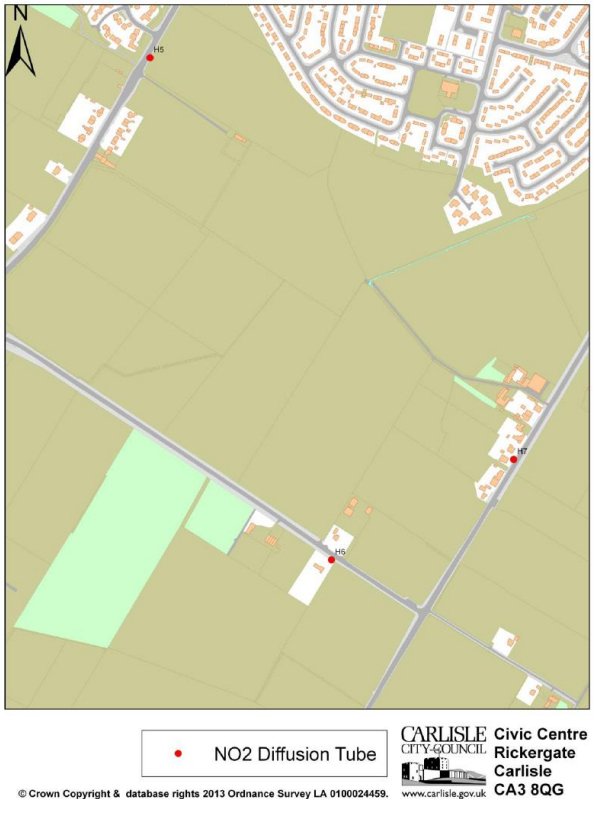
Figure D.9: Map of diffusion tube locations in area G.

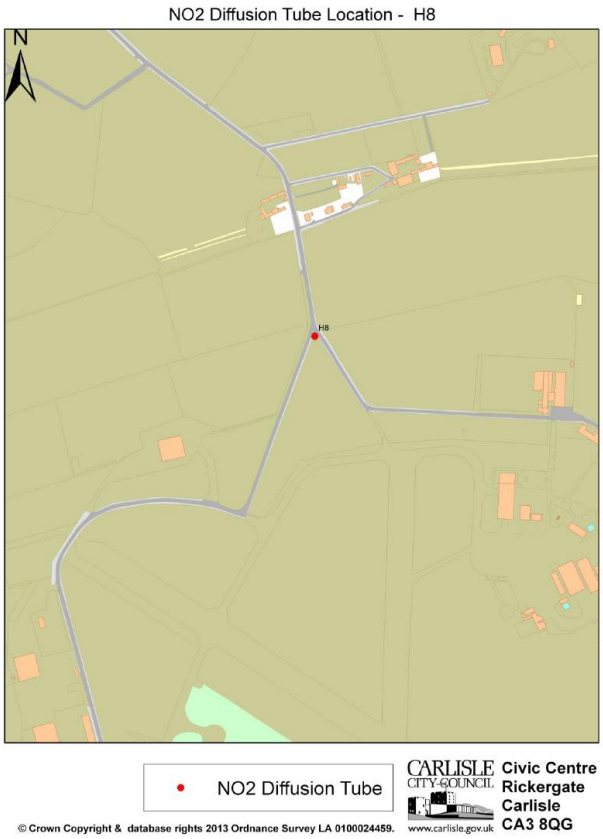


Area H – Outskirts of City, Townships and Airport

Figure D.10: Maps of diffusion tube locations in area H.






NO2 Diffusion Tube Location - H8
N
H8
NO2 Diffusion Tube
CARLISLE CITY COUNCIL
www.carlisle.gov.uk
Civic Centre
Rickergate
Carlisle
CA3 8QG
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Appendix E: Summary of Air Quality Objectives in England

Table E.1 – Air Quality Objectives in England

Pollutant	Air Quality Objective[4]	
	Concentration	Measured as
Nitrogen Dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean
	40 µg/m^3	Annual mean
Particulate Matter (PM_{10})	50 µg/m^3, not to be exceeded more than 35 times a year	24-hour mean
	40 µg/m^3	Annual mean
Sulphur Dioxide (SO_2)	350 µg/m^3, not to be exceeded more than 24 times a year	1-hour mean
	125 µg/m^3, not to be exceeded more than 3 times a year	24-hour mean
	266 µg/m^3, not to be exceeded more than 35 times a year	15-minute mean

[4] The units are in microgrammes of pollutant per cubic metre of air (µg/m^3).

Glossary of Terms

Abbreviation	Description
AQAP	Air Quality Action Plan - A detailed description of measures, outcomes, achievement dates and implementation methods, showing how the local authority intends to achieve air quality limit values'
AQMA	Air Quality Management Area – An area where air pollutant concentrations exceed / are likely to exceed the relevant air quality objectives. AQMAs are declared for specific pollutants and objectives
ASR	Air quality Annual Status Report
Defra	Department for Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges – Air quality screening tool produced by Highways England
EU	European Union
FDMS	Filter Dynamics Measurement System
LAQM	Local Air Quality Management
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
PM_{10}	Airborne particulate matter with an aerodynamic diameter of 10µm (micrometres or microns) or less
$PM_{2.5}$	Airborne particulate matter with an aerodynamic diameter of 2.5µm or less
QA/QC	Quality Assurance and Quality Control
SO_2	Sulphur Dioxide
…	…

References

Carlisle City Council, Environmental Health. Air Quality and Land use planning. (2006)

Carlisle City Council Second Round Review and Assessment Reports:
Carlisle City Council. Air Quality Updating & Screening Assessment. (2003)

Carlisle City Council. Air Quality Detailed Assessment. (2004)

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