2019 Air Quality Annual Status Report (ASR)

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

August 2019

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Executive Summary: Air Quality in Our Area

Air Quality in Carlisle City Council

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].

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 Status 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 initially 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 to the Caldewgate roundabout and properties in Caldcotes.

Carlisle City Council had six AQMAs listed on the Department for Environment, Food and Rural Affairs (Defra) website in 2018: https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=48.

[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

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:

- AQMA 1 (A7):
- AQMA 2 (Currock Street);
- AQMA 4 (Bridge Street);
- AQMA 5 (Dalston Road);

AQMA 1[4] was significantly reduced in size; it no longer includes the area along the A7 from Hardwicke Circus to Junction 44 of the M6 instead it includes just an area extending for approximately 100 m from the Stanwix Bank junction (A7) along Brampton Road including properties 1 to 17 on Brampton Road. The order came into force on 25th July 2019.

The orders for revocation of AQMA 3[5] and AQMA 6[6] came into force on 3rd July 2019. Copies of the orders can be obtained from www.carlisle.gov.uk (see footnotes below).

Actions to Improve Air Quality

Carlisle City Council has taken forward a number of measures during the current reporting year of 2018 in pursuit of improving local air quality. Key local measures continue to support improvements in local air quality and the City Council continues to work on:

- Carlisle Northern Development Route, continues to be monitored to assess the impact of traffic on air quality. Plans to extend the bypass are currently in development, as part of the 'Garden City' project.
- Bus infrastructure improvements: Ongoing improvements to bus services with new shelters and raised kerbs continues. In addition, plans for large new housing developments will include public transport provision.

[4] https://www.carlisle.gov.uk/Portals/0/Documents/Residents/Environment/Air%20Quality%20Management%20Order%20No%201%20.pdf

[5] https://www.carlisle.gov.uk/Portals/0/Documents/Residents/Environment/AL517%20-%20Order%20Revoking%20Air%20Quality%20Management%20Order%20Area%20No%203.pdf

[6] https://www.carlisle.gov.uk/Portals/0/Documents/Residents/Environment/AL517%20-%20Order%20Revoking%20Air%20Quality%20Management%20Order%20.pdf

- Cycling: Works on a pedestrian crossing on Castle Way incorporating Smart Signalling from the main Hardwicke Circus roundabout is complete, linking the city centre to Carlisle Castle.
- Low Carbon Carlisle: A bid for ERDF funding has been submitted with a value of £4m. The scheme has 14 elements including improving the existing cycleways, creating new sections of cycle track and installing vehicle charging points.
- A scheme to introduce 21 vehicle charging points on council owned land is to be introduced during 2019-20. The scheme is aimed at residential properties which have no access to off street parking.

Conclusions and Priorities

In conclusion, monitoring of pollutants over the last 5 years has shown a gradual but steady decline in nitrogen dioxide (NO_2) and particulate (PM_{10} and $PM_{2.5}$) concentrations. Although particulate measurements are well below the air quality objectives, some locations across the city still exceed or are just below the air quality objectives for NO_2. As a result, Carlisle City Council is to retain four of the six AQMAs. Of these four, AQMA 1 will be significantly reduced in size.

AQMA 3 (Wigton Road) and AQMA 6 (London Road) were revoked in July 2019.

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

- Revise the Air Quality Action Plan. Drive forward on actions identified in the Action Plan;
- Promote travel plans and introduction of green spaces for all new housing developments – look to introduce zero and near zero emission vehicle uptake as part of new residential development
- Continue to work with businesses to promote more widespread use of alternative transport.

Local Engagement and 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 2018. 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 compliance with the objectives.

A summary of AQMAs declared by Carlisle City Council can be found in Table 2.1. 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.

See Appendix D: Map(s) of Monitoring Locations and AQMAs.

AQMA 3 and AQMA 6 were revoked 3rd July 2019.

AQMA 1 was significantly reduced in size with the revised order in force on 25th July 2019.

Table 2.1 – Declared Air Quality Management Areas

AQMA Name	Date of Declaration	Pollutants and Air Quality Objectives	City / Town	One Line Description	Is air quality in the AQMA influenced by roads controlled by Highways England?	Level of Exceedance (maximum monitored/modelled concentration at a location of relevant exposure)		Link
						At Declaration	Now (2018)	
AQMA 1	02/12/2005	NO_2 Annual Mean	Carlisle	A7 between Hardwicke Circus and J44 of the M6 and Brampton Rd for a distance of 100m from the Stanwix Bank junction ***Amended 25th July 2019 to include just 100 m Section along B6264 Brampton Road.***	YES	45.3	33.5	https://www.carlisle.gov.uk/LinkClick.aspx?fileticket=r3R76WJIhuI%3D&tabid=729&portalid=0&mid=2838
AQMA 2	26/01/2007	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.	NO	44.6	35.2	https://www.carlisle.gov.uk/LinkClick.aspx?fileticket=r3R76WJIhuI%3D&tabid=729&portalid=0&mid=2838
AQMA 3	01/08/2008	NO_2 Annual Mean	Carlisle	Wigton Road between Crummock Street and Caldewgate roundabout as well as properties on Caldcotes. ***Revoked 3rd July 2019***	NO	40	31.7	https://www.carlisle.gov.uk/LinkClick.aspx?fileticket=r3R76WJIhuI%3D&tabid=729&portalid=0&mid=2838

AQMA 4	01/08/2008	NO_2 Annual Mean	Carlisle	North side of the A595 at Bridge Street, northbound from the junction with Shaddongate.	NO	43.9	40.8	https://www.carlisle.gov.uk/LinkClick.aspx?fileticket=r3R76WJIhuI%3D&tabid=729&portalid=0&mid=2838
AQMA 5	01/08/2008	NO_2 Annual Mean	Carlisle	Junction of Dalston Road and Junction Street	NO	48	35.8	https://www.carlisle.gov.uk/LinkClick.aspx?fileticket=r3R76WJIhuI%3D&tabid=729&portalid=0&mid=2838
AQMA 6	01/08/2008	NO_2 Annual Mean	Carlisle	London Road and properties on either side near the junction with Blake Street ***Revoked 3rd July 2019***	NO	43.3	32.2	https://www.carlisle.gov.uk/LinkClick.aspx?fileticket=r3R76WJIhuI%3D&tabid=729&portalid=0&mid=2838

☒ **Carlisle City Council confirm the information on UK-Air regarding their AQMA(s) is up to date**

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

Defra's appraisal of last year's ASR[7] reviewed the fitness for purpose of each of the Air Quality Management Areas and made a number of recommendations:

- AQMA 1: Monitoring results for all locations apart from Brampton Road are significantly below objective levels and a result the Council should review the boundary of this AQMA;
- AQMA 2: Review monitoring locations;
- AQMA 3: Agreed with proposal to revoke;
- AQMA 4: Confirm if monitoring site is relevant for exposure;
- AQMA 5: Add additional monitoring sites to confirm extent of exceedance;
- AQMA 6: Agreed with proposal to revoke;

In addition, the council should review the measures in its action plan.

As discussed in the Executive Summary AQMA 1 has been reduced in size and AQMA 3 and AQMA 6 were revoked in July 2019.

CCC has taken forward a number of direct measures during the current reporting year of 2018 in pursuit of improving local air quality and targeting overall improvements in air quality which support focussed actions in hotspots. Details of all measures completed, in progress or planned are set out in Table 2.2.

More detail on these measures can be found in the Action Plan. Key completed measures are:

- Carlisle Northern Development Route continues to be monitored to ensure improvements in air quality continue to benefit local residents.
- Effective traffic management leading to reduction in congestion and standing traffic.
- Increased use of alternative transport, including adoption of cycle ways and improvement of pedestrian/cycle bridges.

[7] https://www.carlisle.gov.uk/Portals/0/2018%20ASR_Carlisle_final_2.pdf

The Action Plan will be revised now that AQMA 3 and AQMA 6 have been revoked.

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'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.
- Implement major schemes for cycleway improvements and vehicle charging infrastructure, subject to external funding.
- Work closely with Public Health on air pollution awareness, especially $PM_{2.5}$.

Table 2.2 – Progress on Measures to Improve Air Quality

Measure No.	Measure	EU Category	EU Classification	Organisations involved and Funding Source	Planning Phase	Implementation Phase	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
1	'Carlisle Northern Development Route,' to the west of the City will remove up to 25% of through traffic.	Traffic Management	Other	Cumbria County Council & Carlisle City Council	Complete	2007-2012.	Reduced NO2 levels at monitoring locations and within AQMA's.	Anticipate approx 25% reduction in NO2 in city centre.	CNDR operational. Monitoring at receptors on new road revealed consistently low NO2 levels, monitoring subsequently reduced in 2018. Further evidence of NO2 improvements and traffic reduction in the city centre. Several new cycle links from arterial routes to CNDR complete. Plans for future improvements	Ongoing	Plans now being developed for a further 'Southern Bypass' as part of the Garden Village project This would extend the existing CNDR and link both ends of the bypass to the M6 Motorway, around the City Centre.
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 & Carlisle City Council	Ongoing	Ongoing	Reduced NO2 levels and standing traffic within AQMA's.	Not calculated	Completed works on pedestrian crossing on Castle way incorporating Smart Signalling from the main Hardwicke Circus roundabout. Ongoing work to improve traffic flow	Ongoing.	Such projects require significant investment.
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 applicants.	Not calculated	Environmental Health is consulted on all proposed developments which may impact on air quality. Responses are aimed at minimising AQ impacts. This currently includes many large residential developments on fringe of city. Recommendations made for car charging points on all new residential properties with parking/garage provision.	Ongoing	Environmental Health comment on all potentially polluting developments. The outcome depends on Planning Department and current policy

Measure No.	Measure	EU Category	EU Classification	Organisations involved and Funding Source	Planning Phase	Implementation Phase	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
4	Upgrade of 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 NO2 along main routes	Not calculated	Ongoing improvements to bus services with new shelters and raised kerbs. Plans for large new housing developments include public transport provision and/or sustainable transport options.	Ongoing	Success is dependent on public uptake of sustainable transport options.
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	The pedestrian crossing on Castle way incorporating Smart Signalling is complete. Pedestrian/cycle bridge connecting Currock and Denton Holme, over the railway line are complete. Low Carbon Carlisle bid for ERDF funding has been submitted with a value of £4m. The scheme aims at improving the existing cycleways, creating new sections of cycle track and installing vehicle charging points.	Ongoing	Ongoing plans associated with improved pedestrian and cycle connections to the CNDR. Plans still being developed for a new cycle/footway connecting Etterby area in the north of the city to the west. This will utilise an existing disused railway bridge, over the river Eden. New funding bids have the potential to accelerate major improvements.
6	Travel plans will be required to be implemented and monitored through S106 agreements for all new developments that meet the criteria.	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	All schools within the city now have travel plans. New developments likely to result in increased highway usage must submit a travel plan for approval when making an application.	Ongoing	Difficult to quantify the impact of Travel Plans.

Measure No.	Measure	EU Category	EU Classification	Organisations involved and Funding Source	Planning Phase	Implementation Phase	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
	Existing businesses will be encouraged to implement, monitor and review travel plans.										
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	Limited progress to date	Carlisle City Council continue to make enquiries with Cumbria County Council as to the future of this measure.	This measure is unlikely to be implemented. A long time has passed since work began on the draft document.
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 41 part B & 3 A2 processes which are permitted by Carlisle CC. No recent enforcement action required during 2018 in relation to emissions.	Ongoing	No new major polluting processes in previous year.
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	There is information on website. Environmental Health provide advice and enforcement as required. Smoke complaints are responded to involving domestic fires, bonfires, trade waste, industrial and dark smoke. Recent advice leaflet printed for all cases of domestic burning.	Ongoing	Increase in enquiries and uptake of log burners and multi fuel stoves. Advice given to minimise potential for smoke issues and ensure compliance with smokeless zones.

Measure No.	Measure	EU Category	EU Classification	Organisations involved and Funding Source	Planning Phase	Implementation Phase	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
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	Number of properties taking up schemes, resulting in Improved energy efficiency of housing stock.	Cumbria Warm Homes Project (CWHP) delivered a reduction of 317296 lifetime carbon tonnes.	Carlisle CC Home Improvement Agency is currently delivering Health through Warmth Scheme, supported by the Energy Companies Obligation. This includes boiler upgrades and home insulation. Safe and warm grants are provided by the council to deliver up to £7,500 to enable low income homes to carry out minor repairs and energy efficiency measures to their homes. Work has begun on enforcing the Minimum Energy Efficiency Standards, specifically aimed at private rented sector properties.	Ongoing	Carlisle CC are currently revising Housing Renewal Assistance Policy under the Regulatory Reform Order 2002. This will cover all grants involving housing and energy efficiency measures.
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	Carlisle City Council continues to manage and maintain trees in parks and green spaces, including some additional planting, of mainly mixed broadleaf species, where necessary. Planting of green areas is an essential part of many new developments, including residential.	Ongoing	Limitations to planting options in busy urban areas. Parks and open spaces do not have significant air quality issues. Green Spaces continue to have a positive public impact.

Measure No.	Measure	EU Category	EU Classification	Organisations involved and Funding Source	Planning Phase	Implementation Phase	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
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 most major relevant policies including Local Transport Plan (LTP 3) (2011-26) and The Carlisle District Local Plan (2015-30). New schemes in place to deliver improved cycling routes and vehicle charging infrastructure.	Ongoing	Air Quality considerations are put forward during discussion and consultation stages of policy development.
13	The City Council will 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/ PH	Ongoing	Work closely with DPH and multi-agency partners to raise awareness and AQ issues	Increased public awareness and participation in improving air quality.	Not calculated	Air quality info and real time monitoring data is available on the website. Monitoring data shows continued improvement in most areas. Carlisle CC is actively supporting and promoting Clean Air Day, utilising Social Media and our website, as part of the Global Action Plan. Recent successful Air Quality competition, for all local primary schools. Prizes awarded including bikes and cycling equipment.	Ongoing	Difficult to quantify any improvement as a direct result of promotional work or providing monitoring data.

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 $PM_{2.5}$ levels at Paddys Market AQMS since 2009 as part of the AURN. This is a busy city centre junction between two AQMA's. The annual mean concentrations, since 2012, are consistently well below the objective at around 9-12 µg m^3 at this location (see Figure A.4), 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.

Carlisle City Council now has four designated smoke control areas. The locations of the smoke control areas within Carlisle are highlighted on our online mapping tool (http://maps.carlisle.gov.uk/MyCarlisle.aspx) or can be downloaded as a map (http://www.carlisle.gov.uk/LinkClick.aspx?fileticket=9E67HYHexDw%3d&tabid=729&portalid=0&mid=2838).

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

3.1 Summary of Monitoring Undertaken

3.1.1 Automatic Monitoring Sites

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

Carlisle City Council undertook automatic (continuous) monitoring at Paddy's Market during 2018. Details of the site (known as Carlisle Roadside within the AURN) are presented in Table A.1 in Appendix. Also presented in Table A.1 are details of Carlisle Stanwix Bank site which closed 24th November 2016. National monitoring results and site information for the Carlisle Roadside AURN site are available at https://uk-air.defra.gov.uk/data/flat_files?site_id=CARL and https://uk-air.defra.gov.uk/networks/site-info?site_id=CARL.

Maps showing the location of the monitoring sites are provided in Appendix D. Further details on how the monitors are calibrated and how the data have been adjusted are included in Appendix C.

3.1.2 Non-Automatic Monitoring Sites

Carlisle City Council undertook non-automatic (passive) monitoring of NO_2 at thirty sites during 2018. There had been a significant reduction in the number of diffusion tube sites during 2017 with the total decreasing by twenty sites. For completeness all sites in operation in 2017 and onwards are presented in Table A.2 Appendix A.

Maps showing the location of the monitoring sites are provided in Appendix D. Further details on Quality Assurance/Quality Control (QA/QC) for the diffusion tubes, including bias adjustments are included in Appendix C. As the data capture was greater than 75 % at all sites, annualisation of annual mean concentrations was not required in 2018.

3.2 Individual Pollutants

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

3.2.1 Nitrogen Dioxide (NO_2)

Automatic monitoring of nitrogen dioxide concentrations began in 2006 at Paddy's Market (PM1), while monitoring began at Stanwix Bank in 2007. Figure 3-1 compares the annual mean concentration at both sites with the annual mean objective concentration (40 µg m^{-3}). Monitored NO_2 concentrations at Paddy's Market and Stanwix Bank automatic monitoring stations have been consistently below the objective concentrations since 2011. Monitoring at the Stanwix Bank site has now ceased. Monitoring data from these sites are also presented in Table A.3.

Figure 3-1: Automatic monitoring data (2006 – 2018)

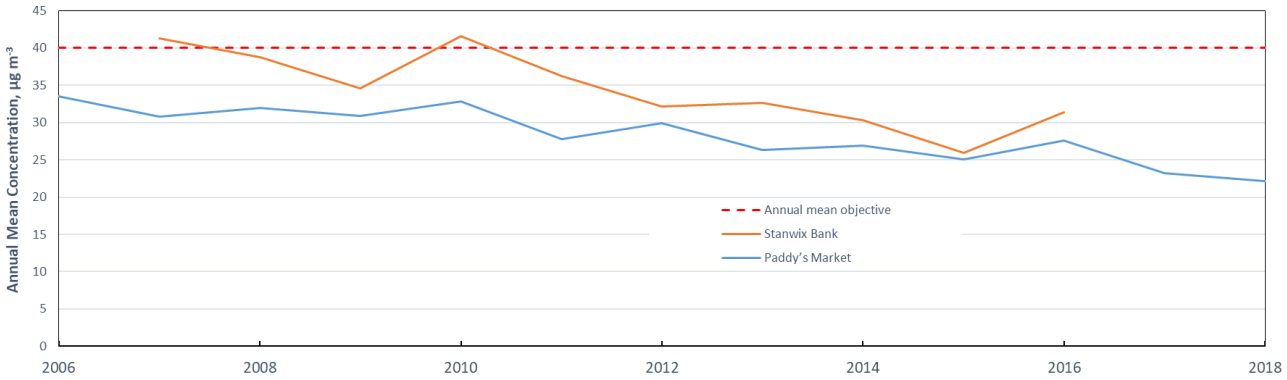


Table A.3 in Appendix A compares all of the ratified and adjusted monitored NO_2 annual mean concentrations since 2006 with the air quality objective of 40 µg m^{-3}.

Additionally, 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 200 µg m^{-3}, not to be exceeded more than 18 times per year. There were no exceedances of the 200 µg m^{-3} in 2018.

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. These areas include: the city centre, areas that were previously border line for inclusion in an AQMA, areas on the outskirts of the city, main arterial roads and the Carlisle Northern Development Route.

Annual mean concentrations measured by diffusion tube within the local authority since 2006 are presented in Table A.3 within Appendix A. Figure A.1 also within the Appendix also shows a gradual decrease in nitrogen dioxide concentrations at most sites.

Table 3-2 presents the annual mean concentrations measured at those thirteen monitoring stations within the six AQMAs (monitoring at E20 on Wigton Road stopped in 2017). Recommendations for retaining, amending or revoking the AQMA's are also evidenced in Table 3-2

Table 3-2 Nitrogen dioxide concentrations measured by diffusion tube within the six air quality management areas. (see Figure

Site ID	Site Name	NO_2 Annual Mean Concentration (µg/m^3)						Recommendation
		AQMA	2014	2015	2016	2017	2018	
A1	45 SCOTLAND RD	1	36.4 (28.9)	35.6 (27.9)	33.7 (26.1)	31.7 (24.5)	30.1 (23.3)	No exceedances of annual objective within AQMA 1 in 2018. Monitoring to continue. ***AQMA reduced in size***
A10	STANWIX BANK		40.9 (36.8)	37.4 (33.6)	42.6 (37.8)	36.4 (32.5)	37.6 (33.5)	
A5	37 KINGSTOWN RD		32.4	32.8	32.1	32.5	29.2	
A7	282 KINGSTOWN RD		24.6 (20.8)	25.4 (21.5)	24.9 (20.4)	23.4 (19.3)	21.2 (17.6)	
A9	BRAMPTON RD		36.5	35.9	37.4	35.5	32.4	
B4	DALSTON RD	5	44.8	41.0	40.0	39.9	35.8	Not exceeding air quality objective since 2015 but concentration within10 % of objective ***Keep AQMA***
B7	12 CURROCK ST	2	36.8	36.5	37.7	37.0	35.2	While no exceedances measured in last five years concentrations are sufficiently high to suggest there may be a risk of exceedance in future years ***Keep AQMA***
E12	3 WIGTON RD	3	36.1 (33.4)	34.0 (31.3)	35.7 (32.5)	33.5 (30.6)	31.9 (29.2)	There continues to be no exceedance over the last five years and there is a clear downward trend in measurements. Revocation was recommended in 2016. ***Revoked 3rd July 2019***
E15	22 WIGTON RD		31.0	29.8	32.0	30.2	28.4	
E16	JOVIAL SAILOR		34.9	30.4	32.7	31.4	31.7	
E19	49 WIGTON RD		38.2	33.0	34.8	31.5	30.6	
E20	44 WIGTON RD		32.0	28.8	29.9	28.7	Discontinued	
E8	BRIDGE ST	4	44.5	41.2	41.5	44.9	40.8	Still exceeding air quality objective ***Keep AQMA***
F7	24 LONDON RD	6	35.3	35.5	34.1	33.8	32.2	There continues to be no exceedance over the last five years and there is a clear downward trend in measurements. ***Revoked 3rd July 2019***

Note: Concentrations in (brackets) have been readjusted for distance to sensitive receptor.

For diffusion tubes, the full 2018 dataset of monthly mean values is provided in Appendix B. No locations exceeded the annual mean greater than 60µg/m^3, which indicates that there were no exceedance of the 1-hour mean objective.

The process to revoke an AQMA is described in Paragraphs 3.48, 3.49 and 3.50 of the Defra's Technical Guidance[8] document. It describes that in most cases a decision to revoke an AQMA should be taken following a detailed study which sets out in detail all the available information used to reach the decision, with the same degree of confidence as was provided for the original declaration.

However, in some instances if compelling evidence exists, for example, when the measured nitrogen dioxide concentrations are consistently less than 10 % of the annual objective concentration, detailed modelling to support the decision to amend/revoke an AQMA may not be necessary. Such compelling evidence is shown by the nitrogen dioxide concentrations measured by diffusion tube concentrations within AQMAs 3 and 6.

The evidence is presented in Table 3.2 and displayed graphically in Figure A1 Area E (3 Wigton Road, 22 Wigton Road, Jovial Sailor, 49 WIGTON RD, 44 Wigton Road and Bridge Street) for AQMA 3 and Area F (24 London Road) for AQMA 6. It shows that the Carlisle City Council can be reasonably certain that any future exceedances of the annual objective concentration (40 µgm^{-3}) is unlikely.

The trend in nitrogen dioxide site at Bridge Street is also shown in the Area E figure. This site is in AQMA 4 and shows that the concentration is consistently above 40 µgm^{-3} but are decreasing.

3.2.2 Particulate Matter (PM_{10})

Table A.5 and Figure A.2 in Appendix A and compares the ratified monitored PM_{10} annual mean concentrations for the past 5 years with the air quality objective of 40 µg m^{-3}.

Table A.6 and Figure A.3 in Appendix A compares the ratified continuous monitored PM_{10} daily mean concentrations for the past 5 years with the air quality objective of 50 µg m^{-3}, not to be exceeded more than 35 times per year.

There are no exceeedances of the air quality objectives for PM_{10}.

[8] https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf

3.2.3 Particulate Matter ($PM_{2.5}$)

Table A.7 and Figure A.4 in Appendix A presents the ratified and adjusted monitored $PM_{2.5}$ annual mean concentrations for the past 5 years.

Monitored $PM_{2.5}$ annual mean results over the last 5 years show a slight downward trend in concentrations.

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	NO	Chemiluminescence	42	4	3
					PM_{10}	NO	TEOM FDMS/BAM	42	4	2.9
					$PM_{2.5}$	NO	TEOM FDMS/BAM	42	4	3
SB1	Stanwix Bank	Roadside	340018	557044	NO_2	YES	Chemiluminescence	32	3	2.2

Notes:

(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) This site is known as Carlisle Roadside within the Automatic Urban and Rural Network (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?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?	Height (m)	Status
A1	45 SCOTLAND RD	Roadside	339995	557188	NO2	Y (1)	4.5	1.5	NO	3.05	
A10	STANWIX BANK	Roadside	340008	556842	NO2	Y (1)	1.5	1.5	NO	2.95	
A12	14 ETTERBY ST	Roadside	339935	557125	NO2	N	0	3	NO	2.8	
A5	37 KINGSTOWN RD	Roadside	339758	558059	NO2	Y (1)	0	4	NO	2.8	
A7	282 KINGSTOWN RD	Roadside	339526	559285	NO2	Y (1)	7.5	4	NO	2.7	
A9	BRAMPTON RD	Roadside	340028	556833	NO2	Y (1)	0	1.5	NO	2.75	
B12	DENTON ST	Kerbside	339921	555406	NO2	N	10	0.5	NO	2.65	Closed April 2017
B4	DALSTON RD	Roadside	339434	555638	NO2	Y (5)	0	3.5	NO	2.8	
B5	8 JUNCTION ST	Roadside	339613	555587	NO2	N	0	2.5	NO	2.7	Closed April 2017
B6	41 CHARLOTTE ST	Roadside	339731	555526	NO2	N	0	2.5	NO	2.75	Closed April 2017
B7	12 CURROCK ST	Roadside	340205	555198	NO2	Y (2)	0	3	NO	3.05	
C1	LOWTHER ST	Roadside	340216	556131	NO2	N	0	3	NO	2.85	
C2	TOURIST INFO	Urban Centre	340069	555955	NO2	N	N/A	N/A	NO	2.7	
C3	DEVONSHIRE ST	Roadside	340218	555768	NO2	N	0	3	NO	2.85	
C4	BAR SOLO	Roadside	340286	555622	NO2	N	0	9	NO	2.7	Closed April 2017
C5	GRIFFIN	Roadside	340298	555589	NO2	N	0	3	NO	3	Closed April 2017
D10	368 WARWICK RD	Roadside	342044	555907	NO2	N	0	5	NO	2.75	Closed April 2017

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?	Height (m)	Status
D11	CARTREF	Roadside	340426	556040	NO2	N	0	4.5	NO	2.7	Closed April 2017
D12	POST OFFICE	Kerbside	340307	555718	NO2	N	N/A	5	NO	2.95	
D5	215 WARWICK RD	Roadside	341310	555914	NO2	N	0	9	NO	2.4	Closed April 2017
D7	282 WARWICK RD	Roadside	341593	555893	NO2	N	0	7	NO	2.8	
D9	251 WARWICK RD	Roadside	341426	555910	NO2	N	0	8.5	NO	2.7	Closed April 2017
E22	FINKLE ST	Roadside	339834	556137	NO2	N	0	12	NO	2.8	
E12	3 WIGTON RD	Roadside	339225	555821	NO2	Y (3)	2	2.5	NO	2.95	
E15	22 WIGTON RD	Roadside	339091	555736	NO2	Y (3)	0	4.5	NO	3.9	
E16	JOVIAL SAILOR	Roadside	339141	555900	NO2	Y (3)	0	2.5	NO	2.7	
E19	49 WIGTON RD	Roadside	338953	555610	NO2	Y (3)	0	2.5	NO	3.1	
E20	44 WIGTON RD	Roadside	339023	555692	NO2	Y (3)	0	5.5	NO	2.5	Closed April 2017
E4	JOHN ST	Roadside	339396	555947	NO2	N	4	3	NO	2.75	Closed April 2017
E6	PADDYS MARKET 1	Roadside	339467	555974	NO2	N	N/A	9	YES	3	
E6	PADDYS MARKET 2	Roadside	339467	555974	NO2	N	N/A	9	YES	3	
E6	PADDYS MARKET 3	Roadside	339467	555974	NO2	N	N/A	9	YES	3	
E8	BRIDGE ST	Roadside	339516	556024	NO2	Y (4)	0	4	NO	3.05	
E21	BURGH RD	Roadside	337730	556118	NO2	N	8	3	NO	2.9	Closed April 2017
F1	3 TAIT ST	Roadside	340482	555489	NO2	N	0	3.5	NO	2.7	Closed April 2017
F10	155 BOTCHERGATE	Roadside	349597	555351	NO2	N	0	3	NO	2.7	

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?	Height (m)	Status
F5	STANLEY HALL	Roadside	340534	555409	NO2	N	0	3	NO	2.7	Closed April 2017
F7	24 LONDON RD	Roadside	340708	555240	NO2	Y (6)	0	4.5	NO	2.7	
F9	129 LONDON RD	Kerbside	341099	554931	NO2	N	0	0.5	NO	2.95	
G1	SPA HOUSE	Rural	338109	557841	NO2	N	0	85	NO	2.8	Closed April 2017
G2	KNOCKUPWORTH COTTAGE	Rural	337093	556785	NO2	N	0	22	NO	2.9	Closed April 2017
G3	CORNHILL FARM	Roadside	336338	556311	NO2	N	0	3	NO	2.9	Closed April 2017
G4	THE HOBBIT	Rural	336905	554036	NO2	N	0	19	NO	2.85	
H1	BRAMPTON	Roadside	352824	561039	NO2	N	0.5	2.5	NO	2.75	Closed April 2017
H3	LONGTOWN	Roadside	338052	568478	NO2	N	0.5	2.5	NO	2.8	Closed April 2017
H4	WARWICK BRIDGE	Roadside	347411	556881	NO2	N	0.5	2.5	NO	2.6	Closed April 2017
H5	WIGTON RD	Roadside	337643	554100	NO2	N	0	1.5	NO	2.4	
H6	PETER LANE	Roadside	337962	553220	NO2	N	0	4	NO	2.4	
H7	DALSTON RD	Roadside	338282	553396	NO2	N	0	6.5	NO	2.4	
H8	AIRPORT	Other	347874	561254	NO2	N	0	2	NO	2.4	

Notes:

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

(2) N/A if not applicable.

Table A.3 – Annual Mean NO_2 Monitoring Results

Site ID	Site Name	Type	Valid data capture	NO_2 concentration, µg m^{-3}												
				2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
PM1	Paddy's Market	Chem	95.2	33.5	30.8	32	30.9	32.8	27.8	29.9	26.3	26.9	25.1	27.6	23.3	22.1
SB1	Stanwix Bank	Chem	--		41.3	38.8	34.6	41.6	36.2	32.2	32.6	30.3	25.9	31.4		
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)	33.7 (26.1)	31.7 (24.5)	30.1 (23.3)
A10	STANWIX BANK	DT	100	51.4	58.1	56.4	49.9 (44.8)	59.2 (52.5)	48.0 (42.9)	46.1 (41.5)	43.9 (39.6)	40.9 (36.8)	37.4 (33.6)	42.6 (37.8)	36.4 (32.5)	37.6 (33.5)
A12	14 ETTERBY ST	DT	100	-	24.5	21.6	21	25.5	23.8	22.3	18.6	19.9	15.8	18.7	28.6	28.2
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	32.1	32.5	29.2
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)	24.9 (20.4)	23.4 (19.3)	21.2 (17.6)
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	37.4	35.5	32.4
B12	DENTON ST	DT	#N/A	-	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)	31.6 (21.9)	26.2 (19.6)	#N/A
B4	DALSTON RD	DT	100	47.2	51.7	51	42.8	52.6	50.2	53.7	43.6	44.8	41.0	40.0	39.9	35.8
B5	8 JUNCTION ST	DT	#N/A	32.5	34.3	29.4	29.1	35.4	27.6	31.5	28.4	29	27.3	28.6	24.3	#N/A
B6	41 CHARLOTTE ST	DT	#N/A	38.1	38.3	33.2	32.3	38.6	33.5	34.9	32.2	30.8	29.9	30.9	27.4	#N/A
B7	12 CURROCK ST	DT	92	41.2	41.9	41.6	39.8	43.3	36.9	39.8	38.7	36.8	36.5	37.7	37.0	35.2
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	27.9	27.2	27.4
C2	TOURIST INFO	DT	100	15.9	20.5	16.2	17.6	19.9	18.2	18.5	19.2	24	17.9	18.7	19.3	20.2
C3	DEVONSHIRE ST	DT	92	35.1	43.2	37.6	35.2	39.4	36.5	39	36.6	31.8	29.3	29.5	25.5	24.4
C4	BAR SOLO	DT	#N/A	36.2	40.2	39.1	33.8	37	34.6	36.2	33.2	32.8	27.8	32.3	24.9	#N/A
C5	GRIFFEN	DT	#N/A	39	47.3	40.5	46.2	43.3	40	39.7	38.3	34.9	33.6	34.1	27.8	#N/A
D10	368 WARWICK RD	DT	#N/A	33.2	34.5	31.6	28.9	35.5	31.1	32.8	30	28.1	27.0	27.2	23.3	#N/A
D11	CARTEF	DT	#N/A	-	38.4	35.6	29.4	37.4	31.5	34.4	32.7	31.9	28.9	31.2	24.7	#N/A
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	36.8	34.4	30.4
D5	215 WARWICK RD	DT	#N/A	24.4	27.2	24.1	22.5	28	22.3	25.5	23.3	23.2	21.9	22.3	19.4	#N/A
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	30.8	32.1	28.0
D9	251 WARWICK RD	DT	#N/A	30.6	32.1	27.7	27.1	34.4	27.6	29.8	29.7	28.2	25.7	26.3	20.5	#N/A
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	31.5	30.5	29.1
E12	3 WIGTON RD	DT	100	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)	35.7 (32.5)	33.5 (30.6)	31.9 (29.2)
E15	22 WIGTON RD	DT	83	38.8	45.3	42.5	39.1	45.5	38.9	35.8	33.1	31	29.8	32.0	30.2	28.4
E16	JOVIAL SAILOR	DT	83	37.8	42.3	44.7	36	39.3	35.7	37.6	35	34.9	30.4	32.7	31.4	31.7
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	34.8	31.5	30.6
E20	44 WIGTON RD	DT	#N/A	33.8	44.9	41.6	37.1	43.4	36.5	36.3	33.2	32	28.8	29.9	28.7	#N/A
E4	JOHN ST	DT	#N/A	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)	33.5 (29.9)	29.0 (26.3)	#N/A
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	29.3	28.0	28.8
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	29.2	26.9	28.5
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	28.6	27.4	27.6
E8	BRIDGE ST	DT	100	50.3	63.6	55.8	50.6	56.6	49.2	47	44.3	44.5	41.2	41.5	44.9	40.8
E21	BURGH RD	DT	#N/A	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)	17.5 (14.0)	16.4 (13.1)	#N/A
F1	3 TAIT ST	DT	#N/A	33.2	33.8	32.6	31.2	35.1	30.5	33.8	30.3	29.1	30.1	27.5	25.3	#N/A
F10	155 BOTCHERGATE	DT	100	34.4	38.7	35.2	33	39.1	33	36	34	37.3	34.7	35.8	36.3	35.3
F5	STANLEY HALL	DT	#N/A	34.9	33.2	38.1	33	39.7	35.5	34.5	32.5	33.4	29.2	33.1	26.1	#N/A
F7	24 LONDON RD	DT	92	43.3	41.4	39.4	36.3	45.5	39.3	42.3	37.8	35.3	35.5	34.1	33.8	32.2
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	32.4	30.4	30.3

Site ID	Site Name	Type	Valid data capture	NO_2 concentration, µg m^{-3}												
				2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
G1	Spa House	DT	#N/A	-	-	-	-	-	-	13.2	12.9	12.6	11.9	10.7	9.9	#N/A
G2	Knockupworth Cottage	DT	#N/A	-	-	-	-	-	-	12	14.6	13.5	12.7	13.4	12.0	#N/A
G3	Cornhill Farm	DT	#N/A	-	-	-	-	-	-	11.2	10.8	11.2	9.2	13.2	11.5	#N/A
G4	The Hobbit	DT	100	-	-	-	-	-	-	15.2	14.1	14.6	12.5	13.0	12.0	12.6
H1	BRAMPTON	DT	#N/A	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)	17.3 (16.8)	15.2 (14.7)	#N/A
H3	LONGTOWN	DT	#N/A	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)	20.7 (20.0)	18.0 (17.5)	#N/A
H4	WARWICK BRIDGE	DT	#N/A	-	-	35.7 (34.5)	31.8 (30.8)	37.2 (35.9)	30.9 (29.8)	33.2 (32.0)	30.8 (29.8)	29.6 (28.5)	27.0 (26.1)	29.6 (28.5)	23.4 (22.6)	#N/A
H5	WIGTON RD	DT	100	-	-	27.3	20	26.8	22	20.5	16.8	17.5	15.7	16.1	16.6	15.7
H6	PETER LANE	DT	100	-	-	11.3	10.2	14.2	11.5	12.6	12.3	11.4	9.8	12.0	9.4	11.4
H7	DALSTON RD	DT	100	-	-	15.8	15.7	20	16.9	17.8	18.1	16.8	15.4	17.0	15.1	18.7
H8	AIRPORT	DT	100	-	-	9.8	9.1	11	9.5	9.7	8.6	8.4	7.7	8.0	7.5	8.2

☒ **Diffusion tube data have been bias corrected**

☒ **Annualisation has been conducted where data capture is <75%**

☒ **If applicable, all data have been distance corrected for relevant exposure (values in parenthesis)**

Notes:

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

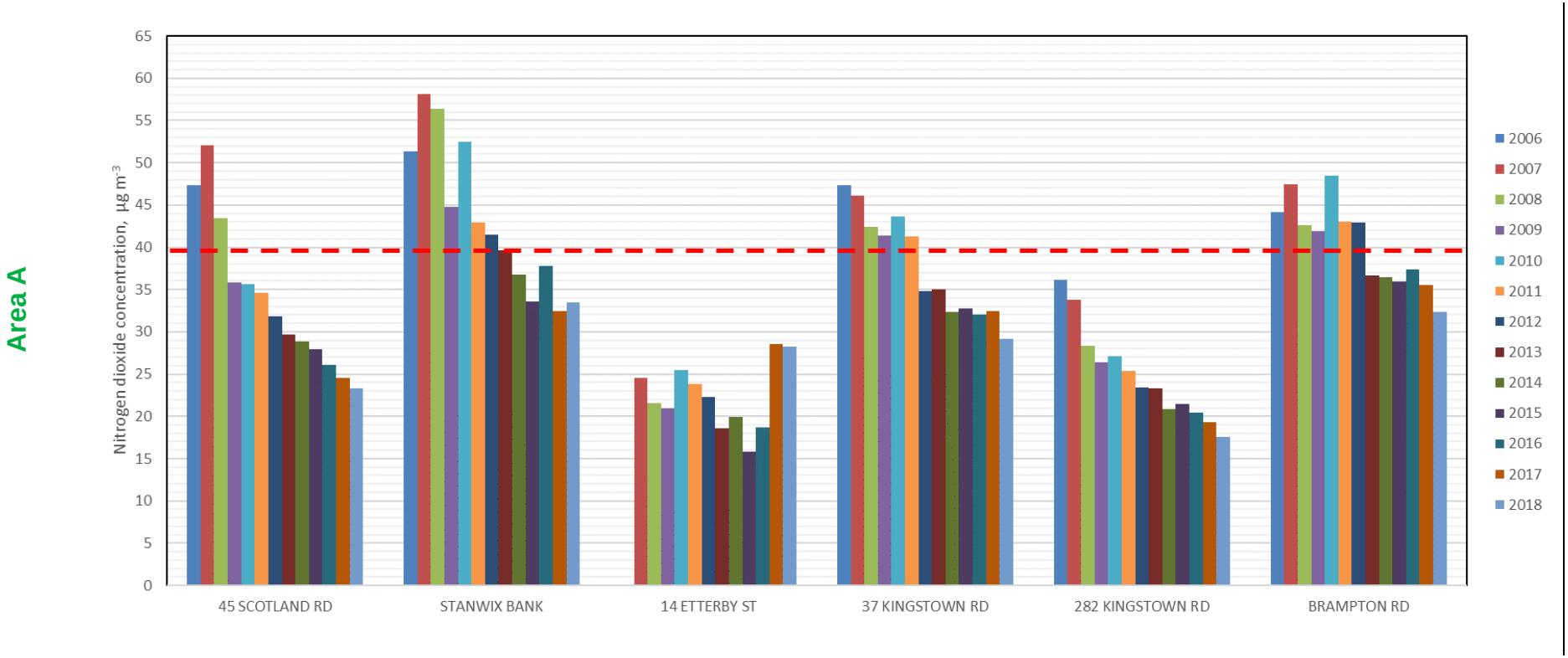
NO_2 annual means exceeding 60µg/m^3, indicating a potential exceedance of the NO_2 1-hour mean objective are shown in **bold and underlined.**

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

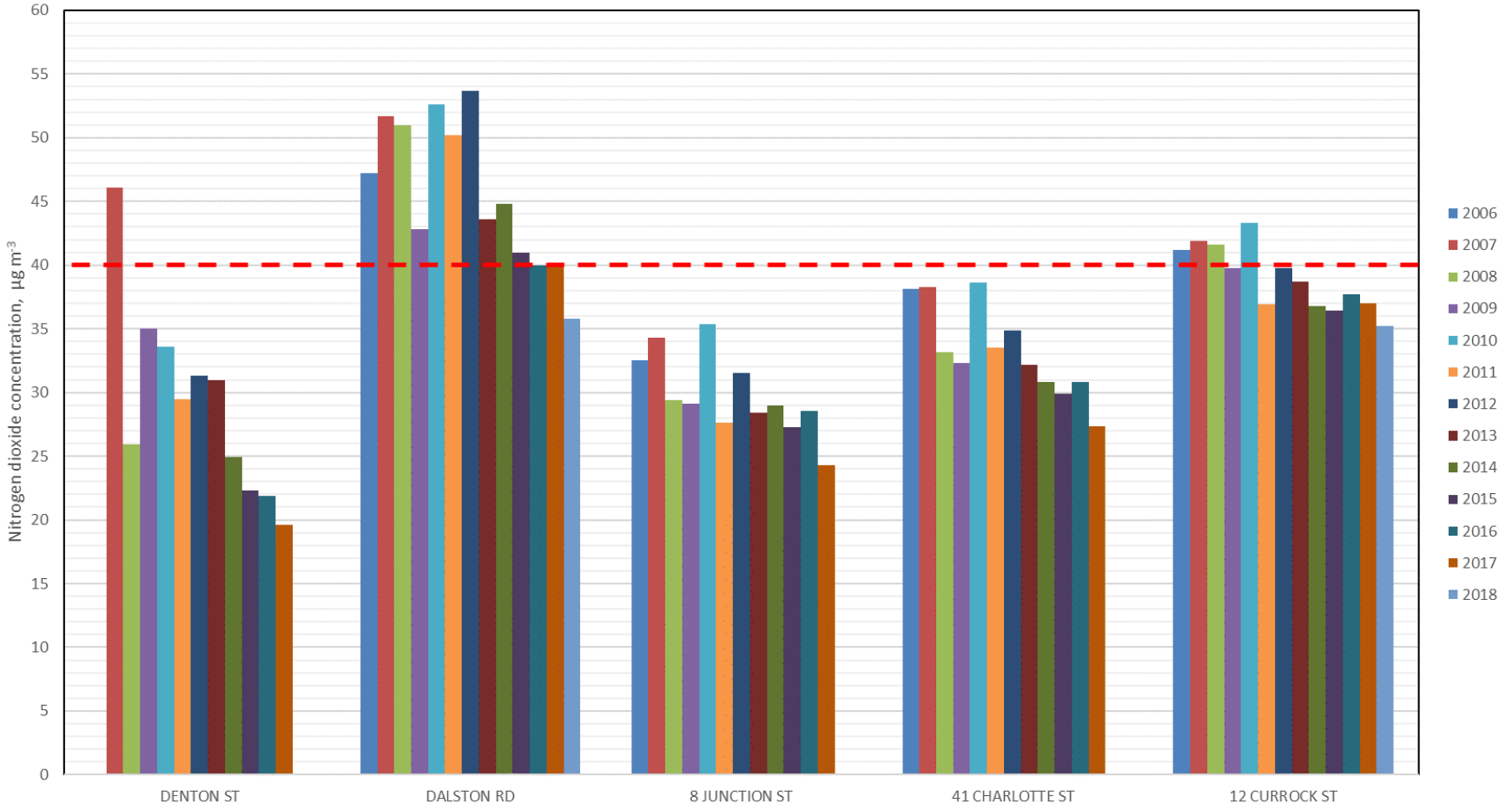
(2) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) Means for diffusion tubes have been corrected for bias. All means have been "annualised" as per Boxes 7.9 and 7.10 in LAQM.TG16 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

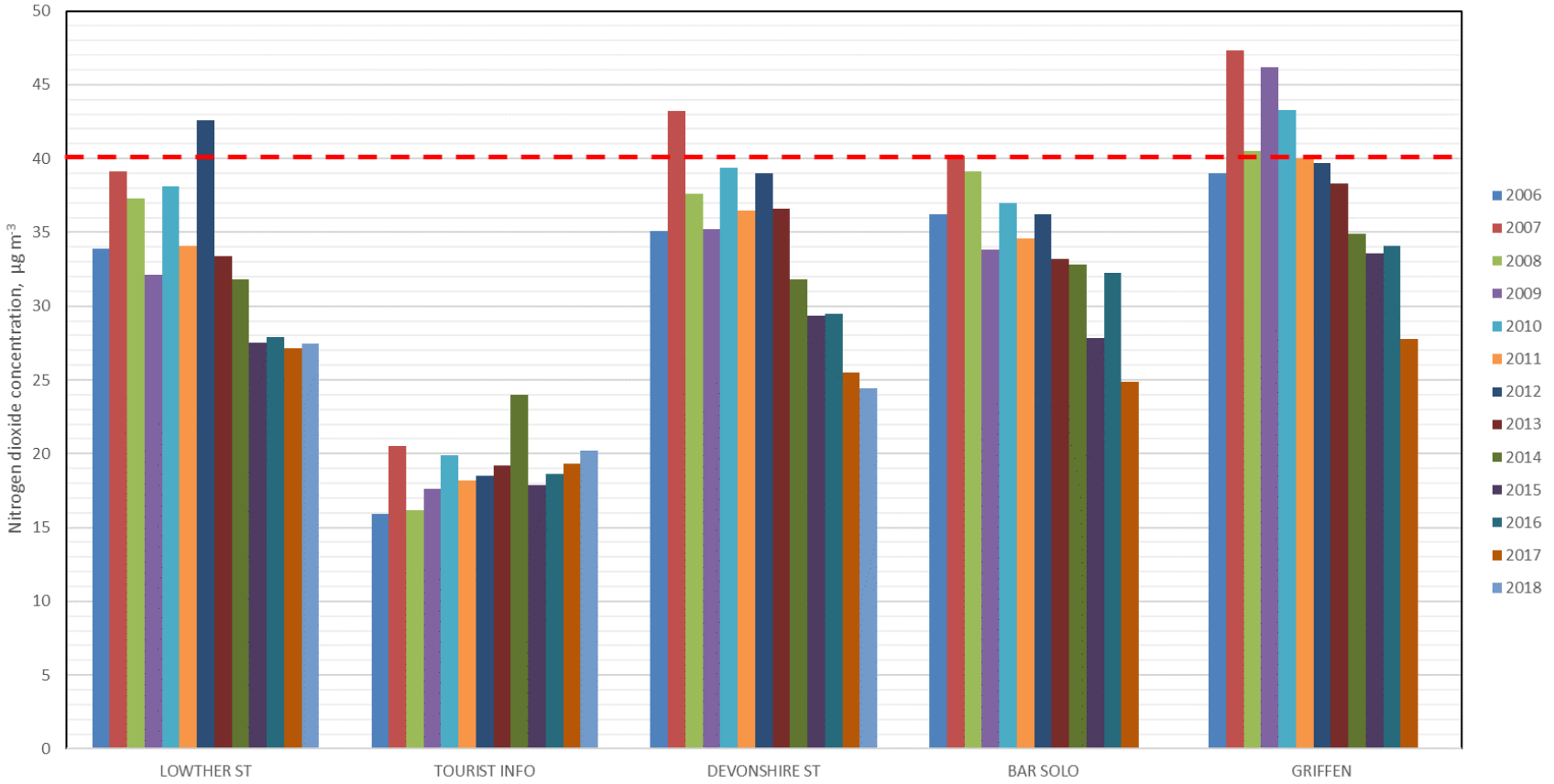
Figure A.1 – Trends in Annual Mean NO_2 Concentrations for each of the diffusion tube measurement areas A to H



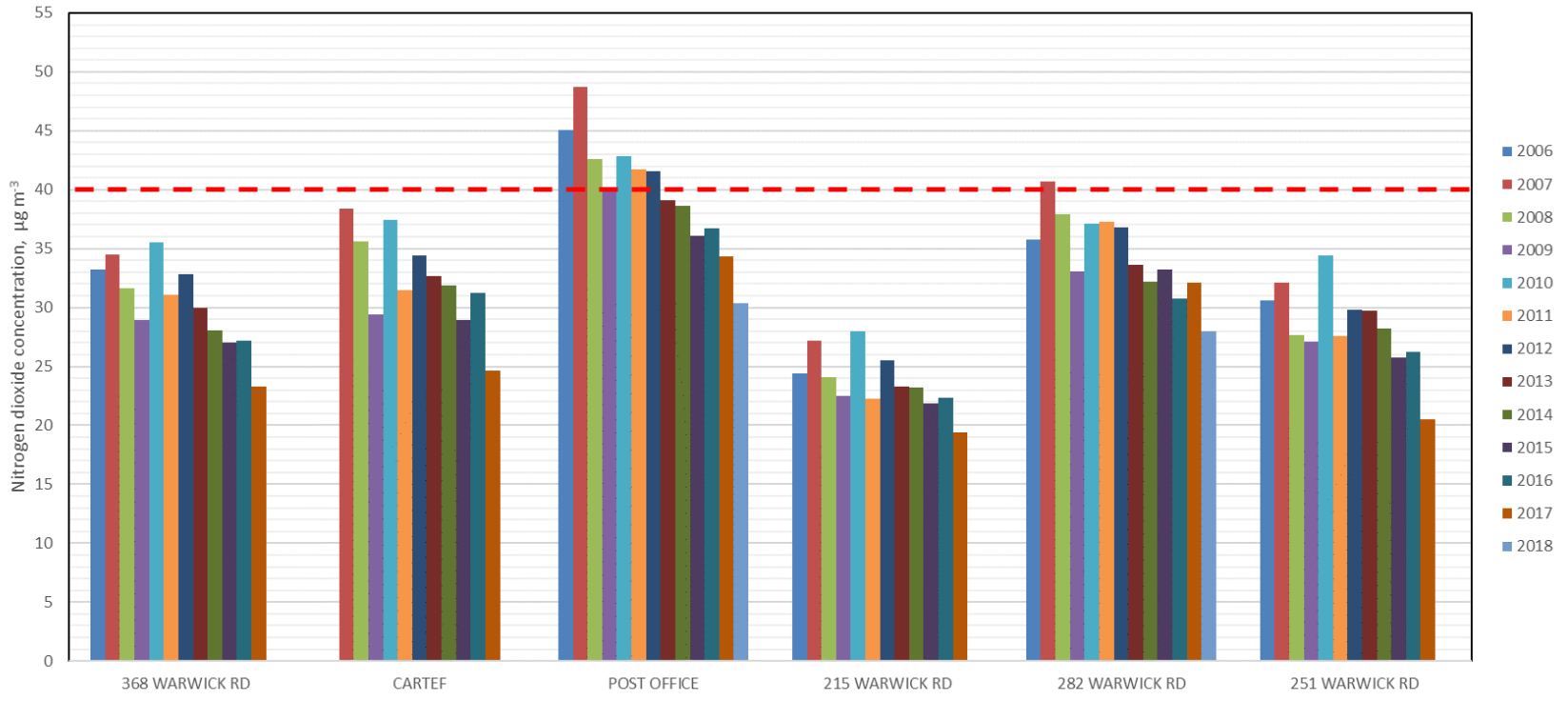
Area B


Nitrogen dioxide concentration, µg m-3
60
55
50
45
40
35
30
25
20
15
10
5
0
DENTON ST
DALSTON RD
8 JUNCTION ST
41 CHARLOTTE ST
12 CURROCK ST
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

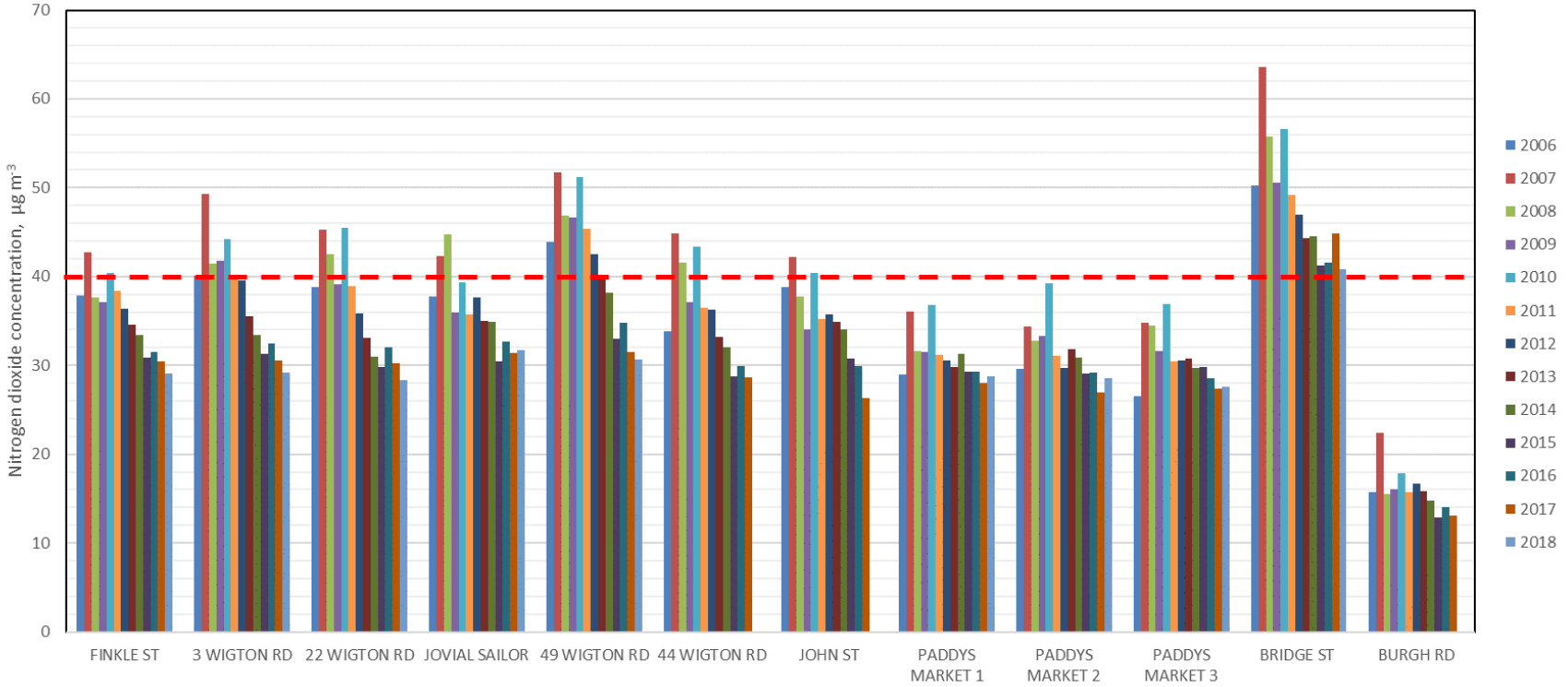
Area C


Nitrogen dioxide concentration, µg m-3
50
45
40
35
30
25
20
15
10
5
0
LOWTHER ST
TOURIST INFO
DEVONSHIRE ST
BAR SOLO
GRIFFEN
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

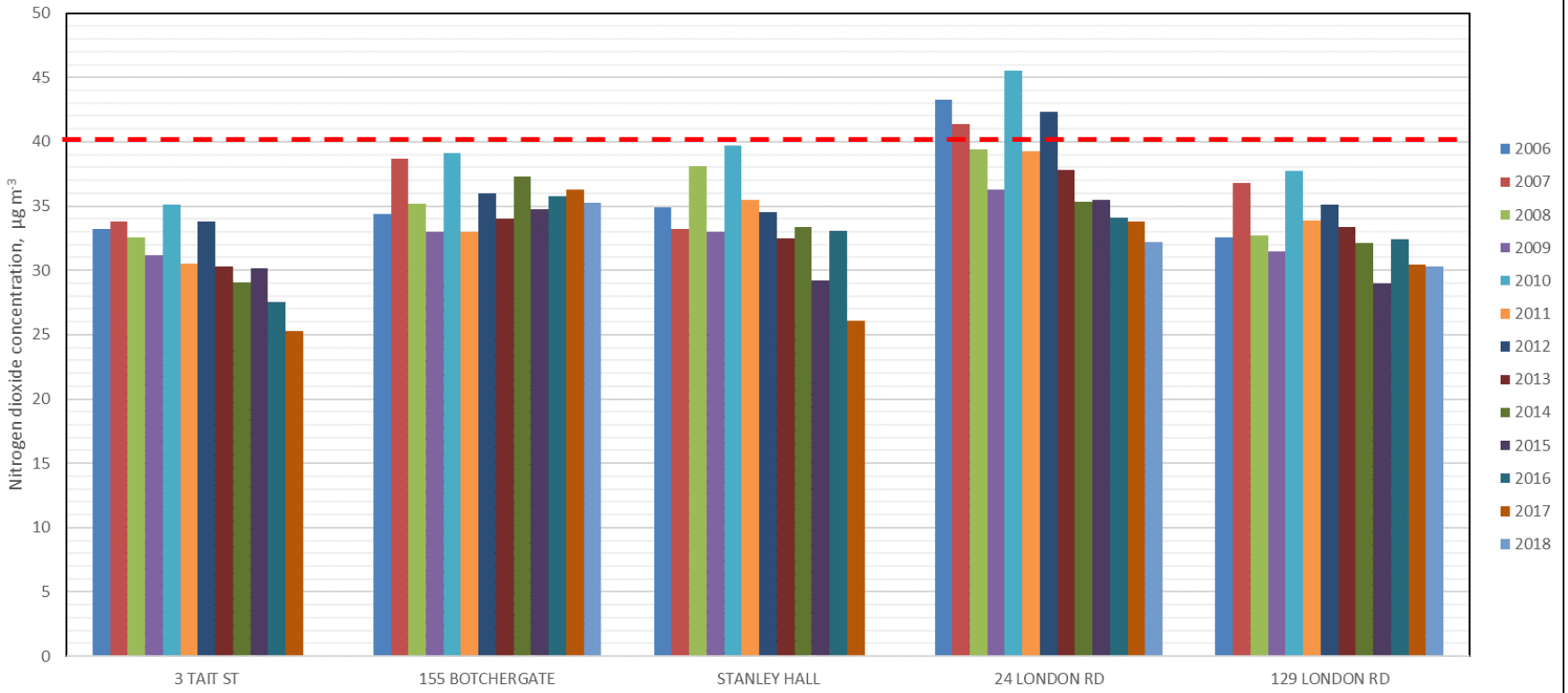
Area D


Nitrogen dioxide concentration, µg m-3
55
50
45
40
35
30
25
20
15
10
5
0
368 WARWICK RD
CARTEF
POST OFFICE
215 WARWICK RD
282 WARWICK RD
251 WARWICK RD
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

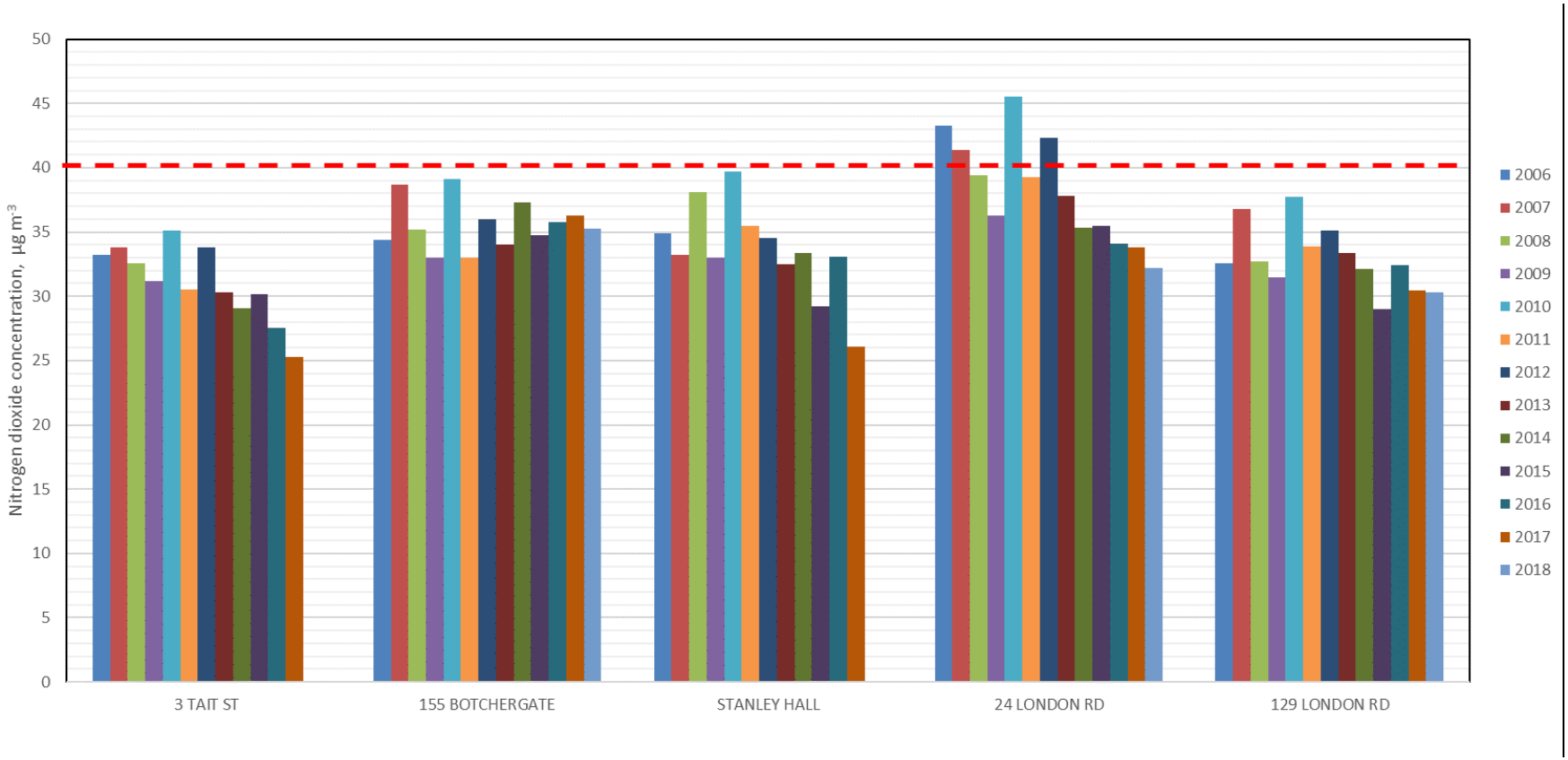
Area E


Nitrogen dioxide concentration, µg m-3
70
60
50
40
30
20
10
0
FINKLE ST
3 WIGTON RD
22 WIGTON RD
JOVIAL SAILOR
49 WIGTON RD
44 WIGTON RD
JOHN ST
PADDYS MARKET 1
PADDYS MARKET 2
PADDYS MARKET 3
BRIDGE ST
BURGH RD
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

Area F


Nitrogen dioxide concentration, µg m-3
50
45
40
35
30
25
20
15
10
5
0
3 TAIT ST
155 BOTCHERGATE
STANLEY HALL
24 LONDON RD
129 LONDON RD
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

Area G


Nitrogen dioxide concentration, µg m-3
50
45
40
35
30
25
20
15
10
5
0
3 TAIT ST
155 BOTCHERGATE
STANLEY HALL
24 LONDON RD
129 LONDON RD
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

Area H

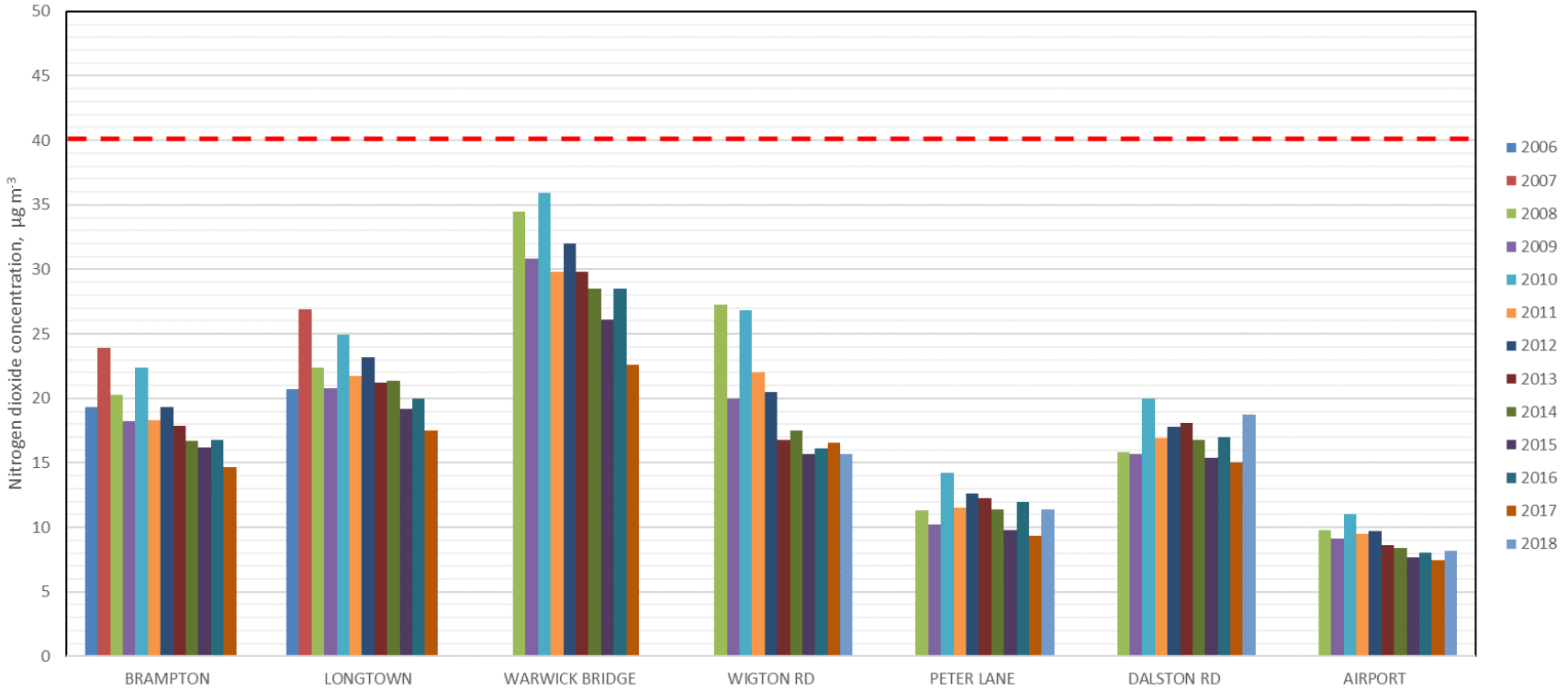

Nitrogen dioxide concentration, µg m-3
50
45
40
35
30
25
20
15
10
5
0
BRAMPTON
LONGTOWN
WARWICK BRIDGE
WIGTON RD
PETER LANE
DALSTON RD
AIRPORT
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

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

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2018 (%) (2)	NO_2 1-Hour Means > 200µg/m^3 (3)				
					2014	2015	2016	2017	2018
PM1	Roadside	Automatic	95.2	95.2	0	0	0	0	0
SB1	Roadside	Automatic	-	-	0	0	9	-	-

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 for Monitoring Period (%) (1)	Valid Data Capture 2018 (%) (2)	PM_{10} Annual Mean Concentration ($\mu g/m^3$) (3)				
				2014	2015	2016	2017	2018
PM1	Roadside	90.6	90.6	15	17.3	13.6	4.6	16.2

☒ **Annualisation has been conducted where data capture is <75%**

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 Boxes 7.9 and 7.10 in LAQM.TG16, valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Figure A.2 – Trends in Annual Mean PM_{10} Concentrations

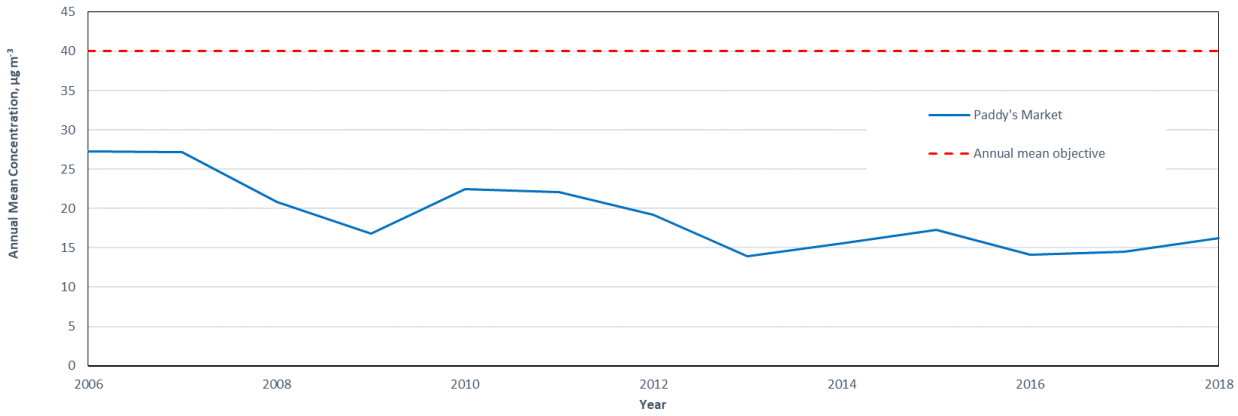


Table A.6 – 24-Hour Mean PM_{10} Monitoring Results

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2017 (%) (2)	PM_{10} 24-Hour Means > 50µg/m³ (3)						
				2012	2013	2014	2015	2016	2017	2018
PM1	Roadside	90.6	90.6	3	1	2	5	0	1	0

Notes:

Exceedances of the PM_{10} 24-hour mean objective (50µg/m³ 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.

Figure A.3 – Trends in Number of 24-Hour Mean PM_{10} Results >50µg/m³

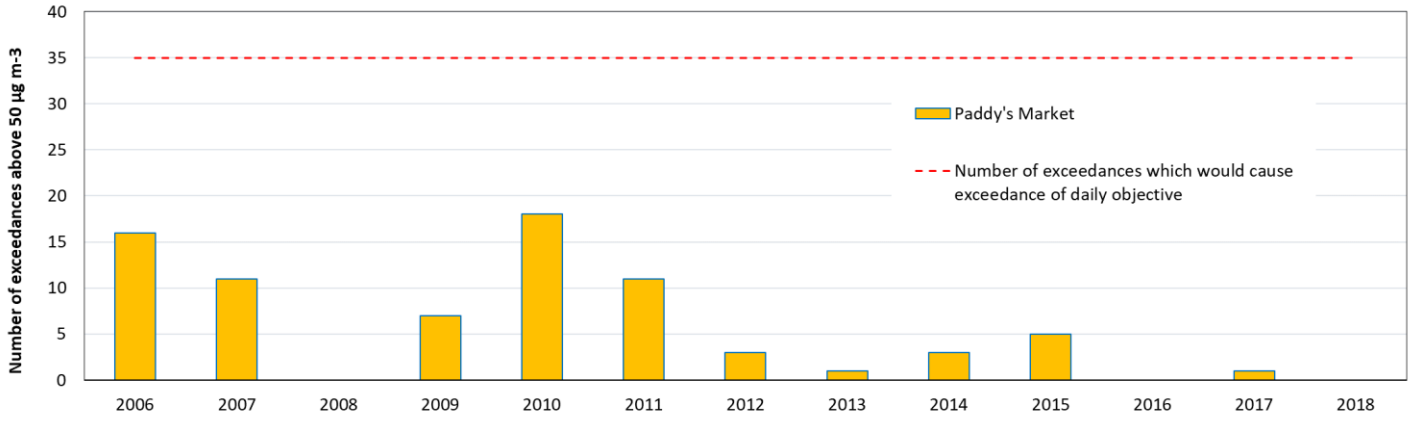


Table A.7 – $PM_{2.5}$ Monitoring Results

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2018 (%) (2)	$PM_{2.5}$ Annual Mean Concentration (µg/m³) (3)						
				2012	2013	2014	2015	2016	2017	2018
PM1	Roadside	91	91	11	12	11	10	10	9	9

☒ **Annualisation has been conducted where data capture is <75%**

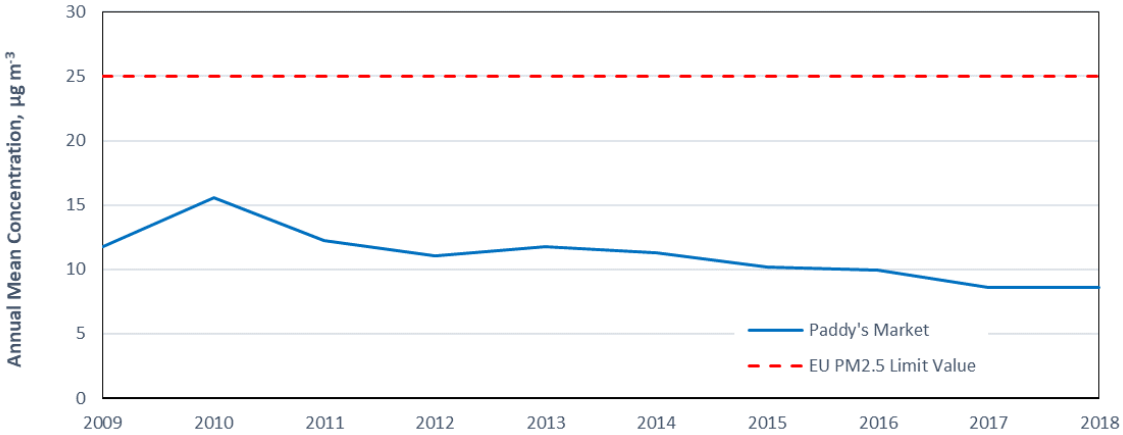
Notes:

(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 Boxes 7.9 and 7.10 in LAQM.TG16, valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Figure A.4 – Trends in Annual Mean $PM_{2.5}$ Concentrations



Appendix B: Full Monthly Diffusion Tube Results for 2018

Table B.1 – NO_2 Monthly Diffusion Tube Results – 2018

Site ID	NO_2 Mean Concentration, µg m^{-3}															
													Annual mean			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Raw Data	Annualisation factor	Bias correction factor, 0.93	Distance corrected to nearest receptor, where required
A1	37.38	40.28	27.9	27.88	24.64	29.56	30.36	31.2	30.16	35.59	32.72	40.99	32.4	1.00	30.1	23.3
A10	43.43	45.5	41.36	37.29	39.11	35.48	40.74	26.44	33.51	34.86	57.68	49.39	40.4	1.00	37.6	33.5
A12	29.34	33.25	24.4	27.38	28.87	31.42	31.82	24.53	30.76	29.38	34.28	39.01	30.4	1.00	28.2	
A5	37.31	33.88	26.46	24.47	28.08	26.88	26.96	33.01	35.56	31.80	31.38	41.15	31.4	1.00	29.2	
A7	24.15	30.63	20.05	27.71	20.4	18.34	18.55	19.11	22.13	23.93	22.88	25.26	22.8	1.00	21.2	17.6
A9	38.47	36.62	30.86	23.02	37.11	40.58	42.34	32.07	35.41	37.51	27.00	36.86	34.8	1.00	32.4	
B4	54.1	47.05	39.7	19.87	37.29	40.77	41.77	39.79	40.09	17.01	37.41	47.06	38.5	1.00	35.8	
B7	a	40.42	34.99	30.24	33.26	35.35	37.00	35.09	38.24	38.39	42.83	50.45	37.8	1.00	35.2	
C1	30.48	34.72	31.59	34.92	26.63	25.81	26.56	21.3	24.26	24.35	34.28	39.15	29.5	1.00	27.4	
C2	22.37	25.44	18.79	32.76	13.56	10.08	28.69	11.76	13.59	28.23	25.10	30.14	21.7	1.00	20.2	
C3	26.56	32.88	32.39	23.71	28.82	24.43	11.93	23.68	25.05	28.23	a	31.16	26.3	1.00	24.4	
D12	34.41	37.67	30.65	26.97	24.75	28.26	31.06	32.1	33.11	28.12	36.51	48.13	32.6	1.00	30.4	
D7	33.25	30.83	27.81	15.81	28.95	27.64	29.75	32.25	34.83	31.71	31.01	37.05	30.1	1.00	28.0	
E22	32.52	34.41	25.52	24	28.95	29.32	26.73	27.87	28.41	31.98	40.70	44.44	31.2	1.00	29.1	
E12	36.34	37.13	36.16	28.3	40.66	28.62	41.61	31.82	18.32	33.50	40.61	38.44	34.3	1.00	31.9	29.2
E15	25.94	34.02	32.29	26.26	31.98	33.22	32.88	27.41	a	a	29.95	31.25	30.5	1.00	28.4	
E16	32.92	38.15	35.33	35.23	38.89	35.51	36.81	26.48	27.87	34.17	a	a	34.1	1.00	31.7	

Site ID	NO_2 Mean Concentration, µg m^{-3}															
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual mean			
													Raw Data	Annualisation factor	Bias correction factor, 0.93	Distance corrected to nearest receptor, where required
E19	33.4	36.48	35.65	28.86	30.68	25.47	34.30	22.61	28.54	31.77	41.24	46.07	32.9	1.00	30.6	
E6_1	37.8	29.81	31.88	36.15	32.49	27.59	30.98	22.65	24.89	26.87	31.78	38.67	31.0	1.00	28.8	
E6_2	31.85	32.9	28.32	31.59	32.3	30.08	31.75	22.12	26.49	30.07	33.36	37.29	30.7	1.00	28.5	
E6_3	33.13	33.54	28.1	26.43	30.15	28.66	29.96	22.94	25.26	27.31	32.31	38.40	29.7	1.00	27.6	
E8	45.79	40.71	43.34	44.74	55.66	47.94	52.43	40.69	25.58	39.41	41.80	48.55	43.9	1.00	40.8	
F10	38.25	44.85	40.03	32.99	37.38	37.37	38.67	28.92	30.49	39.38	39.17	47.36	37.9	1.00	35.3	
F7	35.53	39.23	30.24	30.5	32.19	31.97	a	34.7	36.11	33.41	36.52	40.67	34.6	1.00	32.2	
F9	34.91	38.21	28.55	30.04	31.81	31.32	35.52	24.56	29.05	29.74	33.30	43.85	32.6	1.00	30.3	
G4	17.98	18.9	13.25	9.63	10.61	9.28	11.68	9.49	10.88	13.71	17.36	19.59	13.5	1.00	12.6	
H5	23.16	21.87	16.41	17.15	13.63	12.00	12.57	12.48	11.59	17.84	18.17	25.16	16.8	1.00	15.7	
H6	14.93	16.23	13.9	10.88	11.12	9.17	11.86	5.7	6.63	9.94	18.61	17.62	12.2	1.00	11.4	
H7	18.31	22.62	18.18	17.58	18.13	15.04	17.03	12.79	14.90	35.88	23.80	27.28	20.1	1.00	18.7	
H8	11.67	8.74	13.05	6.14	5.77	5.98	8.02	6.6	6.71	6.83	12.02	13.64	8.8	1.00	8.2	

☐ **Local bias adjustment factor used**

☒ **National bias adjustment factor used**

☒ **Annualisation has been conducted where data capture is <75%**

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) See Appendix C for details on bias adjustment and annualisation.

(2) Distance corrected to nearest relevant public exposure.

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

QA/QC of automatic monitoring data

Paddy's Market (PM1), 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.

Stanwix Bank (SB1) monitoring unit was decommissioned in April 2017.

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.

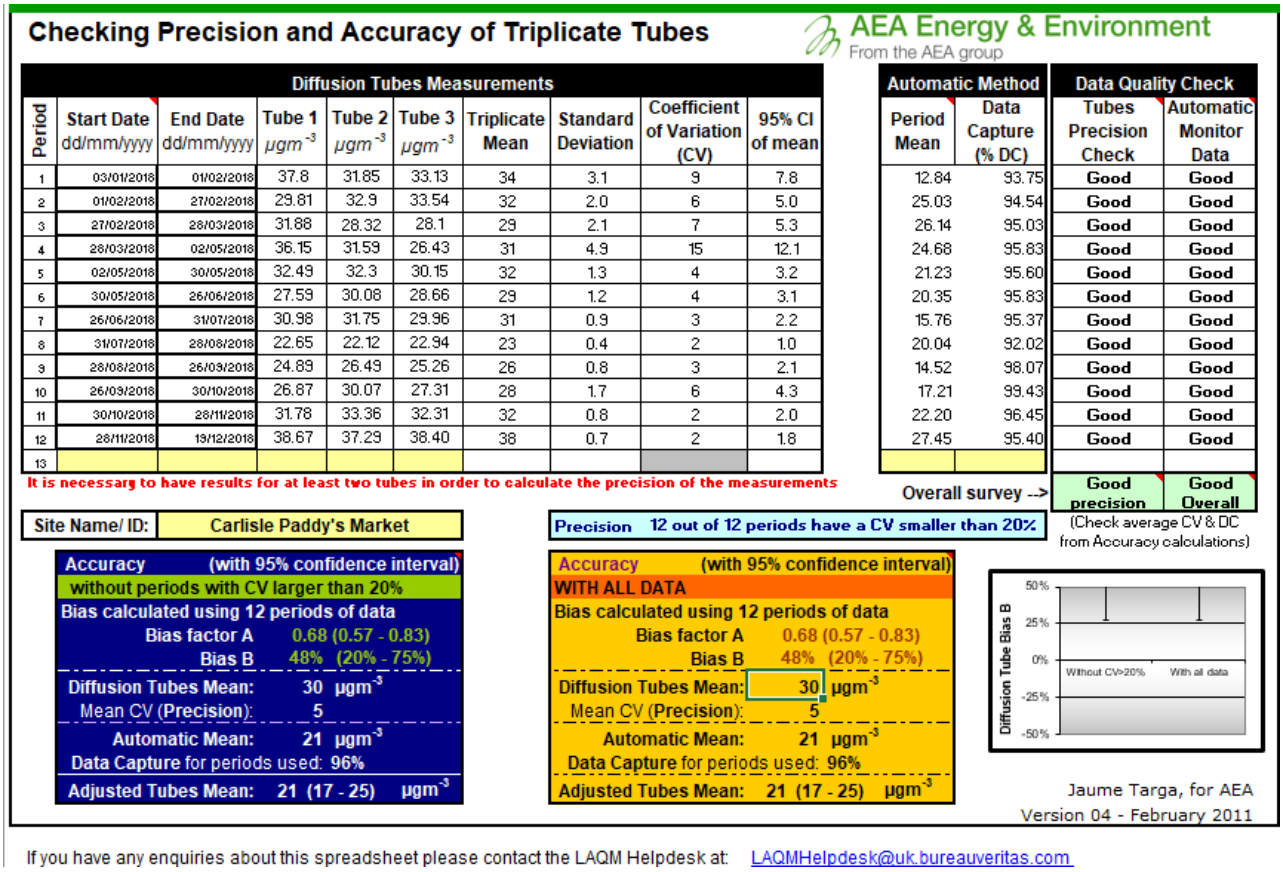
Factor from Local Co-location Study

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 was derived from the diffusion tubes co-located with the automatic analyser at the Paddy's Market monitoring station for 2018. 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 (Figure C.1):

Figure C.1: Co-location precision and accuracy spreadsheet for Paddy's Market AQMS, Carlisle.



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
1	03/01/2018	01/02/2018	37.8	31.85	33.13	34	3.1	9	7.8
2	01/02/2018	27/02/2018	29.81	32.9	33.54	32	2.0	6	5.0
3	27/02/2018	28/03/2018	31.88	28.32	28.1	29	2.1	7	5.3
4	28/03/2018	02/05/2018	36.15	31.59	26.43	31	4.9	15	12.1
5	02/05/2018	30/05/2018	32.49	32.3	30.15	32	1.3	4	3.2
6	30/05/2018	26/06/2018	27.59	30.08	28.66	29	1.2	4	3.1
7	26/06/2018	31/07/2018	30.98	31.75	29.96	31	0.9	3	2.2
8	31/07/2018	28/08/2018	22.65	22.12	22.94	23	0.4	2	1.0
9	28/08/2018	26/09/2018	24.89	26.49	25.26	26	0.8	3	2.1
10	26/09/2018	30/10/2018	26.87	30.07	27.31	28	1.7	6	4.3
11	30/10/2018	28/11/2018	31.78	33.36	32.31	32	0.8	2	2.0
12	28/11/2018	19/12/2018	38.67	37.29	38.40	38	0.7	2	1.8
13									

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

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
12.84	93.75	Good	Good
25.03	94.54	Good	Good
26.14	95.03	Good	Good
24.68	95.83	Good	Good
21.23	95.60	Good	Good
20.35	95.83	Good	Good
15.76	95.37	Good	Good
20.04	92.02	Good	Good
14.52	98.07	Good	Good
17.21	99.43	Good	Good
22.20	96.45	Good	Good
27.45	95.40	Good	Good
Overall survey -->		Good precision	Good Overall

(Check average CV & DC from Accuracy calculations)

Site Name/ ID: Carlisle Paddy's Market

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

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 12 periods of data
Bias factor A: 0.68 (0.57 - 0.83)
Bias B: 48% (20% - 75%)
Diffusion Tubes Mean: 30 µgm^{-3}
Mean CV (Precision): 5
Automatic Mean: 21 µgm^{-3}
Data Capture for periods used: 96%
Adjusted Tubes Mean: 21 (17 - 25) µgm^{-3}

Accuracy (with 95% confidence interval)
WITH ALL DATA
Bias calculated using 12 periods of data
Bias factor A: 0.68 (0.57 - 0.83)
Bias B: 48% (20% - 75%)
Diffusion Tubes Mean: 30 µgm^{-3}
Mean CV (Precision): 5
Automatic Mean: 21 µgm^{-3}
Data Capture for periods used: 96%
Adjusted Tubes Mean: 21 (17 - 25) µgm^{-3}

Jaume Targa, for AEA
Version 04 - February 2011

If you have any enquiries about this spreadsheet please contact the LAQM Helpdesk at: LAQMHelpdesk@uk.bureauveritas.com

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 2018 was good overall. The local bias adjustment factor was calculated as follows:

Diffusion tubes annual mean: **30 µg/m^3**

Automatic monitoring station mean: **21 µg/m^3**

Local bias adjustment factor: **0.68**

Factor from National Co-location Studies

A national bias adjustment factor of 0.93 was calculated using the bias adjustment factor spreadsheet version 03/19 from the Defra LAQM website. This adjustment factor is based on 30 other co-location studies nationwide. All of the studies were analysed by Gradko for the method 20% TEA in water during 2018.

National Diffusion Tube Bias Adjustment Factor Spreadsheet — Spreadsheet Version Number: 03/19

Follow the steps below in the correct order to show the results of relevant co-location studies

Data only apply to tubes exposed monthly and are not suitable for correcting individual short-term monitoring periods

Whenever presenting adjusted data, you should state the adjustment factor used and the version of the spreadsheet

This spreadsheet will be updated every few months: the factors may therefore be subject to change. This should not discourage their immediate use.

This spreadsheet will be updated at the end of June 2019

LAQM Helpdesk Website

The LAQM Helpdesk is operated on behalf of Defra and the Devolved Administrations by Bureau Veritas, in conjunction with contract partners AECOM and the National Physical Laboratory.

Spreadsheet maintained by the National Physical Laboratory. Original compiled by Air Quality Consultants Ltd.

Step 1:	Step 2:	Step 3:	Step 4:
Select the Laboratory that Analyses Your Tubes from the Drop-Down List	Select a Preparation Method from the Drop-Down List	Select a Year from the Drop-Down List	Where there is only one study for a chosen combination, you should use the adjustment factor shown with caution. Where there is more than one study, use the overall factor[3] shown in blue at the foot of the final column.
If a laboratory is not shown, we have no data for this laboratory.	If a preparation method is not shown, we have no data for this method at this laboratory.	If a year is not shown, we have no data[2]	If you have your own co-location study then see footnote[4]. If uncertain what to do then contact the Local Air Quality Management Helpdesk at LAQMHelpdesk@uk.bureauveritas.com or 0800 0327953

Analysed By[1]	Method (To undo your selection, choose (All) from the pop-up list)	Year[2] (To undo your selection, choose (All))	Site Type	Local Authority	Length of Study (months)	Diffusion Tube Mean Conc. (Dm) (µg/m³)	Automatic Monitor Mean Conc. (Cm) (µg/m³)	Bias (B)	Tube Precision[4]	Bias Adjustment Factor (A) (Cm/Dm)
Gradko	20% TEA in water	2018	R	Ards and North Down Borough Council	11	36	29	27.4%	G	**0.78**
Gradko	20% TEA in water	2018	R	Gedling Borough Council	12	33	32	5.6%	G	**0.95**
Gradko	20% TEA in water	2018	R	Lisburn & Castlereagh City Council	12	32	24	32.1%	G	**0.76**
Gradko	20% TEA in water	2018	R	Monmouthshire County Council	12	38	36	4.7%	G	**0.96**
Gradko	20% TEA in water	2018	UB	Northampton Borough Council	12	16	13	26.8%	G	**0.79**
Gradko	20% TEA in water	2018	R	Bedford Borough Council	11	32	29	9.2%	G	**0.92**
Gradko	20% TEA in water	2018	R	Borough Council of King's Lynn and West Nor	12	26	24	6.0%	G	**0.94**
Gradko	20% TEA in water	2018	R	Cheshire West and Chester	12	36	37	-2.5%	G	**1.03**
Gradko	20% TEA in water	2018	R	Cheshire West and Chester	12	43	40	6.1%	G	**0.94**
Gradko	20% TEA in water	2018	R	Fareham Borough Council	12	28	34	-17.5%	G	**1.21**
Gradko	20% TEA in water	2018	R	Fareham Borough Council	12	37	34	8.9%	G	**0.92**
Gradko	20% TEA in water	2018	R	Fareham Borough Council	12	32	28	12.6%	G	**0.89**
Gradko	20% TEA in water	2018	R	NOTTINGHAM CITY COUNCIL	12	35	34	0.3%	G	**1.00**
Gradko	20% TEA in water	2018	R	Bracknell Forest Borough Council	12	44	37	19.4%	G	**0.84**
Gradko	20% TEA in water	2018	R	Brighton & Hove City Council	9	48	50	-3.7%	G	**1.04**
Gradko	20% TEA in water	2018	R	Eastleigh Borough Council	11	28	32	-12.0%	G	**1.14**
Gradko	20% TEA in water	2018	R	Eastleigh Borough Council	12	42	38	10.2%	G	**0.91**
Gradko	20% TEA in water	2018	UB	Eastleigh Borough Council	12	27	28	-4.4%	G	**1.05**
Gradko	20% TEA in water	2018	R	Gateshead Council	12	29	25	13.9%	G	**0.88**
Gradko	20% TEA in water	2018	R	Gateshead Council	12	32	29	10.8%	G	**0.90**
Gradko	20% TEA in water	2018	R	Gateshead Council	9	40	41	-1.8%	G	**1.02**
Gradko	20% TEA in water	2018	R	Wokingham Borough Council	12	38	33	13.2%	G	**0.88**
Gradko	20% TEA in water	2018	R	Bath & North East Somerset	12	40	39	4.0%	G	**0.96**
Gradko	20% TEA in water	2018	R	Bedford Borough Council	10	30	27	8.8%	G	**0.92**
Gradko	20% TEA in water	2018	KS	Marylebone Road Intercomparison	11	93	85	9.3%	G	**0.91**
Gradko	20% TEA in water	2018	R	South Gloucestershire Council	12	21	20	6.3%	G	**0.94**
Gradko	20% TEA in water	2018	R	Thurrock Borough Council	12	53	52	2.3%	S	**0.98**
Gradko	20% TEA in water	2018	R	Thurrock Borough Council	12	34	30	15.1%	G	**0.87**
Gradko	20% TEA in water	2018	R	Thurrock Borough Council	12	31	24	28.8%	G	**0.78**
Gradko	20% TEA in water	2018	UB	Thurrock Borough Council	12	27	25	9.2%	S	**0.92**
Gradko	20% TEA in water	2018		**Overall Factor[3] (30 studies)**					Use	**0.93**

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 34 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 30 diffusion tubes across the district, some of which differ considerably from our own co-location site.

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The annual mean for each diffusion tube location has therefore been adjusted using the national bias adjustment factor of 0.93.

QA/QC of national diffusion tube monitoring

AIR is an independent analytical proficiency-testing (PT) scheme, operated by LGC Standards and supported by the Health and Safety Laboratory (HSL). AIR PT is a new scheme, started in April 2014, which combined two long running PT schemes: LGC Standards STACKS PT scheme and HSL WASP PT scheme.

Defra and the Devolved Administrations advise that diffusion tubes used for LAQM should be obtained from laboratories that have demonstrated satisfactory performance in the AIR NO_2 PT scheme.

Summary of Laboratory Performance in AIR NO_2 Proficiency Testing Scheme (April 2017 – February 2019) show that Gradko achieved the following percentage (%) of results through 2018, which were subsequently determined to be **satisfactory.** (Jan-Feb 100%, April – May 100%, July – August 100%, September – October 100%. (Reference: https://laqm.defra.gov.uk/assets/laqmno2performancedatauptofebruary2019v1.pdf

Annualisation of measurements

No annualisation was required for the automatic or passive measurement of NO_2, PM_{10} or $PM_{2.5}$ as the data capture was greater than 75 %.

Distance correction for NO_2 measurements

Distance correction of NO_2 diffusion tube measurements used the NO_2 fall-off with distance calculator available on the LAQM website and discussed in Paragraphs 7.77-7.79 of LAQM.TG16.

Background concentrations were obtained from the LAQM website https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2015 (file downloaded 48-no2-201.csv). Table C.4 presents the parameters used as input to distance correct the concentrations at the sensitive receptors.

Table C.4 Input parameters used in the distance corrected concentrations

	Site name	Easting	Northing	Distance of DT from kerb, m	Distance of receptor from kerb, m	Looked up NO_2 map value, µg m^{-3}	Measured concentration (bias corrected), µg m^{-3}	Concentration predicted at receptor, µg m^{-3}
A1	45 SCOTLAND RD	339995	557188	1.5	6.0	7.86	30.12	23.3
A10	STANWIX BANK	340008	556842	1.5	3.0	10.58	37.57	33.5
A7	282 KINGSTOWN RD	339526	559285	4	11.5	9.10	21.17	17.6
E12	3 WIGTON RD	339225	555821	2.5	4.5	13.41	31.89	29.2

Table B.1 presents the 2018 NO_2 diffusion tube measurements as distance corrected to the nearest exposure

Appendix D: Map(s) of Monitoring Locations and AQMAs

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

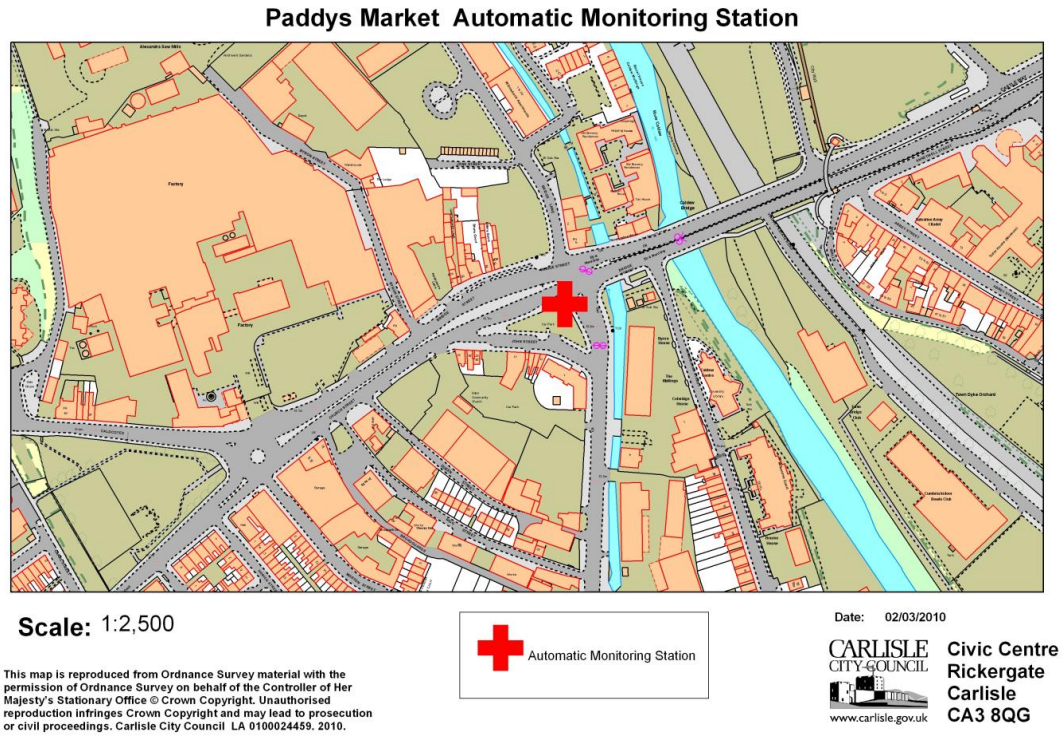
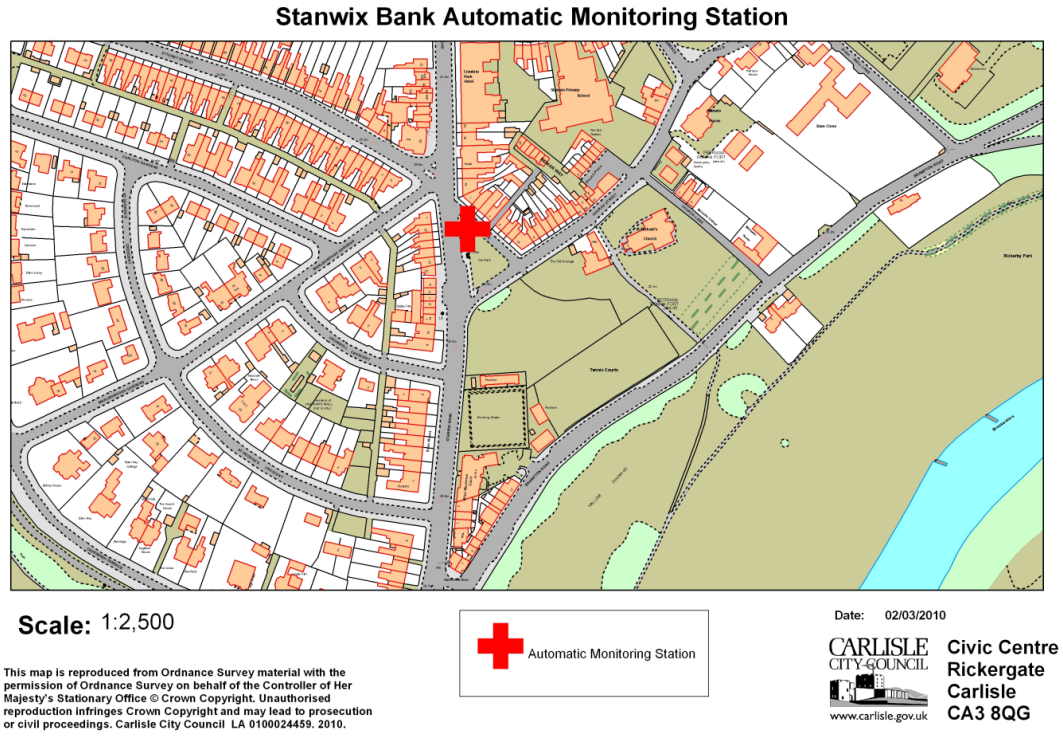


Figure D. 2 Map of Automatic Monitoring Site: Stanwix Bank



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

Figure D. 3a Map of diffusion tube locations in AQMA No1 (Area A).

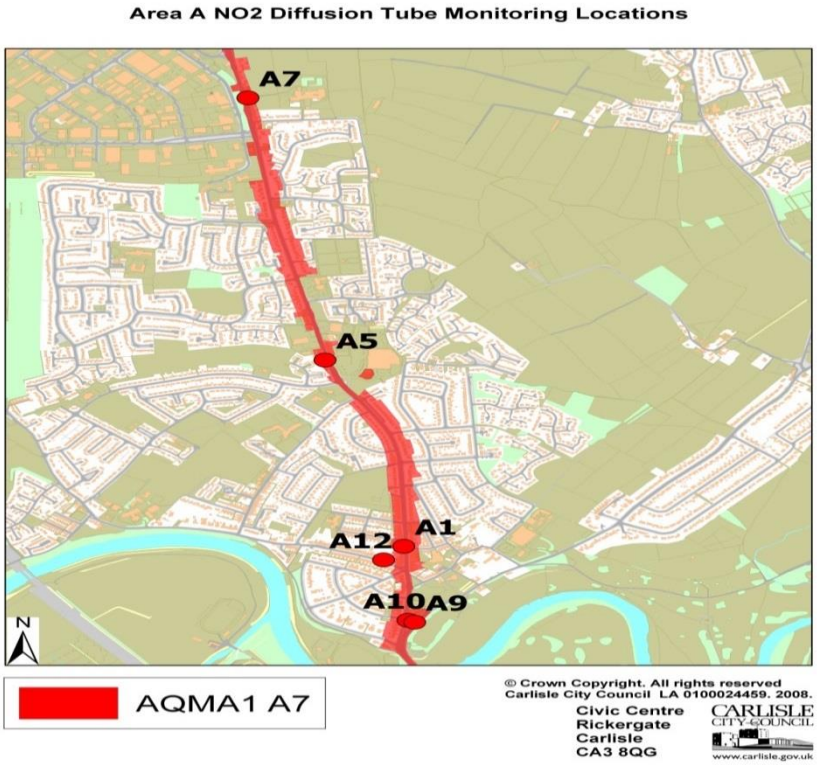
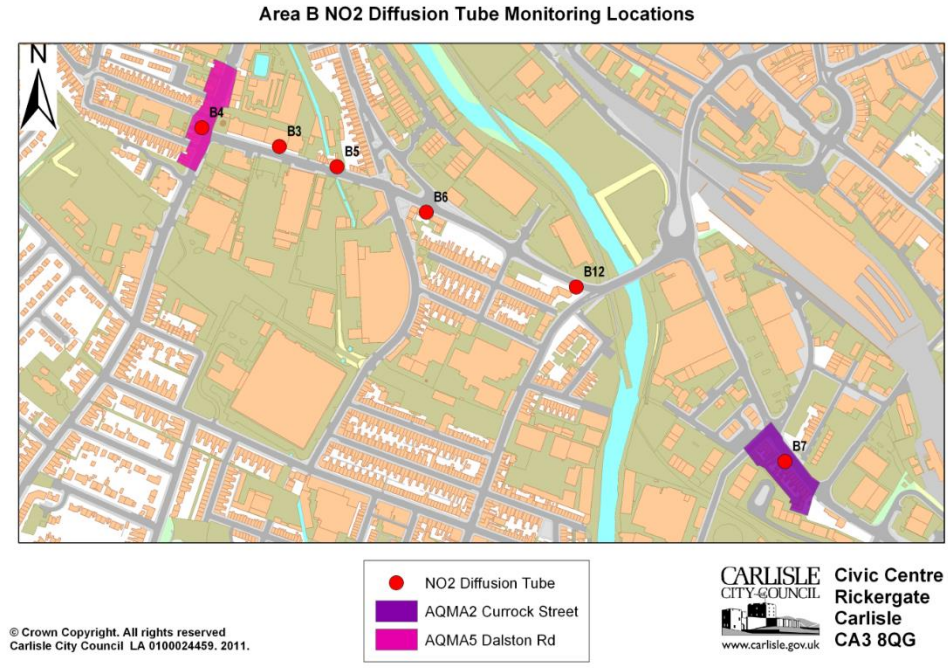


Figure D. 3b Revised AQMA 1 from 25th July 2019

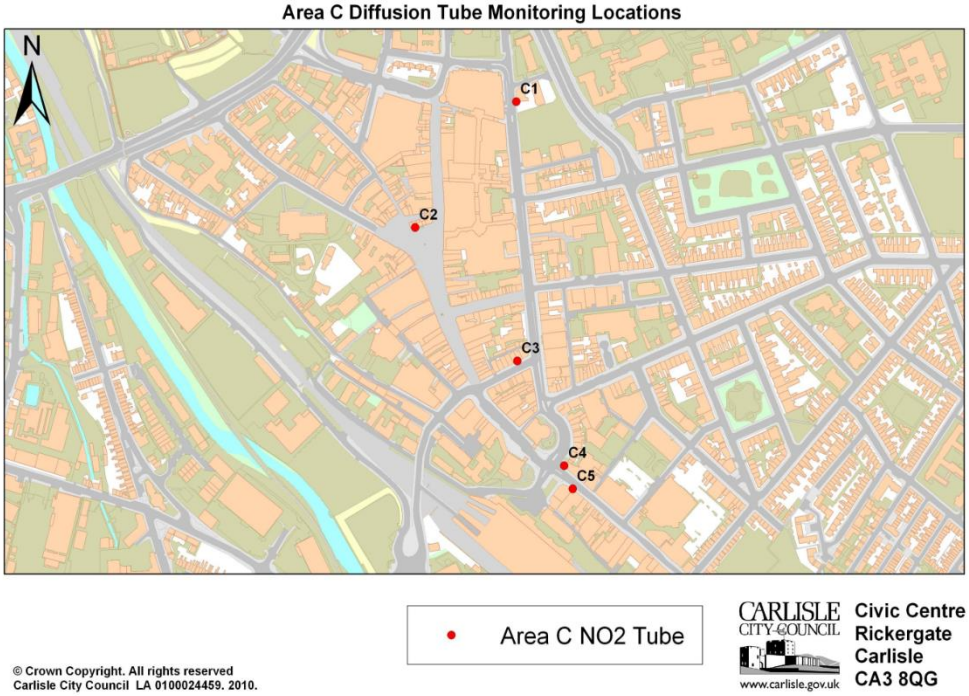
Area B – Currock St, Victoria Viaduct, Charlotte St, Junction St and Dalston Rd (Includes AQMA No.2 and No.5)

Figure D. 4: Map of diffusion tube locations in AQMA No.2 and No.5 (Area B)



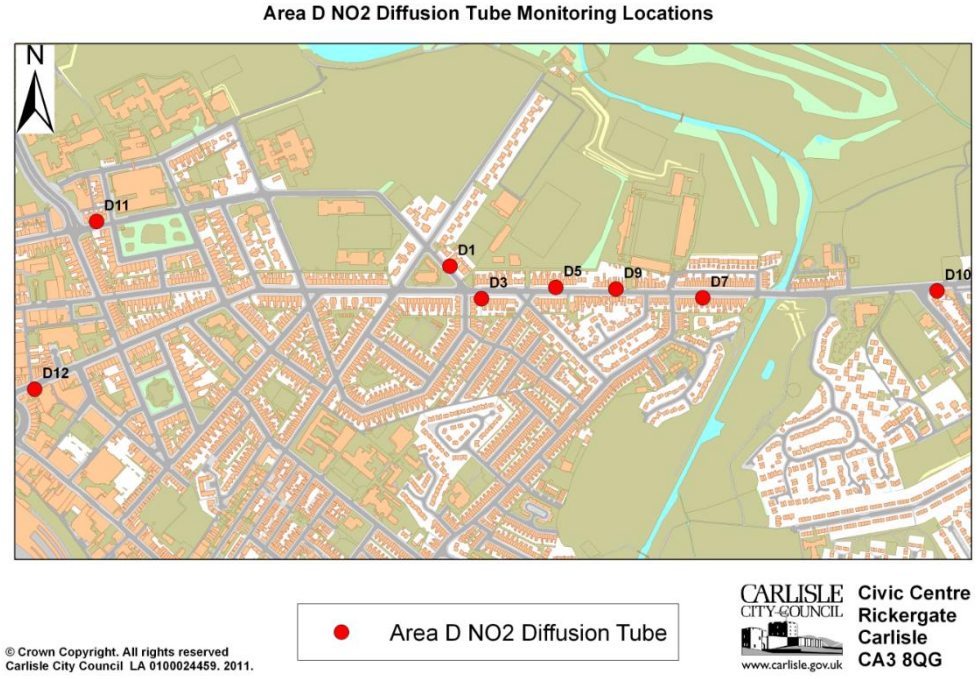
Area C – City Centre Locations

Figure D. 5: Map of diffusion tube locations in City Centre (Area C)



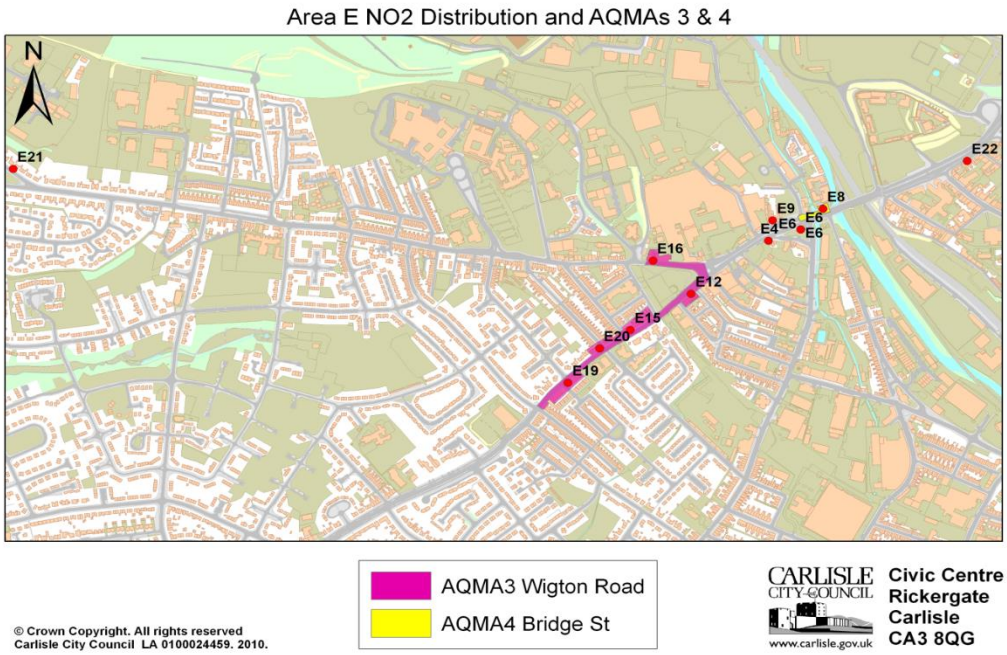
Area D A69 – Warwick Rd

Figure D. 6: Map of diffusion tube locations in A69 – Warwick Rd (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 AQMA No3 (revoked 3rd July 2019) and No4 (Area E).



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

Figure D. 8: Map of diffusion tube locations in AQMA no. 6 (revoked 3rd July 2019) (Area F).

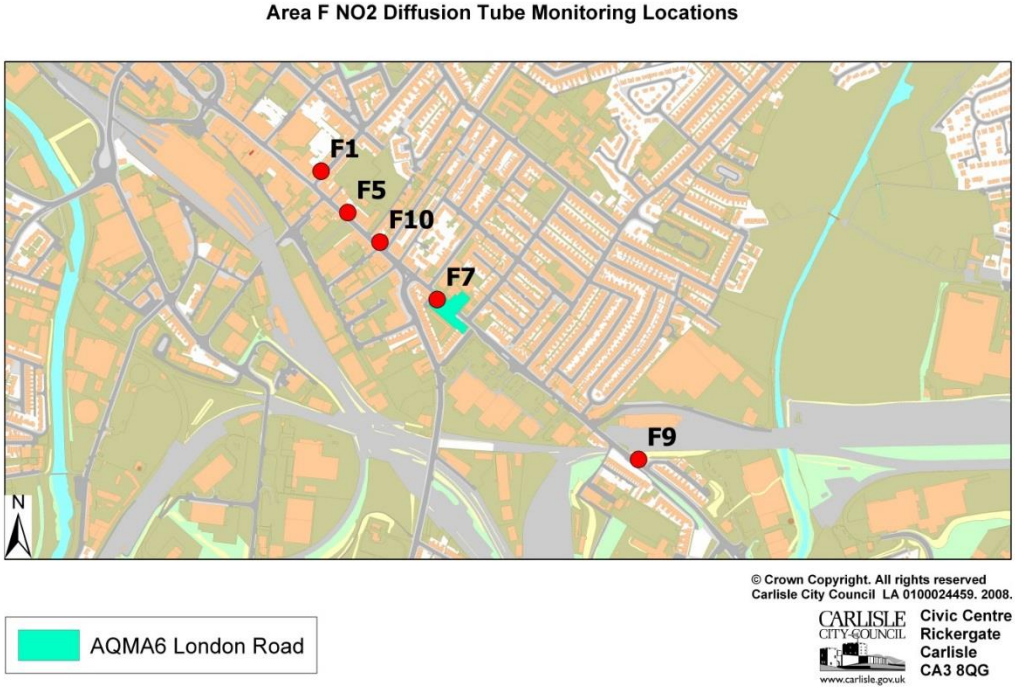
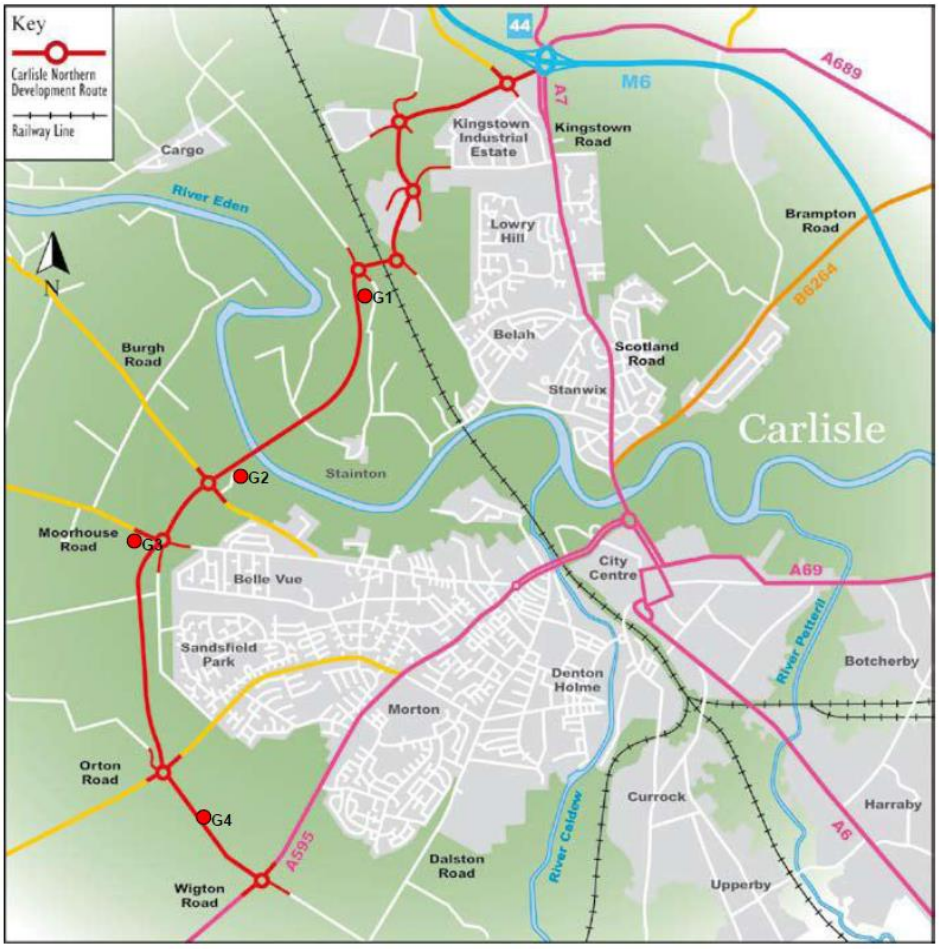


Figure D. 9: Map of diffusion tube locations in Area G.

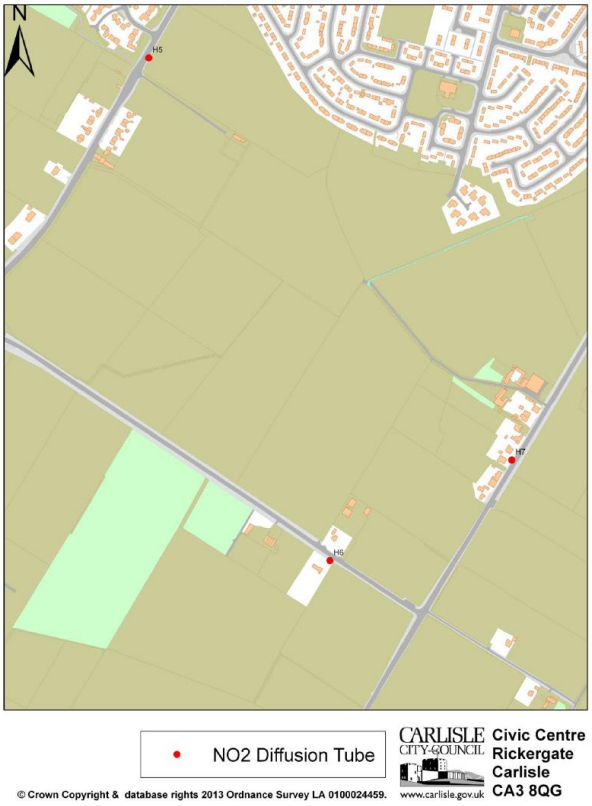
Area G NO2 Diffusion Tube Monitoring Locations

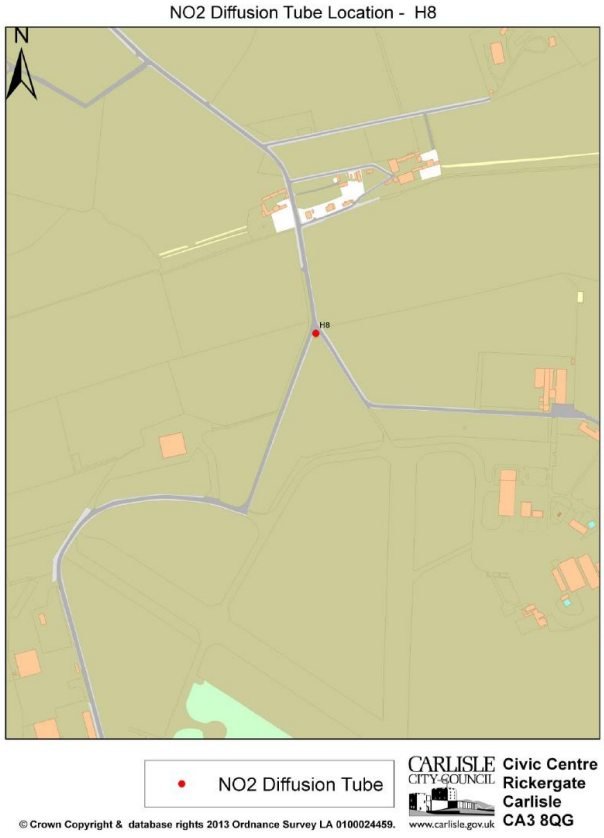


Key
NO2 Diffusion Tube

Area H – Outskirts of City, Townships and Airport

Figure D.10: Maps of diffusion tube locations on city outskirts and airport (Area H).




NO2 Diffusion Tube Location - H8
N
H8
NO2 Diffusion Tube
CARLISLE CITY COUNCIL
Civic Centre
Rickergate
Carlisle
CA3 8QG
www.carlisle.gov.uk
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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[9]	
	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

[9] The units are in micrograms 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