Belfast City Council

2024 Updating Screening Assessment for Belfast City Council

In fulfilment of Environment (Northern Ireland) Order 2002

Local Air Quality Management

Date: September 2024

	Belfast City Council
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Executive Summary

Belfast City Council has completed this 2024 Updating and Screening Assessment in accordance with the provisions of the Environment (Northern Ireland) Order 2002 and the Northern Ireland Local Air Quality Management Policy Guidance document LAQM.PGNI (09).

In completing this Updating and Screening Assessment, we have undertaken a review of potentially significant sources of air pollution across the city in order to identify new sources, sources with increased emissions and locations close to air pollution sources where public exposure did not previously exist.

We have additionally completed a review of recent ambient air quality monitoring data for the city in order to identify locations where new or existing exceedances of Air Quality Strategy objectives are occurring. This review has also identified locations where ambient air quality has improved and exceedances are no longer occurring.

In addition, we have also completed a Detailed Assessment (2021-2023) for the city. This project has been undertaken mainly to address the emerging pollutant of concern, fine particulate matter ($PM_{2.5}$), but it has also considered nitrogen dioxide (NO_2) and particulate matter (PM_{10}) concentrations, all in terms of national and European air quality standards and objectives, and the World Health Organisation (WHO) Air Quality Guideline values (September 2021).

There are four Air Quality Management Areas (AQMAs) declared across the city for a combination of exceedances of the nitrogen dioxide (NO_2) annual and hourly mean Air Quality Strategy objectives. A review of the monitoring data for these Air Quality Management Areas and for the city generally indicates that there have been further improvements in ambient nitrogen dioxide concentrations across Belfast over recent years, notwithstanding the impact of the Covid-19 pandemic on transport and other emissions.

Moreover, the conclusions of the recent Detailed Assessment confirmed that based on predicted/modelled annual mean nitrogen dioxide (NO_2) and particulate matter (PM_{10})

concentrations for a pre Covid-19 2019 base year and for a 2028 forward projection year, all annual mean and shorter-term average concentrations are predicted to be below the UK AQOs for nitrogen dioxide (NO_2) and particulate matter (PM_{10}) at locations of relevant human health exposure within the Belfast City Council area.

The Detailed Assessment‘s conclusion was therefore that consideration should be given to revocation of the Ormeau Road and Upper Newtownards Road AQMAs. More information concerning the detailed assessment is contained within Section 1.5 of our 2023 Progress Report. A summary of the 2023 Detailed Assessment is also attached to this report (Appendix D).

At this stage, the council has however decided not to move to revoke the Ormeau Road and Upper Newtownards Road Air Quality Management Areas and instead to await acceptance of this 2024 Updating and Screening Assessment (USA) report and an update on the conclusions and recommendations of the report from DAERA.

In addition, the council notes DAERA’s recommendations, included within the appraisal letter (dated 28th October 2022), in relation to the council’s 2022 Progress Report. The Department recommended that the council should also consider the revocation of the Cromac Street and Albertbridge Road AQMA due to continual compliance with the NO_2 annual mean objective. DAERA have additionally highlighted that the M1 Motorway / A12 Westlink AQMA could be amended to revoke the designation for the 1-hour mean NO_2 objective as compliance has been achieved for the past 5 years.

There have been no monitored exceedances of Air Quality Strategy Objectives for any pollutant other the nitrogen dioxide (only within AQMA 1) in recent years across the city, and no new emission sources have been identified that would have the potential to alter this position.

Monitored levels of benzene (C_6H_6) and sulphur dioxide (SO_2) remain well below the objectives and show no reason for concern at this time.

Additionally, the council, its competent authority partners, Translink, Belfast Harbour and other significant transport organisations and partners from across the city continue working

towards implementation of the various measures included within the Belfast City Air Quality Action Plan 2021-2026.

The aim of the current AQAP is to continue to reduce nitrogen dioxide (NO_2) emissions from transport sources and to promote and enable a shift towards more sustainable modes of transport in order to achieve compliance with UK Air Quality Strategy objectives for NO_2. Where necessary, an additional aim of this Action Plan is to identify, develop and implement mitigation measures to address concentrations of fine particulate matter ($PM_{2.5}$) across the city.

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1 Introduction

1.1 Description of Local Authority Area

Belfast is the capital city of Northern Ireland and as such, the city, and its wider metropolitan area, is the largest settlement in the region and the second largest city on the island of Ireland with an estimated population of around 348,000. The city lies at the head of Belfast Lough in the lower reaches of the Lagan Valley and is flanked by the Black Mountain to the west and the Castlereagh Hills to the east. The Belfast City Council district area sits at the heart of the growing population of the wider Belfast Metropolitan Urban Area, which also comprises part of the surrounding areas of Lisburn and Castlereagh City Council, North Down and Ards District Council, Antrim and Newtownabbey District Council and Mid and East Antrim District Council.

In terms of historical air quality issues, Belfast used to experience sustained elevated levels of sulphur dioxide (SO_2) and particulate matter (PM_{10}), associated principally with the widespread use of solid fuel for domestic heating. However, through the introduction of the Council's smoke control programme in the late 1960s, the Clean Air (Northern Ireland) Order 1981 and the more recent availability of natural gas to domestic, commercial and industrial sectors, levels of particulate matter and sulphur dioxide have declined substantially to the extent that we do not experience exceedances of any air quality strategy objectives, or indeed European Commission limit values, for either of these pollutants. Accordingly, the number of locations where we monitor these ambient pollutants has been reduced over recent years in accordance with the government's risk and exposure-based approach to local air quality management.

Although Belfast city does not experience exceedances of any air quality strategy objectives, for particulate matter (PM_{10}), we are aware of growing concerns around the effects of fine particulate matter ($PM_{2.5}$) on human health. Therefore, although not included in regulations at present for Northern Ireland councils, Belfast City Council has proactively opted to report $PM_{2.5}$ monitoring data as part of this Progress Report. Moreover, we are aware of the recent evidence from national studies showing that domestic solid fuel burning contributes more than previously thought to particulate emissions.

At the end of 2017, Defra issued a practical guide on open fires and wood burning stoves. This guide (updated in April 2022) provides steps that should be taken to reduce the health impacts of burning solid fuel. This guidance can be found on the Defra smoke control webpage: https://uk-air.defra.gov.uk/library/reports?report_id=948.

The contribution from solid fuel combustion to fine particulate matter ($PM_{2.5}$) concentrations has been also recognised within the UK Clean Air Strategy 2019 and the Clean Air Strategy NI (Public Discussion Document, DAERA November 2020). Therefore, Belfast City Council decided to undertake a detailed assessment for the city, for particulate matter (PM_{10}), fine particulate matter ($PM_{2.5}$) and nitrogen dioxide (NO_2) pollutants. This project commenced in February 2021 and was concluded in March 2023. It comprised additional ambient air quality monitoring (using Zephyr small sensor air quality monitors), development of an emissions inventory database for the city and detailed atmospheric dispersion modelling. The outcomes of this detailed assessment were presented within 2023 Progress Report. Furthermore, a Detailed Assessment Summary Report (March 2023) is attached to this report (Appendix D).

Over recent years, emissions of nitrogen oxides, associated principally with road transport, have become more prominent. This is a similar situation to that experienced in many other major cities and conurbations across the United Kingdom. Accordingly, as a result of the first round of the review and assessment process, which was completed in 2004, Belfast City Council opted to declare four Air Quality Management Areas across the city. We published our first Air Quality Action Plan for the city back in 2006 and it was completed substantially in 2010, with around 90% of planned actions delivered to schedule. Of the outstanding 10% of actions, it was considered that the majority of these would have had limited additional impact within our Air Quality Management Areas.

In order to address the remaining ‘hot spot’ areas of elevated nitrogen dioxide, the council along with relevant partners developed a 2015-2020 Air Quality Action Plan (AQAP) for the city that contained a manageable number of proven air quality mitigation measures. This AQAP concluded at the end of 2020. A final review of the implementation of the various mitigation measures included within 2015-2020 AQAP was undertaken and reported by the council to the Department of Agriculture Environment and Rural Affairs (DAERA) as part of the council’s 2023 Progress Report, submitted to DAERA in June 2023.

Whilst previous AQAPs have delivered further improvements in ambient air quality across the city, a limited number of nitrogen dioxide (NO_2) hotspots still remain. Moreover, fine

particulate matter ($PM_{2.5}$) has emerged as an additional ambient air pollutant of concern for the city.

Accordingly in 2021, the council, competent authorities and other partner organisations developed a new Air Quality Action Plan for the city; the Plan was approved by DAERA and Defra's independent technical appraisers in February 2022 and can be viewed on the Belfast City Council website: https://www.belfastcity.gov.uk/Documents/Belfast-City-Air-Quality-Action-Plan-2021-2026

The aim of the new Air Quality Action Plan 2021-2026 is to continue to reduce nitrogen dioxide emissions from transport sources and to promote and enable a shift towards more sustainable modes of transport in order to achieve compliance with UK Air Quality objectives for nitrogen dioxide. Where necessary, an additional aim of this Action Plan is to identify, develop and implement mitigation measures to address concentrations of fine particulate matter ($PM_{2.5}$) across the city.

1.2 Purpose of Report

This report fulfils the requirements of the Local Air Quality Management process as set out in The Environment (Northern Ireland) Order 2002, the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 and the relevant Policy and Technical Guidance documents. The LAQM process places an obligation on all local authorities to regularly review and assess air quality within their areas, and to determine whether or not the air quality objectives are likely to be achieved. Where exceedances are considered likely, the local authority must then declare an Air Quality Management Area (AQMA) and prepare an Air Quality Action Plan (AQAP) setting out the measures it intends to put in place in pursuit of the objectives.

The aim of this Updating and Screening Assessment is to identify any matters that have changed, which may lead to risk of an air quality objective being exceeded. A checklist approach and screening tools are used to identify significant new sources or changes and whether there is a need for a Detailed Assessment. In addition, the USA report should provide an update of any outstanding information requested previously in Review and Assessment reports.

1.3 Air Quality Objectives

The air quality objectives applicable to LAQM in Northern Ireland are set out in the Air Quality Regulations (Northern Ireland) 2003, Statutory Rules of Northern Ireland 2003, no. 342, and are shown in Table 1.1. This table shows the objectives in units of microgrammes per cubic metre µg/m^3 (milligrammes per cubic metre, mg/m^3 for carbon monoxide) with the number of exceedances in each year that are permitted (where applicable).

Table 1.1 Air Quality Objectives included in Regulations for the purpose of LAQM in Northern Ireland

Pollutant	Air Quality Objective Concentration	Air Quality Objective Measured as	Date to be achieved by
Benzene	16.25 µg/m^3	Running annual mean	31.12.2003
	3.25 µg/m^3	Running annual mean	31.12.2010
1,3-Butadiene	2.25 µg/m^3	Running annual mean	31.12.2003
Carbon monoxide	10.0 mg/m^3	Running 8-hour mean	31.12.2003
Lead	0.5 µg/m^3	Annual mean	31.12.2004
	0.25 µg/m^3	Annual mean	31.12.2008
Nitrogen dioxide	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
	40 µg/m^3	Annual mean	31.12.2005
Particles (PM_{10}) (gravimetric)	50 µg/m^3, not to be exceeded more than 35 times a year	24-hour mean	31.12.2004
	40 µg/m^3	Annual mean	31.12.2004
Sulphur dioxide	350 µg/m^3, not to be exceeded more than 24 times a year	1-hour mean	31.12.2004
	125 µg/m^3, not to be exceeded more than 3 times a year	24-hour mean	31.12.2004
	266 µg/m^3, not to be exceeded more than 35 times a year	15-minute mean	31.12.2005

1.4 Summary of Previous Review and Assessments

As part of the continuing review and assessment process, Belfast City Council completed a 2nd and 3rd stage review and assessment of air quality throughout the city in early 2004. This assessment concluded that modelled and monitored exceedances of short and longer-term objectives for both nitrogen dioxide and particulate matter were occurring in the city and would be likely to continue to do so in some locations beyond 2010. Consequently, in August 2004, the council, in consultation with other relevant authorities, declared four Air Quality Management Areas (AQMA), comprising of the M1 Motorway and

Westlink corridor, Cromac Street to the junction of Short Strand, Woodstock Link and the Albertbridge Road, the Upper Newtownards Road and the Ormeau Road.

The M1-Westlink AQMA was declared on the basis that annual and hourly-mean nitrogen dioxide concentrations would exceed the 31st December 2005 Air Quality Strategy objectives. In addition, particulate matter annual and 24-hour mean concentrations were predicted also to exceed relevant objectives at this location. The three other Air Quality Management Areas were declared on the grounds that the annual mean nitrogen dioxide objective would be exceeded at these locations during 2005 and beyond. A subsequent source apportionment study, completed for each of the Air Quality Management Areas, indicated that the principal source of the exceedances was emissions associated with road transport.

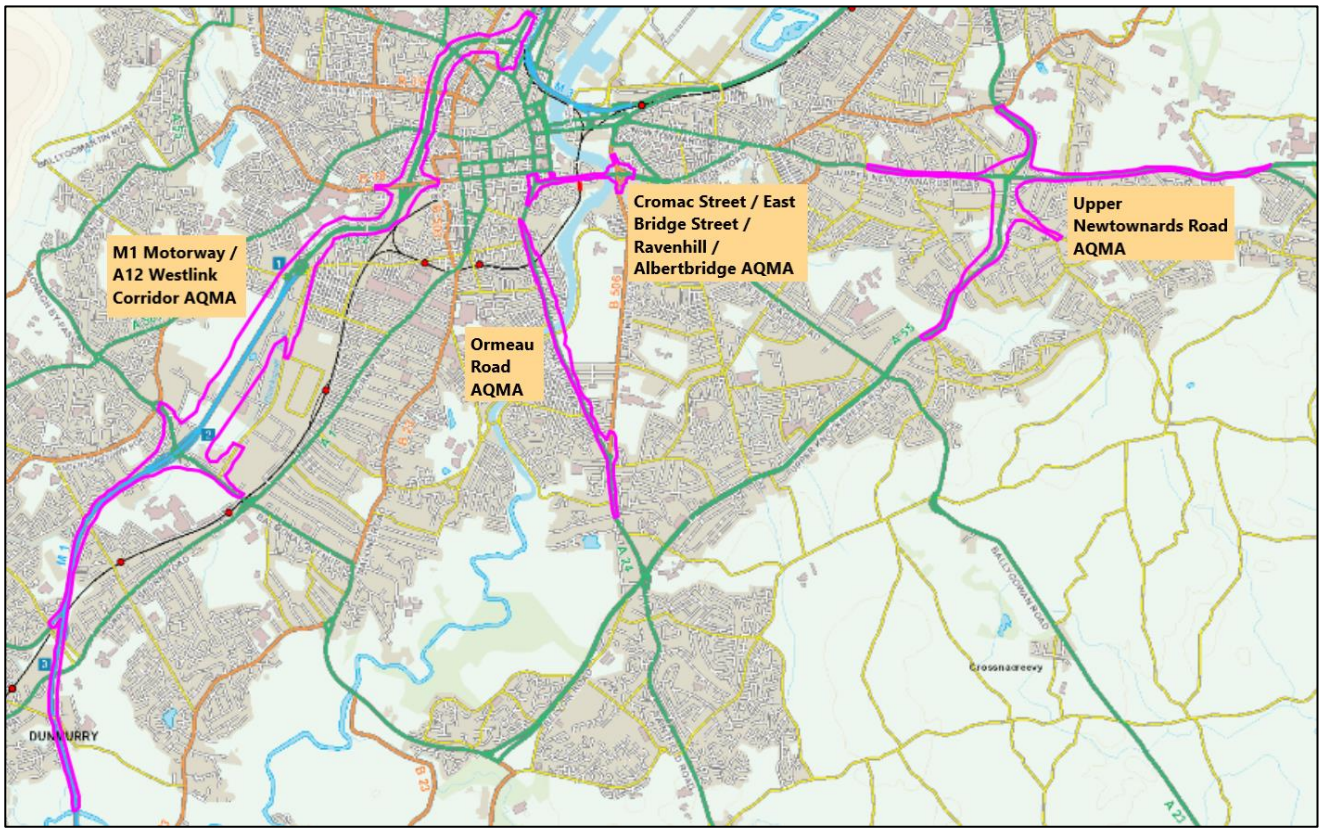
Current Air Quality Management Areas are described and depicted in more detail as follows:

1. The M1 / Westlink corridor from the Belfast City boundary at Sir Thomas and Lady Dixon Park to the end of the Westlink at the junction with Great George's Street and York Street including Stockman's Lane and Kennedy Way. This area was declared for predicted exceedances of both the nitrogen dioxide and particulate material annual mean air quality strategy objectives as well as exceedances of the particulate matter 24-hour mean objective and the nitrogen dioxide 1-hour mean objective. The boundary of the Air Quality Management Area is denoted in pink and has been set to take account of dispersion modelling uncertainties. This AQMA was revoked for exceedances of particulate matter objectives in September 2015, but currently continues to exceed the annual mean air quality objective for nitrogen dioxide.
2. Cromac Street to the junction with East Bridge Street and then from East Bridge Street to the junction with the Ravenhill and Albertbridge Roads and Short Strand. This AQMA was declared for predicted exceedances of the nitrogen dioxide annual mean Air Quality Strategy objective.
3. The Upper Newtownards Road from the North Road junction to the Belfast City boundary at the Ulster Hospital, incorporating the Knock Road to the City boundary at Laburnum Playing Fields and Hawthornden Way. This AQMA was declared for predicted exceedances of the nitrogen dioxide annual mean Air Quality Strategy objective.

4. The Ormeau Road from the junction with Donegall Pass to the city boundary at Galwally. This area was declared for predicted exceedances of the nitrogen dioxide annual mean Air Quality Strategy objective.

Please note that the Belfast City Council boundary was revised in 2015 as a consequence of the reform of local government in Northern Ireland. The above-mentioned AQMAs were declared on the basis of the previous council boundary.

Figure 1.1 Map of AQMA Boundaries



A further detailed air quality review and assessment was completed by Belfast City Council in 2010, informed by the outcome of the 2009 Updating and Screening Assessment. Accordingly, the 2010 Detailed Assessment considered the potential for exceedances of nitrogen dioxide objectives at a number of further locations across the city, including at the junction of the Sydenham Bypass with the Lower Newtownards Road, Shaftesbury Square, Donegall Road and Albertbridge Road, and at locations throughout the city centre. Although atmospheric dispersion modelling studies, undertaken as part of the detailed review and assessment process, did suggest exceedances of the nitrogen dioxide annual mean objective at some the of above-mentioned locations, the review and

assessment identified also that there was no relevant public exposure at these locations during 2010. As a result, the 2010 Detailed Air Quality Review and Assessment for Belfast City Council concluded that there was no need to declare further Air Quality Management Areas or to expand or revoke the existing AQMAs. This conclusion was accepted by DAERA.

Ambient air quality monitoring results, as presented in previous annual progress and updating and screening assessment reports, had identified sustained improvements in particulate matter concentrations within the M1 Motorway / A12 Westlink Air Quality Management Area, confirming that it had been in compliance with the particulate matter (PM_{10}) objectives for a number of years. This resulted in the Westlink / M1 AQMA being revoked for particulate matter 24-hour and annual mean objectives in September 2015.

The current stage of the Review and Assessment process requires that an Updated Screening Assessment (USA) be completed. This report therefore addresses the requirements of the Defra LAQM.TG(22) technical guidance publication in identifying any significant changes that have occurred since the previous round of Review and Assessment, which may have the potential to affect the local air quality.

This report additionally refers to the outcome of the council's 2021-2023 Detailed Assessment, undertaken for particulate matter (PM_{10}), fine particulate matter ($PM_{2.5}$) and nitrogen dioxide (NO_2) pollutants (Appendix D).

For reference and additional background information, historical Belfast City Council air quality review and assessment reports are listed in the following table, and are available to download from the Department of Agriculture, Environment & Rural Affairs for Northern Ireland 'Northern Ireland Air Quality' website via the follow weblink: https://www.airqualityni.co.uk/laqm/district-council-reports#511

Table 1.2 Historical Belfast City Council Air Quality Reports

• Belfast City Council 2023 Air Quality Progress report - Published: 10th January 2024
• Belfast City Council 2022 Air Quality Progress Report - Published: 15th February 2023
• 2021 Updating and Screening Assessment for Belfast City Council - Published: 1st October 2021
• Belfast - Progress Report - 2020 - Published: 11th November 2020
• Belfast - Progress Report - 2019 - Published: 11th November 2020
• Belfast - Updating and Screening Assessment - 2018 - Published: 17th December 2018
• Belfast - Progress Report - 2017 - Published: 17th November 2017
• Belfast - Progress Report - 2016 - Published: 21st October 2016
• Belfast - Updating and Screening Assessment - 2015 - Published: 21st October 2016
• Belfast - LAQM Progress Report - 2014 - Published: 14th November 2014
• Belfast - LAQM Progress Report - 2013 - Published: 1st April 2013
• Belfast - Updating and Screening Assessment report - 2012 - Published: 3rd October 2012
• Belfast - Progress Report - 2011 - Published: 30th April 2011
• Belfast - Detailed Assessment - September 2010 - Published: 30th September 2010
• Belfast - Progress Report - 2010 - Published: 30th April 2010
• Belfast - Updating and Screening Assessment - 2009 - Published: 30th April 2009
• Belfast - Joint Air Quality Progress and Action Plan Progress Report - 2007 - Published: 30th April 2007
• Belfast - Detailed Assessment - April 2007 - Published: 30th April 2007
• Belfast - Joint Air Quality Progress and Action Plan Progress Report - 2008 - Published: 10th June 2008
• Belfast - Updating and Screening Assessment - 2006 Appendix - Published: 31st July 2006
• Belfast - Updating and Screening Assessment - 2006 - Published: 31st July 2006
• Belfast - Health Impact Assessment of the Draft Air Quality Action Plan for Belfast - Published: 1st May 2006
• Belfast - Progress Report - Published: 1st September 2005

2 New Monitoring Data

2.1 Summary of Monitoring Undertaken

2.1.1 Automatic Monitoring Sites

Belfast City Council operates four automatic monitoring stations across the city in order to help inform its air quality management processes and to provide real time information to the public in relation to air pollution levels across the city centre and within our Air Quality Management Areas.

Accordingly, to ensure that the data from our sites is both accurate and representative, the monitors at each site are calibrated on a bi-weekly (Stockman's Lane AURN site) or on a four-weekly basis by the council's technical staff in accordance with the procedures detailed in the Defra Automatic Urban and Rural Network (AURN) local site operators' manual. In addition, data management, quality assurance and quality control and service and maintenance support are all provided by appointed contractors. The data from our sites is made available to the Department of Agriculture, Environment and Rural Affairs (DAERA) and is reported on the 'Northern Ireland Air' website in near real time (https://www.airqualityni.co.uk). Under the current LAQM regime, and for the purpose of LAQM reporting, concentrations should be reported to 1 decimal place; monitoring data in this required format are not currently available from the 'Northern Ireland Air' website. Consequently all 2023 automatic monitoring data reported in this progress report have been obtained from the Defra UK AIR (Air Information Resource) website (https://uk-air.defra.gov.uk). Automatic monitoring data presented in this report relate to the calendar year (i.e. January – December). 2023 data capture levels exceeded the Department's 75% data capture threshold for the calculation of annual statistics at all council sites. Further information regarding our QA/QC procedures and processes has been provided in Appendix A to this report.

In addition to the council's automatic monitoring sites, the UK Environment Agency and DAERA operate an AURN urban background monitoring site at Lombard Street in Belfast City Centre. Unfortunately, during 2023, data capture levels at the Belfast Centre site were below the Department's 75% data capture threshold for nitrogen dioxide (70%). The target data capture for the AURN network is 90%.

In relation to correction of our automatic monitoring data, this process is generally of principal concern with regard to the treatment of particulate matter monitoring data. In 2019, the Belfast Centre site employed Filter Dynamics Measurement System (FDMS) equipped Tapered Element Oscillating Microbalances (TEOMs) for particulate matter (PM10) monitoring up until September whereupon the FDMS equipped TEOMs were replaced by a Palas Fidas 200, which complies with Defra's UK PM Pollution Climate standard. Government equivalence tests have determined that both of types of equipment meet the equivalence criteria, and on that basis, no correction factors need to be applied to this monitoring data.

The Stockman's Lane site is equipped with a Beta Attenuation Monitor (BAM) with a heated inlet for monitoring particulate matter (PM_{10}). Government technical guidance highlights that a BAM, equipped with a heated inlet, also meets the equivalence criteria for PM10 monitoring, provided that the results are corrected for slope. This correction involves dividing measured concentrations by a factor of 1.035. It should be noted that the data presented on the Defra UK-Air, Northern Ireland Air website and in this report have already been corrected to the reference equivalent.

During 2019, Belfast City Council replaced ageing NOx API M200A analysers at two of its monitoring sites, namely the Upper Newtownards Road and Stockman's Lane. In addition, the unheated BAM 1020 particulate matter (PM10) analyser at Stockman's Lane was also replaced with a heated inlet variant in order to continue to collect high quality data and to achieve >90% data collection rates throughout the year. In 2020, the council also replaced a further API M200 NOx analyser at the Ormeau Road site.

During 2022, we progressed with the upgrade of our communication system (including modems) at our four monitoring sites. AQMSs were consequently updated from GSM modems to 4G IP Routers and the T200 analysers were converted to use NumaView software.

A location map showing automatic monitoring site locations across the Belfast City Council area is presented in the following Figure 2.1, with further site-specific monitoring details provided in Table 2.1.

Figure 2.1 Map of Automatic Monitoring Sites

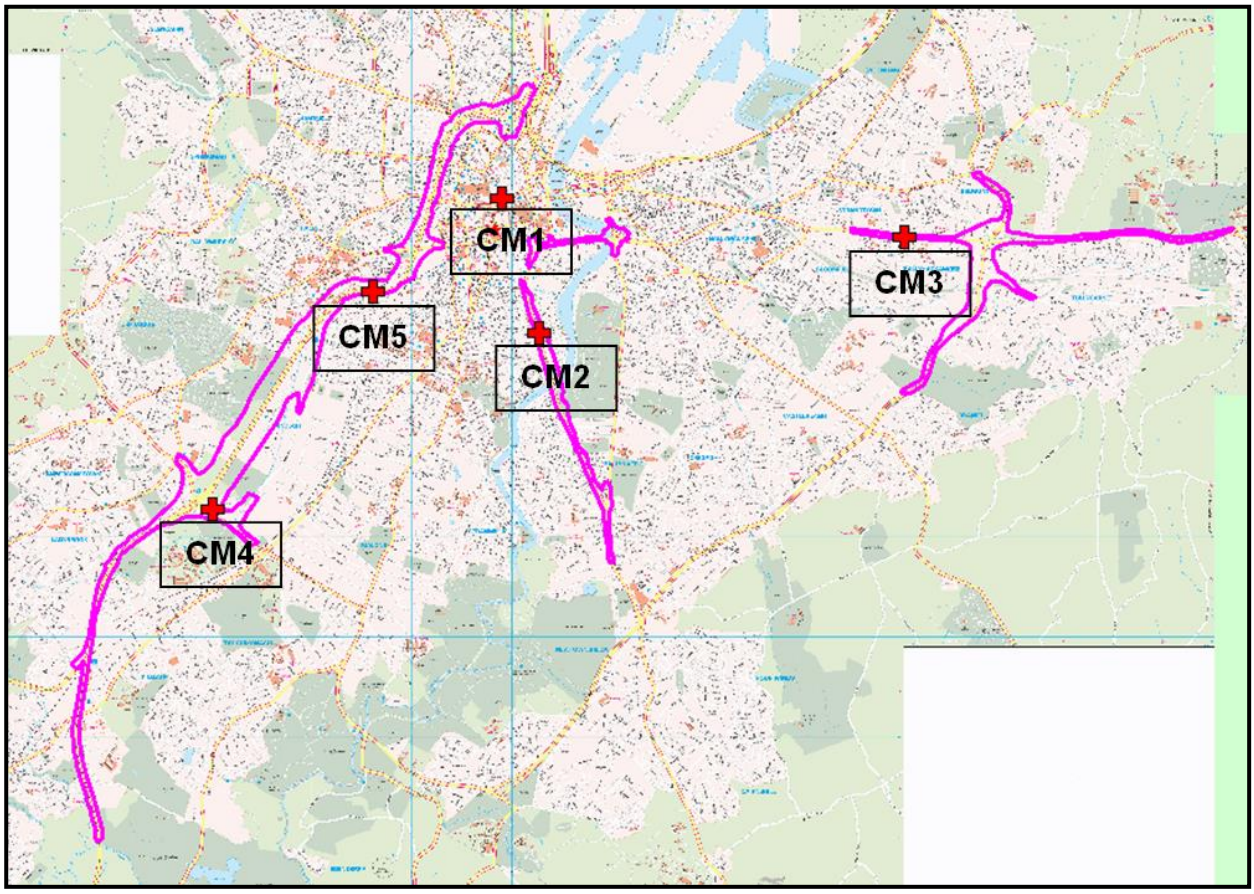


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Table 2.1 Details of Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Reference	Y OS Grid Reference	Inlet Height (m)	Pollutants Monitored	In AQMA?	Monitoring Technique	Relevant Exposure? (Y/N with distance (m) from monitoring site to relevant exposure)	Distance to Kerb of Nearest Road (m) (N/A if not applicable)	Does this Location Represent Worst-Case Exposure?
CM1	Belfast Centre AURN site Lombard Street	Urban Background	333898	374358	4.0	Nitrogen dioxide, sulphur dioxide, carbon monoxide, ozone and particulate matter (PM_{10} and $PM_{2.5}$)	N	Chemiluminescence, UV Fluorescence, IR Absorption, UV Absorption, Light-Scattering Monitor (Palas Fidas 200)	Y (Monitoring site is located in a city centre pedestrian precinct)	26 m	Y
CM2	Belfast Ormeau Road	Roadside	334272	373012	1.3	Nitrogen dioxide	Y	Chemiluminescence	Y (6 m)	3 m	Y
CM3	Belfast Upper Newtownards Road	Roadside	337911	373972	1.3	Nitrogen dioxide	Y	Chemiluminescence	Y (7 m)	2 m	Y
CM4	Belfast Stockman's Lane	Roadside	331010	371252	3.0	Nitrogen dioxide and particulate matter (PM_{10})	Y	Chemiluminescence Beta Attenuation Monitor	Y (10 m)	3 m	Y
CM5	Belfast Westlink Roden Street	Roadside	332609	373434	2.6	Nitrogen dioxide	Y	Chemiluminescence	Y (17 m)	5 m	Y

2.1.2 Non-Automatic Monitoring Sites

The government's risk and exposure-based approach to local air quality management means that Belfast City Council's principal focus has been on addressing citywide ambient nitrogen dioxide (NO_2) levels over recent years. Accordingly, in order to understand how nitrogen dioxide levels are varying across the city and in addition to our automatic analysers, the council operates a range of passive diffusion tubes for nitrogen dioxide at a range of both background and roadside locations across the city.

The NOx diffusion tube monitoring network has changed considerably since the declaration of the Air Quality Management Areas in 2004. In 2023, the extensive council monitoring network comprised 84 diffusion tubes throughout the city at 76 locations, which generate annual mean NO_2 data to assist in the review and assessment process and to aid developers in conducting air quality impact assessments, where deemed necessary. The council regularly reviews its monitoring locations and relocates or discontinues tubes from areas of continued low nitrogen dioxide concentrations. In 2023, we added 8 tubes to the network; 7 (109-115) were added as a result of the outcome of the detailed assessment, to verify compliance with the annual mean air quality objective, and one (116) as a result of a local resident's request. No tubes were removed from the network during 2023. All locations are detailed in Figure 2.2 and Table 2.2.

Nitrogen dioxide diffusion tubes comprise a small clear plastic tube containing a chemical reagent supported on stainless steel grids that absorb the pollutant directly from the surrounding ambient air. In this case, triethanolamine is used as the reagent to monitor levels of ambient nitrogen dioxide. Belfast City Council's diffusion tubes are exposed for successive four or five-week periods, in general accordance with the Defra Diffusion Tube Monitoring Calendar and, as a result, they provide a good general indication of average nitrogen dioxide concentrations, thereby allowing a comparison with the annual mean objective.

To ensure that experimental error is minimised in the preparation and analysis of its nitrogen dioxide diffusion tubes, Belfast City Council has appointed Gradko International Ltd. to supply, analyse and report data for its diffusion tubes. Gradko employs a 20% triethanolamine solution for monitoring ambient nitrogen dioxide and adheres to the

requirements of the government's 'Diffusion Tubes for Ambient NO_2 Monitoring: Practical Guidance for Laboratories and Users' publication.

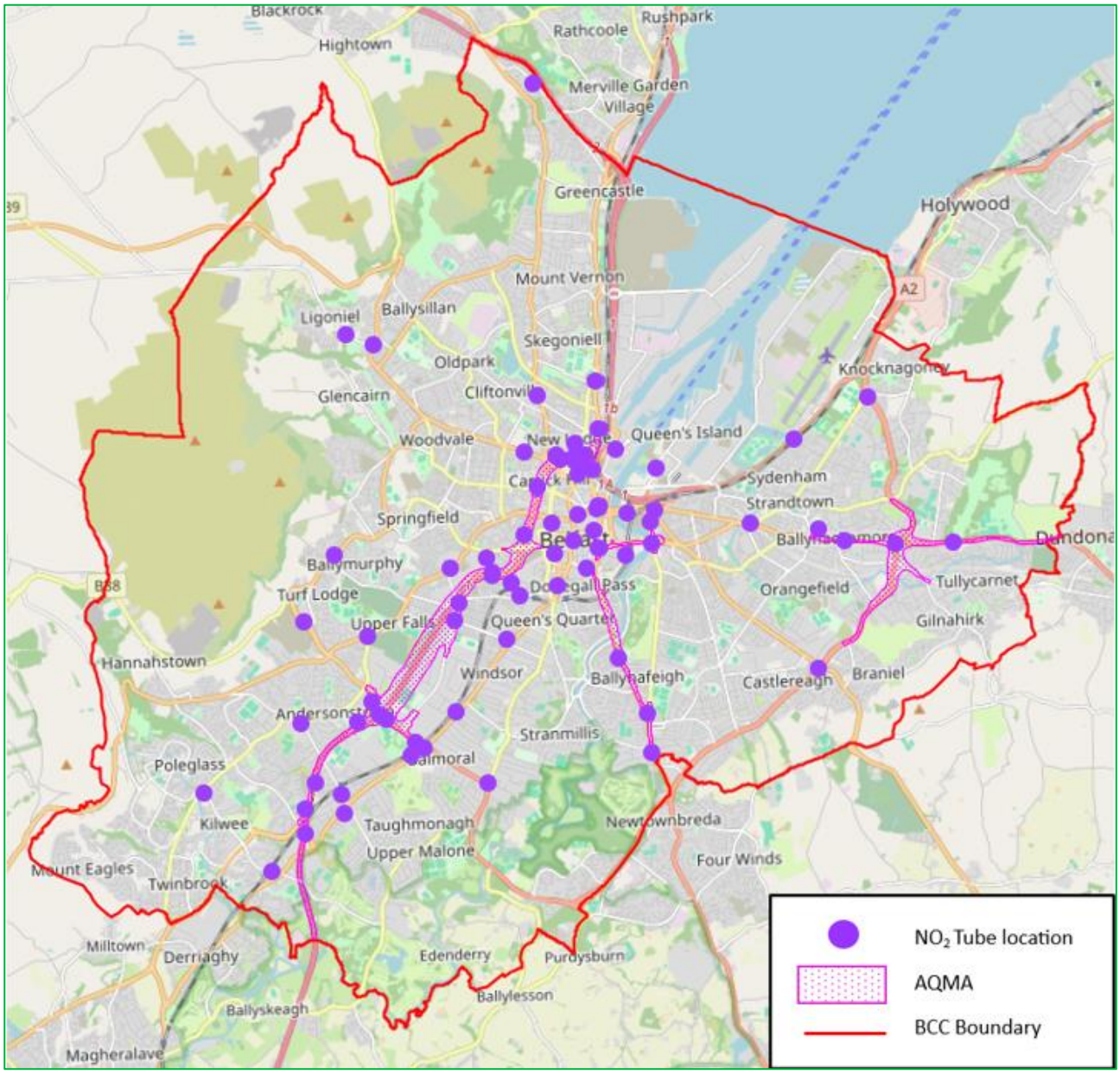
To further ensure that its diffusion tube monitoring data is as accurate as possible, the council co-locates a number of diffusion tubes with reference method compliant chemiluminescent nitrogen dioxide analysers at the Lombard Street, Upper Newtownards Road, Westlink/Roden Street and Stockman's Lane monitoring sites. This process allows a bias adjustment factor (with a 95% confidence interval as an estimate of the uncertainty on the bias adjustment factor) to be calculated and used to correct the diffusion tube monitoring data.

In the case of the diffusion tube data presented in this report, the monitoring data has been corrected using a local bias adjustment factor derived from the above-mentioned three co-location studies (Upper Newtownards Road, Westlink/Roden Street and Stockman's Lane monitoring sites). The Lombard Street site (Belfast Centre) was unable to be considered as part of the 2023 co-location study due to the relatively low data capture rate (70%).

The bias calculation and data scaling were undertaken using Defra's new Diffusion Tube Data Processing Tool. Outputs from the spreadsheet for treatment of Belfast City Council's 2023 diffusion tube data are included in Appendix A to this report.

Figure 2.2 Maps of Non-Automatic Monitoring Sites

Belfast City Boundary



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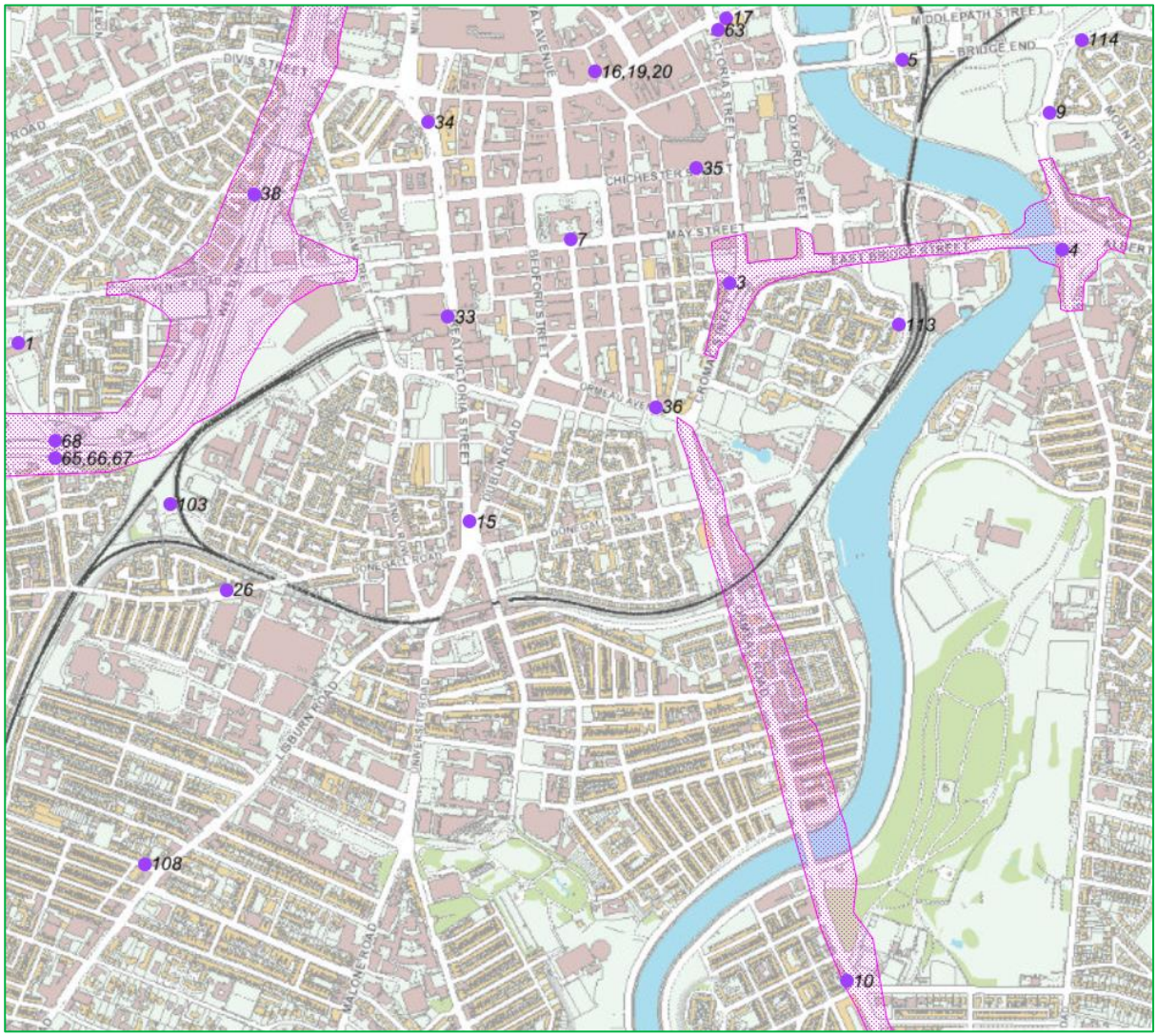
Belfast City Centre



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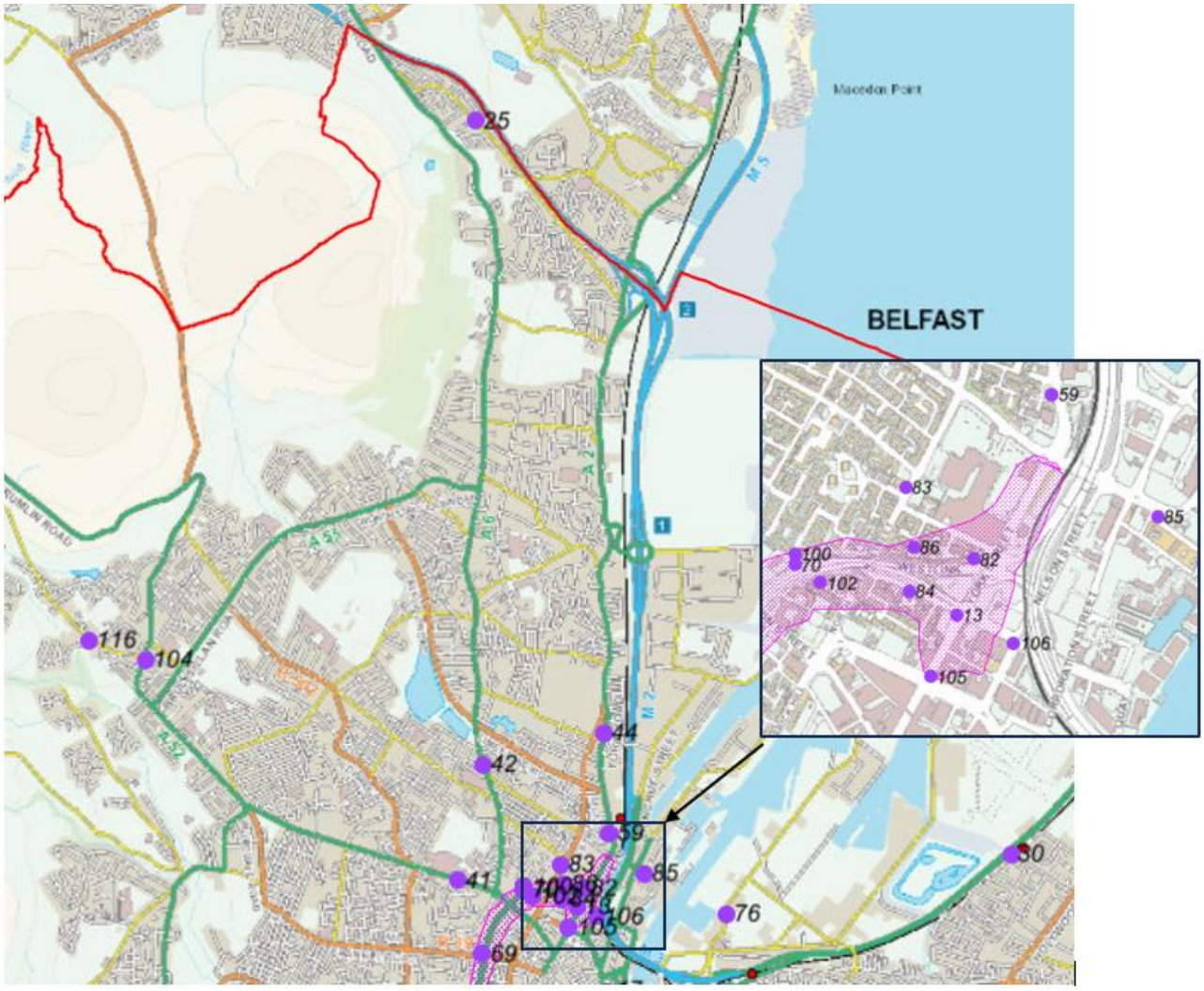
North Belfast



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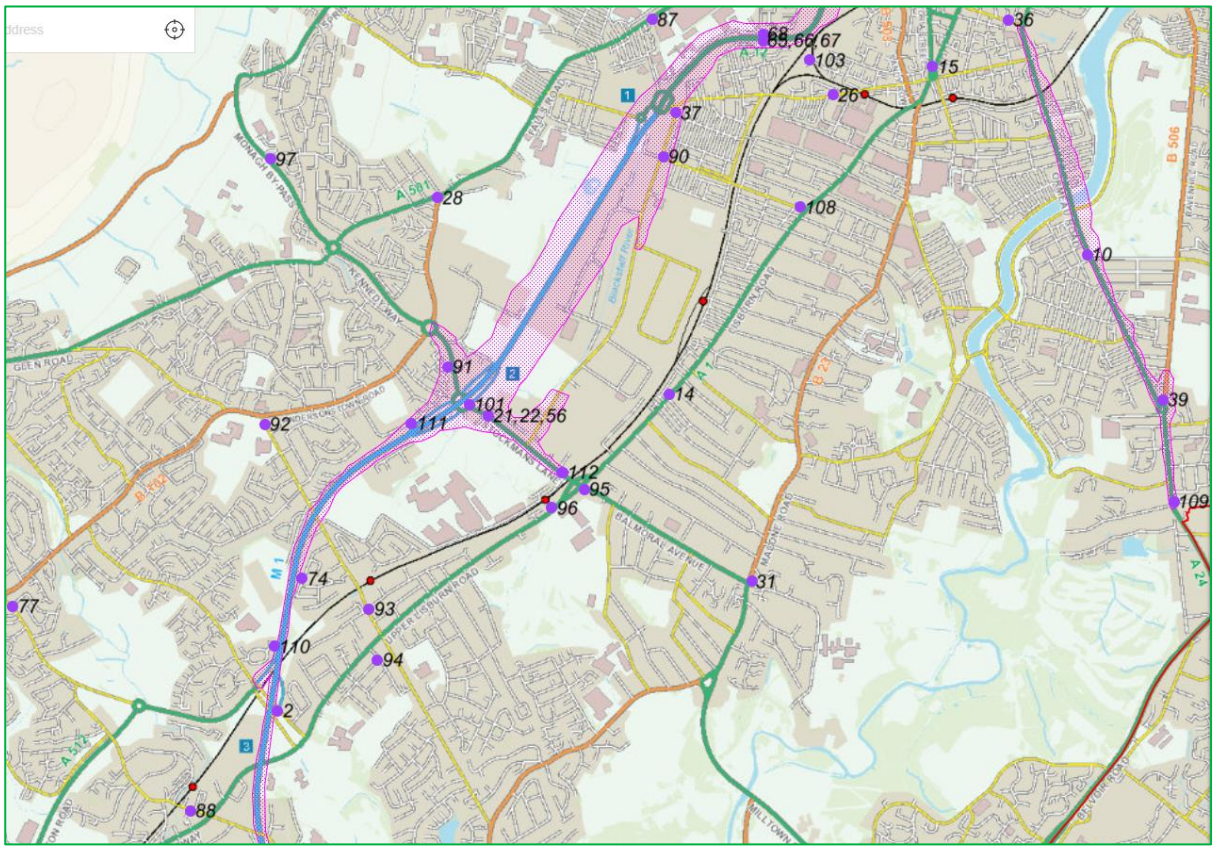
South and West



East Belfast

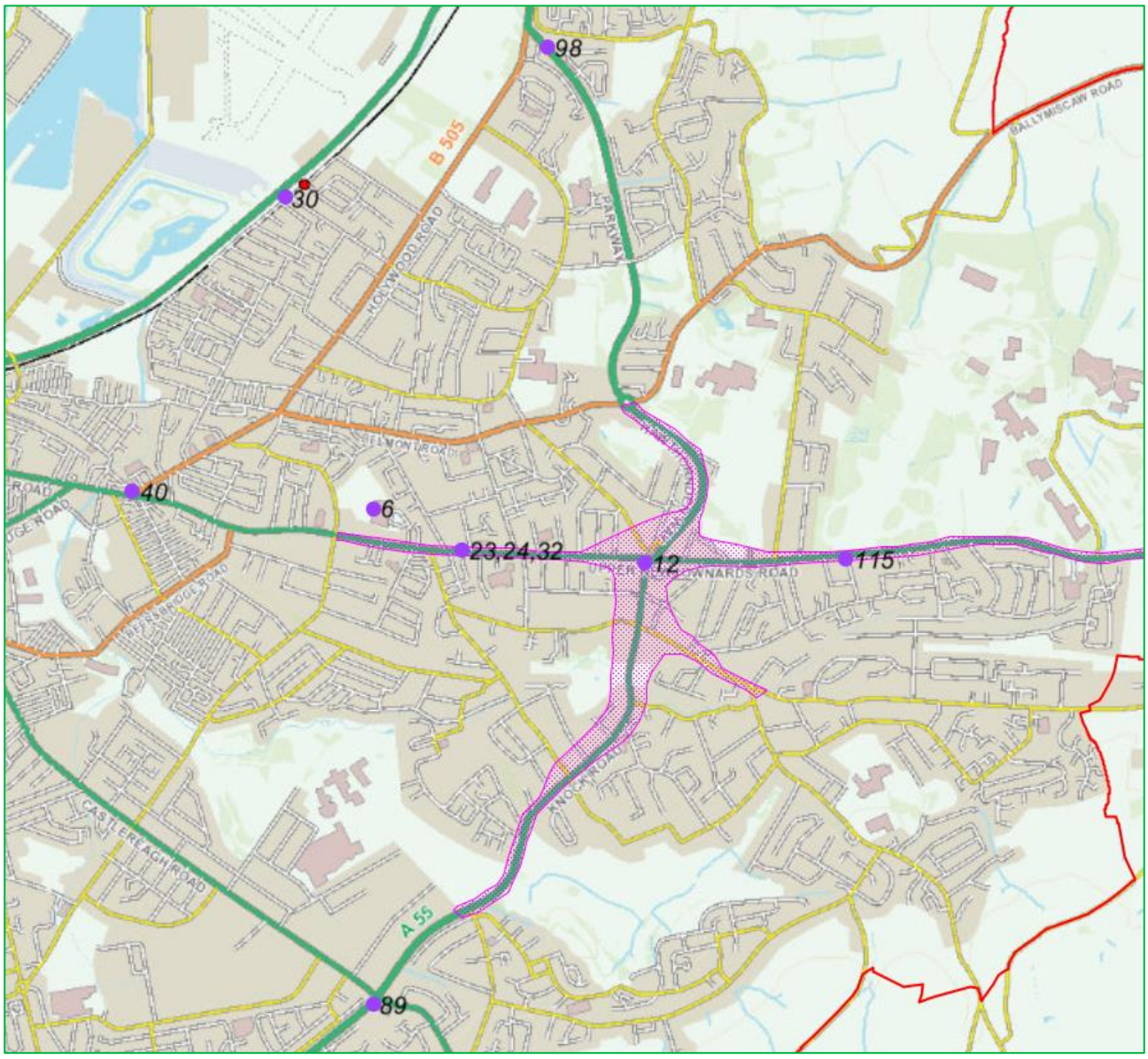


Table 2.2 Details of Non-Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Reference	Y OS Grid Reference	Site Height (m)	Pollutants Monitored	In AQMA?	Is Monitoring Co-located with a Continuous Analyser (Y/N)	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to Kerb of Nearest Road (m) (N/A if not applicable)	Does this Location Represent Worst-Case Exposure?
1	Royal Victoria Hospital	Urban Background	332522	373708	3.2	NO_2	N	N	Y On hospital grounds	80	N/A
2	Black's Road	Roadside	329780	369528	2.7	NO_2	Y	N	Y (27)	2	Y
3	61 Cromac Street	Roadside	334220	373853	3.0	NO_2	Y	N	Y (10)	3	Y
4	Ravenhill Road	Roadside	335013	373932	3.0	NO_2	Y	N	Y (50)	3	Y
5	Queen's Bridge	Roadside	334630	374385	3.0	NO_2	N	N	Y (15)	2	Y
6	North Road	Urban Background	337549	374151	3.0	NO_2	N	N	Y On School Wall	135	N/A
7	Donegall Square South	Roadside	333840	373956	3.0	NO_2	N	N	N	5	Y
9	Short Strand	Kerbside	334983	374260	3.2	NO_2	N	N	Y (11)	1	Y
10	301 Ormeau Road	Roadside	334499	372186	3.0	NO_2	Y	N	Y (0.1)	6	Y
12	Knock Road	Roadside	338718	373918	2.5	NO_2	Y	N	Y (17)	1.5	Y
13	Great George's Street	Kerbside	333981	375102	3.0	NO_2	Y	N	Y (9)	0.5	Y

Site ID	Site Name	Site Type	X OS Grid Reference	Y OS Grid Reference	Site Height (m)	Pollutants Monitored	In AQMA?	Is Monitoring Co-located with a Continuous Analyser (Y/N)	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to Kerb of Nearest Road (m) (N/A if not applicable)	Does this Location Represent Worst-Case Exposure?
14	Lisburn Road	Roadside	332063	371376	2.7	NO_2	N	N	Y (4)	3	Y
15	Shaftesbury Square	Kerbside	333600	373283	2.7	NO_2	N	N	Y (10)	1	Y
16,19,20	Lombard Street AQMS	Urban Background	333898	374358	4.0	NO_2	N	Y	N	30	Y
17	Albert Clock	Roadside	334213	374485	3.1	NO_2	N	N	Y (3.5)	2.5	Y
21,22,56	Stockman's Lane AQMS	Roadside	331009	371251	3.0	NO_2	Y	Y	Y (10)	2.5	Y
23,24,32	Upper Newtownards Road AQMS	Roadside	337930	373972	3.0	NO_2	Y	Y	Y (32)	2.5	Y
25	Whitewell Road	Roadside	333230	380877	2.7	NO_2	N	N	Y (5)	2	Y
26	Donegall Road	Kerbside	333018	373120	2.7	NO_2	N	N	Y (2.5)	1	Y
28	Falls Road and Andersonstown Road	Roadside	330711	372520	3.0	NO_2	N	N	Y (30)	3.5	Y
30	Station Road	Roadside	337168	375485	2.7	NO_2	N	N	Y (20)	2	Y
31	Malone Road	Roadside	332544	370283	3.0	NO_2	N	N	Y (12)	2	Y
33	Great Victoria Street	Roadside	333548	373772	3.2	NO_2	N	N	N	1.5	Y

Site ID	Site Name	Site Type	X OS Grid Reference	Y OS Grid Reference	Site Height (m)	Pollutants Monitored	In AQMA?	Is Monitoring Co-located with a Continuous Analyser (Y/N)	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to Kerb of Nearest Road (m) (N/A if not applicable)	Does this Location Represent Worst-Case Exposure?
34	College Square East	Roadside	333501	374236	3.0	NO_2	N	N	Y (3)	3.0	Y
35	Chichester Street	Roadside	334140	374126	3.5	NO_2	N	N	Y (3)	3	Y
36	Cromac Steet & Ormeau Avenue	Kerbside	334044	373556	2.5	NO_2	N	N	Y (3)	0.5	Y
37	Broadway roundabout at Glenmachan Street	Roadside	332100	373015	3.0	NO_2	Y	N	Y (3)	1	Y
38	Albert Street	Roadside	333085	374065	3.0	NO_2	Y	N	Y (6)	16.0	Y
39	Ormeau Road (junction with Ravenhill Road)	Roadside	334943	371342	3.0	NO_2	Y	N	Y (5.5)	3.0	Y
40	Upper Newtownards Road & Holywood Road	Roadside	336516	374226	3.0	NO_2	N	N	Y (35)	2	Y
41	Crumlin Road	Roadside	333101	375295	3.0	NO_2	N	N	Y (20)	3	Y
42	228 Antrim Road	Roadside	333288	376150	2.7	NO_2	N	N	Y (6)	2	Y

Site ID	Site Name	Site Type	X OS Grid Reference	Y OS Grid Reference	Site Height (m)	Pollutants Monitored	In AQMA?	Is Monitoring Co-located with a Continuous Analyser (Y/N)	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to Kerb of Nearest Road (m) (N/A if not applicable)	Does this Location Represent Worst-Case Exposure?
44	Shore Road (Ivan Street end)	Roadside	334177	376375	3.0	NO_2	N	N	Y (2.5)	5	Y
59	York Street	Roadside	334214	375638	2.7	NO_2	N	N	Y (5)	2	Y
63	Queens Square	Roadside	334193	374457	2.7	NO_2	N	N	Building Façade	7	Y
65,66,67	Westlink AQMS	Roadside	332610	373434	2.6	NO_2	Y	Y	Y (17)	5	Y
68	Opposite Westlink AQMS	Roadside	332610	373474	2.5	NO_2	Y	N	Y (47.5)	2	Y
69	Peter's Hill	Kerbside	333281	374755	3.5 (above the canyon)	NO_2	Y	N	Y (48)	1	Y
70	Henry Place	Kerbside	333588	375224	3.5 (above the canyon)	NO_2	Y	N	Y (17)	1	Y
74	Ardmore Park	Roadside	329923	370300	2.7	NO_2	N	N	Y (7)	2	Y
76	Titanic Quarter	Roadside	335073	375049	2.7	NO_2	N	N	Y (5)	2.5	Y
77	Poleglass	Roadside	328237	370138	2.7	NO_2	N	N	Y (5)	3	Y
82	Molyneaux Street	Roadside	334023	375238	2.7	NO_2	Y	N	Y (2.5)	11	Y
83	North Queen Street	Roadside	333857	375412	2.7	NO_2	N	N	Y (9.5)	3	Y

Site ID	Site Name	Site Type	X OS Grid Reference	Y OS Grid Reference	Site Height (m)	Pollutants Monitored	In AQMA?	Is Monitoring Co-located with a Continuous Analyser (Y/N)	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to Kerb of Nearest Road (m) (N/A if not applicable)	Does this Location Represent Worst-Case Exposure?
84	Portland Place	Roadside	333866	375160	2.7	NO_2	Y	N	Y (5.5)	4	Y
85	Sailortown	Roadside	334469	375341	2.7	NO_2	N	N	Y (17)	4	Y
86	Little Georges Street	Roadside	333876	375267	2.5	NO_2	Y	N	Y (6)	2	N
87	RVH Falls Road	Roadside	331964	373558	2.7	NO_2	N	N	Y (1)	3	Y
88	Dunmurry Lane	Roadside	329273	368947	2.7	NO_2	N	N	Y (5)	2	Y
89	Upper Knockbreda Rd	Kerbside	337547	372019	2.5	NO_2	N	N	Y (25)	1	Y
90	Tates Avenue	Roadside	332028	372759	2.5	NO_2	N	N	Y (8)	2.5	Y
91	Stockman's Crescent	Roadside	330772	371534	3.0	NO_2	Y	N	Y (5)	2	N
92	Andersonstown Road	Roadside	329707	371200	2.5	NO_2	N	N	Y (10)	2	Y
93	Diamond Gardens	Roadside	330313	370121	2.5	NO_2	N	N	Y (3)	2	Y
94	Orpen Road	Roadside	330364	369824	2.5	NO_2	N	N	Y (8)	2	Y
95	Balmoral Avenue	Roadside	331568	370818	2.7	NO_2	N	N	Y (10)	3	Y

Site ID	Site Name	Site Type	X OS Grid Reference	Y OS Grid Reference	Site Height (m)	Pollutants Monitored	In AQMA?	Is Monitoring Co-located with a Continuous Analyser (Y/N)	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to Kerb of Nearest Road (m) (N/A if not applicable)	Does this Location Represent Worst-Case Exposure?
96	Upper Lisburn Road	Roadside	331379	370712	2.7	NO_2	N	N	Y (4.5)	5.5	Y
97	Monagh Bypass	Roadside	329737	372743	2.7	NO_2	N	N	Y (6.5)	3	Y
98	Knocknagoney	Roadside	338297	376131	2.7	NO_2	N	N	Y (7)	2	Y
100	Henry Place 2	Roadside	333589	375251	2.5	NO_2	Y	N	Y (2)	27	N
101	Stockman's Lane Roundabout	Roadside	330900	371316	2.5	NO_2	Y	N	Y (4.5)	3.0	Y
102	North Queen Park	Roadside	333650	375180	2.5	NO_2	Y	N	Y (7)	24	N
103	Blythefield Park	Urban Background	332885	373323	2.5	NO_2	N	N	Y (40)	15	N
104	Ligoniel Crossroads	Roadside	330799	376918	3.0	NO_2	N	N	Y (13)	1.5	Y
105	Ulster University	Kerbside	333918	374952	2.5	NO_2	Y	N	Y (6.5)	1.0	Y
106	M3 Motorway off slip / Nelson Street/ A12 Westlink junction	Kerbside	334120	375033	2.5	NO_2	N	N	Y (15)	0.5	Y
107	Springfield Road	Roadside	330220	373746	2.5	NO_2	N	N	Y (5)	3.5	Y

Site ID	Site Name	Site Type	X OS Grid Reference	Y OS Grid Reference	Site Height (m)	Pollutants Monitored	In AQMA?	Is Monitoring Co-located with a Continuous Analyser (Y/N)	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to Kerb of Nearest Road (m) (N/A if not applicable)	Does this Location Represent Worst-Case Exposure?
108	Lisburn Road and Tates Avenue Junction	Roadside	332825	372465	2.5	NO_2	N	N	Y (2.7)	2.5	Y
109	444 Ormeau Road	Roadside	335005	370749	2.5	NO_2	Y	N	Y (7)	3.0	Y
110	St. Anne's Close	Roadside	329762	369903	2.5	NO_2	Y	N	Y (4.5)	17.0	Y
111	73a Owenvarragh Park	Roadside	330562	371205	2.5	NO_2	Y	N	Y (2.5)	2.0	Y
112	1 Stockmans Lane	Roadside	331440	370918	2.5	NO_2	Y	N	Y (8)	2.0	Y
113	Friendly Street	Urban Background	334623	373752	2.5	NO_2	N	N	Y (1)	1.5	Y
114	Strand Walk	Kerbside	335061	374433	2.5	NO_2	N	N	Y (11)	1.0	Y
115	Stormont	Roadside	339588	373946	2.5	NO_2	Y	N	Y (8)	2.5	Y
116	Ligoniel Road / Mill Valley Road	Roadside	330386	377066	3.0	NO_2	N	N	Y (7)	1.5	Y

** Please note that the various site IDs relate to current monitoring locations across the city. Over the preceding years, some sites may have relocated or monitoring discontinued. For these reasons, site IDs may be non-sequential.*

2.2 Comparison of Monitoring Results with Air Quality Objectives

2.2.1 Nitrogen Dioxide

Automatic Monitoring Data

Tables 2.3 and 2.4 summarise recent monitoring data from the council's nitrogen dioxide automatic analysers for 2023 and preceding years from 2019. In all cases, exceedances of the Air Quality Strategy Objectives are highlighted in bold. In addition, trends in annual mean monitoring data for nitrogen dioxide are summarised in Figure 2.3.

All automatic monitoring sites in Belfast measured NO_2 annual mean concentration below 40 µg/m^3 during 2023. Moreover, there were no NO_2 1-hour means above 200 µg/m^3 recorded in Belfast during 2023.

It is unclear at this stage what impact behavioural changes associated with the Covid pandemic have had on 2022 and 2023 monitoring data, but it is assumed that changing working habits and working locations may have contributed to the continued reduction of annual mean nitrogen dioxide concentrations when compared with 2019 data.

Belfast Centre (Lombard Street) AQMS

The Belfast Centre AURN site is an urban centre / urban background site situated in a substantially pedestrianised area of Belfast City Centre. Urban background sites are located such that the pollution levels monitored are not influenced significantly by any single source or street, but rather by the integrated contribution from all sources upwind of the station e.g. by all traffic, combustion sources etc. Accordingly, there were no exceedances of any nitrogen dioxide air quality objectives recorded at the Belfast Centre AURN during 2023, with the annual mean being 18.8 µg/m^3; less than half of the 40 µg/m^3 objective value. As 2023 data capture levels at the Belfast Centre site were below the Department's 75% data capture threshold for nitrogen dioxide (70%), annualisation of data from this site was required and undertaken in accordance with LAQM.TG22 guidance. The highest nitrogen dioxide hourly mean in 2023 was 109 µg/m^3; substantially less than the 200 µg/m^3 AQO value (18 exceedances permitted per annum).

Ormeau Road AQMS

The Belfast Ormeau Road site experienced extensive problems with air conditioning during 2012 and 2013, which prevented the monitoring equipment from working to full capacity. As this was a recurring problem, a decision was made towards the end of 2013 to upgrade the site infrastructure. Taking account of procurement requirements and liaison with NIE, this upgrade took a considerable length of time, to the point that data capture from this site was such that it was considered unreliable to report for 2013. In addition, we would express some reservations about the reliability of the 2012 monitoring data, as it does not appear to follow established trends. Following the site upgrade however, the annual mean concentration has remained reasonably constant at 27 µg/m^3 in 2014, 27 µg/m^3 in 2015, 28 µg/m^3 in 2016, 25 µg/m^3 in 2017, 26 µg/m^3 in 2018 and 24 µg/m^3 in 2019. Since Covid-19 pandemic (2020) the annual mean results (including 2023 – 18 µg/m^3) at this location are markedly lower when compared to previous years. However, they still appear to be representative, given that all nitrogen dioxide monitoring sites have followed a similar downward trend, due to behavioural changes caused by the pandemic.

The above monitoring data demonstrates that nitrogen dioxide concentrations have been significantly below the annual mean air quality objective since 2014. Moreover, dispersion modelling undertaken as part of Detailed Assessment for the city (Appendix D) predicted that 2019 (base year) and 2028 (future year) annual mean NO_2 concentrations within AQMA 4, which covers Ormeau Road from the junction with Donegall Pass to the Belfast City boundary at Galwally, were below the UK AQO level at locations of relevant exposure.

At this stage, the council has however decided not to move to revoke the Ormeau Road Air Quality Management Area and instead to await acceptance of this 2024 Updating and Screening Assessment (USA) report and an update on the conclusions and recommendations of the report from DAERA.

Upper Newtownards Road AQMS

From the data in Table 2.3, it can be seen that annual mean concentrations of nitrogen dioxide along the Upper Newtownards Road have remained in the range 20 – 27 µg/m^3 since 2019, meaning that the nitrogen dioxide annual mean objective is being consistently achieved along the Upper Newtownards Road. As noted above, since 2020 there have been a marked decrease in nitrogen dioxide concentrations, again due to significant reductions in traffic numbers, as a result of the Covid-19 pandemic restrictions. 2023

annual mean results (21.0 µg/m^3) are lower than pre-pandemic annual mean data and significantly below the objective level.

The Knock Road non-automatic roadside diffusion tube, located at the junction of the Upper Newtownards Road, Hawthornden Way and the Knock Road (Upper Newtownards Road AQMA worst case location) has recorded exceedances of the annual mean objective in previous years up until 2016. The 2017 calendar year was the first year when the annual mean concentration at the Knock Road junction fell below the air quality objective (36 µg/m^3), which was still the case in 2023 (25.8 µg/m^3). Consequently, there have not been any monitored exceedances of the air quality objectives for NO_2 identified within this AQMA over the last seven years.

The above monitoring data for this location, and the outcome of the recently concluded detailed assessment, which also confirmed that the modelled 2019 (base year) and 2028 (future year) annual mean NO_2 concentrations within AQMA 3 are below the annual mean objective suggesting that this AQMA could be revoked.

At this stage, the council has however decided not to move to revoke the Upper Newtownards Road Air Quality Management Area and instead to await acceptance of this 2024 Updating and Screening Assessment (USA) report and an update on the conclusions and recommendations of the report from DAERA.

Moreover, it should be noted that the Belfast Rapid Transit Glider commenced operation along this route from September 2018. In order to facilitate operation of the Glider, a bus lane was established on the Upper Newtownards Road, Albertbridge Road and East Bridge Street, which operates from 07.00 to 19.00, Monday to Saturday inclusive. Glider operations together with introduction of the bus lane are likely to have had a beneficial impact on traffic movements and pollution levels along the Upper Newtownards Road, Albertbridge Road and East Bridge Street.

Stockman's Lane AQMS

Unfortunately, despite the completion of significant structural improvements to the M1 Motorway and A12 Westlink corridor, nitrogen dioxide concentrations at Stockman's Lane have remained high. 2020 was the first year however, when the annual mean concentration (33 µg/m^3) fell below the objective level of 40 µg/m^3, likely due to Covid-19

travel restrictions. Whilst reductions in nitrogen dioxide annual mean concentrations at the Stockman's Lane site had been following a relatively consistent declining trend over recent years (the 2019 nitrogen dioxide annual mean was 45 µg/m^3, which is a ~8% reduction from the 2018 annual mean of 49 µg/m^3), the Covid-19 pandemic has had an obvious impact on the 2021 and 2022 annual means. The 2021 annual mean (36 µg/m^3) was about 20% lower than the 2019 (pre-pandemic) levels. The 2022 annual mean (36.4 µg/m^3) and 2023 annual mean (35.6 µg/m^3) haven't changed significantly since 2020 but although concentrations are now lower than the 40 µg/m^3 annual mean objective, they are still considered elevated (within 10% of the annual mean NO_2 objective). Moreover, one roadside diffusion tube, located near to the Stockman's Lane AQMS, recorded a similar 2023 NO_2 annual mean concentration (Stockman's Lane Roundabout - 36.3 µg/m^3).

Furthermore, results from the council's Detailed Assessment also suggest elevated nitrogen dioxide levels at this location. Therefore, the council will continue its monitoring at this location (within the Westlink Corridor / M1 Air Quality Management Area) to identify any potential further exceedances and nitrogen dioxide concentrations and trends.

There were no NO_2 1-hour means above 200 µg/m^3 recorded at this AQMS location during 2023.

Westlink/Roden Street AQMS

The 2023 nitrogen dioxide annual mean (28.5 µg/m^3) monitored at the Westlink Roden Street has not changed significantly since 2021. Although slightly higher than in 2020 (24 µg/m^3) it is still noticeably lower than the 2019 pre-pandemic level (34 µg/m^3) and comfortably below the annual mean objective of 40 µg/m^3. Also, there were no NO_2 1-hour means above 200 µg/m^3 recorded at this AQMS location during 2023.

The nitrogen dioxide annual mean air quality objective has not been exceeded at the Westlink Roden Street since 2011. However, one roadside diffusion tube, located at Henry Place, further along the Westlink corridor, recorded exceedances of the annual mean objective over the last five years including in 2023 (43.0 µg/m^3). Moreover, results from the council's Detailed Assessment also suggest localised monitored (by small sensor air quality monitor) and modelled exceedances of the annual mean objective along Westlink corridor. Therefore, the council will continue its monitoring within the Westlink Corridor /

M1 Air Quality Management Area (AQMA 1) to identify any continuing, or further exceedances and nitrogen dioxide concentrations and trends.

Historically, modelled and monitored exceedances of the 1-hour mean objective for nitrogen dioxide were encountered only in the vicinity of the M1 Motorway / A12 Westlink corridor. As a result, this is the only Air Quality Management Area within Belfast that has been declared on the basis of exceedances of the 1-hour objective.

From ambient monitoring data for the Stockman's Lane and Westlink/Roden Street monitoring sites, as summarised in Table 2.4, it can be seen that the number of exceedances of the hourly objective has substantially decreased over recent years, both now demonstrating compliance with the 200 µg/m^3 objective, not to be exceeded more than 18 times per year - since 2013. In fact, there have been no recorded 1-hour mean concentrations greater than 200 µg/m^3 at either monitoring site since 2019. As there are residential properties located directly adjacent to the carriageway at Stockman's Lane and most of these properties have gardens facing onto the roadway, thereby providing for short-term relevant public exposure, we will continue to monitor at this location in order to identify any further exceedances of the 1-hour mean objective and to establish trends.

Table 2.3 Results of Automatic Monitoring for Nitrogen Dioxide: Annual Mean NO_2 Monitoring Results ($\mu g/m^3$) for Comparison with the Annual Mean Objective

Site ID	Site Type	Within AQMA? Which AQMA?	Valid Data Capture for Monitoring Period % [a]	Valid Data Capture 2023 % b	Annual Mean Concentration ($\mu g/m^3$)				
					2019*	2020*	2021*	2022*	2023 [c]
Belfast Centre (Lombard Street)	Urban Background	N	70%	70%	26[c]	19[c]	21	21.1	18.8[c]
Belfast Ormeau Road	Roadside	Y (CM2)	99%	99%	24	17	18	18.8	18.0
Belfast Upper Newtownards Road	Roadside	Y (CM3)	99%	99%	27	20	21	22.2	21.0
Belfast Stockman's Lane	Roadside	Y (CM4)	99%	99%	**45**	33	36	36.4	35.6
Belfast Westlink / Roden Street	Roadside	Y (CM5)	99%	99%	34	24	28	27.9	28.5

In **bold**, exceedance of the NO_2 annual mean AQS objective of 40 $\mu g/m^3$.

[a] i.e. data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

[b] i.e. data capture for the full calendar year (e.g. if monitoring was carried out for six months the maximum data capture for the full calendar year would be 50%).

[c] Means "annualised" as per LAQM.TG22, if monitoring was not carried out for the full year.

*Annual mean concentrations for previous years.

Figure 2.3 Trends in Annual Mean Nitrogen Dioxide Concentrations measured at Automatic Monitoring Sites

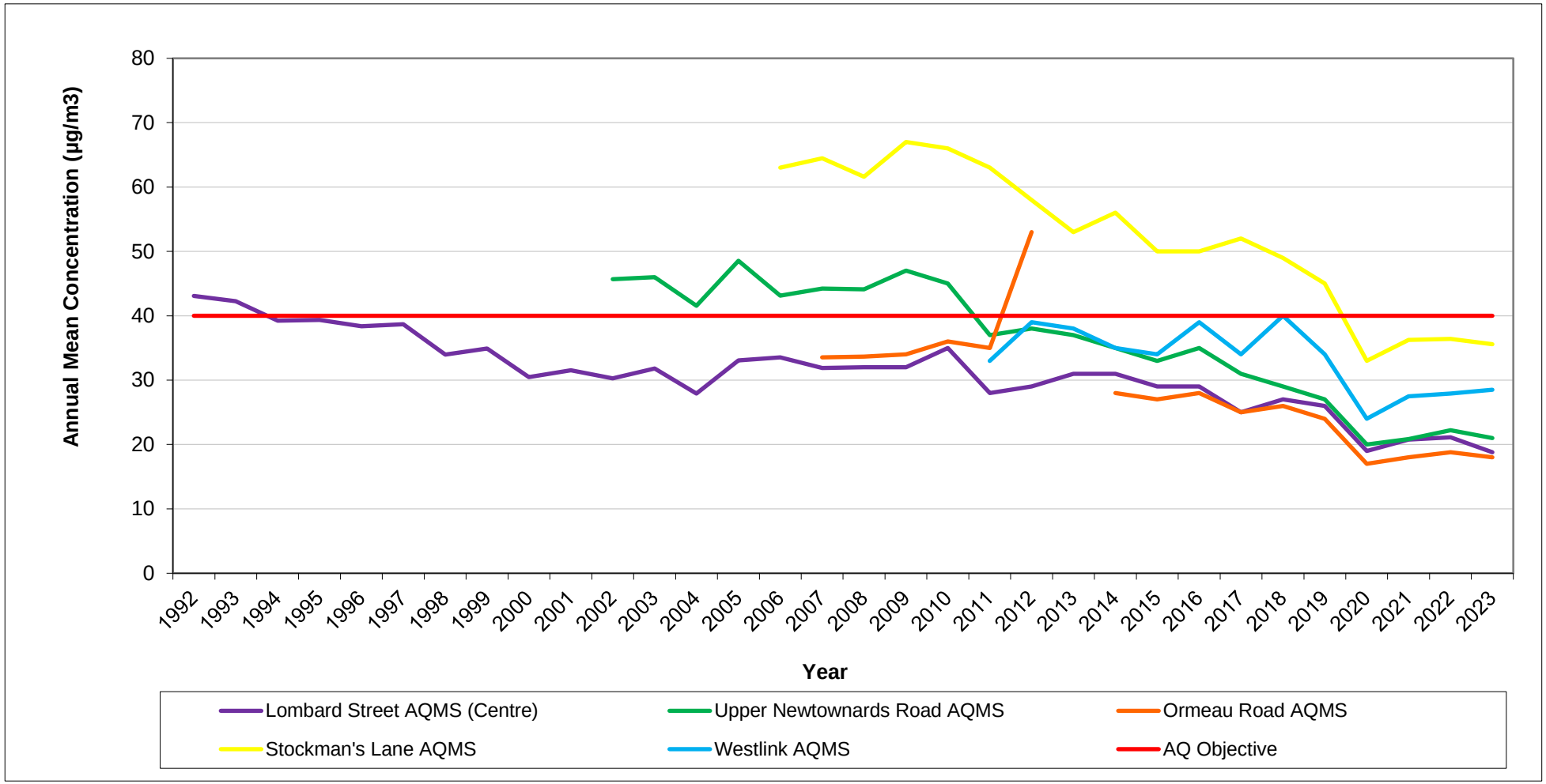


Table 2.4 Results of Automatic Monitoring for Nitrogen Dioxide: Number of Exceedances of 1-hour mean Objective (200 µg/m^3)

Site ID	Site Type	Within AQMA? Which AQMA?	Valid Data Capture for period of monitoring %[a]	Valid Data Capture 2023 % [b]	2019*	2020*	2021*	2022*	2023
Belfast Centre (Lombard Street)	Urban Background	N	70%	70.0%	0 (93)[c]	0 (86)[c]	0	0(93)[c]	0(84)[c]
Belfast Ormeau Road	Roadside	Y (CM2)	99%	99%	0 (86)[c]	0	0	0	0
Belfast Upper Newtownards Road	Roadside	Y (CM3)	99%	99%	0	0	0	0	0
Belfast Stockman's Lane	Roadside	Y (CM4)	99 %	99%	0	0	0	0	0
Belfast Westlink / Roden Street	Roadside	Y (CM5)	99%	99%	0	0	0	0	0

In **bold**, exceedance of the NO_2 hourly mean AQS objective (200 µg/m^3 – not to be exceeded more than 18 times per year

[a] i.e. data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

[b] i.e. data capture for the full calendar year (e.g. if monitoring was carried out for six months the maximum data capture for the full calendar year would be 50%).

[c] If the period of valid data is less than 85%, include the 99.8th percentile of hourly means in brackets

* Number of exceedances for previous years.

Diffusion Tube Monitoring Data

In order to obtain a better understanding of how levels of nitrogen dioxide are varying across the city over time and to investigate those locations where previous rounds of the review and assessment process have highlighted areas of concern, Belfast City Council has placed 84 diffusion tubes at 76 relevant locations across the city. Data from these tubes for 2023 has been summarised in Table 2.5 alongside historical data, where it is available, in Table 2.6.

In terms of the outcome of the 2023 nitrogen dioxide diffusion tube monitoring, it is noted that concentrations at most locations are comparable to 2021 and 2022 results; however, they are still significantly lower than 2019 pre-pandemic levels.

Since the 2023 Progress Report, the council officers have added an additional 8 tubes to the network; 5 located within the AQMAs (109,110,111,112 and 115) and 3 outside the AQMA (113, 114 and 116). We have also relocated two tubes (37 and 90) to 'worst case scenario' locations, along the same streets but closer to busy junctions. These locations are detailed in Figure 2.2 and Table 2.2.

Only two annual mean air quality objective exceedances occurred during 2023, at Henry Place (43.0 µg/m^3) and at a location next to the junctions of the M3 Motorway / M2 Motorway and the A12 Westlink (42.3 µg/m^3). Both tubes are located at kerbside locations adjacent to busy Motorways. The Henry Place tube is located within the existing M1 Motorway / A12 Westlink Air Quality Management Area and has been the subject of mitigation measures for some time.

The M3 Motorway tube was added to the councils' monitoring network due to the introduction of new relevant human health exposure; a new residential development located adjacent to the junction of the M3 Motorway / M2 Motorway and the A12 Westlink. The new monitoring site is located immediately next to the dominant road transport NO_2 pollution source and at a worst-case location (junction). This residential development has recently been completed and it is anticipated that when all public realm works at the residential development are completed later this year, the monitoring site can be relocated from its current kerbside location to a building façade location more representative of public exposure at the residential development.

Nevertheless, Defra NO_2 distance calculations have been provided for the above locations to estimate concentrations at relevant human health receptor locations.

The Diffusion Tube Processing Tool has predicted an annual mean concentration of 29.2 µg/m^3 at Henry Place and 29.1 µg/m^3 at the M3 Motorway junction, which indicates that no exceedances are likely at both relevant receptor locations; the distance adjustment has been calculated using the Diffusion Tube Data Processing Tool (Appendix A).

Overall, in 2023 there were only five diffusion tube sites (Great Georges Street, Henry Place, M3, Stockman's Lane AQMS and Stockman's Lane Roundabout) located at roadside/kerbside locations where annual mean nitrogen dioxide concentrations were above 36 µg/m^3 (within 10% of the annual mean objective of 40 µg/m^3). The Strand Walk monitoring site, located adjacent to the Newtownards Road, Bridge End and Middlepath Street junction, recorded a nitrogen dioxide annual mean of 35.6 µgm^{-3} in 2023.

A summary of fall-off with distance calculations from the Diffusion Tube Data Processing Tool are presented in Table A.4 (Appendix A)

Table 2.5 Results of Nitrogen Dioxide Diffusion Tubes in 2023

Site ID	Location	Site Type	Within AQMA? Which AQMA?	Triplicate or Co-located Tube	Full Calendar Year Data Capture 2023 (Number of Months or %) [a]	2023 Annual Mean Concentration (µg/m^3) - Bias Adjustment factor = 0.80 [b]
1	Royal Victoria Hospital	Urban Background	N	N	100.0	15.9
2	Black's Road	Roadside	Y (Westlink)	N	100.0	30.5
3	61 Cromac Street	Roadside	Y (Cromac Street & Albertbridge Rd)	N	100.0	25.1
4	Ravenhill Road	Roadside	Y (Cromac Street & Albertbridge Rd)	N	82.7	20.5
5	Queen's Bridge	Roadside	N	N	90.4	23.0
6	North Road	Urban Background	N	N	40.4	10.8
7	Donegall Square South	Roadside	N	N	100.0	26.8
9	Short Strand	Roadside	N	N	100.0	30.7
10	301 Ormeau Road	Roadside	Y (Ormeau Rd)	N	100.0	23.3
12	Knock Road	Roadside	Y (Upper Newtownards Rd)	N	100.0	25.8
13	Great George's Street	Kerbside	Y (Westlink)	N	100.0	36.5
14	Lisburn Road	Roadside	N	N	75.0	22.6
15	Shaftesbury Square	Kerbside	N	N	84.6	27.1
16,19,20	Lombard Street AQMS	Urban Centre	N	Triplicate and Co-located	100.0	20.9
17	Albert Clock	Roadside	N	N	100.0	28.6
21,22,56	Stockman's Lane AQMS	Roadside	Y (Westlink)	Triplicate and Co-located	100.0	36.4
23,24,32	Upper Newtownards Road AQMS	Roadside	Y (Upper Newtownards Rd)	Triplicate and Co-located	100.0	19.7
25	Whitewell Road	Roadside	N	N	100.0	19.0
26	Donegall Road	Kerbside	N	N	100.0	24.7
28	Falls Road and Andersonstown	Roadside	N	N	100.0	20.6
30	Station Road	Roadside	N	N	90.4	16.6
31	Malone Road	Roadside	N	N	100.0	25.5
33	Great Victoria Street	Roadside	N	N	92.3	30.8

Site ID	Location	Site Type	Within AQMA? Which AQMA?	Triplicate or Co-located Tube	Full Calendar Year Data Capture 2023 (Number of Months or %) [a]	2023 Annual Mean Concentration (µg/m^3) - Bias Adjustment factor = 0.80 [b]
34	College Square East	Roadside	N	N	100.0	28.0
35	Chichester Street	Roadside	N	N	92.3	30.2
36	Cromac & Ormeau Avenue	Kerbside	N	N	100.0	23.9
37	Broadway roundabout at Glenmachan Street	Roadside	Y (Westlink)	N	100.0	32.6
38	Albert Street	Roadside	Y (Westlink)	N	100.0	26.3
39	Ormeau Road (junction with Ravenhill Road)	Roadside	Y (Ormeau Rd)	N	100.0	22.1
40	Upper Newtownards Road & Holywood Road	Roadside	N	N	100.0	18.5
41	Crumlin Road	Roadside	N	N	100.0	22.4
42	228 Antrim Road	Roadside	N	N	100.0	26.1
44	Shore Road (Ivan Street end)	Roadside	N	N	90.4	23.2
59	York Street	Roadside	N	N	100.0	30.1
63	Queens Square	Kerbside	N	N	100.0	26.3
65,66,67	Westlink AQMS	Roadside	Y (Westlink)	Triplicate and Co-located	100.0	29.4
68	Opposite Westlink AQMS	Roadside	Y (Westlink)	N	100.0	35.2
69	Peter's Hill	Kerbside	Y (Westlink)	N	100.0	30.7
70	Henry Place	Kerbside	Y (Westlink)	N	100.0	**43.0**
74	Ardmore Park	Roadside	N	N	100.0	23.4
76	Titanic Quarter	Roadside	N	N	92.3	17.5
77	Poleglass	Roadside	N	N	100.0	18.2
82	Molyneaux Street	Roadside	Y (Westlink)	N	100.0	29.4
83	North Queen Street	Roadside	N	N	92.3	28.4
84	Portland Place	Roadside	Y (Westlink)	N	92.3	26.9
85	Sailortown	Roadside	N	N	100.0	24.2
86	Little Georges Street	Roadside	Y (Westlink)	N	100.0	27.5
87	RVH Falls Road	Roadside	N	N	100.0	26.3
88	Dunmurry Lane	Roadside	N	N	92.3	18.4

Site ID	Location	Site Type	Within AQMA? Which AQMA?	Triplicate or Co-located Tube	Full Calendar Year Data Capture 2023 (Number of Months or %) [a]	2023 Annual Mean Concentration (µg/m^3) - Bias Adjustment factor = 0.80 [b]
89	Upper Knockbreda Rd	Kerbside	N	N	90.4	23.3
90	Tates Avenue	Roadside	Y (Westlink)	N	100.0	33.0
91	Stockman's Crescent	Roadside	Y (Westlink)	N	100.0	18.2
92	Andersonstown Road	Roadside	N	N	90.4	22.0
93	Diamond Gardens	Roadside	N	N	90.4	17.9
94	Orpen Road	Roadside	N	N	100.0	12.6
95	Balmoral Avenue	Roadside	N	N	100.0	28.6
96	Upper Lisburn Road	Roadside	N	N	90.4	18.4
97	Monagh Bypass	Roadside	N	N	100.0	19.1
98	Knocknagoney	Roadside	N	N	100.0	31.1
100	Henry Place 2	Roadside	Y Westlink)	N	84.6	26.0
101	Stockman's Lane Roundabout	Roadside	Y (Westlink)	N	100.0	36.3
102	North Queen Park	Roadside	Y (Westlink)	N	100.0	24.9
103	Blythefield Park	Urban Background	N	N	100.0	19.2
104	Ligoniel Crossroads	Roadside	N	N	92.3	13.0
105	Ulster University	Kerbside	Y (Westlink)	N	82.7	30.3
106	M3 Motorway off slip / Nelson Street / A12 Westlink junction	Kerbside	N	N	92.3	**42.3**
107	Springfield Road	Roadside	N	N	100.0	19.6
108	Lisburn Rd and Tates Av Junction	Roadside	N	N	100.0	29.2
109	444 Ormeau Road	Roadside	Y (Ormeau Rd)	N	84.6	24.2
110	St. Anne's Close	Roadside	Y (Westlink)	N	84.6	21.0
111	73a Owenvarragh Park	Roadside	Y (Westlink)	N	84.6	19.5
112	1 Stockmans Lane	Roadside	Y (Westlink)	N	84.6	32.8
113	Friendly Street	Urban Background	N	N	76.9	19.6
114	Strand Walk	Kerbside	N	N	84.6	35.6

Site ID	Location	Site Type	Within AQMA? Which AQMA?	Triplicate or Co-located Tube	Full Calendar Year Data Capture 2023 (Number of Months or %) [a]	2023 Annual Mean Concentration (µg/m^3) - Bias Adjustment factor = 0.80 [b]
115	Stormont	Roadside	Y ((Upper Newtownards Rd)	N	67.3	17.6
116	Ligoniel Road / Mill Valley Road	Roadside	N	N	76.9	16.9

In **bold**, exceedance of the NO_2 annual mean AQS objective of 40 µg/m^3.

Underlined, annual mean > 60 µg/m^3, indicating a potential exceedance of the NO_2 hourly mean AQS objective.

[a] Means should be "annualised" as per LAQM.TG22, if full calendar year data capture is less than 75%.

[b] If an exceedance is measured at a monitoring site not representative of public exposure, NO_2 concentration at the nearest relevant exposure should be estimated based on the NO_2 fall-off with distance calculator, and results should be discussed in a specific section.

Table 2.6 Results of Nitrogen Dioxide Diffusion Tubes, adjusted for bias (µg/m^3): 2019 to 2023.

Site ID	Site Name	Within AQMA? Which AQMA?	Annual Mean Concentration (µg/m^3) - Adjusted for Bias				
			2019 [a] (Bias Adjustment Factor = **0.91**)	**2020** [a] (Bias Adjustment Factor = **0.79**)	**2021** [a] (Bias Adjustment Factor = **0.79**)	**2022** [a] (Bias Adjustment Factor = **0.81**)	**2023** [a] (Bias Adjustment Factor = **0.80**)
1	Royal Victoria Hospital	N	21	17.6	18.1	16.6	15.9
2	Black's Road	Y (Westlink)	**42**	33.3	30.7	31.5	30.5
3	61 Cromac Street	Y (Cromac Street & Albertbridge Rd)	36	22.4	24.5	26.2	25.1
4	Ravenhill Road	Y (Cromac Street & Albertbridge Rd)	28	20.5	20.8	21.0	20.5
5	Queen's Bridge	N	27	20.7	23.1	24.4	23.0
6	North Road	N	14	10.8	12.3	10.7	10.8
7	Donegall Square South	N	32	22.8	23.4	25.5	26.8
9	Short Strand	N	40	30.5	32.8	31.7	30.7
10	301 Ormeau Road	Y (Ormeau Rd)	30	21.6	23.5	23.2	23.3
12	Knock Road	Y (Upper Newtownards Rd)	35	24.8	26.0	25.2	25.8
13	Great Georges Street	Y (Westlink)	**45**	32.8	36.3	35.1	36.5
14	Lisburn Road	N	27	23.5	22.4	23.1	22.6
15	Shaftesbury Square	N	31	25.1	26.4	26.7	27.1
16,19,20	Lombard Street AQMS	N	26	19.5	21.1	21.0	20.9
17	Albert Clock	N	40	26.5	28.1	28.7	28.6
21,22,56	Stockman's Lane AQMS	Y (Westlink)	**45**	29.9	33.4	37.8	36.4
23,24,32	Upper Newtownards Road AQMS	Y (Upper Newtownards Rd)	27	18.9	19.8	19.8	19.7
25	Whitewell Road	N	25	16.1	19.0	18.6	19.0
26	Donegall Road	N	31	21.9	24.8	24.0	24.7
28	Falls Road and Andersonstown	N	27	19.3	22.3	21.2	20.6
30	Station Road	N	22	16.6	17.2	17.1	16.6
31	Malone Road	N	31	22.8	26.3	23.9	25.5
33	Great Victoria Street	N	36	24.9	28.3	29.5	30.8
34	College Square East	N	33	22.1	27.5	27.9	28.0

Site ID	Site Name	Within AQMA? Which AQMA?	Annual Mean Concentration (µg/m^3) - Adjusted for Bias				
			2019 [a] (Bias Adjustment Factor = **0.91**)	**2020** [a] (Bias Adjustment Factor = **0.79**)	**2021** [a] (Bias Adjustment Factor = **0.79**)	**2022** [a] (Bias Adjustment Factor = **0.81**)	**2023** [a] (Bias Adjustment Factor = **0.80**)
35	Chichester Street	N	40	27.8	32.1	33.2	30.2
36	Cromac & Ormeau Avenue	N	31	21.4	23.4	24.1	23.9
37	Broadway roundabout at Glenmachan Street	Y (Westlink)	38	27.9	30.2	33.1	32.6
38	Albert Street	Y (Westlink)	28	20.8	22.8	24.5	26.3
39	Ormeau Road (junction with Ravenhill Road)	Y (Ormeau Rd)	36	26.0	26.7	27.1	22.1
40	Upper Newtownards Road & Holywood Road	N	27	18.9	20.2	20.0	18.5
41	Crumlin Road	N	27	20.6	23.2	22.7	22.4
42	228 Antrim Road	N	31	25.1	26.5	25.9	26.1
44	Shore Road (Ivan Street end)	N	30	21.3	23.9	23.2	23.2
59	York Street	N	36	26.8	29.7	30.8	30.1
63	Queens Square	N	34	25.3	34.3	32.4	26.3
65,66,67	Westlink AQMS	Y (Westlink)	34	27.8	30.1	28.8	29.4
68	Opposite Westlink AQMS	Y (Westlink)	**45**	33.6	31.8	36.0	35.2
69	Peter's Hill	Y (Westlink)	40	30.6	32.3	30.5	30.7
70	Henry Place	Y (Westlink)	**53**	**41.1**	**45.7**	**42.0**	**43.0**
74	Ardmore Park	N	30	24.3	23.3	25.7	23.4
76	Titanic Quarter	N	22	18.1	17.2	18.3	17.5
77	Poleglass	N	24	18.3	18.1	19.3	18.2
82	Molyneaux Street	Y (Westlink)	36	26.7	28.3	29.6	29.4
83	North Queen Street	N	33	26.5	28.8	26.7	28.4
84	Portland Place	Y (Westlink)	30	25.5	26.9	26.7	26.9
85	Sailortown	N	28	22.9	23.9	23.2	24.2
86	Little George's Street	Y (Westlink)	33	26.4	27.3	27.5	27.5
87	RVH Falls Road	N	33	24.1	28.1	27.2	26.3
88	Dunmurry Lane	N	26	17.7	19.2	18.8	18.4
89	Upper Knockbreda Rd	N	34	23.0	24.2	24.3	23.3
90	Tates Avenue/Boucher Rd	N	27	20.5	21.0	27.8	33.0

Site ID	Site Name	Within AQMA? Which AQMA?	Annual Mean Concentration (µg/m^3) - Adjusted for Bias				
			2019 [a] (Bias Adjustment Factor = **0.91**)	**2020** [a] (Bias Adjustment Factor = **0.79**)	**2021** [a] (Bias Adjustment Factor = **0.79**)	**2022** [a] (Bias Adjustment Factor = **0.81**)	**2023** [a] (Bias Adjustment Factor = **0.80**)
91	Stockman's Crescent	Y (Westlink)	24	17.7	19.5	18.5	18.2
92	Andersonstown Road	N	N/A	22.5	25.0	22.8	22.0
93	Diamond Gardens	N	24	17.8	18.8	18.3	17.9
94	Orpen Road	N	18	13.3	13.3	13.2	12.6
95	Balmoral Avenue	N	39	25.5	28.1	28.9	28.6
96	Upper Lisburn Road	N	N/A	20.1	20.3	19.5	18.4
97	Monagh Bypass	N	N/A	16.4	18.0	18.4	19.1
98	Knocknagoney	N	N/A	31.4	33.5	32.0	31.1
100	Henry Place 2	Y	N/A	N/A	26.9	28.8	26.0
101	Stockman's Lane Roundabout	Y	N/A	N/A	32.6	39.2	36.3
102	North Queen Park	Y	N/A	N/A	28.3	25.4	24.9
103	Blythefield Park	N	N/A	N/A	20.2	19.8	19.2
104	Ligoniel Crossroads	N	N/A	N/A	N/A	13.5	13.0
105	Ulster University	N	N/A	N/A	N/A	29.8	30.3
106	M3 Motorway off slip / Nelson Street / A12 Westlink junction	N	N/A	N/A	N/A	**45.8**	**42.3**
107	Springfield Road	N	N/A	N/A	N/A	20.8	19.6
108	Lisburn Rd and Tates Av Junction	N	N/A	N/A	N/A	31.7	29.2
109	444 Ormeau Road	Y (Ormeau Rd)	N/A	N/A	N/A	N/A	24.2
110	St. Anne's Close	Y (Westlink)	N/A	N/A	N/A	N/A	21.0
111	73a Owenvarragh Park	Y (Westlink)	N/A	N/A	N/A	N/A	19.5
112	1 Stockman's Lane	Y (Westlink)	N/A	N/A	N/A	N/A	32.8
113	Friendly Street	N	N/A	N/A	N/A	N/A	19.6
114	Strand Walk	N	N/A	N/A	N/A	N/A	35.6
115	Stormont	Y ((Upper Newtownards Rd)	N/A	N/A	N/A	N/A	17.6

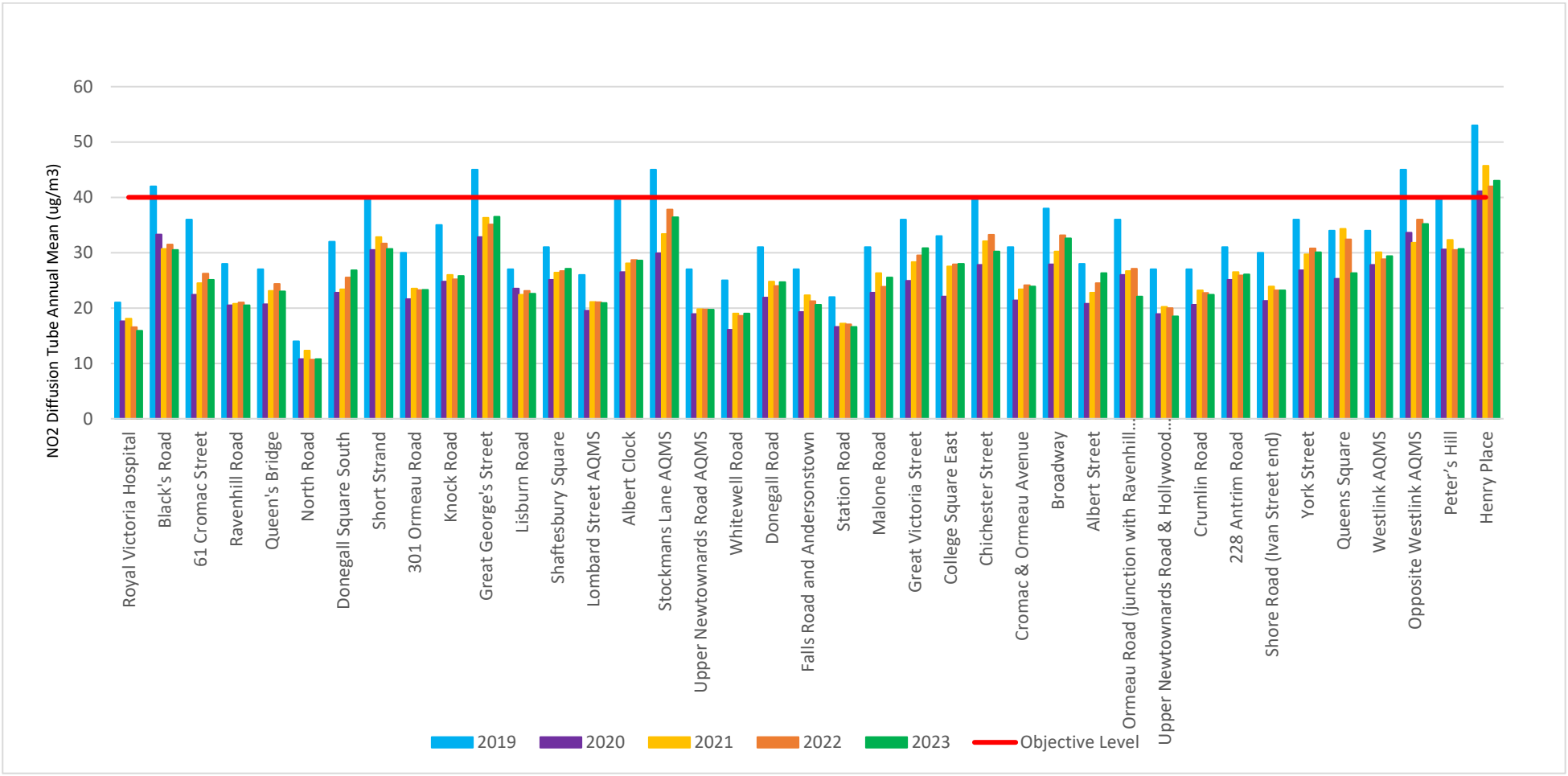
Site ID	Site Name	Within AQMA? Which AQMA?	Annual Mean Concentration (µg/m^3) - Adjusted for Bias				
			2019 [a] (Bias Adjustment Factor = **0.91**)	**2020** [a] (Bias Adjustment Factor = **0.79**)	**2021** [a] (Bias Adjustment Factor = **0.79**)	**2022** [a] (Bias Adjustment Factor = **0.81**)	**2023** [a] (Bias Adjustment Factor = **0.80**)
116	Ligoniel Road / Mill Valley Road	N	N/A	N/A	N/A	N/A	16.9

In **bold**, exceedance of the NO_2 annual mean AQS objective of 40 µg/m^3.

Underlined, annual mean > 60 µg/m^3, indicating a potential exceedance of the NO_2 hourly mean AQS objective.

[a] Means should be "annualised" as per LAQM.TG22, if full calendar year data capture is less than 75%.

Figure 2.4 Trends in Annual Mean Nitrogen Dioxide Concentrations measured at Diffusion Tube Monitoring Sites



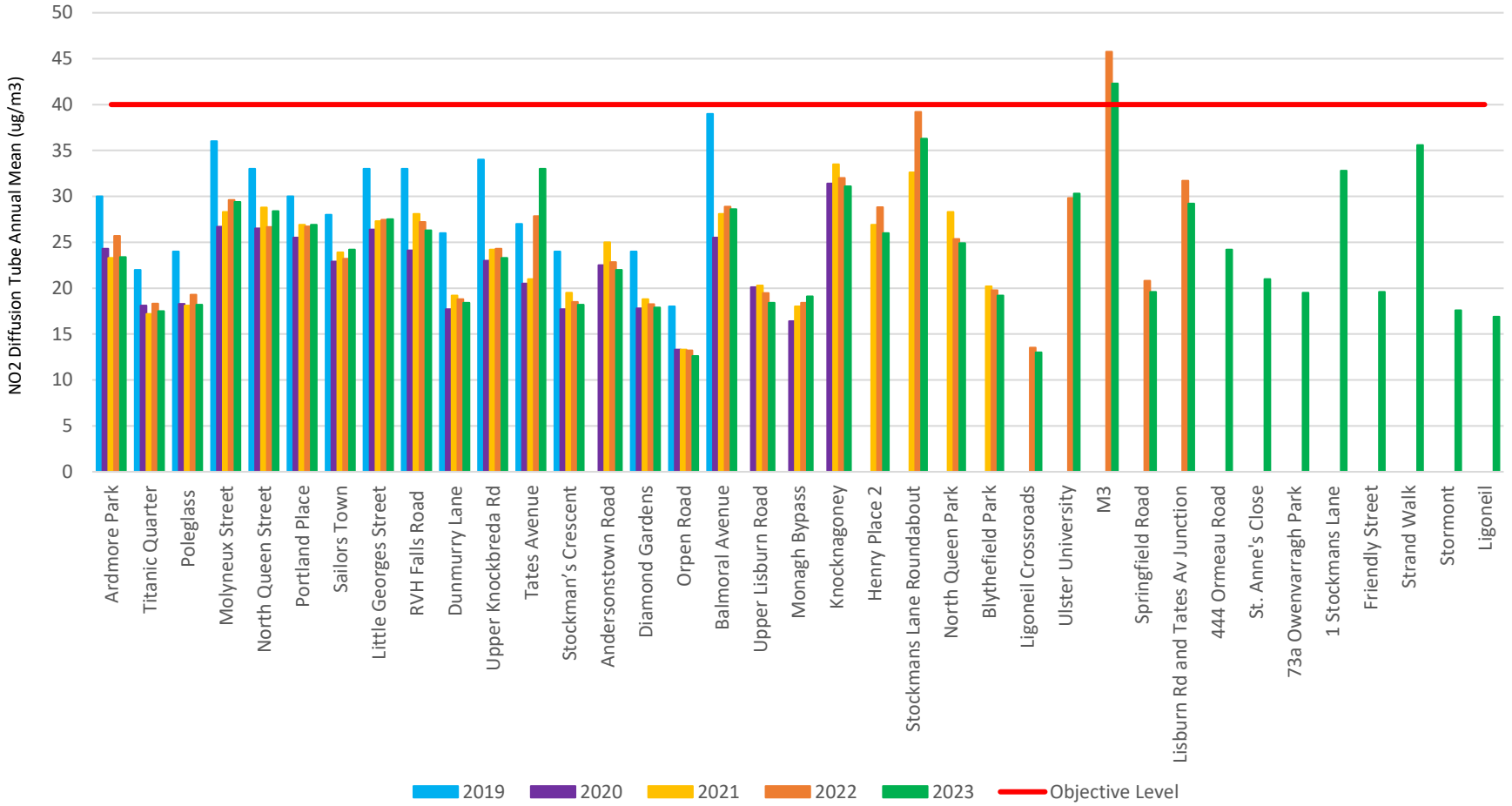
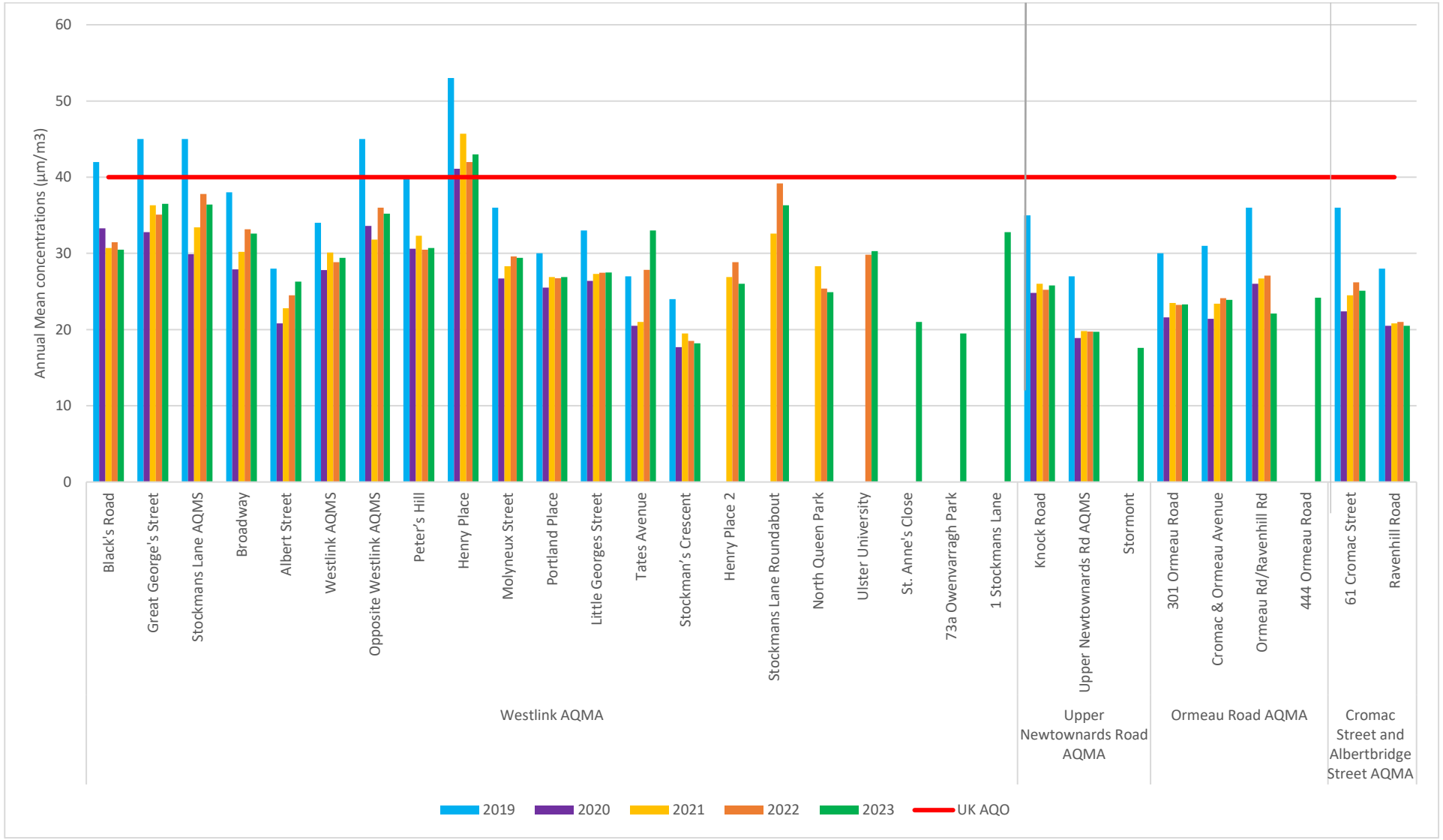

NO2 Diffusion Tube Annual Mean (ug/m3)
50
45
40
35
30
25
20
15
10
5
0
Ardmore Park
Titanic Quarter
Poleglass
Molyneux Street
North Queen Street
Portland Place
Sailors Town
Little Georges Street
RVH Falls Road
Dunmurry Lane
Upper Knockbreda Rd
Tates Avenue
Stockman's Crescent
Andersonstown Road
Diamond Gardens
Orpen Road
Balmoral Avenue
Upper Lisburn Road
Monagh Bypass
Knocknagoney
Henry Place 2
Stockmans Lane Roundabout
North Queen Park
Blythefield Park
Ligoneil Crossroads
Ulster University
M3
Springfield Road
Lisburn Rd and Tates Av Junction
444 Ormeau Road
St. Anne's Close
73a Owenvarragh Park
1 Stockmans Lane
Friendly Street
Strand Walk
Stormont
Ligoneil
2019
2020
2021
2022
2023
Objective Level

Figure 2.5 Trends in Annual Mean Nitrogen Dioxide Concentrations measured at Diffusion Tube Monitoring Sites



2.2.2 Particulate Matter (PM_{10})

As a result of a historic reliance upon solid fuel for domestic heating, Belfast used to experience frequent exceedances of the 24-hour and annual mean objectives for particulate matter (PM_{10}) across the city. However, with completion of the city's smoke control programme and the widespread availability of natural gas to all sectors, emissions of particulate matter have decreased significantly since around 2000. As a result, the council was able to decommission its Belfast Clara Street particulate matter monitoring site in east Belfast in 2007.

However, as domestic and industrial emissions were addressed, so emissions of particulate matter from road transport along the M1 Motorway and A12 Westlink corridor gained in prominence. Upon completion of the council's first review and assessment of air quality in 2004, it was concluded that the M1 Motorway and A12 Westlink corridor should be declared as an Air Quality Management Area on the basis of modelled and monitored exceedances of the 24-hour and annual mean objectives for particulate matter.

As highlighted in the subsequent 2006 Air Quality Action Plan for Belfast, a range of structural improvements, designed to relieve traffic congestion, were completed for the M1 Motorway and A12 Westlink corridor. As a result, monitored levels of particulate matter began to decline within this Air Quality Management Area. Monitoring data for this site is summarised and reviewed in the following Tables 2.7, 2.8 and in Figure 2.6.

In terms of exceedances of the 40 $\mu g/m^3$ particulate matter annual mean objective, there have been no exceedances of the annual mean objective within this AQMA since 2008. Monitoring data from the Belfast Westlink site at Roden Street, which was established in 2010 and is located within the M1 Motorway / A12 Westlink Air Quality Management Area, indicated no exceedances of particulate matter objectives up until 2014 whereupon PM_{10} monitoring was discontinued at this site. Particulate matter monitoring continues however at the Stockman's Lane site.

Reflecting upon the particulate matter 24-hour mean objective data, as summarised in Table 2.8, the data has remained comfortably below the objective at all sites during recent years.

On the basis of historical monitoring data, which demonstrated sustained improvements in particulate matter, the council revoked the M1 Motorway / A12 Westlink Air Quality Management Area for exceedances of the particulate matter annual and 24-hour mean objectives in September 2015.

2023 results, with an annual mean of 16.6 µg/m^3 recorded at the Stockman's Lane site are only slightly lower in comparison to previous years' results - with and without Covid-19 restrictions. It is considered that more information is required to accurately investigate the impact of the Covid-19 lockdowns on particulate matter concentrations; the consistency in annual means recorded at the Stockman's Lane could be due to increased levels of 'working from home' during the pandemic, which may have resulted in increased domestic combustion processes, replacing commercial combustion particulate matter emissions, which are likely to have been reduced due to Covid-19 restrictions.

Nevertheless Figure 2.6 shows that the 2023 levels of PM_{10} recorded at Stockman's Lane (16.6 µg/m^3) and Belfast Centre (12.6 µg/m^3) sites are similar to several previous years. Overall, there were no exceedances of the 24-hour and annual mean objectives for particulate matter (PM_{10}) in Belfast.

Moreover, during 2023 Belfast City Council completed a Detailed Assessment for the city, for PM_{10}, $PM_{2.5}$ and NO_2 pollutants (Summary Report – Appendix D). Detailed atmospheric dispersion modelling was undertaken for a 2019 base year and for a 2028 forward projection year for PM_{10}. The dispersion modelling was validated, verified and adjusted using data from Belfast City Council's two automatic particulate monitors as well as additional PM_{10} monitoring undertaken by Zephyr small sensor air quality monitors.

For the 2019 base year, detailed atmospheric dispersion modelling indicated that there were no sensitive receptor locations within the city, where predicted annual mean PM_{10} concentrations were greater than 40 µg/m^3. In actuality, the highest predicted annual mean PM_{10} concentration in 2019 was around 21 µg/m^3, and at a non-residential location. It is unlikely therefore that there were any areas of exceedance of the UK annual mean PM_{10} AQO during 2019. Similarly, city-wide gridded predicted annual mean PM_{10} concentrations for 2019 were all well below the UK AQO throughout the city. For the forward projection year of 2028, there are no predicted annual mean PM_{10} concentrations greater than 40 µg/m^3 and therefore unlikely to be any locations of exceedance of the UK

annual mean PM_{10} AQO. City-wide gridded predicted annual mean PM_{10} concentrations for 2028 are predicted to be well below the UK AQO throughout the city. Moreover, there are no anticipated exceedances of the PM_{10} 50 µg/m^3 24-hour mean objective (35 exceedances allowed per annum) in either 2019 or 2028.

The outcome of the detailed assessment for PM_{10} therefore indicates that there are no predicted exceedances of the relevant PM_{10} AQOs in either the 2019 base year or 2028 forward projection year. This outcome is in accordance with the conclusions of previous Updating and Screening Assessments, Progress Reports and Detailed Assessments undertaken by the council in respect of PM_{10}.

Table 2.7 Annual Mean PM_{10} Monitoring Results ($\mu g/m^3$) for Comparison with the Annual Mean Objective

Site ID	Site Type	Within AQMA? Which AQMA?	Valid Data Capture for monitoring Period %[a]	Valid Data Capture 2023 %[b]	Confirm Gravimetric Equivalent (Y or N/A)	2019* [c]	2020* [c]	2021* [c]	2022* [c]	2023 [c]
CM1 Belfast Centre (Lombard Street)	Urban Background	N	100	100	Y	15	12	13	13.9	12.6
CM4 Belfast Stockman's Lane	Roadside	Y (Westlink)	87	87	Y	18	17	19	18.2	16.6

In **bold,** exceedance of the PM_{10} annual mean AQS objective of 40 $\mu g/m^3$.

[a] i.e. data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

[b] i.e. data capture for the full calendar year (e.g. if monitoring was carried out for six months the maximum data capture for the full calendar year would be 50%).

[c] Means should be "annualised" as per LAQM.TG22, if monitoring was not carried out for the full year.

* Optional.

Table 2.8 Results of Automatic Monitoring for PM_{10}: Number of Exceedances of 24-hour mean Objective (50 µg/m^3)

Site ID	Site Type	Within AQMA? Which AQMA?	Valid Data Capture for monitoring Period %[a]	Valid Data Capture 2023 %[b]	Confirm Gravimetric Equivalent	2019*	2020*	2021*	2022*	2023
CM1 Belfast Centre (Lombard Street)	Urban Background	N	100	100	Y	2	1	0	4	1
CM4 Belfast Stockman's Lane	Roadside	Y (Westlink)	87	87	Y	4	1	1	7	0

In **bold**, exceedance of the PM_{10} daily mean AQS objective (50 µg/m^3 – not to be exceeded more than 35 times per year).

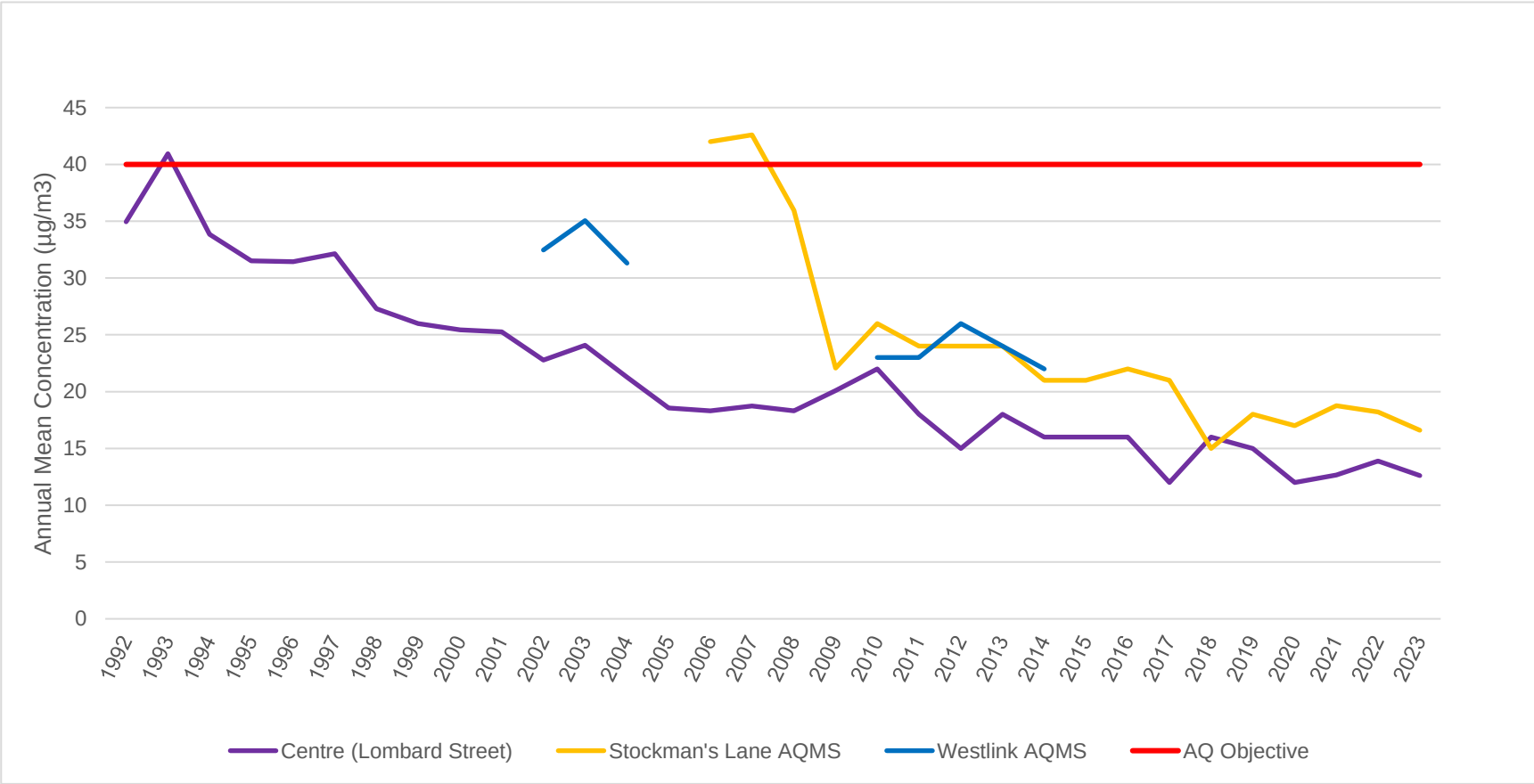
[a] i.e. data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

[b] i.e. data capture for the full calendar year (e.g. if monitoring was carried out for six months the maximum data capture for the full calendar year would be 50%).

[c] if data capture is less than 85%, include the 90.4th percentile of 24-hour means in brackets.

* Optional.

Figure 2.6 Trends in Annual Mean PM_{10} Concentrations



2.2.3 Sulphur Dioxide

As a result of a historic reliance upon solid fuel for domestic heating, Belfast City used to experience frequent and widespread exceedances of the 15-minute, 1-hour and 24-hour mean objectives for sulphur dioxide (SO_2). However, with completion of the city's smoke control programme and the widespread availability of natural gas to all sectors, levels of sulphur dioxide have decreased dramatically since 2000. There have been no exceedances of any sulphur dioxide objective in the city since 2002. Sustained low levels of sulphur dioxide have meant that the council, in consultation with Defra, has been able to terminate ambient monitoring at all locations with the exception of the Belfast Centre AURN site at Lombard Street. No Air Quality Management Areas have been declared for sulphur dioxide across Belfast.

Recent sulphur dioxide monitoring data from the Belfast Centre site is summarised in Table 2.9. As indicated, no exceedances of any objective were observed during 2023.

Table 2.9 Results of Automatic Monitoring of SO_2: Number of Exceedances of Objectives (percentile in bracket)

Site ID	Site Type	Within AQMA? Which AQMA?	Valid Data Capture for monitoring Period %[a]	Valid Data Capture 2023 %[b]	15-minute Means > 266 µg/m^3	1-hour Means > 350 µg/m^3	24-hour Means > 125 µg/m^3
Belfast Centre (Lombard Street)	Urban Background	N	98	98	0	0	0

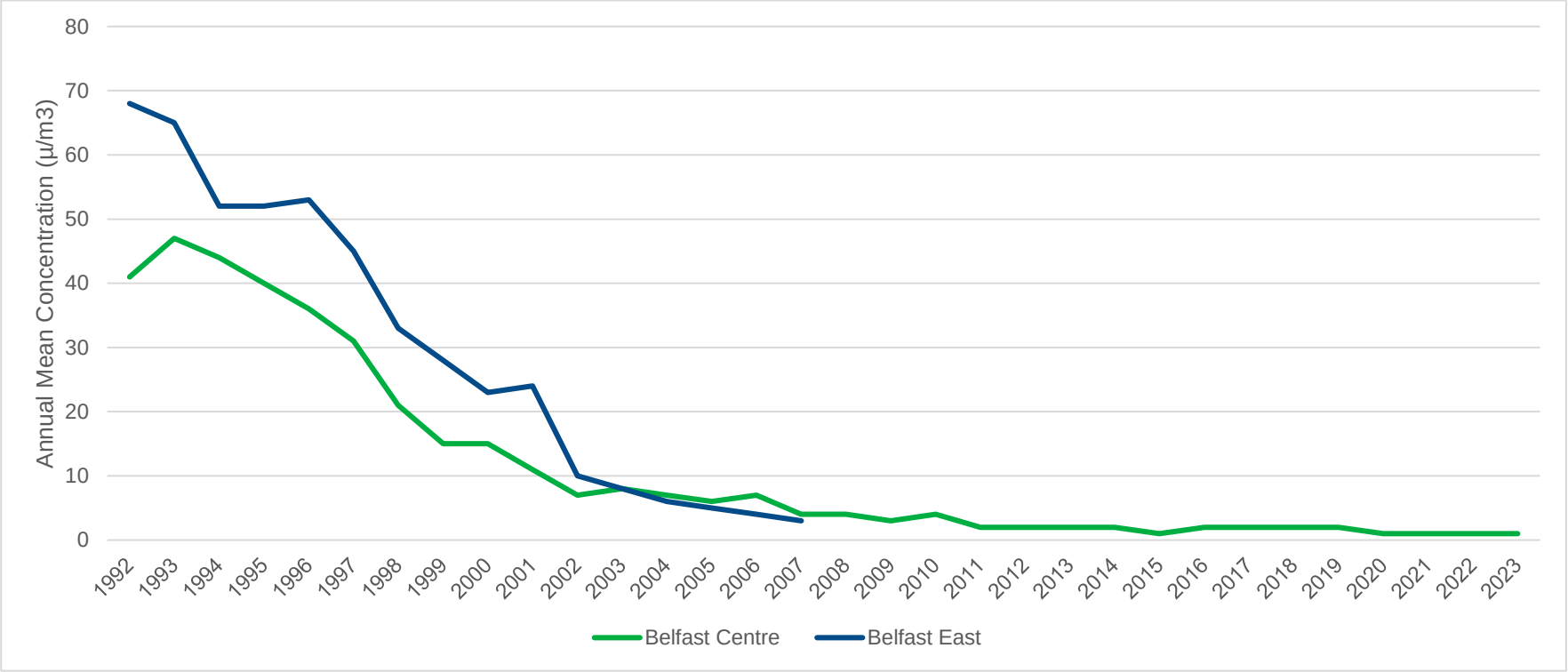
In **bold**, exceedance of the relevant AQS objective (15-min mean = 35 allowed/year; 1-hour mean = 24 allowed/year; 24-hour mean = 3 allowed/year).

[a] i.e. data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

[b] i.e. data capture for the full calendar year (e.g. if monitoring was carried out for six months the maximum data capture for the full calendar year would be 50%).

[c] if data capture is less than 85%, include the relevant percentile in brackets (in µg/m^3): 15-min mean = 99.9th ; 1-hour mean = 99.7th ; 24-hour mean = 99.2th percentile.

Figure 2.7 Trends in Annual Mean SO_2 Concentrations



2.2.4 Benzene

Benzene concentrations have been monitored at the Belfast Centre Lombard Street and Belfast Roadside sites since 2002. The Belfast Centre site monitors benzene exposure for the City Centre whilst the Belfast Roadside site monitored benzene concentrations on the Upper Newtownards Road. Whilst monitoring concluded at the Belfast Upper Newtownards Road site in October 2007, no exceedances of the 2010 Air Quality Strategy objective (3.25 µg/m^3 running annual mean) or the 2010 EU Limit Value (5 µg/m^3 annual mean) for benzene have been recorded in Belfast since 2002.

Previous rounds of review and assessment and monitoring results going back to 2018, and provided in Table 2.10 below, confirm that there have been no exceedances of the running annual mean of 3.25 µg/m^3 for benzene within Belfast over recent years.

Table 2.10 Annual Mean Concentrations for the Belfast Centre Site 2019 – 2023

Site ID	Site type	Within AQMA? Which AQMA?	Valid Data Capture 2023 %	Running annual mean concentrations (µg/m^3)				
				2019	2020	2021	2022	2023
Belfast Centre (Lombard Street)	Urban Background	N	100	0.44	0.37	0.39	0.38	0.42

2.2.5 Other pollutants monitored.

Fine Particulate Matter ($PM_{2.5}$)

Fine particulate matter ($PM_{2.5}$) concentrations have been monitored at the Belfast Centre AURN site since 2008. Although it is not a statutory requirement for NI local authorities to report on $PM_{2.5}$ levels, as this pollutant is not in scope of LAQM regulations, Belfast City Council has nevertheless included $PM_{2.5}$ results for 2023 in this progress report - Table 2.11 and Figure 2.9 below.

The annual mean for this pollutant in 2023 was 6.9 µg/m^3, which is substantially below the UK air quality annual mean objective of 20 µg/m^3, to be achieved by 2020.

Although Belfast does not experience monitored exceedances of any air quality strategy objectives, we are aware of growing concerns around the effects of the $PM_{2.5}$ fraction on human health. Therefore, although not included in Regulations at present for Northern Ireland councils, Belfast City Council has proactively opted to monitor and assess ambient $PM_{2.5}$ concentrations within Belfast.

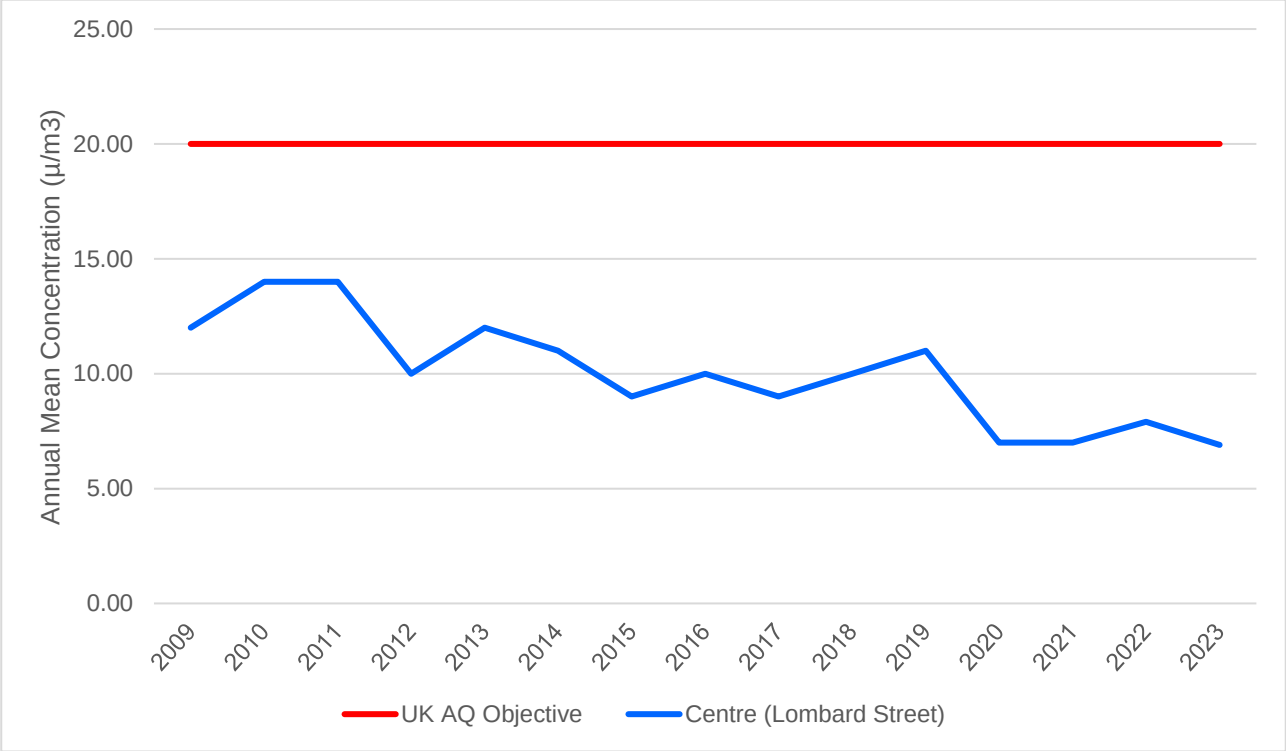
Moreover, Belfast City Council has recently completed a Detailed Assessment for the city, for PM_{10}, $PM_{2.5}$ and NO_2 pollutants. Detailed atmospheric dispersion modelling was undertaken for a 2019 base year and for a 2028 forward projection year for $PM_{2.5}$. The dispersion modelling was validated, verified and adjusted using data from Belfast City Council various automatic particulate monitors as well as additional $PM_{2.5}$ monitoring undertaken by Zephyr small sensor air quality monitor.

During 2019, detailed atmospheric dispersion modelling indicated that there were no sensitive receptor locations where predicted 2019 annual mean $PM_{2.5}$ concentrations were greater than 20 µg/m^3. The highest predicted annual mean $PM_{2.5}$ concentration in 2019 was 14.1 µg/m^3, at a non-residential location. For 2028, there are similarly no predicted annual mean $PM_{2.5}$ concentrations greater than 20 µg/m^3 and therefore unlikely to be locations of exceedance of the UK annual mean $PM_{2.5}$ AQO.

Table 2.11 Annual Mean Levels for the Belfast Centre site 2019-2023

Site ID	Site type	Within AQMA? Which AQMA?	Valid Data Capture 2023%	Annual mean concentrations (µg/m^3)				
				2019	2020	2021	2022	2023
Belfast Centre (Lombard Street)	Urban Background	N	100%	11.0	7.0	7.0	7.9	6.9

Figure 2.8 Trends in Annual Mean $PM_{2.5}$ Concentrations at Belfast Centre Monitoring Site.



2.2.6 Summary of Compliance with AQS Objectives

Belfast City Council has examined the results from monitoring within its district. Concentrations of ambient pollutants, as prescribed in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland, outside of existing Air Quality Management Areas, are all below the respective objectives at relevant receptor locations. It is therefore the council's considered view that there is no need to proceed to a Detailed Assessment at this time.

Moreover, a Detailed Assessment for the city for NO_2, PM_{10} and $PM_{2.5}$ was recently concluded in March 2023. The Detailed Assessment indicated that there were no predicted exceedances of any AQO in relation to particulate matter (PM_{10} and $PM_{2.5}$) for a pre-Covid 2019 base year and for a 2028 forward assessment year. In relation to NO_2, there were predicted exceedances of the nitrogen dioxide UK annual mean objective of 40 µg/m^3 at a number of sensitive receptor locations during 2019. However, all of these receptors are located within, or near to the boundaries of the existing Air Quality Management Areas (AQMAs) along the M1 Motorway / A12 Westlink corridor (AQMA 1) and East Bridge Street / Cromac Street (AQMA 2). For the future assessment year of

2028, predicted annual mean NO_2 concentrations are below the UK AQO of 40 µg/m^3 at all locations of relevant exposure throughout the city.

During 2023, a new diffusion tube monitoring site was established adjacent to Strand Walk at the junction of the Newtownards Road, Bridge End and Middlepath Street junction in order to investigate the detailed assessment predicted exceedance of the annual mean nitrogen dioxide objective near to the East Bridge Street / Cromac Street AQMA 2. The 2023 monitored annual mean for the Strand Walk monitoring site was 35.6 μgm^{-3} at roadside and will be reduced further when distance corrected to the façade of the nearest residential property. On the basis of this monitoring for 2023, and the conclusions of the Detailed Assessment, Belfast City Council is therefore content that there is no requirement to extend the boundary of AQMA 2 at this time. The other diffusion tube monitoring sites situated close to or within AQMA 2, i.e. Ravenhill Road, Short Strand and 61 Cromac Street were all substantially below the 40 μgm^{-3} nitrogen dioxide annual mean objective in 2023.

As a consequence, the council will continue to monitor ambient conditions across the city in order to confirm that recent improvements in air quality are sustained and that those locations where poorer air quality persist are addressed.

3 Road Traffic Sources

It should be noted that within Northern Ireland, the Department for Infrastructure Roads has responsibility for transport planning and maintenance of the road network. Accordingly, DfI Roads maintains and improves the road network and infrastructure in order to keep it safe, effective and reliable. In the earlier rounds of the review and assessment process, the council obtained a copy of the Belfast road transportation model which comprised traffic data for around 5,600 road nodes across the city. In addition, the council bolstered this data through supplementary traffic counts in congested streets and we have undertaken monitoring at these locations through the use of diffusion tubes and automatic analysers.

Moreover, road sources were assessed again in detail as part of the council' Detailed Assessment project, finalised in 2023. Traffic flow data representative of 2019 and 2028 were obtained from the baselines of the Belfast Strategic Transport Model (Department for Infrastructure) for the major road network in Belfast and a large number of minor roads. The 2019 assessment year was chosen to represent the most recent year unaffected by the COVID pandemic, whilst 2028 was chosen as the future assessment year as this is the first available future year within the Belfast Strategic Transport Model.

The vehicle fleet composition was also informed by local ANPR surveys that were undertaken, specifically for the detailed assessment. Additional monitoring was undertaken to support the verification process of the assessment of road source emissions.

Source apportionment calculations were carried out for NO_2, PM_{10} and $PM_{2.5}$ to examine the relative contributions of different sources to modelled concentrations across the city. The relative contributions of different sources are strongly influenced by proximity to source. Therefore, source apportionment calculations were carried out at individual receptor level, but also at the city-wide level in order to give a balanced representation of the relative importance of different source contributions. Estimated Average Contribution of each Source Sector including Roads, to the 2019 Annual Mean NO_2, PM_{10} and $PM_{2.5}$ are presented below.

Figure 3.1 City-Wide Weighted Average Source Apportionment, 2019 Annual Mean NO_2 Concentration.

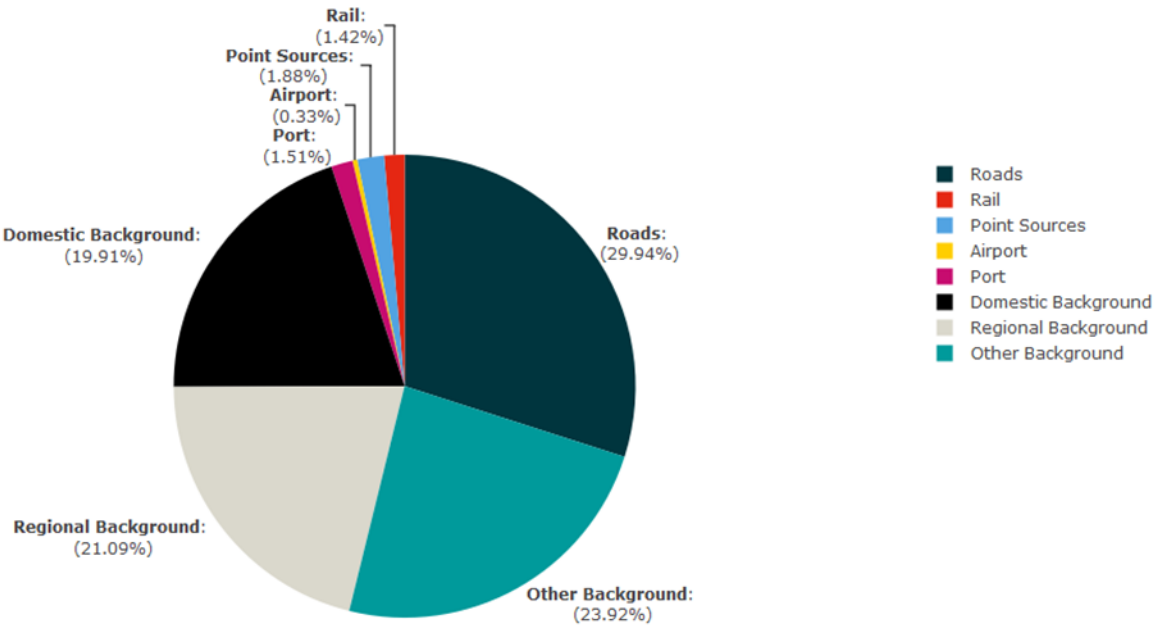


Figure 3.2 City-Wide Weighted Average Source Apportionment, 2019 Annual Mean PM_{10} Concentration.

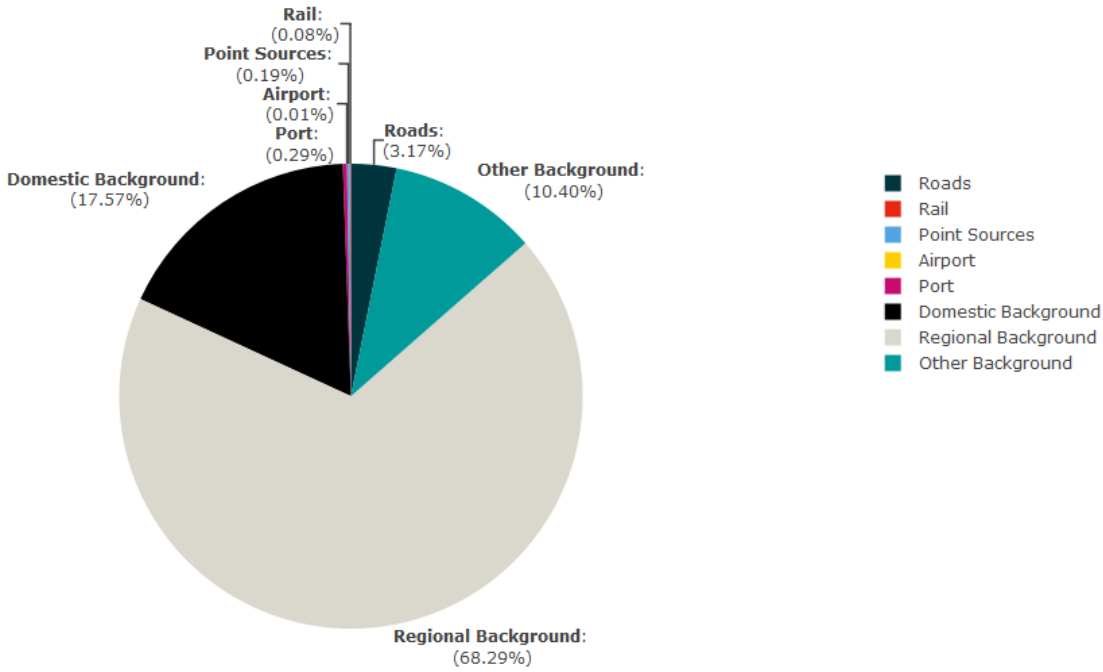
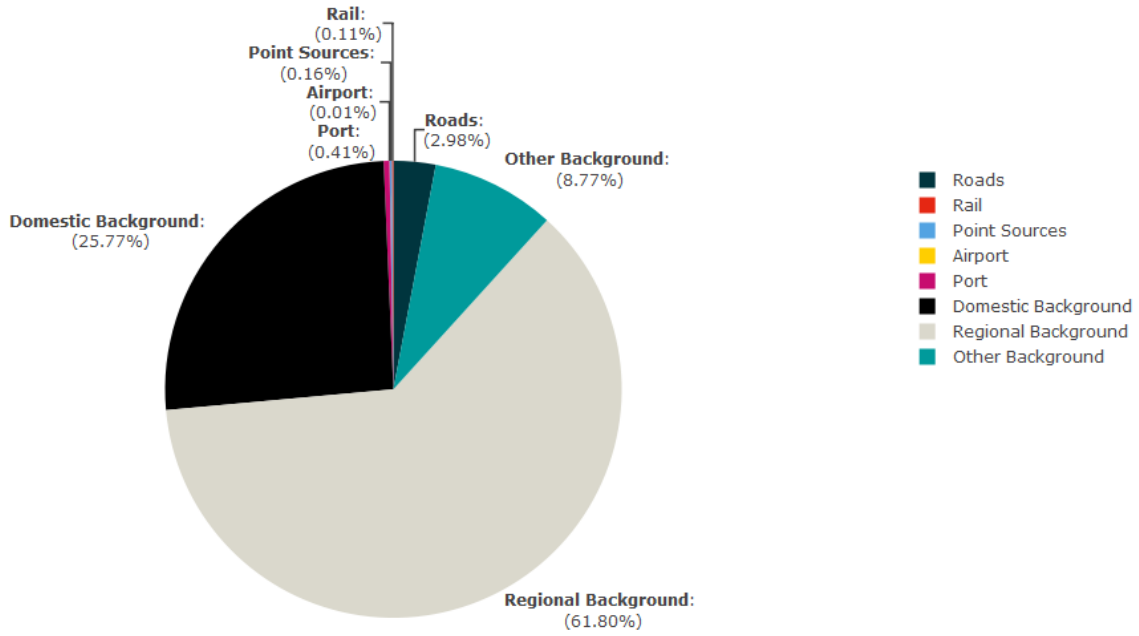


Figure 3.3 City-Wide Weighted Average Source Apportionment, 2019 Annual Mean $PM_{2.5}$ Concentration.



Based on city-wide source apportionment calculations for NO_2 in 2019 (Figure 3.1), road transport was identified as the main source of modelled NO_2 concentrations, accounting for almost 30% of total modelled NO_2 concentrations in Belfast. At receptor locations near to the major road network these contributions were typically much higher (greater than 60%).

The detail conclusions of the assessment were reported within Chapter 1 of the Belfast City Council 2023 Air Quality Progress report.

3.1 Narrow Congested Streets with Residential Properties Close to the Kerb

Based on the previous and recent detailed assessment process, we believe that we have a good understanding of traffic and development control patterns across the city. Consequently, Belfast City Council confirms that there are no newly identified congested streets with a vehicle flow above 5,000 vehicles per day and with residential properties close to the kerb that have not been adequately considered, either in a previous or recent review and assessment process.

3.2 Busy Streets Where People May Spend 1 hour or More Close to Traffic

Belfast City Council confirms that there are no new/newly identified busy streets where people may spend 1 hour or more close to traffic.

A detailed assessment, finalised by the council in 2023, identified that the highest predicted NO_2 concentration in 2019 at a relevant receptor location near to the Stockman's Lane roundabout (Westlink AQMA) was 55.9 µg/m^3. For the future assessment year of 2028, predicted annual mean NO_2 concentrations were below the UK AQO of 40 µg/m^3 at locations of relevant exposure throughout the city. The highest predicted concentration at the Stockman's Lane roundabout is 31.1 µg/m^3 at a residential receptor location.

Consequently, the recent council's air quality monitoring and modelling results confirm that there are no locations within Belfast City Council area where annual mean NO_2 concentrations are above 60 µg/m^3. It should be noted that the Defra / DAERA LAQM.TG(22) reaffirms that a study carried out on behalf of Defra and the Devolved Administrations identifies that exceedances of the NO_2 1-hour mean are unlikely to occur where the annual mean is below 60 µg/m^3. Analysis of data in more recent years has shown local authorities should continue to use this assumption where NO_2 1-hour mean monitoring data are not available (typically if monitoring NO_2 using passive diffusion tubes). It should be noted that this relationship is based upon observations made predominantly at roadside and kerbside monitoring sites where road traffic is the primary source of emissions.

3.3 Roads with a High Flow of Buses and/or HGVs.

In earlier rounds of the review and assessment process, Belfast City Council conducted screening assessments of the Belfast road network in order to identify locations with a high incidence of buses and / or heavy goods vehicles. In accordance with government's technical guidance LAQM.TG(16), an unusually high proportion can be taken to be greater than 20% of heavy-duty vehicles. This screening criterion has been supplanted within LAQM.TG(22) by a 2,500 HDVs / day and relevant human exposure within 10 m from kerb (20 m in conurbations > 2 million inhabitants) threshold, with a corollary that roads with unusually high proportion of buses and/or HGVs can lead to high concentrations, even if total traffic is not particularly high. The only part of the road network within Belfast that historically approached the % HDV and / or HDVs per day criteria was the M1 Motorway / A12 Westlink corridor with approximately 15% of heavy-duty vehicles. On this basis, a

detailed review and assessment was completed, and this corridor was designated as an Air Quality Management Area for both short and longer-term exceedances of the nitrogen dioxide and particulate matter objectives. This Air Quality Management Area has been the subject of mitigation measures as part of the council's various Air Quality Action Plans for Belfast.

On the basis of monitoring data, which demonstrated sustained improvements in particulate matter concentrations, the council revoked the M1 Motorway / A12 Westlink Air Quality Management Area for exceedances of the particulate matter annual and 24-hour mean objectives in September 2015. The declarations for nitrogen dioxide objectives remain.

The outcomes of 2021-2023 Detailed Assessment confirm that highest levels of NO_2 and PM_{10} are still at locations within the A12 Westlink corridor (AQMA 1). Although, some localised exceedances of the UK AQO level of 40 µg/m^3 remain within AQMA 1 for nitrogen dioxide, predicted annual mean PM_{10} concentrations for the 2019 base year and 2028 future year are well below the UK AQO level of 40 µg/m^3. The highest predicted PM_{10} concentration at a discrete sensitive receptor location was 21.2 µg/m^3 (for base year 2019).

It should be noted that the recently installed kerbside diffusion tube monitoring site at the M3 Motorway off slip / Nelson Street / A12 Westlink junction, installed to address a new residential development at that location has returned nitrogen dioxide annual means of 45.8 μgm^{-3} in 2022 and 42.3 μgm^{-3} in 2023. However, the measured 2023 nitrogen dioxide annual mean, distance corrected to the façade of the development, results in a 2023 annual mean of 29.1 μgm^{-3}; comfortably below the 40 μgm^{-3} annual mean objective.

Accordingly, Belfast City Council confirms that there are no new/newly identified roads with high flows of buses/HDVs.

3.4 Junctions

Belfast City Council confirms that there are no new/newly identified busy junctions/busy roads.

However, the council identified new relevant exposure (residential) in close proximity to busy junctions. Consequently, new air quality monitoring points (diffusion tubes - DT) were installed in 2022 at Tates Avenue/Lisburn Rd (DT 108), M3 (DT 106) and York Street / Ulster University (DT 105). Monitored annual mean NO_2 concentrations at these two new

locations (tubes no 105, 108) were below AQO level of 40 µg/m^3 in 2022 and 2023. An annual mean air quality objective exceedance occurred during 2022 and 2023 at a location next to the junctions of the M3 Motorway / M2 Motorway (DT 106). Defra's NO_2 distance calculations have been undertaken for the above location to estimate concentrations at upcoming relevant human health receptor locations.

The Diffusion Tube Processing Tool (Appendix A) has predicted an annual mean concentration of 31.3 µg/m^3 in 2022 and 29.1 µg/m^3 in 2023 at the receptor location; this indicates that no exceedances are likely at the above relevant receptor location.

Moreover, this new residential development located adjacent to the busy junction of the M3 Motorway / M2 Motorway was not finalised in 2023; the development has become available for occupancy from mid-2024.

3.5 New Roads Constructed or Proposed Since the Last Round of Review and Assessment

Belfast City Council confirms that there are no new/proposed roads that meet the criteria for review and assessment at this time.

3.6 Roads with Significantly Changed Traffic Flows

In Nothern Ireland, the Department for Infrastructure Roads has responsibility for public roads and traffic information. Traffic and travel information (incorporating annual traffic census and variations in traffic flow) is provided by the Department on annual basis and can be access here: https://www.infrastructure-ni.gov.uk/publications/traffic-and-travel-information-incorporating-annual-traffic-census-and-variations.

It should be noted that the Department advised that, '*In 2015, Traffic data was collected from 351 automatic traffic counting sites located throughout the road network in Northern Ireland. Since then resource limitations have necessitated a reduction in the number of permanent traffic counters, retaining only those that are fully automated. There were a total of 73 such sites operational across Northern Ireland in 2022'.*

The 2022 Traffic and Travel report shows that, due to the Covid-19 pandemic, traffic flows recorded in 2021 and 2022 in Belfast were generally higher compared to 2020 but lower when compared to 2019 and before.

Consequently, the council confirms that there are no newly identified roads with a significant traffic flow increase.

3.7 Bus and Coach Stations

Belfast City Council confirms that there have been no new relevant bus stations in the Local Authority area. However, the Department for Infrastructure and Translink are presently finalising the construction of a new Belfast Transport Hub at Great Victoria Street. Known as Weavers Cross, the new transport hub Belfast Grand Central Station will provide a new integrated public transport interchange for Belfast comprising a new station concourse, 26 bus stands, 8 railway platforms, bus maintenance and parking, a bus access bridge, cycle and taxi provision, car parking, a new public square, public realm improvements, highway improvements and infrastructure improvements. The main works and infrastructure enhancement phases were commenced in 2022 and the station is scheduled to open in autumn 2024.

Belfast City Council therefore confirms that the abovementioned development was considered through the council's planning consultation process (LA04/2017/1388/F); a submitted Air Quality Impact Assessment for the station development demonstrated that the development will not have a significant adverse impact on ambient air quality and relevant human health receptors.

4 Other Transport Sources

4.1 Airports

Belfast City Council has previously considered the air quality impact of the George Best Belfast City Airport and, on the basis of ambient monitoring data for nitrogen dioxide, concluded that an Air Quality Management Area did not need to be declared for the airport. In order to provide ongoing surety regarding the air quality impact of the airport, we have maintained a nitrogen dioxide diffusion tube at Station Road in east Belfast adjacent to the nearest residential receptors to the airport. It should be noted that the Station Road diffusion tube is located so as to take account also of the impact of nearby road traffic on the Sydenham Bypass and of the Belfast to Bangor rail line.

Annual mean concentrations of nitrogen dioxide at Station Road have remained comfortably below the annual mean objective of 40 µg/m^3 (in the range 17-26 µg/m^3 since 2007). We are therefore content that any changes to airport operations over recent years have had little impact upon ambient air quality at the nearest relevant receptors. Therefore, it is considered that a further Detailed Assessment for this existing airport is not required at this stage.

However, the airport's emissions were considered as part of the council's Detailed Assessment project finalised in 2023.

As part of this project, a new monitoring sensor was installed in 2021 directly adjacent to the George Best Belfast City Airport, along the Sydenham By-Pass. The nitrogen dioxide (NO_2) and particular matter (PM_{10}, $PM_{2.5}$) monitoring was carried out using a Zephyr small sensor air quality analyser. The 2021 annual mean data (NO_2 – 22.9 µg/m^3; PM_{10}- 15.9 µg/m^3; $PM_{2.5}$ -9.2 µg/m^3) confirmed that the site remains compliant with all AQS objectives.

Belfast City Council continues to operate and collect data from the abovementioned Zephyr sensor; 2023 data are presented in Appendix C.

Emissions from aviation activities at Belfast City Airport were also modelled as volume sources using ADMS-5 to predict concentrations of NO_2, PM_{10} and $PM_{2.5}$.

The airport was found to contribute approximately 0.3% (2019-base year) and 0.5% (2028) to the total modelled NO_2 at the city-wide scale. The contribution of emissions from the airport to modelled PM_{10} concentrations was approximately 0.01% for all years modelled.

The same contribution of emissions was predicted for $PM_{2.5}$ concentrations at the city-wide scale. Consequently, the council is confident to report that the airport is not a significant source of NOx and particulate matter emissions.

Moreover, earlier this year, Belfast City Airport also commenced its own air quality monitoring programme, which includes an automatic monitoring station (particular matter, nitrogen dioxide) and several diffusion tubes (nitrogen dioxide). The council will liaise with the airport in relation to the outcomes of this monitoring programme.

Belfast City Council confirms that there are no new airports within the Local Authority area.

4.2 Railways (Diesel and Stream Trains)

Belfast City Council confirms that based on criteria prescribed within Chapter 7, Section 1, of LAQM.TG22 a Detailed Assessment of railway sources is not required at this stage.

However, contributions of railway sources to pollutants concentrations across the city were modelled as part of Belfast Detailed Assessment concluded in 2023. Based on city-wide source apportionment calculations, rail movements account for about 1.4% (2019 base year) and 2% (2028 future year) of total modelled NO_2 concentrations. In relation to PM_{10} and $PM_{2.5}$, the railway sector accounted for about 0.1% of the city-wide concentrations for base and future years.

In future years, an increase in rail activity due to the anticipated shift to more sustainable modes of transport and increased demand is predicted. However, under action 4 of the council's AQAP 2021-2026, Translink is committed to carrying out a feasibility assessment to decarbonise the rail network including the potential roll out of electrification, battery traction and hydrogen technologies. As part of this commitment, Translink has confirmed that the Class 4000 railcars will be replaced with more fuel-efficient trains in the near future. It is therefore expected that any increase in activity will be offset by a simultaneous improvement in fuel efficiency.

4.2.1 Stationary Trains

Belfast City Council confirms that there are no locations where diesel or steam trains are regularly stationary for periods of 15 minutes or more, with potential for relevant exposure within 15m.

However, as described within section 3.7 the Department for Infrastructure and Translink are presently finalising the construction of a new Belfast Transport Hub (Grand Central

Station) in the locality of Grosvenor Road and Great Victoria Street. The new transport hub will provide a new integrated public transport interchange for Belfast, including 8 railway platforms. The main works and infrastructure enhancement phases commenced in 2022 and the station is scheduled to be operational from autumn 2024.

Belfast City Council confirms that the above development was considered as part of the council's planning process (LA04/2017/1388/F); a submitted Air Quality Impact Assessment demonstrated that this development will not have a significant adverse impact on ambient air quality and relevant receptors.

4.2.2 Moving Trains

Belfast City Council confirms that there are no new locations with a large number of movements of diesel locomotives, and potential long-term relevant exposure within 30m.

4.3 Ports

Referring to the government's technical guidance regarding the treatment of ports and shipping, the screening assessment approach is to collect information regarding the number of ship movements per year, where such movements are confined to large ships, including cross-channel ferries, roll-on and roll-off vessels, container ships and cruise liners and movements' number between 5,000 and 15,000 per annum. This movement data is contrasted subsequently with the potential for relevant exposure within 250 metres of the shipping berths. We have obtained activity data from the Port of Belfast which has confirmed that the number of ship movements in 2023 was 11,516 in total. However, an analysis of the geographic location of the Port confirms that there is little potential for relevant public exposure within 250 metres for 15-minute periods. The majority of ferry terminals are now located within Port confines at Westbank Road off Dargan Road. This area is predominantly used for industrial and commercial activities and there is no relevant public exposure within 250 m of the berths.

Belfast City Council confirms that there are no ports or shipping that meet the specified assessment criteria within the Local Authority area.

Nevertheless, emissions of NO_2, PM_{10} and $PM_{2.5}$ from Belfast Harbour were included in the emissions inventory and dispersion modelling for the 2021-2023 BCC Detailed Assessment.

Based on city-wide source apportionment calculations for NO_2 concentrations, Belfast Harbour was estimated to contribute approximately 1.5% in 2019 (Figure 3.1) and 2.3% in 2028. In relation to PM_{10}, the Harbour contribution was about 0.3% in 2019 (Figure 3.2) and 2028, and for $PM_{2.5}$, the contribution was about 0.4% for both modelled years (Figure 3.3).

5 Industrial Sources

5.1 Industrial Installations

In Northern Ireland, the permitting of prescribed industrial activities under The Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland) 2013 is undertaken by both local authorities and the Industrial Pollution and Radiochemical Inspectorate (IPRI) of the Department of Agriculture, Environment and Rural Affairs. IPRI has responsibility for the permitting of what are defined as Part A and B processes whereas district councils permit Part C processes. Part A processes have the greatest capacity to pollute and as a result can impact detrimentally upon air, land and water. For this reason, they require an integrated approach to permitting whereas Part B and Part C processes are regulated for emissions to air only.

The public register of Northern Ireland Part A and B processes is accessible on the DAERA / NIEA website via the following web link: https://public-registers.daera-ni.gov.uk/pollution-prevention-control.

In order to complete this 2024 Update and Screening Assessment, Belfast City Council has liaised with the IPRI regarding Part A and B processes.

Industrial sources were also assessed as part of the council's Detailed Assessment project, finalised in 2023. Emissions from sixteen industrial / point source activities were modelled using ADMS-5 to predict concentrations of NO_2, PM_{10} and $PM_{2.5}$.

Estimated Average Contributions for each Source Sector, including Industrial Installations, to the 2019 Annual Mean NO_2, PM_{10} and $PM_{2.5}$. are presented within Figures 3.1 – 3.3. It is estimated that industrial installations are not substantial pollution sources across the Belfast City Council area. The conclusions of the detailed assessment were reported within Chapter 1 of Belfast City Council 2023 Air Quality Progress report and a Summary Report is included in Appendix D.

The Council is presently commencing regulation of Medium Combustion Plant (MCP) and Specified Generators (SG). (DAERA / IPRI will regulate any MCPs / SGs associated with their Part A / B permitted premises). Medium Combustion Plant are generally used to generate heat and / or power but as combustion plant, they may be a significant source of air pollution and many are currently unregulated for ambient air pollution emissions. Accordingly, all medium combustion plant between 1 and 50 MW (net rated thermal input)

are required to obtain a permit or be registered. Since 20th December 2018, all new medium combustion plants need to be registered or to have obtained a permit and comply with emission limit values (ELVs) in respect of sulphur dioxide (SO_2), nitrogen oxides (NOx) and dust, established via the Medium Combustion Plant Directive (Annex II, Part 2 of the MPCD). Existing plant, i.e. those which were put into operation before 20th December 2018, need to have obtained a permit or be registered and comply in accordance with the following schedule; 1-5 MW plant, obtain a permit or be registered by 1st January 2029 and comply with ELVs by 1st January 2030; 5-50 MW plant, obtain a permit or be registered by 1st January 2024 and comply with ELVs by 1st January 2025.

5.1.1 New or Proposed Installations for which an Air Quality Assessment has been Carried Out

Belfast City Council confirms that since the last Updating and Screening Assessment in 2021, the following new or proposed industrial installations, situated within its area or nearby in a neighbouring authority, have been granted planning approval. These installations have been subject to air quality impact assessments.

- *Energy Centre, Royal Victoria Hospital* – was approved through the planning process in 2021 ((LA04/2021/1492/F). This approved installation was supported by an Air Quality Impact Assessment. The assessment demonstrated that the proposal would not have an impact on local air quality or relevant human health receptors.
- *Development of new, replacement Animal Health Sciences Building with General Stores Building, Post-Mortem Suite and Carcass Incineration Facility, and associated works* – was approved through the planning process in 2023 (LA04/2022/0915/F). A preliminary Air Quality Impact Assessment (AQIA) was submitted and reviewed, and subsequently, an updated AQIA confirming compliance with the respective air quality objectives at relevant human health receptor locations was requested prior to the installation of the combustion plant (condition 12 of the Planning Permission dated 17th November 2023). This incineration facility will be subject to permitting under The Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland) 2013 when in operation.

Belfast City Council has therefore assessed new / proposed industrial installations and concluded that it will not be necessary to proceed to a Detailed Assessment.

5.1.2 Existing Installations where Emissions have Increased Substantially or New Relevant Exposure has been Introduced.

Belfast City council confirms that there are no industrial installations with substantially increased emissions or new relevant exposure in their vicinity within its area or nearby in a neighbouring authority.

5.1.3 New or Significantly Changed Installations with No Previous Air Quality Assessment

Belfast City Council confirms that there are no new or significantly changed industrial installations with no previous air quality impact assessment.

5.2 Major Fuel Depots

There is a major fuel storage depot within the Port area of Belfast, but its impact has been considered in previous updating and screening and review and assessment reports.

5.3 Petrol Stations

Belfast City council confirms that there are no petrol stations meeting the specified criteria.

5.4 Poultry Farms

Belfast City Council confirms that there are no poultry farms meeting the specified criteria.

6 Commercial and Domestic Sources

Belfast City Council confirms that all below commercial and domestic sources were considered as part of a previous and current review and assessment process and although there are no new relevant sources to report this year, the council would advise that due to recent evidence from national studies showing that domestic solid fuel burning contributes more than previously thought to particulate emissions the council decided to undertake a detailed assessment for the city, for particulate matter (PM_{10}), fine particulate matter ($PM_{2.5}$) and nitrogen dioxide (NO_2) pollutants. This project commenced in February 2021, was concluded earlier this year (March 2023), and included additional ambient air quality monitoring (using Zephyr small sensor air quality monitors), development of an emissions inventory database for the city and detailed atmospheric dispersion modelling. The outcomes of this detailed assessment were presented within 2023 Progress Report.

Domestic background sources (which include domestic, commercial, and institutional space heating) were estimated to account for more than 25% of the total modelled particulate matter concentrations across the city. Consequently, one of the recommendations of the BCC Detailed Assessment was to target actions to reduce domestic background sources across the city. Source apportionment calculations also indicated that targeting of the domestic background sector will also help to reduce NO_2 concentrations.

6.1 Biomass Combustion – Individual Installations

Belfast City Council confirms that since the 2021 Updating and Screening Assessment, there haven’t been new individual biomass plants installed within the council’s area.

6.2 Biomass Combustion – Combined Impacts

Belfast City Council confirms that there is no relevant biomass combustion plant within the Local Authority area.

6.3 Domestic Solid Fuel Burning

Belfast City Council confirms that there are no areas of significant domestic fuel use in the Local Authority area, however the Detailed Assessment, including domestic sources, was

undertaken and reported in the previous 2023 annual Air Quality Progress Report. Also, a Summary Report is included within Appendix D to this USA.

7 Fugitive or Uncontrolled Sources

Belfast City Council confirms that there are no new potential sources of fugitive particulate matter emissions within the Local Authority area.

8 Conclusions and Proposed Actions

8.1 Conclusions from New Monitoring Data

Belfast City Council has presented a range of monitoring data within this Updating and Screening Assessment Report that addresses a range of pollutants prescribed within the UK Air Quality Strategy. Although these pollutants are routinely measured across the city, the council's focus remains principally upon addressing the existing Air Quality Management Areas and those areas of the city centre where traffic volumes and congestion might lead to further exceedances of the nitrogen dioxide annual mean and hourly objectives. There were no monitored exceedances for any of the Air Quality Strategy objectives for sulphur dioxide, benzene and particulate matter during 2023.

2023 monitoring data for nitrogen dioxide confirms continuing exceedances of the annual mean objective for nitrogen dioxide within the M1 Motorway / A12 Westlink Air Quality Management Area (AQMA 1) at Henry Place and also at a new monitoring location next M3 motorway (close to AQMA 1). Both locations are monitored using diffusion tubes. Defra NO_2 distance correction calculations have been provided for the above locations to calculate expected concentrations at a relevant receptor location.

The Diffusion Tube Processing Tool has predicted an annual mean concentration of 29.2 µg/m^3 at Henry Place and 29.1 µg/m^3 at the M3 Motorway monitoring location, which indicates that no exceedances are likely at the relevant receptor locations (Appendix A). The 2023 nitrogen dioxide annual mean (28.5 µg/m^3) monitored at the Westlink Roden Street automatic site (AQMA 1) has not changed significantly since 2021 and is comfortably below the annual mean objective of 40 mg/m^3. Additionally, nitrogen dioxide concentrations recorded at the Stockman's Lane automatic monitoring site, also within AQMA 1, have decreased significantly since 2020 and are now below the annual mean objective level of 40 µg/m^3. The current 2023 annual mean (35.6 µg/m^3) has not significantly varied when compared to the 2020 annual mean.

Although concentrations recorded around the Stockman's Lane area are lower than 40 µg/m^3 they are still considered elevated (within 10% of the annual mean NO_2 objective). A

roadside diffusion tube, located near to the Stockman's Lane AQMS, recorded a similar 2023 NO_2 annual mean concentration (Stockman's Lane Roundabout - 36.3 µg/m^3). Moreover, results from the council's Detailed Assessment finalised in 2023, also suggested localised monitored (by small sensor air quality monitor) and modelled exceedances of the annual mean objective along Westlink corridor. Therefore, the council will continue its monitoring within the Westlink Corridor / M1 Air Quality Management Area (AQMA 1) to identify any continuing or further exceedances of the nitrogen dioxide objectives and nitrogen dioxide concentrations and trends.

However, from ambient monitoring data for the Stockman's Lane and Westlink/Roden Street monitoring sites, as summarised in Table 2.4, it can be seen that the number of exceedances of the hourly objective (NO_2) has substantially decreased over recent years, both now demonstrating compliance with the 200 µg/m^3 objective, not to be exceeded more than 18 times per year - since 2013. In fact, there have been no recorded 1-hour mean concentrations greater than 200 µg/m^3 at either monitoring site since 2019. Based on the above monitoring data and also DAERA's recommendations, included within the appraisal letter (dated 10th January 2024) in relation to the council's previous 2023 Progress Report, the council will give consideration to an AQMA 1 amendment to revoke the 1-hour mean NO_2 objective designation.

Monitoring data at the Ormeau Road site demonstrates that nitrogen dioxide concentrations have been significantly below the annual mean air quality objective since 2014. Moreover, dispersion modelling undertaken as part of Detailed Assessment for the city (Appendix C) predicted that annual mean NO_2 concentrations within this AQMA 2, which covers the Ormeau Road from the junction with Donegall Pass to the Belfast City boundary at Galwally, are below the UK AQO level at all locations of relevant exposure.

At this stage, the council has however decided not to move to revoke the Ormeau Road Air Quality Management Area and instead to await acceptance of this 2024 Updating and Screening Assessment (USA) report and an update on the conclusions and recommendations of the report from DAERA.

The magnitude of the decrease in nitrogen dioxide levels along the Upper Newtownards Road (AQMA 4) has been beyond the year-on-year reductions that might have been reasonably predicted using Defra's forward projection factors; even before Covid-19.

Moreover, from the data in Table 2.3, it can be seen that annual mean concentrations of nitrogen dioxide along the Upper Newtownards Road have remained in the range 20 – 27 µg/m^3 since 2019, meaning that the nitrogen dioxide annual mean objective is being consistently achieved along the Upper Newtownards Road. 2023 annual mean results (21.0 µg/m^3) recorded at the automatic monitoring site are lower than pre-pandemic annual mean data and significantly below the 40 mgm^{-3} objective level. Moreover, there have not been any monitored exceedances of air quality objectives for NO_2 identified within this AQMA for the last seven years.

The above cited monitoring data for this location, and the outcome of the recently concluded detailed assessment, confirms that the modelled 2019 (base year) and 2028 (future year) annual mean NO_2 concentrations within AQMA 4 are below the annual mean objective.

At this stage, the council has however decided not to move to revoke the Upper Newtownards Road Air Quality Management Area and instead to await acceptance of this 2024 Updating and Screening Assessment (USA) report and an update on the conclusions and recommendations of the report from DAERA.

The council also notes DAERA's recommendations, included within their appraisal letter (dated 28th October 2022), in relation to the council's previous 2022 Progress Report. The Department recommended that the council should also '*consider the revocation of the Cromac Street and Albertbridge Road AQMA due to continual compliance with the NO_2 annual mean objective. Additionally, the M1-Westlink AQMA could be amended to revoke the designation of the 1-hour mean NO_2 objective as compliance has been achieved for the past 5 years.'*

Moreover, although Belfast city has not experienced exceedances of any air quality strategy objectives for particulate matter (PM_{10} and $PM_{2.5}$) for many years, to address growing concerns around the effects of fine particulate matter ($PM_{2.5}$) on human health we undertook a Detailed Assessment for the city. This project commenced in February 2021 and was finalised in 2023. The Detailed Assessment (using additional monitoring data and dispersion modelling) indicated that the annual mean PM_{10} and $PM_{2.5}$ AQOs were achieved at all monitoring locations, including at the additional six small sensor air quality monitoring locations. Moreover, modelled annual mean PM_{10} and $PM_{2.5}$ concentrations for

the 2019 (base year) and 2028 (future year) are also predicted to be well below the UK AQOs level at locations of relevant exposure throughout the city.

Finally, Belfast City Council confirms that no new Air Quality Management Areas need to be declared for the city at this time.

8.2 Conclusions from Assessment of Sources

The assessment of new or altered sources of air pollution for 2023 has led the council to conclude that there are no new roads or road junctions within the city that require a detailed assessment. In addition, there are no new roads that have a significant proportion of heavy-duty vehicles or significantly changed traffic flows.

In relation to bus/train stations, a new Belfast Transport Hub at Great Victoria Street, known as Weavers Cross / Grand Central Station, is currently approaching completion. Belfast City Council confirms that the above development was considered as part of the council's planning process (LA04/2017/1388/F); a submitted Air Quality Impact Assessment demonstrated that this development will not have a significant adverse impact on ambient air quality and relevant receptors.

There are no new locations in the city where stationary or moving trains are likely to detrimentally impact upon relevant receptors and the location of Port of Belfast means also that shipping is presently unlikely to impact detrimentally upon relevant receptors.

Moreover, the council is content to report that the airport is not a significant source of NOx and particulate matter emissions.

There were only two industrial installations (Part A) in Belfast City Council area, for which air quality assessments have been carried out/requested. Belfast City Council has assessed the new / proposed industrial installations and concluded that it will not be necessary to proceed to a Detailed Assessment in consequence.

No new major fuel storage depots have been established within Belfast since the last round of review and assessment and none of the new petrol stations that have since opened, have required a detailed assessment due to presence of emissions abatement equipment.

There are no poultry farms within the city. Moreover, since the 2021 Updating and Screening Assessment, there haven't been any new biomass plants installed within the council's area.

The council is not aware of any significant new areas of domestic solid fuel use or any new sources of significant fugitive particulate matter emission within the city confines.

In addition, the council would advise that source apportionment calculations were carried out as part of 2021-2023 Detailed Assessment to examine the relative contributions of different sources to modelled concentrations (NO_2, PM_{10} and $PM_{2.5}$) across the city. The relative contributions of different sources are strongly influenced by proximity to source. Therefore, source apportionment calculations were carried out at individual receptor level, but also at the city-wide level in order to give a balanced representation of the relative importance of different source contributions.

Based on city-wide source apportionment calculations, road transport was identified as the main source of modelled NO_2 concentrations in 2019. The regional background was the dominant contributor to 2019 modelled PM_{10} and $PM_{2.5}$ concentrations; the domestic background sector, which includes the contribution from domestic heating, was a second major source of modelled PM_{10} and $PM_{2.5}$ concentrations in the city. A summary report for the Detailed Assessment is included in Appendix D.

8.3 Proposed Actions

In conclusion, this 2024 Updating and Screening Assessment has not identified the need to proceed to a Detailed Assessment for any pollutant under consideration.

However, the council would advise that a Detailed Assessment for the city, for particulate matter (PM_{10}, $PM_{2.5}$) and nitrogen dioxide (NO_2) pollutants was undertaken and finalised in spring 2023. The decision to undertake a Detail Assessment was based on recent evidence from national studies confirming that domestic solid fuel burning contributes more than previously thought to particulate emissions. The project also allowed the council to investigate fine particulate matter ($PM_{2.5}$) concentrations across the city as this pollutant is not currently in regulation for the purposes of local air quality management. The project commenced in February 2021 and was finalised in March 2023; its key outcomes were

presented within a 2023 Progress Report and also a summary report is attached to this report (Appendix D).

Furthermore, Belfast City Council has already highlighted that it operates an expansive air quality monitoring network across the city, predominantly for nitrogen dioxide. In 2023, we added a further seven diffusion tubes to the network to address the outcomes of 2023 Detailed Assessment, and to confirm modelled NO_2 concentrations within and in the vicinity of our existing AQMAs.

On this basis, the council is content that current monitoring locations provide an appropriately detailed representation of pollution levels for the city and, as a consequence, we consider that the network does not to be expanded further at this time. We will however continue, on an annual basis, to review our monitoring locations and to relocate monitoring sites to better capture relevant exposure, and we will discontinue monitoring from areas of continued low concentrations, significantly below air quality objective levels.

Moreover, as part of the council's Detailed Assessment project for fine particulate matter and nitrogen dioxide, five new monitoring locations, employing small sensor air quality monitoring equipment, were installed in July 2021; providing a more detailed analyses of particulate matter and nitrogen dioxide concentrations across the city. The council took over ownership and operation of the monitors in May 2022. 2023 monitoring data and sensors' locations are presented in Appendix C.

In 2024, we relocated some of these sensors for the purpose of a new School Streets monitoring project. The purpose of this project is to undertake ambient monitoring in the vicinity of schools, with a view to helping to inform the designation of 'school streets'. The designation of 'school streets' has been proposed as Action 22 of the Belfast City Air Quality Action Plan 2021-2026 by DfI and Sustrans. (https://www.belfastcity.gov.uk/documents/belfast-city-air-quality-action-plan-2021-2026)

To ensure that we continue to collect high quality data, we maintain and update, where necessary, our ambient air quality monitoring equipment. In 2019/2020, Belfast City

Council replaced its ageing API NOx analysers at three monitoring sites: the Upper Newtownards Road, Stockman's Lane and Ormeau Road. The non-heated Met One Instruments BAM 1020 PM10 particulate matter analyser, located at the Stockman's Lane site, was also upgraded to a new heated inlet instrument. The only analyser, which has not been yet replaced, is the API Model 200E NOx analyser, located at Westlink/Roden Street site, which still continues to perform satisfactorily and remains supported by the manufacturer.

During 2022, we updated the communication system (including modems) to 4G at all four of our monitoring sites. Moreover, the T200 analysers at the Upper Newtownards Road, Stockman's Lane and Ormeau Road monitoring sites were converted over to operate NumaView software.

With regard to our four Air Quality Management Areas, a review of the monitoring data within the AQMAs and for the city indicates that there have been improvements in annual mean nitrogen dioxide levels across the city over recent years.

Moreover, the detailed assessment for the city, for particulate matter (PM_{10}, $PM_{2.5}$) and nitrogen dioxide (NO2) pollutants was concluded in March 2023. It is considered that the detailed atmospheric dispersion modelling, in addition to monitoring data, provides sufficient evidence to give consideration to revocation of the Ormeau Road and Upper Newtownards Road AQMAs.

At this stage, the council has however decided not to move to revoke the Ormeau Road and Upper Newtownards Road Air Quality Management Areas and instead to await acceptance of this 2024 Updating and Screening Assessment (USA) report and an update on the conclusions and recommendations of the report from DAERA.

In terms of forward actions, the council will continue to monitor implementation of the Air Quality Action Plan 2021-2026 via at least annual meetings of the Air Quality Action Planning Steering Group, and we will report progress to the Department of Agriculture,

Environment and Rural Affairs (DAERA) via our various Action Plan Progress Reports and via submission of the 2025 Progress Report.

The primary aim of the current Air Quality Action Plan is to continue to reduce NO_2 emissions from transport sources and to promote and enable a shift towards more sustainable modes of transport in order to achieve compliance with UK Air Quality Objectives for NO_2. Where necessary, an additional aim of this Action Plan is to identify, develop and implement mitigation measures to address concentrations of fine particulate matter ($PM_{2.5}$) across the city.

In addition, the recommendations of the recent Detailed Assessment, with regard to nitrogen dioxide, are that local actions aimed at road traffic are likely to remain the most effective action for reducing ambient concentrations at nitrogen dioxide hotspot locations in the city. Fleet projections indicated that the next few years would see accelerated uptake of low-emissions / zero-emissions vehicles and efforts should continue to be made to support the improvement of the vehicle fleet alongside the continued incentivisation of other transport modes and active travel options.

For PM_{10} and $PM_{2.5}$, the Detailed Assessment recommended that targeted actions to reduce public exposure to PM_{10} and $PM_{2.5}$ should focus on those sources that contribute to the domestic background sector, as source apportionment has indicated that this sector accounts for more than 25% of the total modelled particulate matter concentrations across the city.

These above-mentioned recommendations are consistent with the objectives of the Belfast City Air Quality Action Plan 2021-2026.

9 References

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DAERA Northern Ireland Air – Air Quality in Northern Ireland website

https://www.airqualityni.co.uk/

Appendices

Appendix A: Quality Assurance / Quality Control (QA/QC) Data

Appendix B: Monthly diffusion tube data

Appendix C: Non-LAQM Monitoring (Zephyrs) Results 2023

Appendix D: LAQM Detailed Assessment Report, Summary Report (AECOM, 30 March 2023)

Appendix A: Quality Assurance / Quality Control (QA/QC) Data

QA/QC of Diffusion Tube Monitoring

In 2023, Belfast City Council appointed Gradko International Ltd. to supply, analyse and report data for its diffusion tubes. Gradko employs a 20% triethanolamine solution for monitoring ambient nitrogen dioxide and adheres to the requirements of the government's 'Diffusion Tubes for Ambient NO_2 Monitoring: Practical Guidance for Laboratories and Users' publication.

Government provides an additional layer of surety for local authorities operating nitrogen dioxide diffusion tubes through the independent analytical proficiency-testing scheme, the AIR PT scheme.

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 scheme, started in April 2014, which combines two long running PT schemes: LGC Standards STACKS PT scheme and HSL WASP PT scheme. As part of this scheme, laboratories are provided with a number of test samples that are designed to test their proficiency in undertaking chemical analyses of diffusion tubes.

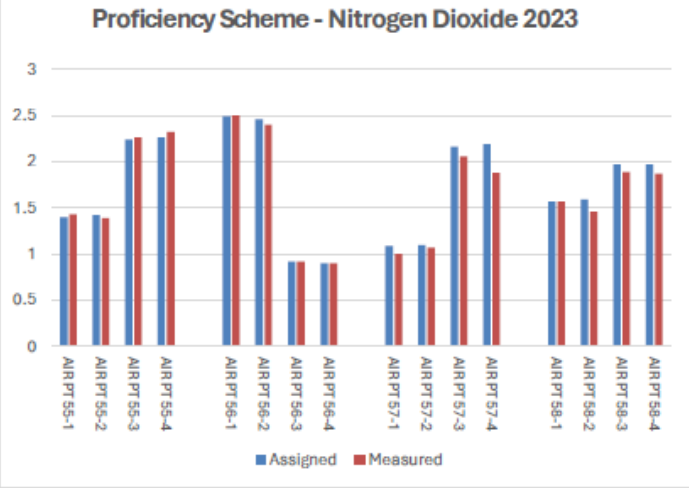
For the 2023 sampling period, Gradko's performance was assessed as follows:

gradko environmental
(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
tel.: 01962 860331 fax: 01962 841339 email:diffusion@gradko.com

AIR PT Nitrogen Dioxide Proficiency Scheme Results 2023

Methods: GLM 7 – CARY 60 Spectrophotometer

AIR PT Proficiency Scheme - Nitrogen Dioxide 2023					
Date	Round	Assigned value	Procedure GLM 7		
			Measured concentration	z-Score	% Bias
Feb-23	AIR PT 55-1	1.4	1.43	0.29	2.1%
Feb-23	AIR PT 55-2	1.42	1.39	-0.28	-2.1%
Feb-23	AIR PT 55-3	2.24	2.26	0.11	0.9%
Feb-23	AIR PT 55-4	2.26	2.32	0.34	2.7%
Jun-23	AIR PT 56-1	2.49	2.5	0.05	0.4%
Jun-23	AIR PT 56-2	2.46	2.4	-0.33	-2.4%
Jun-23	AIR PT 56-3	0.92	0.92	0	0.0%
Jun-23	AIR PT 56-4	0.9	0.9	0	0.0%
Aug-23	AIR PT 57-1	1.09	1.00	-1.1	-8.3%
Aug-23	AIR PT 57-2	1.10	1.07	-0.36	-2.7%
Aug-23	AIR PT 57-3	2.16	2.06	-0.62	-4.6%
Aug-23	AIR PT 57-4	2.19	1.88	-1.89	-14.2%
Oct-23	AIR PT 58-1	1.57	1.57	0	0.0%
Oct-23	AIR PT 58-2	1.59	1.46	-1.09	-8.2%
Oct-23	AIR PT 58-3	1.97	1.89	-0.54	-4.1%
Oct-23	AIR PT 58-4	1.97	1.87	-0.68	-5.1%



April 2024

The council's 2023 passive nitrogen dioxide monitoring network comprises 84 diffusion tubes situated throughout the city at 76 locations. The monitoring has been completed in accordance with Defra's *Local Air Quality Management Technical Guidance document LAQM.TG(22)* and Defra's 2023 Diffusion Tube Monitoring Calendar.

Diffusion Tube Annualisation

Based on 2023 monitoring data, annualisation was required for two non-automatic diffusion tube monitoring sites: North Road (40% data capture) and Stormont (67% data capture). All tubes were annualised using automatic monitoring results from Derry Rosemount and Ballymena Ballykeel automatic monitoring stations, both of which had >85% data capture. The Belfast Centre (Lombard Street) AURN site had 70% data capture for nitrogen dioxide in 2023.

The annualisation was undertaken using the Defra Diffusion Tube Processing Tool. Calculations are provided in Table A.2.

Diffusion Tube Bias Adjustment Factors

Belfast City Council have applied a local bias adjustment factor of 0.80 to the 2023 monitoring data. A summary of bias adjustment factors used by Belfast City Council over the past five years is presented in Table A.1.

The council co-locates a number of diffusion tubes with reference method compliant chemiluminescent nitrogen dioxide analysers at the Lombard Street, Newtownards Road, Westlink/Roden Street and Stockman's Lane monitoring sites. This process allows a bias adjustment factor (with a 95% confidence interval as an estimate of the uncertainty on the bias adjustment factor) to be calculated and used to correct the diffusion tube monitoring data. In the case of the diffusion tube data presented in this report, the monitoring data has been corrected using a local bias adjustment factor derived from the three co-location studies: Newtownards Road, Westlink/Roden Street and Stockman's Lane; as highlighted above, the Belfast Centre site (Lombard Street) AURN site had only 70% data capture (DC) in 2023. As the overall data capture was below 90%, this monitoring data was therefore considered to be poor overall data capture and excluded from the local bias adjustment calculation.

The local bias adjustment factor was calculated using the Defra Diffusion Tube Processing Tool. Calculations are presented within Table A.3.

For those local authorities that do not wish or are unable to undertake a triplicate diffusion tube colocation study, government publishes a database of bias adjustment factors derived from other local authority co-location studies throughout the United Kingdom. These factors are used subsequently to calculate a combined bias adjustment factors for a range of nitrogen dioxide diffusion tube laboratories.

The latest factors were published in June 2024 and the 2023 derived bias adjustment factor for Gradko Laboratories for a 20% solution of triethanolamine was 0.81. This factor is only slightly higher than the council's 2023 locally derived bias adjustment factor of 0.80. The council therefore considers the locally derived factor to be acceptable and of the good precision; consequently, Belfast City Council has applied a local bias adjustment factor of 0.80 to the 2023 monitoring data.

Table A.1 Belfast City Council Bias Adjustment Factors.

Year	Local or National	If National, Version of National Spreadsheet	Adjustment Factor
2023	Local	-	0.80
2022	Local	-	0.81
2021	Local	-	0.79
2020	Local	-	0.79
2019	Local	-	0.91

NO_2 Fall-off with Distance from the Road

Only two annual mean exceedances were recorded during 2023; Henry Place adjacent to the A12 Westlink (43.0 µg/m^3) and at a location next to the M3 Motorway / A12 Westlink at Nelson Street (42.3 µg/m^3). Both diffusion tubes are located at kerbside locations adjacent to strategic network roadway. The Henry Place tube is located within the existing M1 Motorway / A12 Westlink Air Quality Management Area and has been the subject of mitigation measures for some time.

The M3 Motorway / A12 Westlink at Nelson Street diffusion tube was added to the councils' monitoring network due to the introduction of new relevant human health exposure at a residential development. This new monitoring site is located next to a dominant strategic network road transport pollution source and situated at a worst-case exposure location. It is anticipated however that when all of the construction and associated public realm works are finalised, this monitoring site will be moved from its current kerbside site to a roadside / façade location more reflective of actual human health exposure at the residential development.

Nevertheless, Defra NO_2 distance calculations have been provided for the above locations to predict annual mean concentrations at relevant human health receptor locations. The Diffusion Tube Processing Tool has predicted an annual mean concentration of 29.2 µg/m^3 at Henry Place and 29.1 µg/m^3 at the M3 Motorway, which indicates that no exceedances were likely at these relevant human health receptor locations (Table A.3) during 2023.

Also, as distance correction should be considered at any monitoring site where the annual mean concentration is greater than 36 µg/m^3, and the monitoring site is not located at a point of relevant exposure, the diffusion tubes located at Great Georges Street, Stockman's Lane AQMS, Henry Place 2 and Stockman's Lane Roundabout required distance correction for 2023 monitoring data. A summary of fall-off with distance calculations from the Diffusion Tube Data Processing Tool are presented in Table A.4.

QA/QC of Automatic Monitoring

Belfast City Council operates four automatic monitoring stations across the city in order to help inform its air quality management processes and to provide real time information to the public in relation to air pollution levels across the city centre and within our Air Quality Management Areas.

Accordingly, to ensure that the data from our sites is both accurate and representative, the monitors at each site are calibrated on a biweekly (Stockman's Lane AURN site) or on a four-weekly basis by the council's technical staff in accordance with the procedures detailed in the Defra Automatic Urban and Rural Network (AURN) local site operators' manual.

For our automatic nitrogen dioxide analysers, we complete a two-point calibration using internal zero and a nitric oxide span gas of certified concentration. We obtain our calibration gases under contract from BOC Ltd. who also provide similar gases to government operated AURN monitoring stations. By considering instrument operating parameters and the results of successive calibrations, we can make a determination regarding the ongoing performance of our analysers.

Where an instrument is found not to be operating within normal operating parameters, we refer the matter promptly to *Enviro Technology*, who provided service and maintenance

support for our equipment throughout 2023. In addition, data management support including data collection, scaling, reporting and ratification was provided by *AQDM.*

The data from our sites is made available to the Department of Agriculture, Environment and Rural Affairs and is reported on the 'Northern Ireland Air' website in near real time.

Finally, in 2023 *NPL* provided quality assurance and quality control support for the council's monitoring equipment to ensure compliance with the requirements of the National Air Quality Strategy as detailed within the Defra Technical Guidance Document LAQM.TG(22). *NPL* staff visited our sites on an approximately six-monthly basis and compared the performance of our analysers against a range of laboratory grade standards. *NPL* subsequently provided a series of calibration and scaling factors that were used to correct our 2023 automatic monitoring data.

Automatic data presented in this report relates to the calendar year (i.e. January – December). 2023 ratified data capture levels exceeded the Department's 75% data capture threshold for the calculation of annual statistics at all council sites.

PM_{10} and $PM_{2.5}$ Monitoring Adjustment

In relation to the correction of our automatic monitoring data, this process is generally of principal concern with regard to the treatment of particulate matter monitoring data. In 2019, the Belfast Centre site employed Filter Dynamics Measurement System (FDMS) equipped Tapered Element Oscillating Microbalances (TEOMs) for particulate matter (PM_{10}) monitoring up until September whereupon the FDMS equipped TEOMs were replaced by Palas Fidas 200, which complies with DEFRA's UK PM Pollution Climate standard. Government equivalence tests have determined that both of types of equipment meet the equivalence criteria and, on that basis, no correction factor needs to be applied to this monitoring data.

The Stockman's Lane site is equipped with a Beta Attenuation Monitor (BAM) with a heated inlet for monitoring particulate matter. Government technical guidance highlights that a BAM, equipped with a heated inlet, meets the equivalence criteria for PM_{10} monitoring, provided that the results are corrected for slope. This correction involves dividing measured concentrations by a factor of 1.035. It should be noted that the data

presented on the Defra and Northern Ireland Air websites and included within this USA report has already been corrected to the reference equivalent.

Automatic Monitoring Annualisation

Defra operates an urban background monitoring site (Belfast Centre) at Lombard Street. Unfortunately, in 2023, data capture levels at the Belfast Centre site were below the Department's 75% data capture threshold for nitrogen dioxide (70%). Annualisation of data from this site was therefore required.

In order to complete the annualisation process, councils are required to identify two to four nearby, long-term background continuous monitoring sites for nitrogen dioxide. The data capture for each of these sites should ideally be at least 85%.

Apart from Belfast Centre site, there are only two other long-term, continuous, urban background monitoring sites in Northern Ireland, which measure nitrogen dioxide; namely Ballymena Ballykeel and Derry Rosemount. Both sites achieved the required 85% data capture in 2023 and as the result were identified as acceptable sites to be used in ''annualisation process'' for the Belfast Centre site nitrogen dioxide data.

Two individual adjustment ratios and average ratios have been calculated and the results are provided in Table A.2.

NO_2 Fall-off with Distance from the Road

No automatic NO_2 monitoring locations within Belfast City Council required distance correction during 2023.

Table A.2 Annualisation Summary (concentrations presented in µg/m^3)

Site ID	Annualisation Factor Ballymena Ballykeel	Annualisation Factor Derry Rosemount	Average Annualisation Factor	Raw Data Simple Annual Mean (µg/m^3)	Annualised Data Simple Annual Mean (µg/m^3) Annual Mean	Comments
DT6	1.0025	1.0650	1.0338	13.1	13.6	
DT115	1.0712	1.0282	1.0497	21.0	22.1	
Belfast Centre	0.97	0.94	0.96	19.6	18.8	

Table A.3 Local Bias Adjustment Calculations

	STEP 3a Local Bias Adjustment Input 1	STEP 3b Local Bias Adjustment Input 2	STEP 3c Local Bias Adjustment Input 3	STEP 3d Local Bias Adjustment Input 4
Periods used to calculate bias	11	12	12	
Bias Adjustment Factor A	0.78 (0.73 - 0.83)	0.77 (0.73 - 0.82)	0.84 (0.81 - 0.88)	
Diffusion Tube Bias B	29% (21% - 37%)	29% (23% - 36%)	18% (13% - 24%)	
Diffusion Tube Mean (µg/m^3)	36.9	45.7	24.7	
Mean CV (Precision)	3.3%	2.4%	2.0%	
Automatic Mean (µg/m^3)	28.6	35.3	20.8	
Data Capture	99%	99%	99%	
Adjusted Tube Mean (µg/m^3)	29 (27 - 31)	35 (33 - 37)	21 (20 - 22)	
Overall Diffusion Tube Precision	Good Overall Precision	Good Overall Precision	Good Overall Precision	Good Overall Precision
Overall Continuous Monitor Data Capture	Good Overall Data Capture	Good Overall Data Capture	Good Overall Data Capture	Good Overall Data Capture
Combined Local Bias Adjustment Factor	0.80			

Notes:

A single local bias adjustment factor has been used to bias adjust the 2023 diffusion tube results.

Table A.4 NO_2 Fall off With Distance Calculations (concentrations presented in µg/m^3)

Diffusion Tube ID	Distance (m)		NO_2 Annual Mean Concentration (µg/m^3)			Comment
	Monitoring Site to Kerb	Receptor to Kerb	Bias Adjusted and Annualised	Background	Predicted at Receptor	
13	0.5	9.5	36.5	20.6	28.2	
21, 22, 56	2.5	12.5	36.4	16.4	28.5	
70	1.0	18.0	43.0	19.4	29.2	
100	27.0	18.0	26.0	16.4	28.3	*Warning: your monitor is more than 10m further from the kerb than your receptor - treat result with caution.*
101	3.0	7.5	36.3	19.4	32.3	
106	0.5	15.5	42.3	20.6	29.1	

Appendix B: Monthly diffusion tube data

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	NO_2 Mean Concentrations (µg/m^3)												Simple Annual Mean (µg/m3)		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Raw Data	Bias Adjusted (0.8) and Annualised	Distance Corrected to Nearest Exposure
1	332522	373708	25.0	23.5	22.0	18.4	16.4	18.2	12.3	15.1	20.7	22.2	26.1	19.8	20.0	15.9	_
2	329780	369528	49.4	50.0	39.5	35.0	38.1	32.9	32.3	33.2	38.6	31.7	41.3	36.8	38.2	30.5	_
3	334220	373853	34.6	35.2	32.9	34.3	30.9	33.7	22.2	25.9	32.6	34.0	34.6	27.3	31.5	25.1	_
4	335013	373932	29.2	30.4	27.5	25.8		27.2	19.3	21.7	24.1	29.0		22.8	25.7	20.5	_
5	334630	374385	31.5	31.2		29.7	29.1	31.4	22.1	22.9	30.7	28.5	36.0	23.9	28.8	23.0	_
6	337549	374151	17.8	14.4						9.4	11.0	13.1			13.1	10.8	_
7	333840	373956	33.0	36.0	33.2	33.7	31.6	34.9	33.0	28.4	34.9	36.5	39.3	28.1	33.6	26.8	_
9	334983	374260	43.3	40.6	39.8	36.8	40.9	40.3	24.2	33.0	41.5	37.6	50.9	32.6	38.5	30.7	_
10	334499	372186	35.5	33.1	31.1	27.6	27.8	29.1	24.2	24.9	31.1	26.5	32.6	27.8	29.3	23.3	_
12	338718	373918	36.3	32.9	33.6	34.4	30.1	34.1	24.6	27.2	30.9	36.8	40.1	27.4	32.4	25.8	_

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	NO_2 Mean Concentrations (µg/m^3)												Simple Annual Mean (µg/m3)		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Raw Data	Bias Adjusted (0.8) and Annualised	Distance Corrected to Nearest Exposure
13	333981	375102	34.5	44.1	58.2	56.2	49.5	60.2	36.7	38.3	44.4	46.5	44.2	36.4	45.8	36.5	28.2
14	332063	371376	36.1	34.5	31.5			24.1	20.9	24.0	30.5	26.5		27.3	28.4	22.6	-
15	333600	373283	37.1	37.5	39.2	32.2	31.7	35.8	25.3	27.4		33.4	40.2		34.0	27.1	-
16	333898	374358	30.2	29.2	25.8	23.6	22.2	26.9	17.5	21.4	27.4	28.4	37.1	26.2	-	-	-
19	333898	374358	29.8	30.7	27.4	24.4	21.5	24.8	18.5	21.5	28.1	25.8	37.0	24.6	-	-	-
20	333898	374358	27.6	30.4	26.4	23.4	21.4	26.7	17.8	21.7	28.2	27.8	32.9	27.0	26.1	20.9	-
17	334213	374485	38.0	40.5	39.1	39.6	31.9	38.6	27.9	29.6	36.7	37.9	42.8	28.0	35.9	28.6	-
21	331009	371251	46.7	43.6	44.4	42.3	47.2	47.3	40.9	42.6	48.9	47.9	46.2	38.8	-	-	-
22	331009	371251	48.7	44.1	49.2	45.3	47.0	47.9	42.4	42.6	49.7	47.4	50.3	39.1	-	-	-
56	331009	371251	50.8	44.8	45.6	45.1	48.9	47.9	41.6	43.3	51.2	47.5	47.2	39.4	45.7	36.4	28.5
23	337930	373972	28.2	27.0	27.3	23.5	22.8	22.6	18.3	20.2	23.6	25.7	31.8	21.9	-	-	-
24	337930	373972	30.1	27.1	27.0	23.5	23.9	22.9	18.4	20.1	23.0	26.6	32.1	23.4	-	-	-

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	NO_2 Mean Concentrations (µg/m^3)												Simple Annual Mean (µg/m3)		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Raw Data	Bias Adjusted (0.8) and Annualised	Distance Corrected to Nearest Exposure
32	337930	373972	28.3	27.5	26.2	24.2	23.5	22.7	18.1	20.2	24.2	27.4	31.5	23.7	24.7	19.7	_
25	333230	380877	21.1	22.1	28.8	29.3	23.4	25.3	18.9	20.2	21.8	28.5	25.7	20.0	23.8	19.0	_
26	333018	373120	33.4	30.5	32.1	32.4	31.8	32.4	23.9	26.4	32.8	34.3	37.9	23.7	31.0	24.7	_
28	330711	372520	29.4	29.3	29.3	27.1	23.5	25.4	18.5	20.9	25.8	27.9	28.6	23.3	25.8	20.6	_
30	337168	375485	27.4	24.0	22.6	18.9	20.3	16.9	14.5		19.4	18.3	28.3	18.1	20.8	16.6	_
31	332544	370283	35.7	35.4	35.9	32.1	28.9	34.2	23.2	26.3	31.0	35.6	36.8	27.7	31.9	25.5	_
33	333548	373772		45.1	41.7	36.6	41.0	36.5	31.3	34.6	38.7	34.5	47.0	37.8	38.6	30.8	_
34	333501	374236	33.5	37.7	39.6	40.7	36.0	37.6	25.5	29.6	35.6	38.9	35.9	30.2	35.1	28.0	_
35	334140	374126	39.9	41.8	39.5	41.5	35.2	43.7	29.3	34.1	37.1		41.9	32.3	37.9	30.2	_
36	334044	373556	33.4	31.9	31.6	30.9	30.1	31.8	21.8	24.1	31.2	30.4	35.2	26.9	30.0	23.9	_
37	332104	373005	50.3	48.7	44.8	40.5	39.9	35.4	32.5	35.8	39.3	40.9	46.9	35.5	40.9	32.6	_
38	333085	374065	28.7	31.9	38.6	38.9	31.8	39.8	23.9	27.2	33.1	39.5	33.8	28.6	33.0	26.3	_

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	NO_2 Mean Concentrations (µg/m^3)												Simple Annual Mean (µg/m3)		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Raw Data	Bias Adjusted (0.8) and Annualised	Distance Corrected to Nearest Exposure
39	334943	371342	43.3	31.4	29.7	19.6	23.2	20.6	20.8	22.9	29.8	26.5	36.2	28.0	27.7	22.1	_
40	336516	374226	27.9	25.9	23.8	22.9	19.3	22.0	16.6	18.9	23.0	25.2	30.4	21.8	23.1	18.5	_
41	333101	375295	29.1	29.7	32.4	29.4	28.5	27.3	21.4	24.2	28.4	31.5	30.2	24.8	28.1	22.4	_
42	333288	376150	31.4	34.4	37.1	37.1	31.6	33.5	24.7	25.6	35.1	36.2	37.9	28.1	32.7	26.1	_
44	334177	376375	28.9	31.9		32.7	26.9	31.5	22.3	25.2	29.9	31.7	32.5	26.5	29.1	23.2	_
59	334214	375638	36.1	39.1	45.6	41.8	37.0	41.7	29.7	31.9	38.2	39.0	40.2	31.9	37.7	30.1	_
63	334193	374457	37.7	35.7	36.0	36.6	31.3	35.8	24.0	8.2	33.0	43.6	38.5	35.3	33.0	26.3	_
65	332610	373434	31.4	35.7	40.9	43.9	40.9	41.7	26.9	31.7	36.6	42.5	36.8	28.4	-	-	_
66	332610	373434	31.3	35.4	42.0	42.5	38.6	45.6	26.8	31.2	34.3	39.4	43.7	28.6	-	-	_
67	332610	373434	32.8	36.1	39.1	40.7	38.1	43.1		45.8	36.5	41.9	39.3	28.4	36.8	29.4	_
68	332610	373474	49.9	48.5	41.6	43.5	37.9	41.0	36.6	38.7	51.2	49.4	51.2	40.2	44.1	35.2	_
69	333281	374755	35.3	40.1	44.3	43.8	39.5	43.7	28.9	31.6	40.4	42.0	39.8	31.8	38.4	30.7	_

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	NO_2 Mean Concentrations (µg/m^3)												Simple Annual Mean (µg/m3)		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Raw Data	Bias Adjusted (0.8) and Annualised	Distance Corrected to Nearest Exposure
70	333588	375224	61.0	68.1	56.6	56.2	46.1	46.6	47.5	43.7	55.2	51.3	57.6	56.5	53.9	**43.0**	29.2
74	329923	370300	39.4	39.2	31.6	23.8	26.0	22.4	21.6	24.4	28.7	28.0	35.9	31.1	29.3	23.4	-
76	335073	375049	26.1	25.0	21.6	18.2	19.9	20.6	15.0	18.3	23.9	20.4	31.8		21.9	17.5	-
77	328237	370138	30.5	27.5	26.1	20.0	21.5	17.6	17.5	18.2	21.0	21.3	29.0	23.1	22.8	18.2	-
82	334023	375238	39.1	38.9	41.5	40.4	35.9	40.0	29.4	30.6	38.2	35.1	39.3	33.1	36.8	29.4	-
83	333857	375412		38.4	43.9	33.9	31.1	35.6	26.4	29.0	38.6	40.5	40.3	34.2	35.6	28.4	-
84	333866	375160	31.5	31.6	36.0	38.8	35.6	37.3	24.1	29.2	32.6	37.6	37.1		33.8	26.9	-
85	334469	375341	34.1	34.6	33.2	26.3	28.2	31.4	21.0	26.4	31.7	33.2	37.7	26.6	30.4	24.2	-
86	333876	375267	38.4	43.4	37.5	34.1	29.9	32.4	25.1	26.5	36.0	36.7	39.6	33.5	34.4	27.5	-
87	331964	373558	35.2	36.4	36.9	35.5	30.7	32.5	25.6	26.1	34.2	36.1	37.4	29.0	33.0	26.3	-
88	329273	368947	26.6	25.9	26.0	26.3		21.3	17.3	17.3	23.1	23.7	27.5	19.2	23.1	18.4	-
89	337547	372019	32.5	32.7	30.6	29.6	31.0	27.2	23.8	26.7	30.1	28.2		28.7	29.2	23.3	-

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	NO_2 Mean Concentrations (µg/m^3)												Simple Annual Mean (µg/m3)		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Raw Data	Bias Adjusted (0.8) and Annualised	Distance Corrected to Nearest Exposure
90	332028	372759	46.4	45.0	43.4	40.8	40.1	39.8	34.6	36.2	45.1	43.2	45.0	37.4	41.4	33.0	-
91	330772	371534	22.2	24.8	27.5	25.0	21.2	24.8	15.1	18.2	23.8	24.2	27.8	19.0	22.8	18.2	-
92	329707	371200	32.2	31.9		26.8	28.7	22.8	21.9	22.7	29.2	28.9	32.9	25.6	27.6	22.0	-
93	330313	370121	28.7	28.5		21.2	19.2	18.5	15.0	17.5	22.9	23.8	29.7	22.0	22.4	17.9	-
94	330364	369824	19.7	17.7	16.8	15.4	14.1	13.1	10.8	11.9	16.3	16.1	23.6	14.4	15.8	12.6	-
95	331568	370818	37.6	39.2	41.5	39.0	37.5	38.7	28.1	28.6	33.9	35.5	39.2	30.8	35.8	28.6	-
96	331379	370712	26.6	26.8		22.8	22.4	23.1	17.3	20.5	23.7	25.0	28.4	16.5	23.0	18.4	-
97	329737	372743	24.2	25.3	25.5	24.0	24.0	24.6	20.6	20.7	25.6	25.2	27.2	20.0	23.9	19.1	-
98	338297	376131	47.2	41.6	41.7	38.9	43.0	35.6	34.8	36.7	41.2	31.4	44.4	31.0	38.9	31.1	-
100	333589	375251			37.4	34.2	28.8	32.9	25.3	24.5	35.4	36.8	37.4	33.1	32.6	26.0	28.3
101	330900	371316	58.3	51.4	48.6	44.2	46.2	38.9	37.5	40.5	46.1	38.7	53.0	42.5	45.5	36.3	32.3
102	333650	375180	33.2	33.4	34.3	33.5	31.3	32.6	21.5	25.9	30.6	34.2	37.6	25.7	31.2	24.9	-

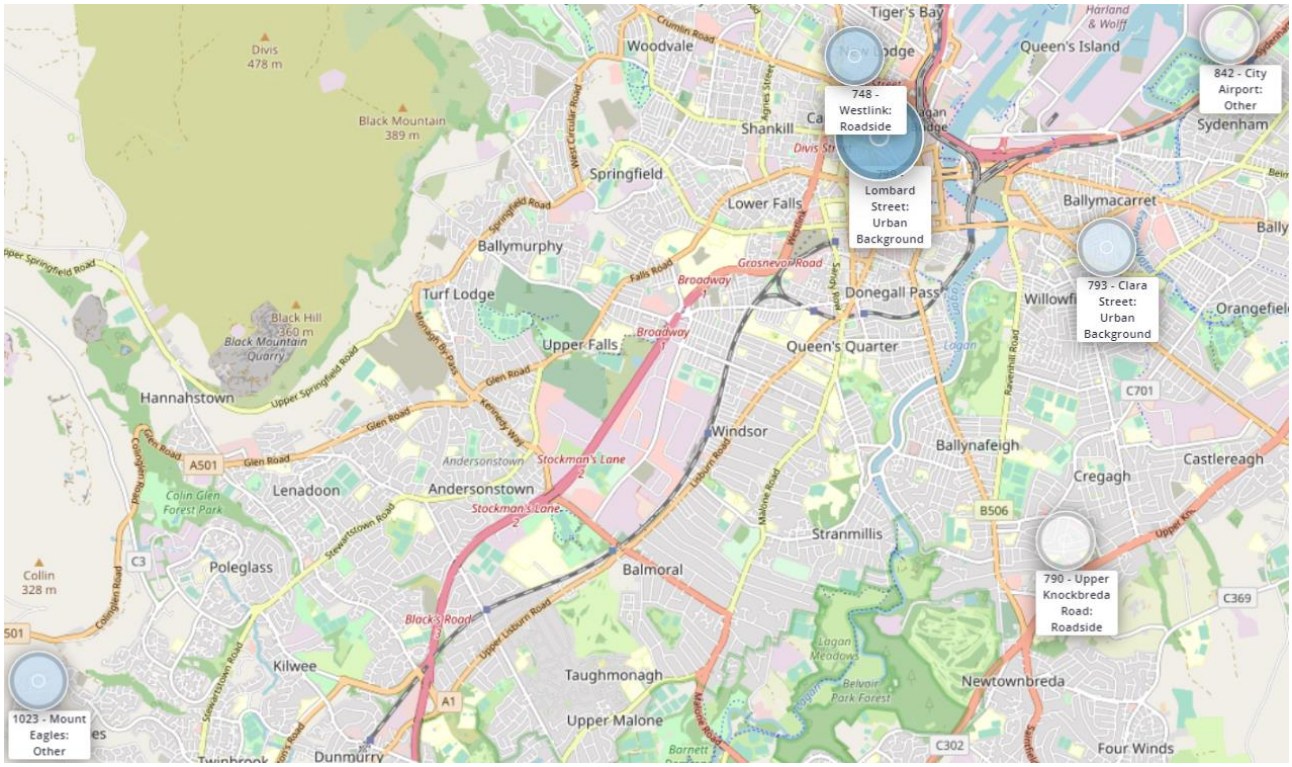
Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	NO_2 Mean Concentrations (µg/m^3)												Simple Annual Mean (µg/m3)		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Raw Data	Bias Adjusted (0.8) and Annualised	Distance Corrected to Nearest Exposure
103	332885	373323	26.9	25.9	26.8	26.4	23.9	26.0	16.0	18.9	27.2	23.7	29.9	17.6	24.1	19.2	-
104	330799	376918	16.8	15.6	17.5		14.2	14.6	12.6	14.3	16.8	18.6	24.1	13.9	16.3	13.0	-
105	333918	374952	33.7	35.8	40.6	40.0	38.2	47.2			36.6	37.9	41.4	29.1	38.0	30.3	-
106	334120	375033	50.2		57.8	60.6	65.9	66.1	23.7	51.3	55.2	52.1	55.2	45.4	53.0	**42.3**	29.1
107	330220	373746	23.3	25.7	27.8	25.4	20.8	27.7	17.8	19.3	25.4	29.2	28.6	24.7	24.6	19.6	-
108	332825	372465	33.9	35.7	41.2	42.9	42.5	42.8	27.0	29.7	38.5	39.2	36.8	29.5	36.7	29.2	-
109	335005	370749			35.5	31.4	31.7	31.9	23.4	25.1	32.8	27.3	39.9	24.8	30.4	24.2	-
110	329762	369903			32.8	35.6	23.6	30.8	17.5	18.1	27.8	27.7	27.8	21.1	26.3	21.0	-
111	330562	371205			29.9	26.4	21.3	25.4	17.3	19.3	24.8	29.6	27.3	23.4	24.5	19.5	-
112	331440	370918			45.4	39.6	41.0	41.4	32.7	36.6	46.8	42.4	48.8	36.6	41.1	32.8	-
113	334623	373752			22.9	23.4	23.1	26.9	16.0	20.0	23.6		45.6	20.1	24.6	19.6	-
114	335061	374433			49.2	45.4	49.7	46.7	37.9	38.5	45.0	44.4	52.5	36.9	44.6	35.6	-

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	NO_2 Mean Concentrations (µg/m^3)												Simple Annual Mean (µg/m3)		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Raw Data	Bias Adjusted (0.8) and Annualised	Distance Corrected to Nearest Exposure
115	339588	373946				21.6	19.6	20.9	15.5	18.3	18.9	21.9	31.4		21.0	17.6	-
116	330386	377066			22.8	23.7	18.7	22.6	15.5	17.7		24.5	28.6	16.5	21.2	16.9	-

Appendix C: Non-LAQM Monitoring (Zephyrs) Results 2023

During 2023, Belfast City Council has also carried out nitrogen dioxide and particulate matter monitoring using Zephyr samplers at six locations; at the A2 Sydenham By-Pass adjacent to George Best Belfast City Airport; at the A55 Upper Knockbreda Road; at Clara Street in east Belfast; at Lombard Street in the city centre; at the A12 Westlink at Henry Place; and at Mount Eagles Glen in southwest of the city.

Figure C.1 - Map of Zephyr Locations



Taken from Earthsense MyAir Portal: EarthSense.

The Zephyr analyser is an active indicative grade analyser and is used to monitor NO_2 using electrochemical sensors, and PM_{10} and $PM_{2.5}$ using optical particle counting sensors giving real-time results every minute. Prior to installation, the monitoring unit is tested by the manufacturer against EU reference analyser standards. Moreover, the Zephyr monitors recently obtained MCERTS Performance Standards as an Indicative Ambient Particulate Monitor, which gives additional confidence in the performance of the monitors.

These six Zephyrs were installed in 2021 as part of Detailed Assessment project (Appendix D); 2021 and 2022 results and methodology were also reported within 2023 Progress Report. The council would note that in 2022, in the absence of the standardised QA/QC methodology, council officers followed the US Environment Protection Agency guidance *The Enhanced Air Sensor Guidebook* available on Defra's website https://uk-ir.defra.gov.uk/research/aqeg/pollution-sensors.php; similar approach was undertaken as part of Detailed Assessment project.

In 2023, we didn't undertake a two-stage data scaling calculation of an annual mean. We did, however, monitor performance of each sensor by periodically installing a second sensor cartridge at each of the sites. 2023 results downloaded from Zephyr's website (provided by Earthsense) are presented below.

Table C.1 - 2023 Annual Zephyrs Results

Site ID	Site Name	NO_2 (µg/m^3)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
ZAURN	AURN (Lombard Street)	21.70	10.45	6.30
N1	Upper Knockbreda Road (A55)	16.08	8.36	5.15
N6	Clara Street	12.91	9.14	5.41
N8	Sydenham By-Pass (A2) / City Airport	18.46	8.66	5.22
N10	Westlink (A12)	32.94	8.99	5.33
N12	Mount Eagles Glen	7.73	6.54	3.70

Overall, there were no monitored exceedances of the statutory AQS objectives during 2023 at any Zephyr monitoring site.

Appendix D: LAQM Detailed Assessment Report – Summary Report (30 March 2023)

LAQM Detailed Assessment Report

Summary Report

Belfast City Council

Project number: 60652891

30 March 2023

Delivering a better world

Quality information

Prepared by	Checked by	Verified by	Approved by
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Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	30/03/2023	Draft for comment	GC	Gareth Collins	Regional Director

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Tables

1. Introduction

In view of recent public health concerns around fine particulate matter ($PM_{2.5}$), and in fulfilment of the Local Air Quality Management (LAQM) Review and Assessments requirements for Northern Ireland, Belfast City Council (BCC) has carried out a Detailed Assessment (DA) of air pollution in their administrative area. In addition to $PM_{2.5}$, the DA also assesses concentrations of nitrogen dioxide (NO_2) and particulate matter with a diameter less than 10 microns (PM_{10}) as these are the other main pollutants of concern across the city. NO_2 is the pollutant for which BCC's Air Quality Management Areas (AQMAs) are currently declared.

The DA aims to identify the key areas of the city where pollutant concentrations are exceeding or likely to be at risk of exceeding the legally-binding UK Air Quality Objectives (AQO) with a view to determining appropriate mitigation policies and measures to reduce ambient concentrations and public exposure. Comparisons are also made against the much more stringent World Health Organisation (WHO) Air Quality Guidelines (AQG). Whilst attainment of the WHO AQGs is not legally-binding, understanding which pollutants and locations are at risk of exceeding these AQGs can also help to formulate policies and actions aimed at reducing public exposure to air pollution.

The DA is divided into two parts: Part A covers monitoring undertaken by the Council to provide additional information on the pollutants of concern and Part B covers the assessment carried out to understand the spatial distribution of air pollution across the city through atmospheric dispersion modelling. This summary report provides an overview of the DA, presenting the key findings of the monitoring and modelling undertaken for the DA.

For a complete discussion of the methodologies employed and the full results, please refer to the following reports (available upon request from BCC):

- LAQM Detailed Assessment Report: Part A – Monitoring; and
- LAQM Detailed Assessment Report: Part B – Modelling

2. Part A – Monitoring

Part A of the DA consisted of the collation and analysis of recent air quality monitoring data collected by BCC from automatic air quality monitoring stations and NO_2 diffusion tubes within the Council's administrative area. In addition, Earthsense Zephyr sensors were installed at selected locations across the city to identify any areas of potential exceedance of the PM_{10}, $PM_{2.5}$ and NO_2 UK AQOs and corresponding WHO AQG values, and to provide additional monitoring data for the verification of the atmospheric dispersion modelling carried out in Part B of the DA.

Sensor Monitoring Locations

Earthsense Zephyr sensors, providing near-reference standard, real-time measurements of NO_2, PM_{10} and $PM_{2.5}$ concentrations were installed at six locations. The sensors were installed in mid-2021 and were operated by AECOM on behalf of the Council, until March 2022. Thereafter, the sensors have continued to be operated by BCC air quality officers.

Details of the monitoring locations are shown in Table 1. A map of the sensor monitoring locations, automatic monitoring locations, and diffusion tube monitoring locations is shown in Figure 1. A typical Zephyr installation is shown in Figure 2.

Table 1. Earthsense Zephyr Sensor Monitoring Locations

Site ID	Description	Type	X	Y	Height (m)	Distance to Kerb (m)
N1	A55	Roadside	335735	370740	2.5	6
N6	Clara Street	Urban Background	336030	373469	2.5	N/A
N8	Belfast City Airport Boundary	Other Sources	337110	375535	2.5	N/A
N10	Adjacent to the Westlink	Roadside	333645	375239	4	4
N12	Mt. Eagles Glen	Urban Background	326190	369255	2.5	N/A
ZAURN (AURN co-location)	Lombard Street AURN	Urban Background	333898	374358	4	N/A

The monitoring locations were chosen to represent a range of different environments within the city. Locations N1 (A55) and N10 (Westlink) were selected to represent roadside locations. Locations N6 (Clara Street) and N12 (Mt. Eagles Glen) were chosen to investigate domestic $PM_{2.5}$ concentrations in urban background settings, and N8 was selected for its proximity to the airport and the characterisation of $PM_{2.5}$ from aviation activities. ZAURN was a co-location with the Belfast Centre Automatic Urban and Rural Network (AURN), enabling the raw sensor data to be scaled appropriately and thereby improving the accuracy and reliability of the data.

Figure 1. Map of Monitoring Site Locations

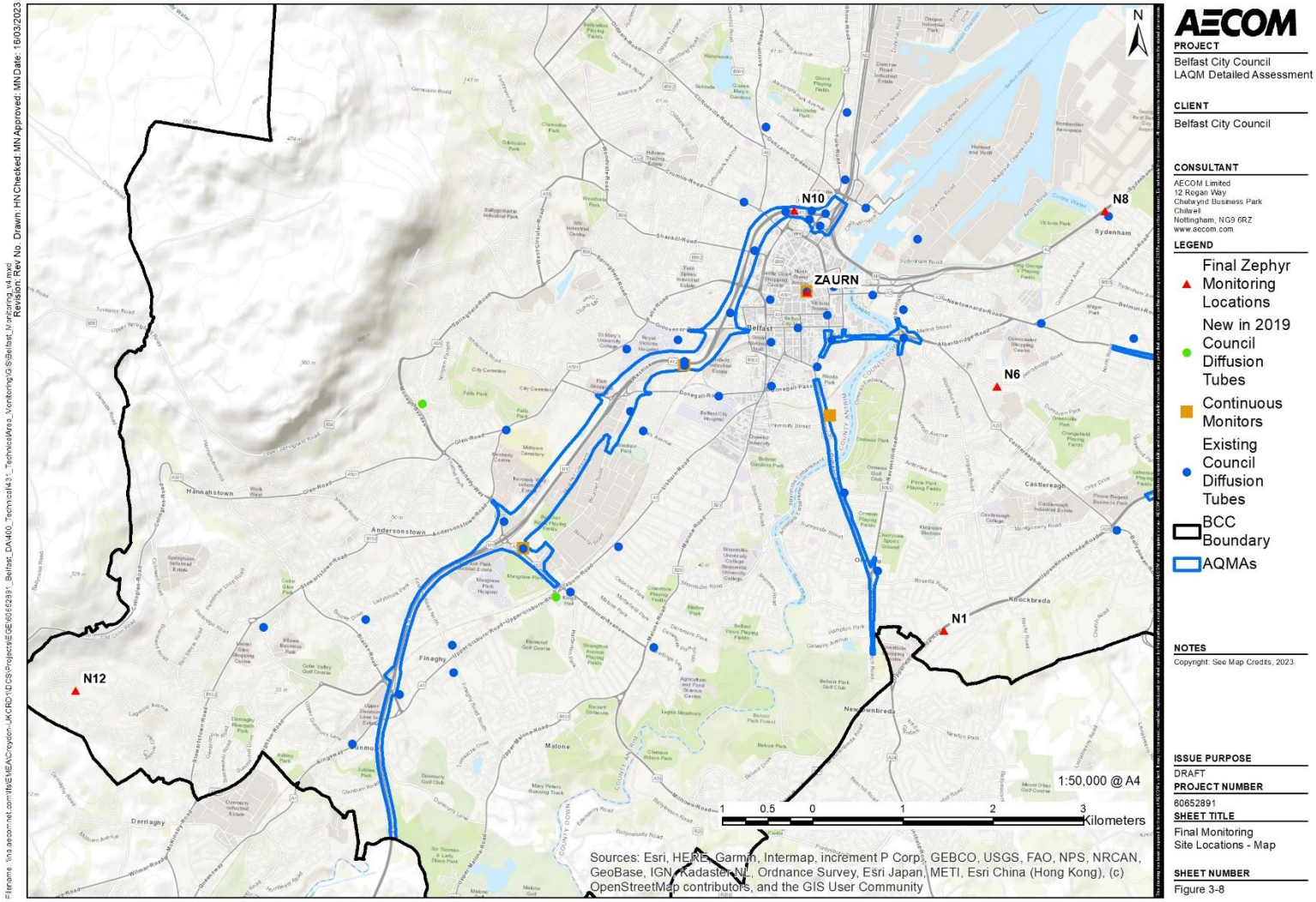


Figure 2. Typical Earthsense Zephyr Installation

Sensor Data Processing and Scaling

The data collected from the sensor network was processed and ratified in accordance with best-practice guidance. The raw data was collated and examined in detail to remove any negative concentrations or other spurious values. Data deemed to be related to instrument fault and/or noise was removed from consideration so as not to provide a false representation of ambient concentrations. Upon completion of this detailed examination the dataset is considered 'ratified'.

The ratified data was then passed through a two-stage data scaling process to account for any bias in the measurement method and for variation between sensor cartridges. To do this, one Zephyr sensor was co-located with the Belfast Centre AURN monitoring station. Measurements obtained from the Zephyr were compared with the AURN station measurements and adjustment factors were calculated for each pollutant. These adjustment factors were used to scale the raw sensor data relative to the AURN station. To account for variations in response between sensor cartridges at different locations, a second cartridge, pre-calibrated against the AURN station, was periodically moved around the five Zephyr monitoring locations. A similar process of comparing the measurements from the two cartridges was used to derive a second set of adjustment factors, which were also applied to the raw data.

Further details on the data processing and scaling can be found in the LAQM Detailed Assessment Report: Part A – Monitoring.

Monitoring Results

For the purposes of the DA the monitoring data from the Zephyr sensors were adjusted ("annualised") in accordance with best-practice guidance to be representative of a 2019 annual mean, to align with the year for which verification of the atmospheric dispersion modelling was carried out. The data were also annualised to 2021 annual means to enable BCC to report the results in subsequent LAQM Review and Assessment reports, if required.

The measured pollutant concentrations were compared against the relevant UK AQOs and WHO AQG as shown in Table 2. The WHO AQGs are not legally binding standards, but exceedance of the AQG level is associated with important risks to public health.

Table 2. UK Air Quality Objectives and WHO Air Quality Guidelines

Pollutant	Averaging Period	AQS Objective ($\mu g/m^3$)	Not to be Exceeded More Than	WHO Guideline ($\mu g/m^3$)*	Not to be Exceeded More Than
Nitrogen dioxide (NO_2)	Annual	40	N/A	10	N/A
	1-hour	200	18 hours (99.79th percentile)	N/A	N/A
	Daily	N/A	N/A	25	3 days (99th percentile)
Particulate matter (PM_{10})	Annual	40	N/A	15	N/A
	Daily	50	35 days (90.4th percentile)	45	3 days (99th Percentile)
Particulate matter ($PM_{2.5}$)	Annual	20	N/A	5	N/A
	Daily	N/A	N/A	15	3 days (99th Percentile)

Data Capture and Quality

The Earthsense Zephyr sensors were deployed with solar panels to avoid the requirement for connections to mains power, which can be problematic in some locations. However, during the winter months, data capture was limited at some locations by the availability of daylight and solar power. Where possible, mains power connections were established and data capture improved, although this was not possible at all locations.

Sensor technology is an emerging market, with no type-approval or certification regime yet in place. Therefore, there are inherent uncertainties associated with the data as compared to reference standard monitoring, especially when “annualising” data to allow comparisons to calendar annual means not explicitly monitored. The Zephyr monitors used in the DA recently obtained MCERTS Performance Standards as an Indicative Ambient Particulate Monitor, which gives additional confidence in the performance of the monitors. The results obtained are considered to be representative of the localities within which each sensor was deployed, allowing useful conclusions drawn from the data.

NO_2

The scaled, annualised results for NO_2 in 2019 and 2021 indicated that the annual mean NO_2 AQO of 40 µg/m^3 was achieved at all monitoring locations except N10 (see Table 3 and Table 4). The 2019 annualised mean NO_2 concentration at N10 was 50.3 µg/m^3. The 2021 annualised mean NO_2 concentration at this location was 45.5 µg/m^3. This site is located immediately adjacent to the Westlink, so after adjustment for distance it is likely that the AQO would be achieved at the nearest location of relevant exposure. However, the results highlighted the likely need to retain the Westlink AQMA (AQMA 1).

The 1-hour mean NO_2 AQO was achieved at all monitoring locations based on 2019 and 2021 scaled, annualised concentrations. The only location to record any 1-hour mean NO_2 concentrations of greater than 200 µg/m^3 was N10 in 2019 with 4 exceedance hours. This was well below the 18 hours permitted to achieve the AQO. The 99.79th percentiles of hourly NO_2 concentrations were also less than 200 µg/m^3 at all sites with data capture lower than 85% indicating exceedances of the 1-hour NO_2 AQO were very unlikely to have occurred.

The more stringent WHO AQG for annual mean NO_2 concentrations of 10 µg/m^3 was exceeded at all sites, based on 2019 and 2021 scaled, annualised means. Analysis of both the Zephyr and the Council's wider continuous monitoring indicates that the 24-hour mean NO_2 WHO AQG was also exceeded in both 2019 and 2021 at all locations, given the 99th percentile concentrations were all above 25 µg/m^3.

Table 3. 2019 Annual Mean Results for NO_2

Site	Adjusted Annual Mean Data Capture (%)	Scaled 2019 Annualised Annual Mean µg/m^3	Scaled Number of 1-hour mean concentrations >200µg/m^3	99th Percentile of 24-hour Mean NO_2 (µg/m^3)
AURN Belfast Centre (AURN)	51.4	24.1	0 (92.9)	53
AURN co-location (ZAURN)	58.5	29.7	0 (116.9)	82
N1	63.1	20.3	0 (93.8)	82
N10	80.1	50.3	4 (168.3)	99
N12	59.7	13.2	0 (95.6)	83
N6	83.8	23.0	0 (108.1)	81
N8	84.7	25.6	0 (109.4)	81

Where data capture is below 85%, for short term mean objectives, 99.79th percentiles have been presented in brackets

Table 4. 2021 Annual Mean Results for NO_2

Site	Adjusted Annual Mean Data Capture (%)	Scaled 2021 Annualised Annual Mean µg/m^3	Scaled Number of 1-hour mean concentrations >200µg/m^3	99th Percentile of 24-hour Mean NO_2 (µg/m^3)
AURN Belfast Centre (AURN)	90.6	20.7	0	56
AURN co-location (ZAURN)	58.5	26.2	0 (104.9)	74
N1	63.1	18.6	0 (84.2)	74
N10	80.1	45.5	0 (151.0)	92
N12	59.7	12.0	0 (85.7)	74
N6	83.8	20.6	0 (97.0)	73
N8	84.7	22.9	0 (98.2)	73

Where data capture is below 85%, for short term mean objectives, 99.79th percentiles have been presented in brackets

PM_{10}

The scaled, annualised results for PM_{10} in 2019 and 2021 indicated that the annual mean PM_{10} AQO of 40 µg/m^3 was achieved at all monitoring locations (see Table 5 and Table 6). The highest PM_{10} concentration in both years was recorded at N6 at Clara Street (19.7 µg/m^3 and 18.3 µg/m^3 in 2019 and 2021, respectively), which may be indicative of the contribution of local domestic source emissions.

All monitoring locations achieved the 24-hour mean PM_{10} AQO of 50 µg/m^3 not to be exceeded more than 35 days per year on the basis of 2019 and 2021 scaled, annualised results. The 90.4th percentiles of daily PM_{10} concentrations were also less than 50 µg/m^3 at all sites with data capture lower than 85% indicating exceedances of the 24-hour mean PM_{10} AQO were very unlikely to have occurred. All sites did, however, record two or more exceedance days. These days of 24-hour mean PM_{10} concentrations greater than 50 µg/m^3 were largely related to a regional pollution event in late March 2022, caused by the importation of Saharan dust across the UK. There was also an isolated exceedance at N10 in November 2021, which may have been related to a localised event or source (e.g. fireworks, roadworks).

The more stringent PM_{10} annual mean WHO AQG of 15 µg/m^3 was exceeded at all Zephyr monitoring locations, except the Lombard Street AURN co-location site based on the scaled, annualised 2019 results. Based on the scaled, annualised 2021 period, the AQG was exceeded at N6, N8 and N10.

Table 5. 2019 Annual Mean Results for PM_{10}

Site	Adjusted Annual Mean Data Capture (%)	Scaled 2019 Annualised Annual Mean µg/m^3	Scaled Number of 24-hour Means >50µg/m^3
AURN Belfast Centre (AURN)	88.3	15.4	2
AURN co-location (ZAURN)	61.8	12.7	7 (28.0)
N1	62.6	15.4	6 (29.2)
N10	79.8	18.5	9 (33.5)
N12	62.2	16.2	3 (30.3)
N6	84.6	19.7	7 (30.7)
N8	85.0	17.2	6 (30.3)

Where data capture is below 85%, for short-term objectives, the 90.4th percentiles have been presented in brackets

Table 6. 2021 Annual Mean Results for PM_{10}

Site	Adjusted Annual Mean Data Capture (%)	Scaled 2021 Annualised Annual Mean µg/m^3	Scaled Number of 24-hour Means >50µg/m^3
AURN Belfast Centre (AURN)	99.3	12.7	0
AURN co-location (ZAURN)	61.8	13.7	4 (25.7)
N1	62.6	14.4	4 (26.1)
N10	79.8	17.3	8 (29.1)
N12	62.2	15.0	2 (25.4)
N6	84.6	18.3	6 (28.2)
N8	85.0	15.9	5 (27.2)

Where data capture is below 85%, for short-term objectives, the 90.4th percentiles have been presented in brackets

$PM_{2.5}$

The scaled, annualised results for $PM_{2.5}$ in 2019 and 2021 indicated that the annual mean $PM_{2.5}$ AQO of 20 µg/m^3 was achieved at all monitoring locations (see Table 7 and Table 8). The highest $PM_{2.5}$ concentration in both years was recorded at the ZAURN co-location site at Lombard Street (13.0 µg/m^3 and 12.1 µg/m^3 in 2019 and 2021, respectively).

The much more stringent $PM_{2.5}$ annual mean WHO AQG of 5 µg/m^3 was exceeded at all Zephyr monitoring locations, on the basis of scaled, annualised data for both 2019 and 2021.

Table 7. 2019 Annual Mean Results for $PM_{2.5}$

Site	Adjusted Annual Mean Data Capture (%)	Scaled 2019 Annualised Annual Mean µg/m^3
AURN Belfast Centre (AURN)	88.2	10.6
AURN co-location (ZAURN)	61.7	13.0
N1	62.6	8.5
N10	79.7	11.5
N12	62.2	7.6
N6	84.6	11.9
N8	84.7	9.9

Table 8. 2021 Annual Mean Results for $PM_{2.5}$

Site	Adjusted Annual Mean Data Capture (%)	Scaled 2021 Annualised Annual Mean µg/m^3
AURN Belfast Centre (AURN)	99.3	7.4
AURN co-location (ZAURN)	61.7	12.1
N1	62.6	7.8
N10	79.7	10.7
N12	62.2	7.5
N6	84.6	11.0
N8	84.7	9.2

3. Part B - Modelling

Part B of the DA consisted of the assembly of a comprehensive emissions inventory of the major sources of air pollutant emissions in the city and subsequent atmospheric dispersion modelling based on data in the emissions inventory to predict concentrations of NO_2, PM_{10} and $PM_{2.5}$ at sensitive locations.

An emissions inventory was compiled providing annual emissions estimates for a baseline assessment year of 2019 and a future assessment year of 2028. The 2019 base year was chosen as this represents the most recent year unaffected by the effects of the Covid-19 pandemic. The future assessment year of 2028 was chosen to align with the data available within the strategic transport model used for the DA. The emissions inventory covers all of the key sources of NO_2, PM_{10} and $PM_{2.5}$ in Belfast, including the major road network and a large number of local roads, major industrial facilities and associated operations, Belfast Harbour, Belfast City Airport and the rail network. The inventory also contains physical source characteristics required for dispersion modelling of each source.

Dispersion modelling of the emissions inventory was carried out using ADMS-Roads and ADMS-5 atmospheric dispersion models. The models were configured to predict annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations at 1,797 discrete receptor points representing residential properties, health care facilities, hospitals and education facilities and other locations that are considered sensitive to air pollution. To provide an indication of the spatial patterns of pollutant concentrations across the city, contour plots of pollutant concentrations were generated using model predictions made across a detailed network of receptor points covering the four AQMAs, supplemented by a less-detailed network of points covering the whole BCC administrative area. Model outputs were verified by comparing against monitoring data collected by BCC during 2019 and data obtained from the network of sensors operated during 2021 and 2022. Good agreement was found between modelled and measured NO_2, PM_{10} and $PM_{2.5}$ concentrations across the majority of the monitoring network, indicating good model performance and providing confidence in the modelling results.

NO_2

Annual mean NO_2 concentrations for 2019 were predicted to be above the UK AQO level of 40 µg/m^3 at 25 discrete sensitive receptor locations. All of these receptors were within or near to the boundaries of the existing AQMAs along the Westlink (AQMA 1) and East Bridge Street / Cromac Street (AQMA 2), with the highest predicted concentration of 55.9 µg/m^3 at a receptor near to the Stockman's Lane roundabout.

The contour plot of modelled 2019 annual mean NO_2 concentrations (Figure 3) indicated these exceedances at locations outside of the AQMA boundaries were localised and likely to affect very few locations of relevant exposure. Within the uncertainties of the modelling, it was concluded that these exceedances do not warrant any amendment to the boundaries of AQMA 1 and AQMA 2 at this time.

Predicted 2019 annual mean NO_2 concentrations within AQMA 3, which covers a section of Upper Newtownards Road, Knock Road and Hawthornden Way, and AQMA 4 which covers Ormeau Road from the junction with Donegall Pass to the Belfast City boundary at Galwally, were below the UK AQO level at locations of relevant exposure. The results of recent years' monitoring at locations within AQMA 3 and AQMA 4 have also indicated that the AQO is now being met. Consideration should therefore be given to the revocation of AQMA 3 and AQMA 4, subject to a continuation of monitored NO_2 concentrations below the AQO in these AQMAs.

With the exception of the rural areas in the western part of the BCC administrative area, predicted 2019 annual mean NO_2 concentrations throughout the city exceeded the much more stringent WHO AQG of 10 µg/m^3.

For the future assessment year of 2028, predicted annual mean NO_2 concentrations were below the UK AQO of 40 µg/m^3 at locations of relevant exposure throughout the city. The highest predicted concentration at a discrete sensitive receptor location was 31.1 µg/m^3 at a receptor near to the Stockman's Lane roundabout. Consistent with 2019, the contour plot for 2028 (Figure 4) indicated that the highest levels of NO_2 are likely to be at locations along the main road corridors, in particular the Westlink and connecting routes.

In comparison to the much more stringent WHO AQG for annual mean NO_2 concentrations of 10 µg/m^3, most of the city centre and surrounding areas, particularly close to the major road network, were predicted to exceed this AQG in 2028.

Figure 3. City-wide Modelled 2019 Annual Mean NO_2 Concentrations

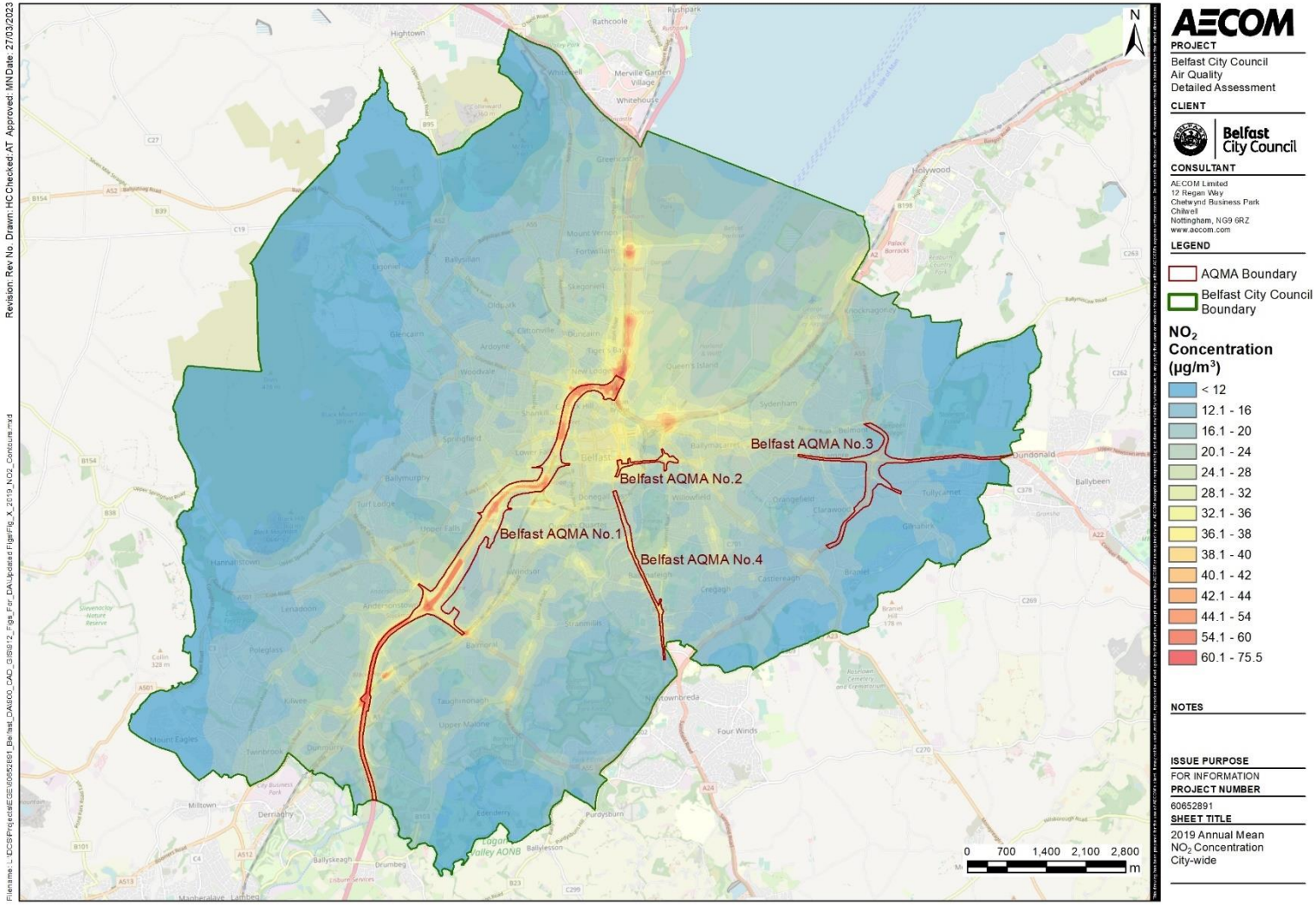
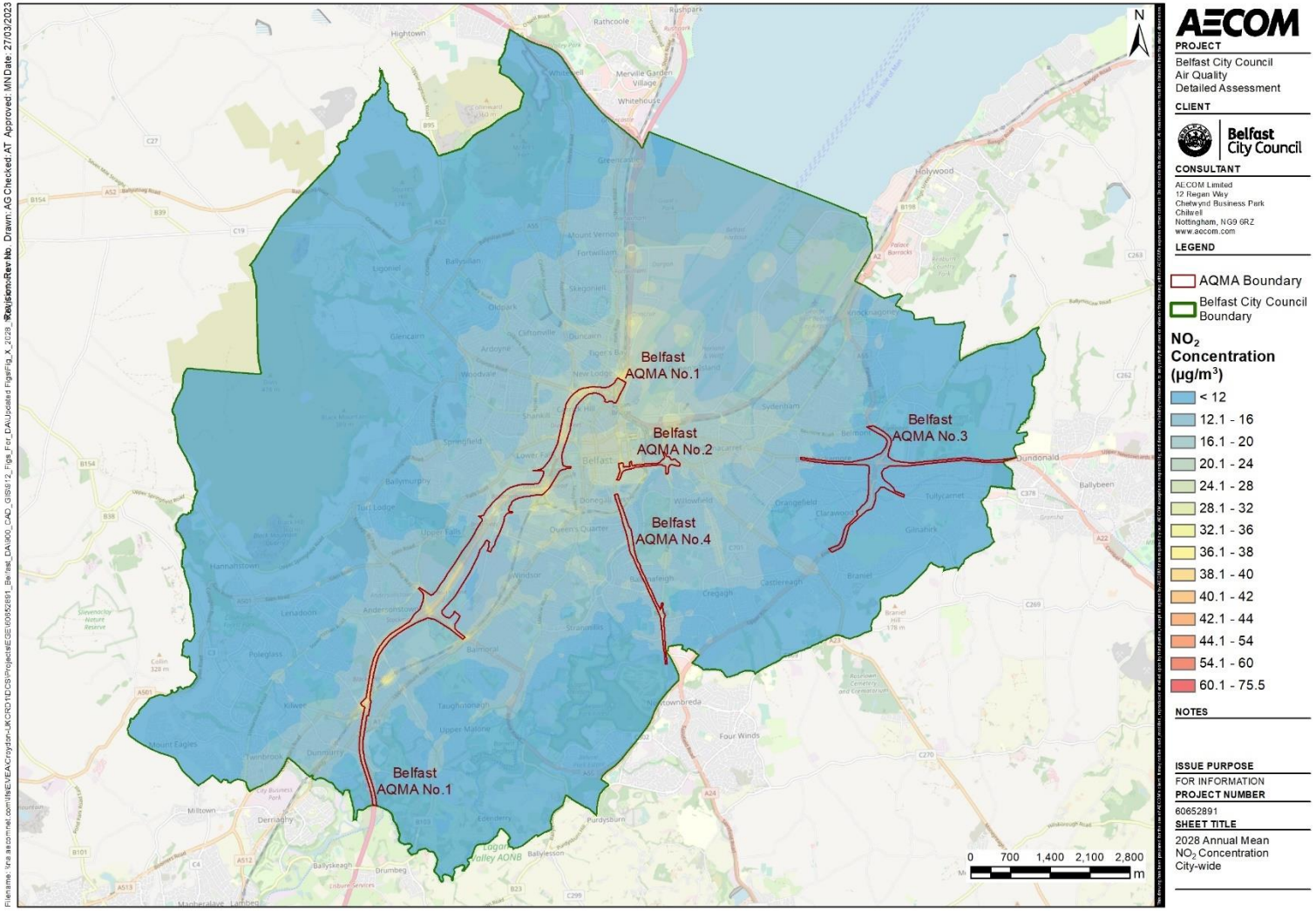


Figure 4. City-wide Modelled 2028 Annual Mean NO_2 Concentrations



PM_{10}

Annual mean PM_{10} concentrations in 2019 were predicted to be well below the UK AQO level of 40 µg/m^3 at locations of relevant exposure throughout the city. The highest predicted concentration at a discrete sensitive receptor location was 21.2 µg/m^3 at a receptor near to the Westlink at Barrack Street. Annual mean PM_{10} concentrations in 2019 exceeded the much more stringent WHO AQG for PM_{10} of 15 µg/m^3 at 1,100 of the 1,797 modelled discrete receptors and the contour plots indicated that the AQG was exceeded across most of the city centre area. In many areas background PM_{10} concentrations alone were found to approach or exceed the AQG level.

The contour plot of modelled annual mean PM_{10} concentrations in 2019 (Figure 5) indicated that the AQG was exceeded across much of the city centre area. The highest PM_{10} concentrations were predicted in areas where local source contributions coincide with elevated background concentrations, such as the Westlink corridor and the city centre.

For the future assessment year of 2028, predicted annual mean PM_{10} concentrations were well below the UK AQO of 40 µg/m^3 at locations of relevant exposure throughout the city. The contour plot for 2028 (Figure 6) indicated that the highest levels of PM_{10} occur where local source contributions coincide with elevated background concentrations. The highest predicted concentration at a discrete sensitive receptor location was 20.3 µg/m^3 at a receptor near to the Westlink at Barrack Street. Compared to NO_2, there were relatively small reductions in concentrations between 2019 and 2028. This illustrates the limited scope for further reductions in road traffic PM_{10} emissions as the majority of PM_{10} emitted by road vehicles is from non-exhaust sources (i.e. brake wear, tyre wear, road abrasion) that are more difficult to control, and the large contribution from regional background sources, outside the Council's control.

Annual mean PM_{10} concentrations in 2028 exceeded the much more stringent WHO AQG for PM_{10} of 15 µg/m^3 at 645 of the 1,797 modelled discrete receptors, and the contour plots indicated that the AQG was exceeded across a large part of the city centre area. In many areas background PM_{10} concentrations alone were found to approach or exceed the AQG level.

Figure 5. City-wide Modelled 2019 Annual Mean PM_{10} Concentrations

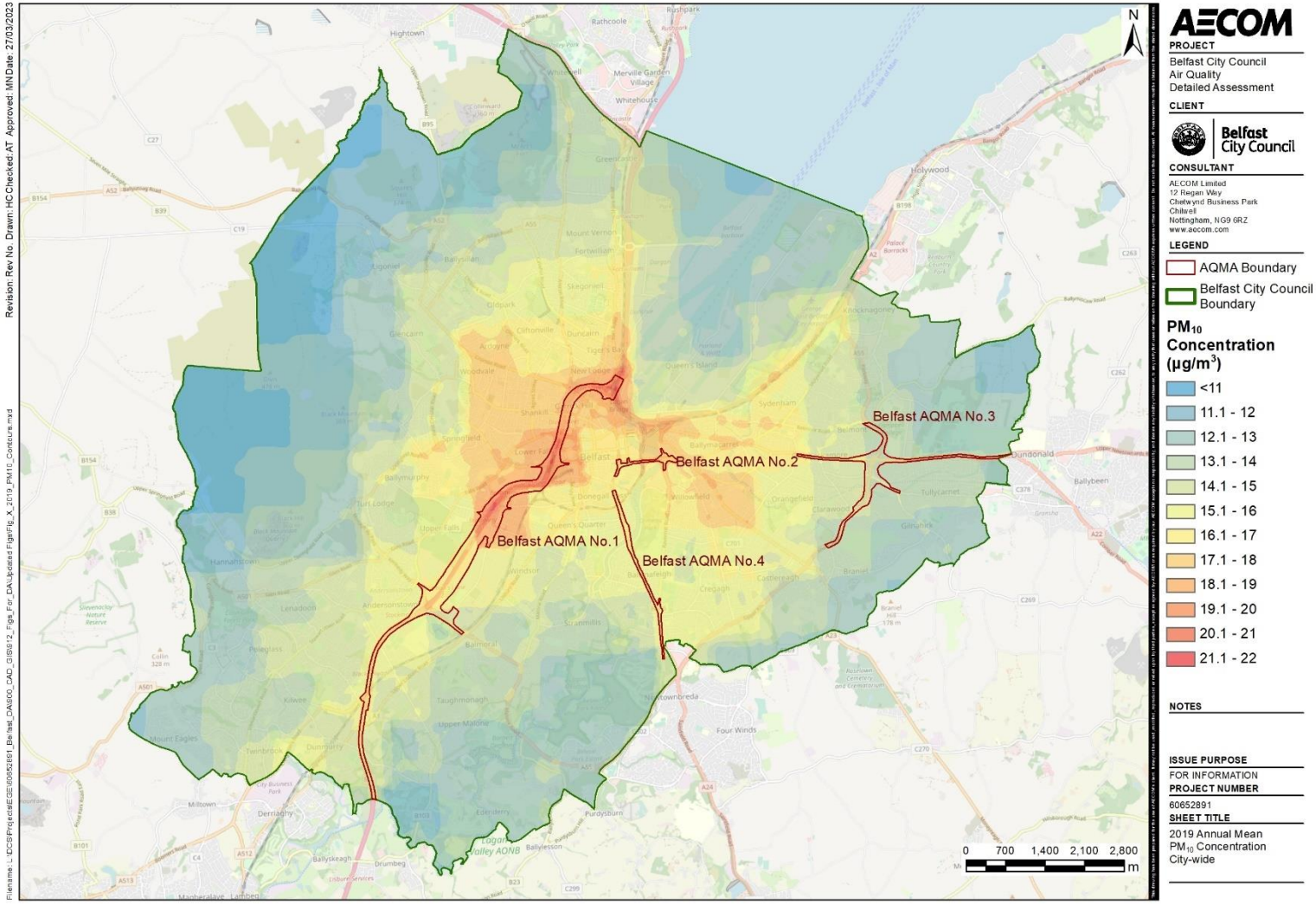
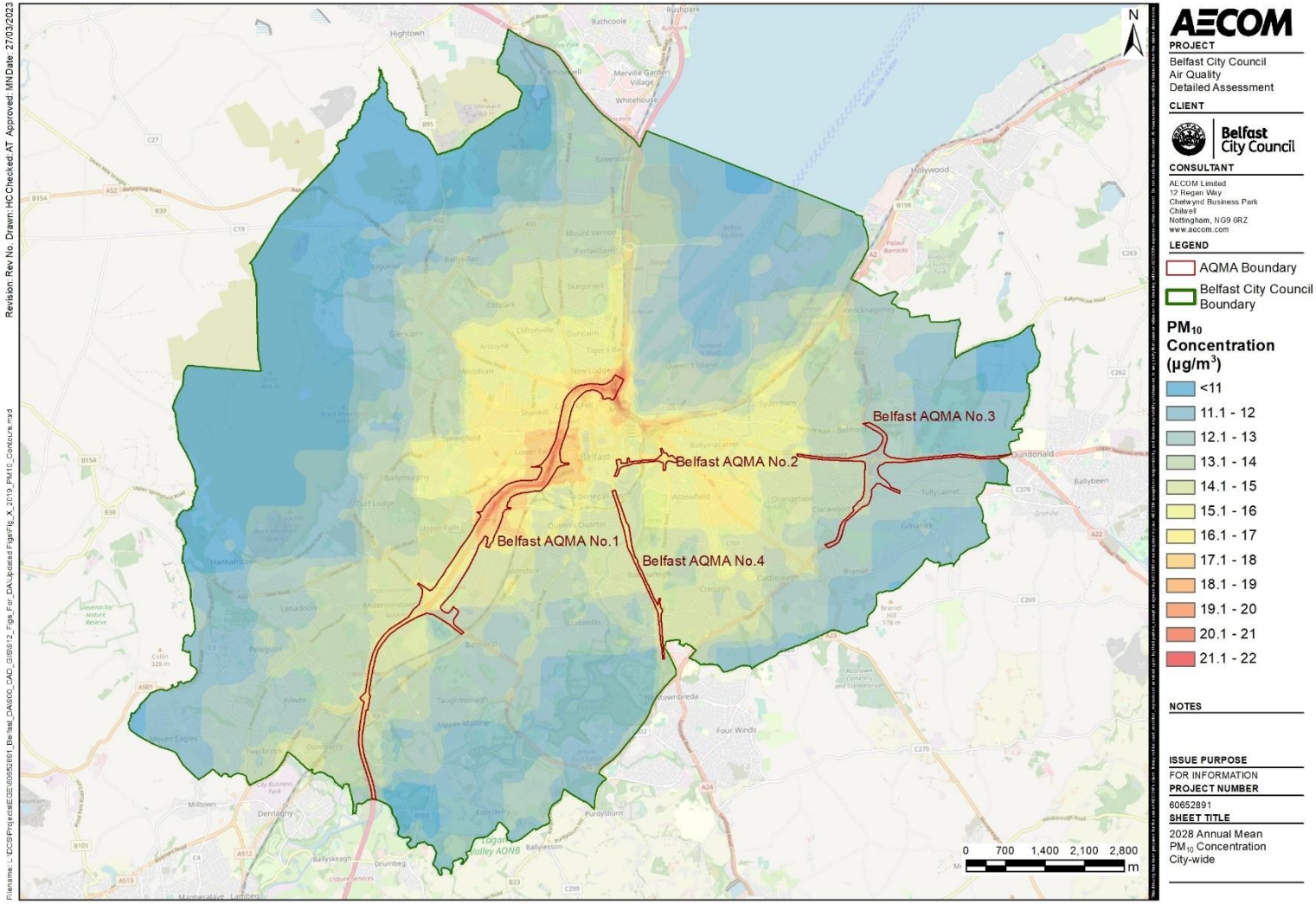


Figure 6. City-wide Modelled 2028 Annual Mean PM_{10} Concentrations



$PM_{2.5}$

Annual mean $PM_{2.5}$ concentrations in 2019 were predicted to be well below the UK AQO level of 20 µg/m^3 at locations of relevant exposure throughout the city. The highest predicted concentration at a discrete sensitive receptor location was 14.1 µg/m^3 at a receptor near to the Westlink at Barrack Street.

Annual mean $PM_{2.5}$ concentrations in 2019 exceeded the much more stringent WHO AQG for $PM_{2.5}$ of 5 µg/m^3 at all of the 1,797 modelled discrete receptors, and the contour plot for 2019 (Figure 7) indicated that the AQG was exceeded throughout the Council's administrative area. Background $PM_{2.5}$ concentrations alone were found to exceed the AQG level. The highest $PM_{2.5}$ concentrations were predicted in areas where local source contributions coincide with elevated background concentrations, such as the Westlink corridor and the city centre.

For the future assessment year of 2028, predicted annual mean $PM_{2.5}$ concentrations were well below the UK AQO of 20 µg/m^3 at locations of relevant exposure throughout the city. The contour plot for 2028 (Figure 8) indicated that the highest levels of PM_{10} occur where local source contributions coincide with elevated background concentrations. The highest predicted concentration at a discrete sensitive receptor location was 13.1 µg/m^3 at a receptor near to the Westlink at Barrack Street.

As was noted for PM_{10}, the relatively small reductions in $PM_{2.5}$ concentrations between 2019 and 2028 illustrate the limited scope for further reductions in road traffic $PM_{2.5}$ emissions, the majority of which is from non-exhaust sources (i.e. brake wear, tyre wear, road abrasion), and the large contribution from regional background sources, over which the Council has no control.

Annual mean $PM_{2.5}$ concentrations in 2028 exceeded the much more stringent WHO AQG for $PM_{2.5}$ of 5 µg/m^3 at all of the 1,797 modelled discrete receptors, and the contour plot indicated that the AQG was exceeded throughout the Council's administrative area.

Figure 7. City-wide Modelled 2019 Annual Mean $PM_{2.5}$ Concentrations

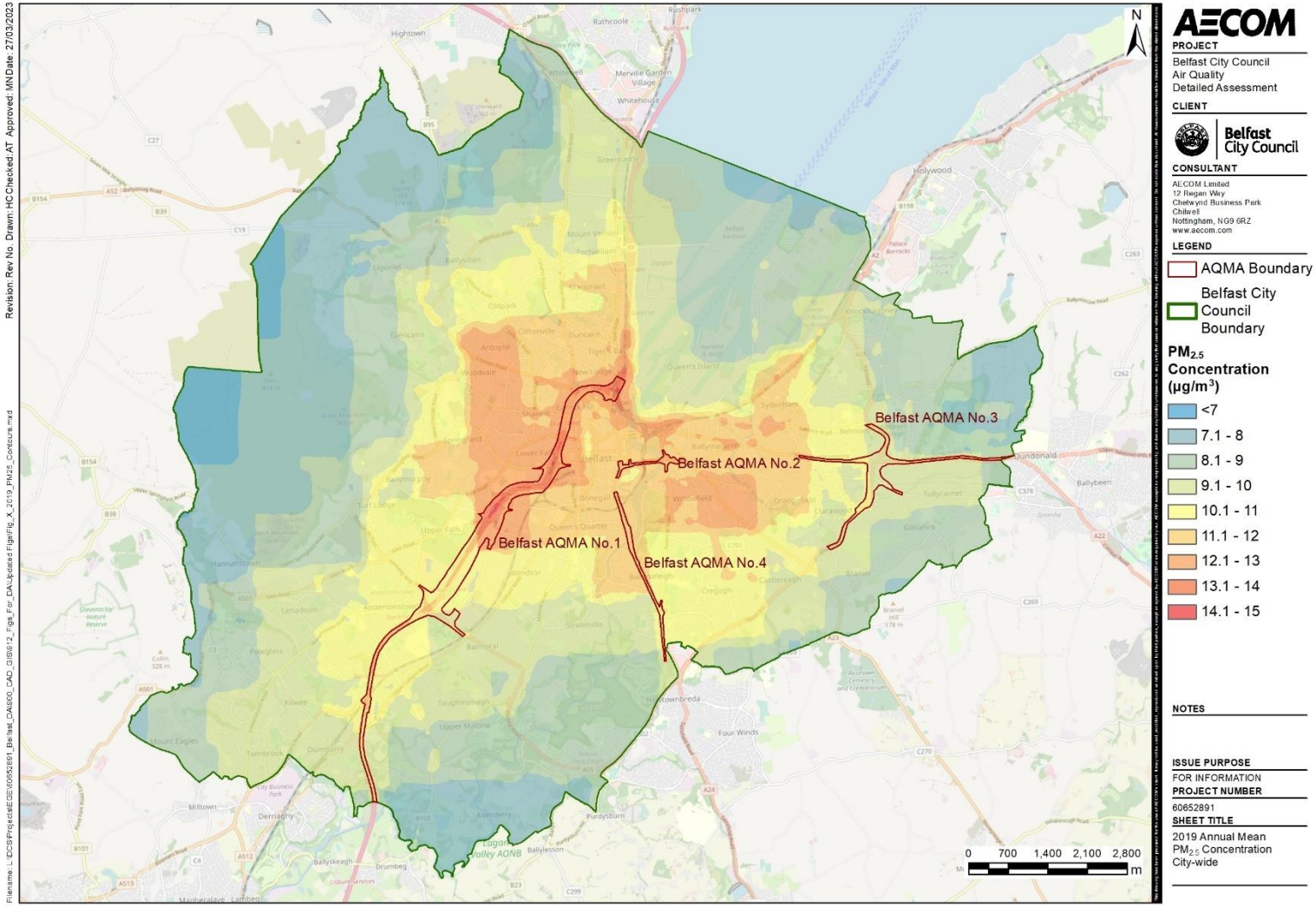
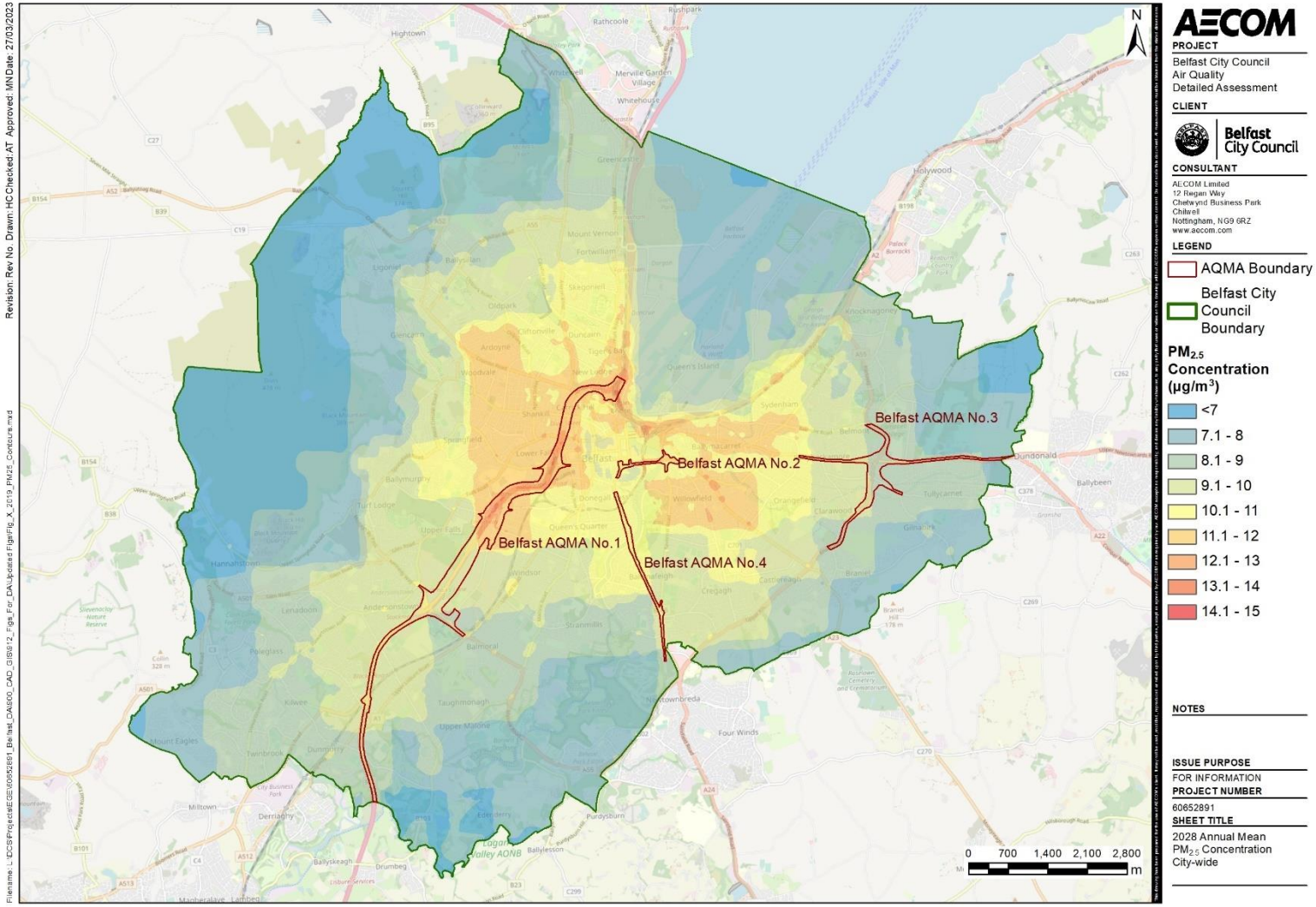


Figure 8. City-wide Modelled 2028 Annual Mean $PM_{2.5}$ Concentrations

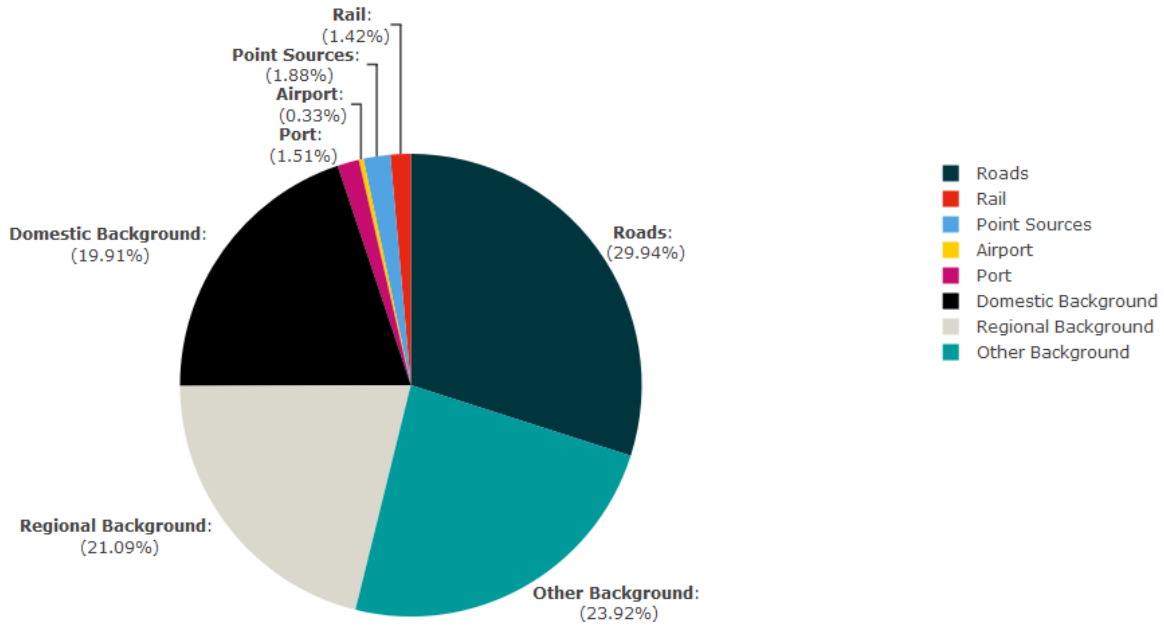


Source Apportionment

Source apportionment calculations were carried out for NO_2, PM_{10} and $PM_{2.5}$ to examine the relative contributions of different sources to modelled concentrations across the city. The relative contributions of different sources are strongly influenced by proximity to source. Therefore, source apportionment calculations were carried out at individual receptor level, but also at the city-wide level in order to give a balanced representation of the relative importance of different source contributions.

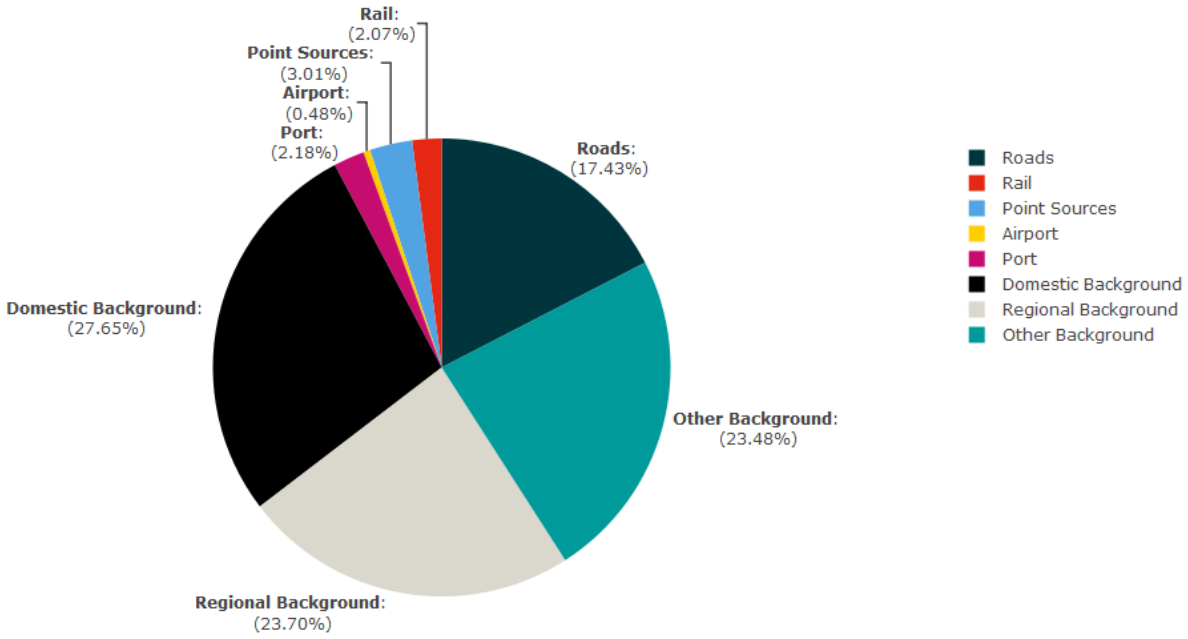
Based on city-wide source apportionment calculations, for NO_2 in 2019 (Figure 9), road transport was identified as the main source of modelled NO_2 concentrations, accounting for almost 30% of total modelled NO_2 concentrations. At receptor locations near to the major road network these contributions were typically much higher (greater than 60%). Of the other sources explicitly modelled, industrial point sources were the next largest contributor after roads (1.9%). The rail sector was found to make notable contributions at some locations near to railway lines, but at the city-wide scale accounted for 1.4% of the total modelled NO_2. Belfast Harbour was estimated to contribute approximately 1.5% and the airport 0.3%. Background sources that weren't explicitly modelled were found to be an important contributor to modelled NO_2 concentrations. The domestic background sector (domestic, commercial and institutional space heating) accounted for an estimated 19.9% and emissions from distant, regional sources outside of Belfast, collectively accounted for almost 45% of the total modelled NO_2 concentration in 2019.

Figure 9. City-Wide Weighted Average Source Apportionment, 2019 Annual Mean NO_2 Concentration



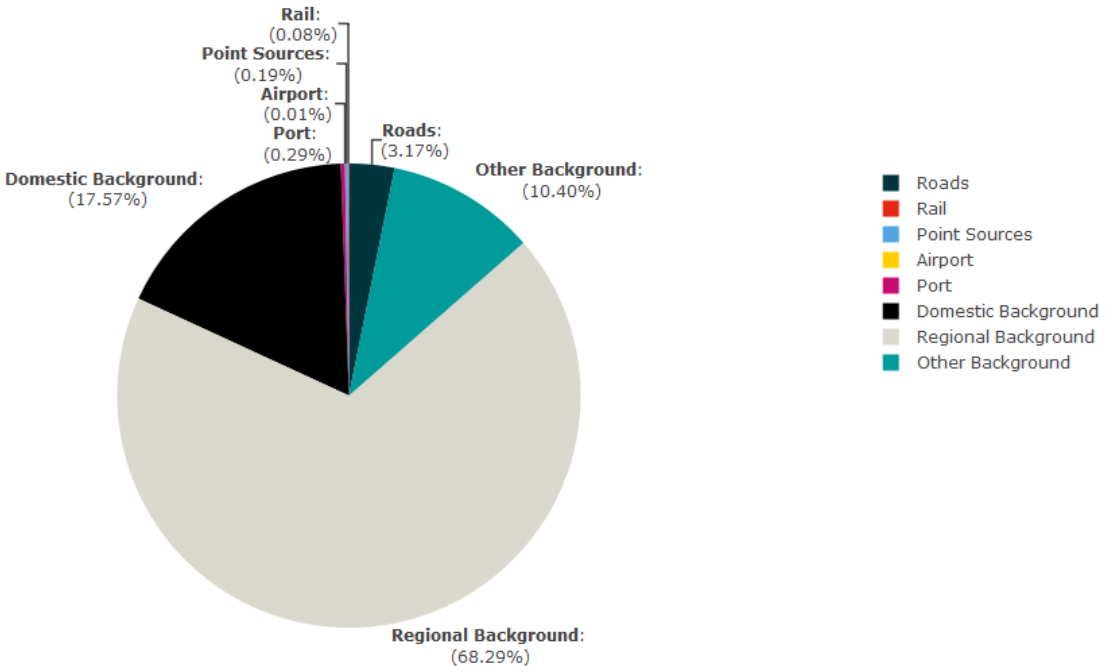
For NO_2 in 2028, city-wide source apportionment (Figure 10) calculations revealed a similar pattern to 2019 with road transport identified as the main source of modelled NO_2 concentrations, accounting for approximately 17% of total modelled NO_2 concentrations. Modelled road traffic emissions were assumed to decrease between 2019 and 2028 in line with Defra projections whereas emissions from other sources explicitly modelled (i.e. industrial point sources, rail, shipping, aviation) were assumed to remain at 2019 levels. Consequently, the relative contribution of road traffic was predicted to decrease, whilst the other source sectors increased in relative proportion. Industrial point sources were calculated to contribute approximately 3% to modelled NO_2 concentrations, the Harbour around 2.2%, rail around 2.2% and the airport approximately 0.5%. The domestic background sector contribution increased to an estimated 27.6%, whilst the collective contribution of other background sources, including emissions from distant, regional sources outside of Belfast, increased slightly to approximately 47% of the total modelled NO_2 concentration in 2028.

Figure 10. City-Wide Weighted Average Source Apportionment, 2028 Annual Mean NO_2 Concentration



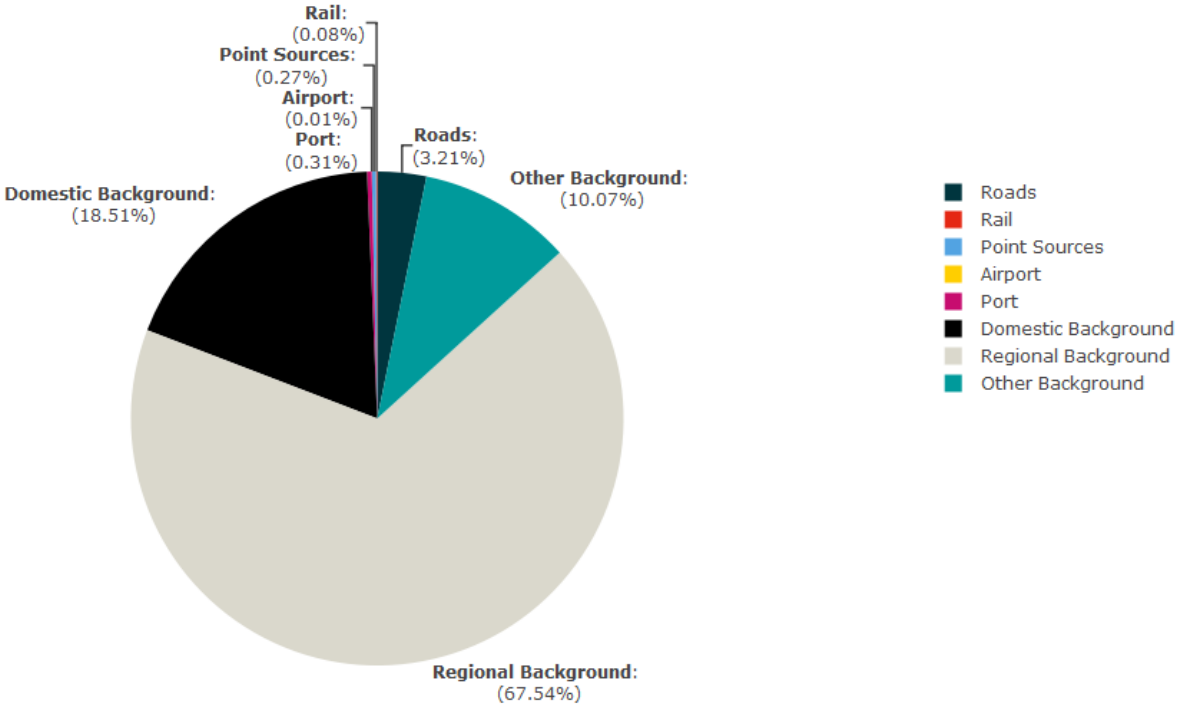
Based on city-wide source apportionment calculations, for PM_{10} in 2019 (Figure 11), the contributions of sources explicitly modelled were minor compared to the contributions of background PM_{10} sources. Regional background was estimated to account for more than 68% of the total modelled PM_{10}. The regional background sector includes contributions from sources outside of Belfast that the Council has no influence over, including natural sources such as windblown dust and sea salt, and secondary particulates. The domestic background sector, which includes the contribution of domestic heating, contributed an estimated 17.6% to modelled PM_{10} concentrations in 2019. Of the sources explicitly modelled, road transport accounted for an estimated 3.2% of the total modelled PM_{10} concentrations. The combined contribution of emissions from industrial point sources, rail, the Harbour and the airport to modelled PM_{10} concentrations was approximately 0.5%.

Figure 11. City-Wide Weighted Average Source Apportionment, 2019 Annual Mean PM_{10} Concentration



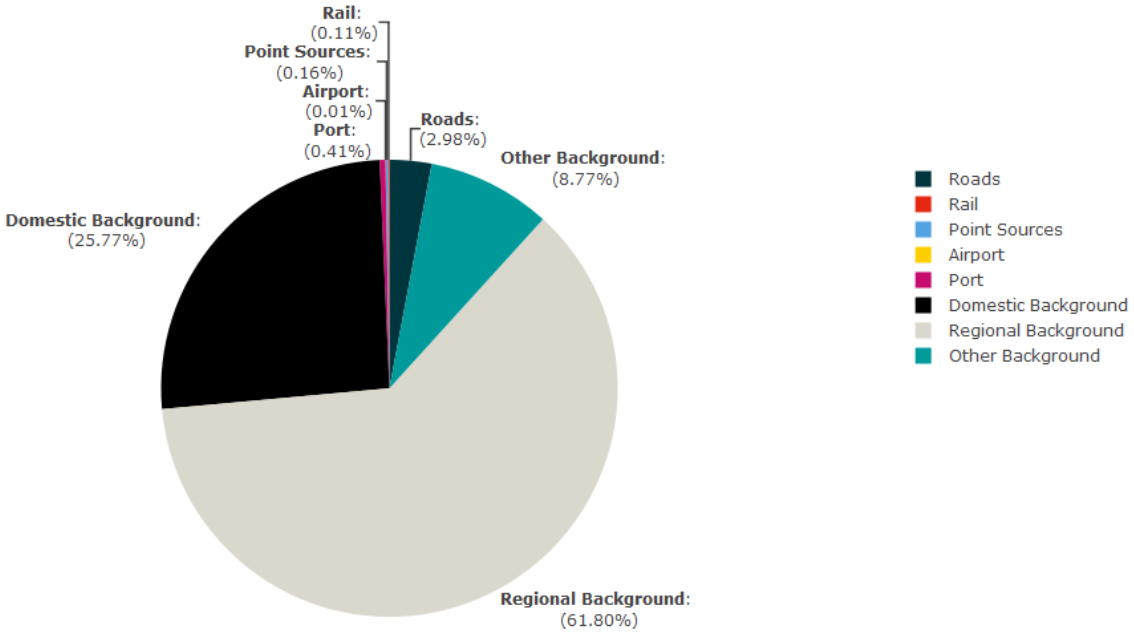
For PM_{10} in 2028, the city-wide source apportionment (Figure 12) calculations showed a similar pattern to 2019. Regional background was again the dominant contributor to modelled PM_{10} concentrations, accounting for 67.5% of the total modelled PM_{10}. The domestic background sector, which includes the contribution of domestic heating, contributed an estimated 18.5% to modelled PM_{10} concentrations in 2028. Of the sources explicitly modelled, road transport accounted for an estimated 3.2% of the total modelled PM_{10} concentrations, whilst the combined contribution of emissions from industrial point sources, rail, the Harbour and the airport to modelled PM_{10} concentrations was approximately 0.7%.

Figure 12. City-Wide Weighted Average Source Apportionment, 2028 Annual Mean PM_{10} Concentration



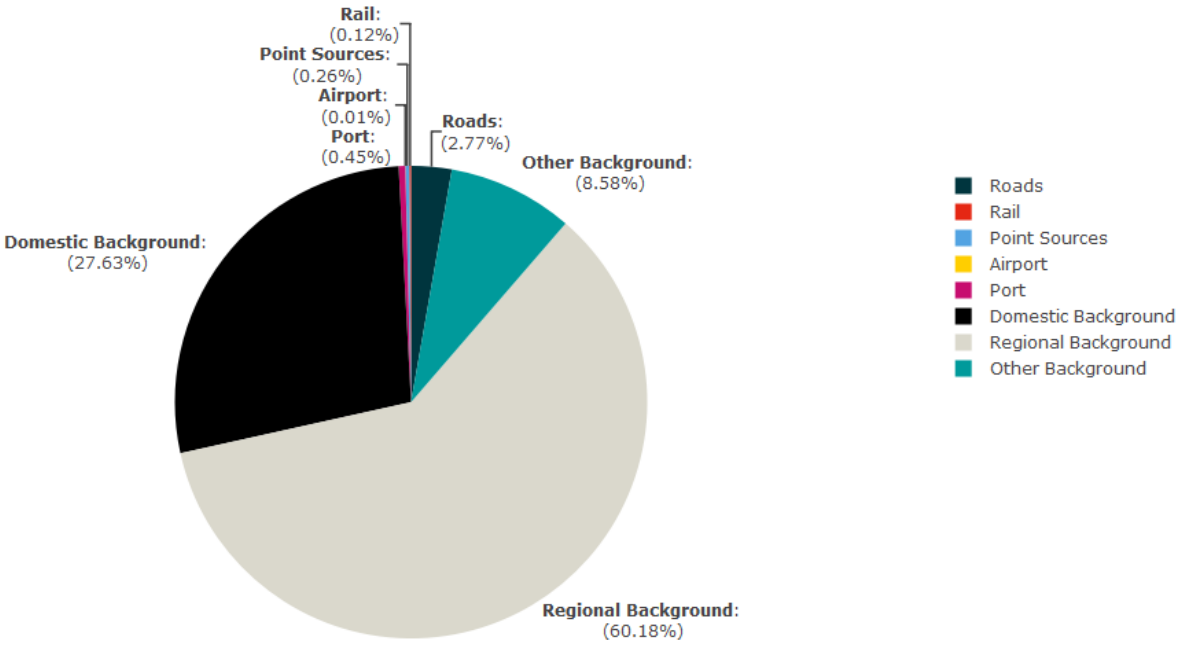
For $PM_{2.5}$ in 2019, the city-wide source apportionment (Figure 13) calculations exhibited similar patterns to those seen for PM_{10}. Background sources were the majority contributor. The regional background sector accounted for an estimated 61.8% of the total modelled $PM_{2.5}$ concentrations across the city. The regional background sector includes contributions from sources outside of Belfast that the Council has no influence over, including natural sources such as windblown dust and sea salt, and secondary particulates. The domestic background sector, which includes the contribution of domestic heating, contributed an estimated 25.8% to modelled $PM_{2.5}$ concentrations in 2019. Of the sources explicitly modelled, road transport accounted for an estimated 3.0% of the total modelled $PM_{2.5}$ concentrations. The combined contribution of emissions from industrial point sources, rail, the Harbour and the airport to modelled $PM_{2.5}$ concentrations was approximately 0.7%.

Figure 13. City-Wide Weighted Average Source Apportionment, 2019 Annual Mean $PM_{2.5}$ Concentration



For $PM_{2.5}$ in 2028, the city-wide source apportionment (Figure 14) calculations displayed similar patterns to the 2019 source apportionment. The regional background sector accounted was estimated to account for slightly more than 60% of the total modelled $PM_{2.5}$ concentration across the city. The domestic background sector, which includes the contribution of domestic heating, contributed an estimated 27.6% to modelled $PM_{2.5}$ concentrations. Of the sources explicitly modelled, road transport accounted for an estimated 2.8% of the total modelled $PM_{2.5}$ concentrations. The combined contribution of emissions from industrial point sources, rail, the Harbour and the airport to modelled $PM_{2.5}$ concentrations was approximately 0.8%.

Figure 14. City-Wide Weighted Average Source Apportionment, 2019 Annual Mean $PM_{2.5}$ Concentration



For PM_{10} and $PM_{2.5}$, the dispersion modelling and source apportionment results highlight an important finding with respect to potential future adoption and attainment of more stringent air quality standards based on the WHO AQGs. Should the WHO AQGs be adopted in the future, achievement of the AQGs will be highly challenging, not just within Belfast, but across much of the UK. Within Belfast, the source apportionment calculations indicated that a major proportion of ambient PM_{10} and $PM_{2.5}$ concentrations is likely to be attributable to regional sources originating outside of the city and which the Council will have little or no influence over. Whilst there remains the potential to target and reduce emissions from local PM_{10} and $PM_{2.5}$ sources, notably those sources which contribute to the domestic heating, attainment of the annual mean PM_{10} WHO AQG will be extremely challenging. In the case of $PM_{2.5}$, even the complete eradication of emissions from the domestic background sector appears unlikely to be sufficient to achieve the annual mean $PM_{2.5}$ WHO AQG of 5 µg/m^3.

4. Conclusions and Recommendations

In view of recent public health concerns around fine particulate matter ($PM_{2.5}$), and in fulfilment of the Local Air Quality Management (LAQM) Review and Assessments requirements for Northern Ireland, Belfast City Council (BCC) has carried out a Detailed Assessment (DA) of air pollution in their administrative area.

The main conclusions and recommendations from Part A (Monitoring) and Part B (Atmospheric Dispersion Modelling) are summarised below.

Part A – Monitoring

Near-reference sensors for the real-time measurement of NO_2, PM_{10} and $PM_{2.5}$ were installed at six locations across the city. The monitoring locations were chosen to provide information on a range of different environments within the city (roadside, urban background, airport) and to provide additional data for use in verification of the atmospheric dispersion modelling outputs under Part B.

The monitoring results, annualised to 2019 and 2021, indicated that:

- The UK AQO for annual mean NO_2 was achieved at all monitoring locations in 2019 and 2021, except for sensor N10, located adjacent to the Westlink. This location is within the existing Westlink AQMA, indicating that the current AQMA declaration should remain. The sensor monitoring results indicated that NO_2 exceedances were unlikely elsewhere.
- The more stringent WHO AQG for annual mean NO_2 was exceeded at all sites in 2019 and 2021.
- The UK AQO for 1-hour mean NO_2 was achieved at all monitoring locations in 2019 and 2021. At all sites, except N10 (Westlink), there were no recorded hours of NO_2 concentrations greater than 200 µg/m^3. The WHO AQG for 24-hour mean NO_2 was also exceeded at all continuous monitoring sites in 2019 and 2021.
- The UK AQOs for annual mean PM_{10} and $PM_{2.5}$ were achieved at all monitoring locations in 2019 and 2021. For PM_{10}, the highest concentrations in both years were measured at N6 (Clara Street) indicating the possible contribution of domestic sources in this area. For $PM_{2.5}$, the highest concentrations occurred at the AURN co-location site at Lombard Street; again, this indicates that local and regional background sources may be an important contributor.
- The more stringent WHO AQG for annual mean PM_{10} was exceeded at all monitoring locations, except Lombard Street in 2019. In 2021, this AQG was exceeded at N6 (Clara Street), N8 (Airport) and N10 (Westlink), but achieved elsewhere.
- The more stringent WHO AQG for annual mean $PM_{2.5}$ was exceeded at all monitoring locations in 2019 and 2021.

Other conclusions drawn from the monitoring survey, include:

- The additional sensor monitoring provided good spatial coverage and captured a range of different site types in a more cost-effective manner than could be achieved with reference standard monitoring.
- The sensor monitoring has largely confirmed the Council's existing understanding of air quality in Belfast, re-enforcing the conclusions of previous LAQM assessments.
- The units were not vandalised, damaged or removed unexpectedly over the course of the survey, showing that they can be securely deployed in the city and are relatively robust.
- A regime to ratify and scale the data was established, that can be applied moving forward should the Council continue with the monitoring longer term.

Based on the results of the monitoring, and the experiences of operating the sensor network, the following recommendations are made:

- The monitoring indicated that there is not presently the need to declare any new AQMAs for any area of previously unidentified elevated concentrations.

- BCC should continue the Zephyr / AURN co-location for QA/QC purposes in order to minimise uncertainties associated with sensor monitoring. Re-location of a second cartridge with the AURN site for a period and subsequent rotation of the second cartridge around the sensor network is also recommended.
- Co-location of one or more sensors with NO_2 diffusion tubes could be considered, as a relatively low-cost way of building in an additional data quality check.
- A review of the monitoring sites is recommended, as the Council may wish to characterise other sources (e.g. rail, or specific point sources) or investigate other areas of the city. The elevated PM_{10} concentrations at N6 (Clara Street) may warrant further monitoring in this vicinity to see if this is a localised effect.
- The Zephyr monitors have confirmed that roadside NO_2 is still likely to be the principal concern with regard to exceedance of statutory objectives, as indicated by the results from N10 (Westlink). N1 (A55) did not record concentrations that would be expected of a roadside site, so could either be re-located or reclassified.
- As per manufacturer specification, it will be necessary to consider the replacement of sensor cartridges in July 2023, and for these to be replaced with newly calibrated cartridges due to length of exposure.
- If the monitoring survey is intended to be continued over a much longer duration for continued LAQM compliance monitoring, it is recommended that options are explored to connect each of the Zephyrs to continuous power. Some of the units suffered from a lack of solar power, especially in winter with fewer hours of sunlight.

Part B – Modelling

To understand the spatial distribution of air pollution across the city, an emissions inventory of the main sources of air pollution in Belfast was assembled. Atmospheric dispersion modelling was then carried out to predict levels of NO_2, PM_{10} and $PM_{2.5}$ at sensitive receptors and across the city and comparisons made against the relevant UK AQOs and WHO AQGs.

Based on the findings and results, the following recommendations are made:

- With reference to predicted exceedances of the UK AQO level for annual mean NO_2 concentrations at locations outside of existing AQMA boundaries, identify the presence of relevant exposure, examine existing monitoring data and, as necessary, carry out additional monitoring in these areas to confirm or otherwise the modelled NO_2 concentrations. Should monitored concentrations support the model predictions then amendments to the boundaries of AQMA 1 and AQMA 2 may need to be considered. These areas of predicted exceedance include Short Strand / Bridge End, York Street / Dock Street / Brougham Street, Clifton Street, and Stockman's Lane / Lisburn Road / Balmoral Avenue.
- On the basis of model predictions at locations of relevant exposure and subject to a continuation of monitored NO_2 concentrations within AQMA 3 and AQMA 4, consider the revocation of these AQMAs with respect to the annual mean NO_2 UK AQO.
- Continue to update, refine and enhance the emissions inventory to support future modelling studies and LAQM Review and Assessment obligations. A comprehensive emissions inventory has been assembled as part of this DA, which provides a strong foundation upon which to build and refine the inventory in the future. Any emissions inventory will have limitations and areas for improvement. The cyclical nature of inventory development allows these limitations to be frequently revisited and, where possible, addressed. It also ensures the emissions inventory remains current and up-to-date and is regularly updated with the latest information.
- Targeted action to reduce public exposure to PM_{10} and $PM_{2.5}$ should focus on the sources which contribute to the domestic background sector, as source apportionment has indicated that this sector is accountable for more than 25% of the total modelled PM concentrations across the city. Source apportionment calculations indicate that targeting of the domestic background sector will also reduce NO_2 concentrations.

- For NO_2, local action aimed at road traffic is likely to remain the most effective action for reducing ambient concentrations at hotspot locations in the city. Fleet projections indicate that the next few years will see accelerated uptake of low-emissions / zero-emission vehicles and efforts should continue to be made to support the improvement of the vehicle fleet alongside the continued incentivisation of other transport modes and active travel options.

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