



Environment Agency / Defra
**UK Urban NO₂ Network Operational
Annual Report 2025**

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Environment Agency / Defra

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Executive summary

The UK Urban NO₂ Network (UUNN) is a nitrogen dioxide (NO₂) monitoring network that was developed to provide additional monitoring data for the national compliance assessment for NO₂. Data from the UUNN supplements the other data used in the assessment, from the Automatic Urban and Rural Network (AURN) and national modelling.

Monitoring is completed using Palmes-type diffusion tubes, a monitoring method widely used for the measurement of NO₂ across the UK. The diffusion tubes used in the UUNN, as detailed within Appendix A, are modified to improve data quality. The tubes are deployed in triplicate at each monitoring location to reduce the level of uncertainty and therefore increase the level of accuracy associated with each monitored concentration.

This report summarises activities undertaken, and data collected on the UUNN during 2025. The key statistics from the 2025 UUNN monitoring results are as follows:

- Monitoring was successfully undertaken at 308 locations during 2025. 270 of these are at roadside sites unique to the UUNN, with one located at the Manchester Air Quality Supersite located within the University of Manchester's Fallowfield campus, and 37 are located at existing AURN roadside monitoring stations (also known as 'co-locations');
- Across all 308 UUNN sites a data capture of 93.9% was achieved in 2025;
- 36 sites (35 UUNN sites and one co-location site at an AURN analyser) were removed from the compliance assessment due to being 'Red Flagged';
- The expanded uncertainty of the annual mean concentrations was found to be 11.49% which is well within the required 25% uncertainty level required for indicative monitoring;
- UUNN data were ratified and adjusted based upon data recorded at sites co-located with AURN monitors. This led to the slope and intercept correction factors of 1.134 and -1.407 µg/m³ respectively, derived from the AURN co-location study;
- Following slope and intercept correction one UUNN site exceeded the annual mean limit value for nitrogen dioxide (40 µg/m³), as required under the Air Quality Standards Regulations 2010;
- A further five UUNN sites were within 10% of the limit value in 2025.

1. Introduction

1.1 Aims of UUNN

The primary aim of the UUNN is to supplement the current national assessment for air quality (which is comprised of the Automatic Urban and Rural Network (AURN) and modelling) to provide additional local NO₂ monitoring data for the national UK compliance report.

UUNN monitoring is sited on major roads where concentrations predicted by national modelling and by local modelling (completed by a relevant local authority) were not in good agreement. UUNN monitoring has also been sited on road links where local authority monitoring has identified a potential exceedance that is not yet captured in the national assessment.

1.2 The Network

The UUNN was established in January 2020 and over the last few years has developed in different phases, responding to the evidence needs of the national compliance assessment.

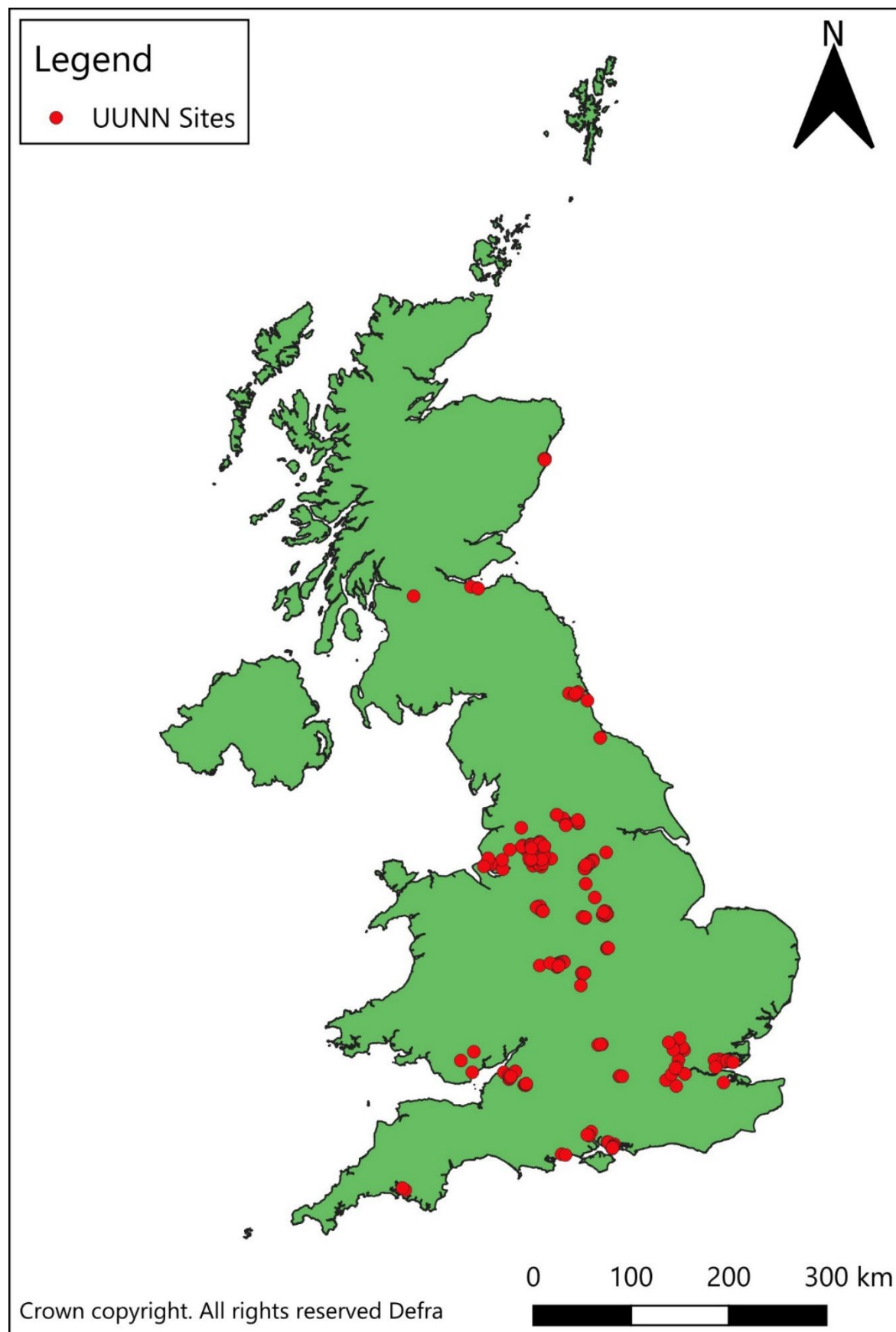
In 2024 the network reported data at 300 sites. At the end of 2024 a small number of sites were removed or deployed for monitoring in 2025. This report therefore describes data for 308 sites that were live in 2025. 270 of the monitoring locations are at roadside sites, 37 are located at existing AURN roadside monitoring stations to provide co-located monitoring data for validating monitored NO₂ concentrations and one site is the Manchester Air Quality Supersite.

Figure 1-1 provides a map of the UUNN monitoring locations that were operational during 2025.

Monitoring is completed using Palmes-type diffusion tubes, a monitoring method widely used for the measurement of NO₂ across the UK. The diffusion tubes used in the UUNN are modified to improve data quality, as detailed in Appendix A. UUNN diffusion tubes are sited in line with the UK's Air Quality Standards Regulations (2010)¹, deployed in triplicate at each monitoring location to reduce the level of uncertainty, and therefore increase the level of accuracy associated with each monitored concentration. UUNN diffusion tubes differ from those used to monitor for the UK Local Air Quality Management (LAQM) regime in terms of siting criteria, and also in the use of the additional wind cap, which is used in the UUNN to reduce the effects of turbulence on monitored concentrations. Diffusion tubes collect data on a monthly basis; each set of diffusion tubes is changed every 4-5 weeks adhering to a specific UUNN monitoring calendar. The monthly diffusion tube changeovers are undertaken by a cohort of Local Site Operators (LSOs). The 2025 UUNN monitoring calendar is provided in Appendix B.

¹ [Air Quality Standards Regulations \(2010\)](#)

Figure 1-1 UUNN Monitoring Locations



2. Data Adjustment and Uncertainty

Monitoring has been undertaken at 37 existing AURN monitoring stations to provide data for validating all UUNN monitored NO₂ concentrations (co-located sites). At these 37 sites the UUNN diffusion tubes are co-located with reference method chemiluminescent analysers. Data from these 37 sites allows for the calculation of correction factors and uncertainties that can be applied for all sites in the UUNN.

Correction factors and the overall uncertainty have both been calculated in line with the Guide to Demonstration of Equivalence 2010 (GDE 2010)². Annual averages of the 37 co-location sites have been used to plot an x/y scatter graph with the reference method on the x-axis and the average of the three co-located diffusion tubes on the y-axis.

In order that potential problems in the co-location data are not used to make calculations that could propagate to create errors for other UUNN sites, data have only been processed where the data capture of the reference method is greater than 85%, recognising the balance between data capture and number of sites included in the derivation of correction factors.

In line with GDE 2010, the line of best fit has been calculated using orthogonal regression, allowing the intercept to be non-zero. The results of this analysis are given in Figure 2-1. The resultant slope is 1.134 and the intercept is -1.407.

Regarding the resultant slope of 1.134, this is significantly different to 1. This is the first year of the UUNN's operation that it has been significantly different to 1. However, the slope remains close to 1 (which would indicate no bias).

The determination of the difference being significant has been calculated as follows (which is taken from the BS EN 16450:2017 Standard³):

- The slope b is insignificantly different from 1 if: $|b - 1| \leq 2u_b$
- The intercept a is insignificantly different from 0 if: $|a| \leq 2u_a$

Where u_b and u_a are the uncertainties in the slope and intercept, respectively.

Additional analysis was carried out to investigate potential reasons for the slope being significantly different to 1. The first stage of additional analysis looked at whether there may have been changes to the diffusion tube components, preparation or analysis. It found no evidence for any significant changes and concluded that the observed increase in diffusion tube overestimation in summer and autumn of 2025 was likely related to weather conditions and that this should be investigated further. The second stage of additional analysis investigated whether there were any unusual meteorological factors in 2025 which might have contributed to the fact that the diffusion tubes co-located at AURN sites were overestimating relative to the reference method (chemiluminescent analyser). It found that, although weather conditions in 2025 do not appear to have been unusual, there was a relatively warm and sunny summer, and relatively high urban ozone concentrations appear to have persisted into the autumn.

² Guide to Demonstration of Equivalence 2010 ([Assessment of ambient air quality](#))

³ BS EN 16450:2017 – TC Ambient air. Automated measuring systems for the measurement of the concentration of particulate matter (PM₁₀; PM_{2.5})

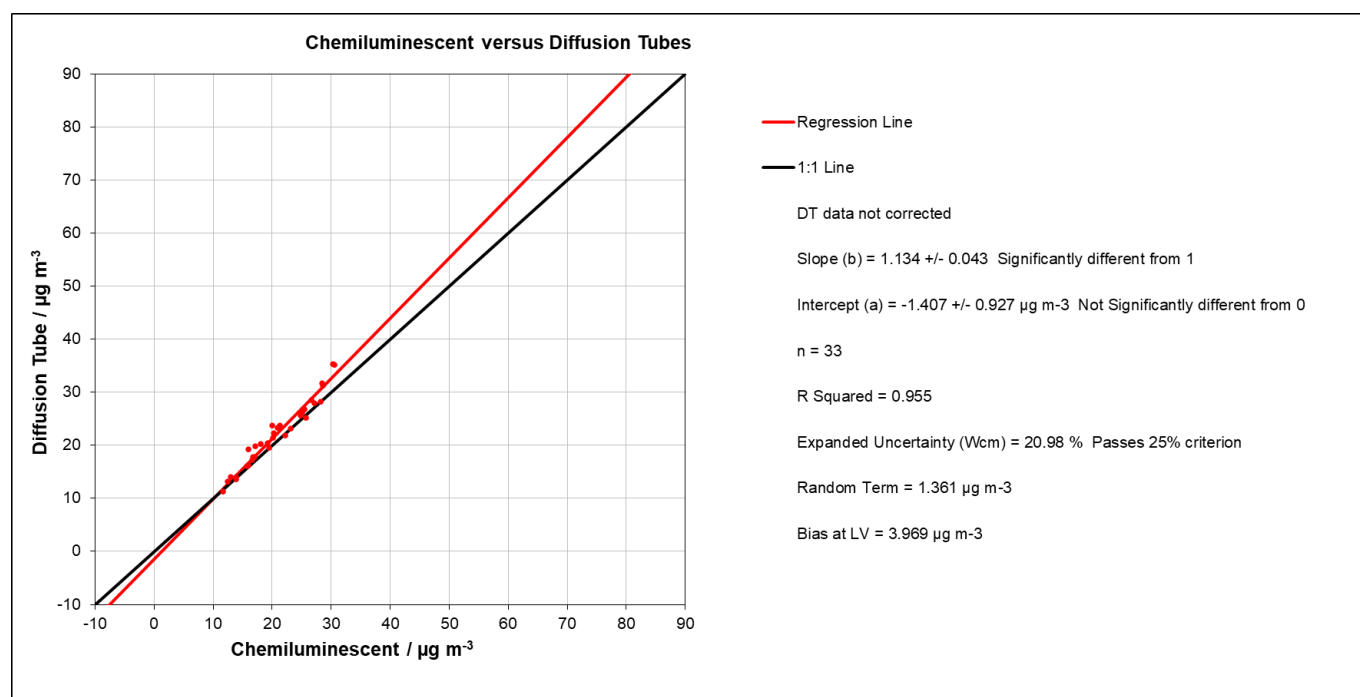
These factors may have contributed to the observed positive bias in the co-located diffusion tube measurements, particularly in the summer and the latter part of 2025.

The level of bias⁴ at the limit value ($40 \mu\text{g}/\text{m}^3$), must also be considered. Without slope correction applied, the level of bias at the limit value is $3.969 \mu\text{g}/\text{m}^3$. It is considered that this level of bias is too high and, therefore, the slope correction has been applied, resulting in a small residual bias at the limit value of $-0.056 \mu\text{g}/\text{m}^3$.

The annual average concentrations, after slope and intercept correction (subtracting $-1.407 \mu\text{g}/\text{m}^3$ (intercept) and dividing by 1.134 (slope)), are shown in Figure 2-2.

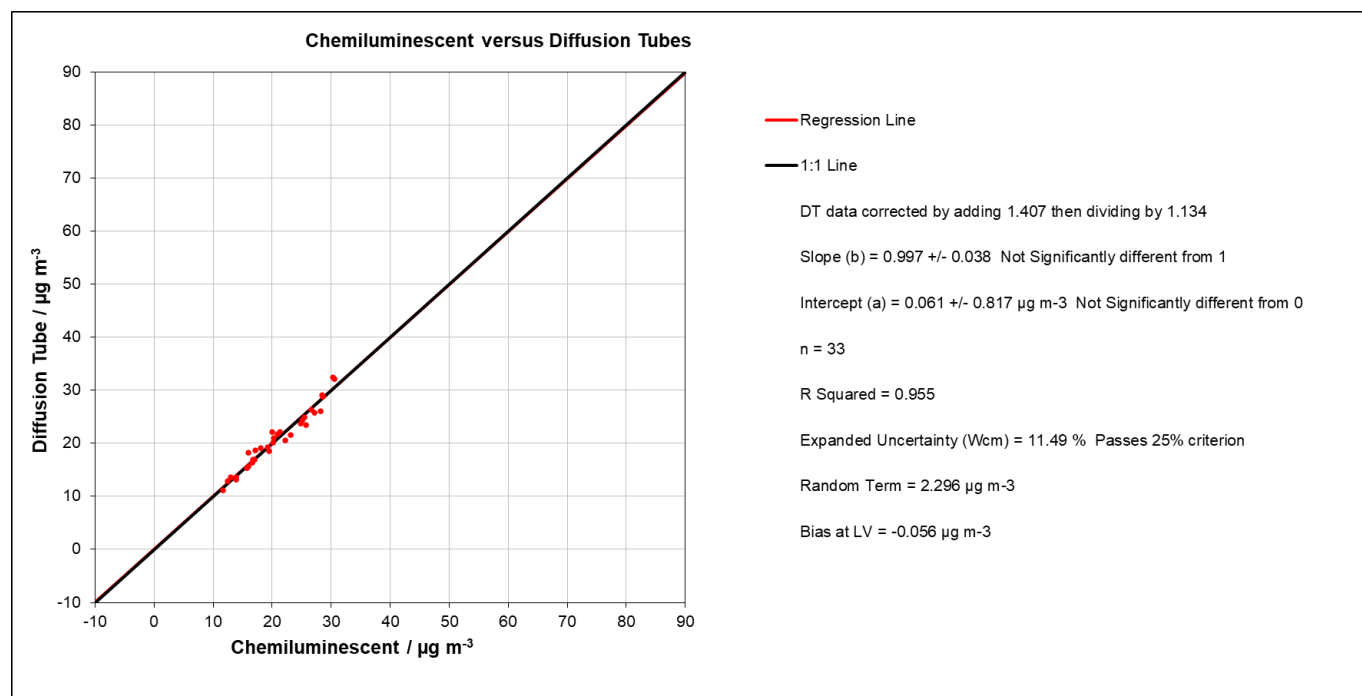
The expanded uncertainty of the annual mean concentrations after applying the correction, is 11.49%. This is well within the 25% uncertainty level required for supplementary measurements such as diffusion tubes to be used to determine compliance with the annual mean NO_2 limit value.

Figure 2-1 Scatter plot for the annual averages of 2025 data without correction



⁴ Bias represents the overall tendency of the diffusion tubes to under or over-read relative to the reference chemiluminescent analyser

Figure 2-2 Scatter plot for the annual averages of 2025 data with slope and intercept correction



3. Network Performance and Corrected Data

The following section provides an overview of both the data capture achieved across the UUNN within 2025, and the NO₂ concentration data for the UUNN sites that met specific data capture requirements within 2025. All concentration data presented within this section have been slope and intercept corrected as detailed in Section 2.

3.1 2025 Data Capture

Data capture within the UUNN has been assessed through a two-tiered 'flag' assessment.

- A Yellow Flag is issued to a UUNN site if:
 - No valid data is returned for one month in a calendar year; or
 - Valid data returned for only a single tube for two months in a calendar year; or
 - No valid data is returned for one month plus valid data returned for only a single tube for one month in a calendar year.
- A Red Flag is issued for a UUNN site if:
 - No valid data is returned for two or more months in a calendar year; or
 - Valid data returned from only a single tube for three or more months in a calendar year; or
 - No valid data is returned for one month and valid data returned from only a single tube for two or more months in a calendar year.

Of the 308 sites operational within the UUNN in 2025 (excluding the Manchester Air Quality Supersite which is not used in the compliance assessment⁵) there were 36 Red Flag sites; 35 UUNN sites and one co-location site at an AURN analyser. These Red Flag sites do not meet the data capture requirements for compliance reporting and are not included in the compliance assessment.

The total number of UUNN sites used in the compliance assessment is therefore 272; a combination of 236 UUNN sites and 36 co-location sites at AURN analysers. In addition to the Red Flagged sites, there were 67 sites that met the criteria for a Yellow Flag. The Yellow Flag and Red Flag sites are listed in Table 3-1 and Table 3-2 respectively.

The cause for the majority of data loss was tubes being removed during an exposure period, either being stolen or vandalised. After being deployed in accordance with the monitoring calendar a number were found to be missing on the subsequent changeover date. In addition to tubes being removed, site access restrictions / roadworks taking place at monitoring locations also resulted in lower data capture. In January 2026 there was a postal issue with the parcel containing the December 2025 tubes from the East Midlands and Leicester routes. This parcel was mis-delivered by Royal Mail and did not arrive at

⁵ The site is not used in the compliance assessment because it is a background, rather than roadside, site

Gradko (Gradko supplies and analyses the tubes deployed on the UUNN). Tracking information was retained and enquires were made to Royal Mail, but unfortunately the parcel could not be located. Therefore, these tubes have been lost.

It was identified that the AURN automatic site at which one UUNN site was co-located (UUNN_UK00513) had been decommissioned, due to being deemed to no longer meet AQSR criteria. The UUNN site was therefore also decommissioned, and the data have not been included in the 2025 compliance assessment. This site is not listed in the red flagged sites table below.

Table 3-1 Red Flagged Sites

Red Flag Sites				
UUNN_BOLT_009	UUNN_CVTR_003	UUNN_NOTT_011	UUNN_SHEF_002	UUNN_TAME_005
UUNN_BRAD_009	UUNN_CVTR_011	UUNN_NOTT_015	UUNN_SHEF_005	UUNN_TRAF_003
UUNN_BRIS_006	UUNN_GATE_001	UUNN_OLDH_002	UUNN_SHEF_018	UUNN_TRAF_005
UUNN_BRIS_018	UUNN_HERT_003	UUNN_PORT_002	UUNN_SHEF_019	UUNN_UKA00603
UUNN_BRIS_019	UUNN_LEIC_002	UUNN_READ_005	UUNN_SHEF_020	
UUNN_BROX_001	UUNN_MANC_024	UUNN_RHCY_001	UUNN_SOUT_008	
UUNN_BROX_003	UUNN_MANC_032	UUNN_SGLO_001	UUNN_STOC_013	
UUNN_BURY_004	UUNN_NOTT_003	UUNN_SGLO_002	UUNN_STOK_005	

Table 3-2 Yellow Flagged Sites

Yellow Flag Sites				
UUNN_BIRM_001	UUNN_BOLS_001	UUNN_CVTR_010	UUNN_MANC_007	UUNN_UKA00525
UUNN_BIRM_002	UUNN_BOLT_001	UUNN_DERB_001	UUNN_MANC_016	UUNN_UKA00553
UUNN_BIRM_003	UUNN_BRAD_007	UUNN_DERB_004	UUNN_NOTT_012	UUNN_UKA00564
UUNN_BIRM_004	UUNN_BROX_004	UUNN_DUDL_001	UUNN_PORT_005	UUNN_UKA00595
UUNN_BIRM_005	UUNN_BROX_005	UUNN_EDIN_003	UUNN_PORT_006	UUNN_UKA00609
UUNN_BIRM_007	UUNN_BROX_006	UUNN_EHER_001	UUNN_PORT_007	UUNN_UKA00612
UUNN_BIRM_008	UUNN_BROX_007	UUNN_FARE_001	UUNN_PORT_011	UUNN_UKA00620
UUNN_BIRM_009	UUNN_BURY_003	UUNN_FARE_002	UUNN_READ_003	UUNN_UKA00626
UUNN_BIRM_010	UUNN_BURY_006	UUNN_GLON_004	UUNN_SHEF_003	UUNN_UKA00634
UUNN_BIRM_012	UUNN_CVTR_001	UUNN_GLON_007	UUNN_SHEF_013	UUNN_UKA00649
UUNN_BIRM_013	UUNN_CVTR_002	UUNN_HERT_002	UUNN_STOC_001	UUNN_UKA00653
UUNN_BIRM_016	UUNN_CVTR_007	UUNN_LEIC_001	UUNN_STOC_002	

UUNN_BIRM_017	UUNN_CVTR_008	UUNN_LEIC_003	UUNN_WELW_001	
UUNN_BIRM_018	UUNN_CVTR_009	UUNN_LIVE_023	UUNN_UKA00315	

3.2 Annual Mean Concentrations

Following the removal of Red Flag sites, there was one site that exceeded the 40 µg/m³ limit value in 2025. This site is presented in Table C. 1 in Appendix C.

The UUNN site that exceeded the annual mean limit value, and those that are within 10% of the annual mean in 2025 are presented in Appendix C. A full list of 2025 annual mean NO₂ monitoring results can be accessed using the UK Air resource⁶.

3.3 Monthly Mean Concentrations

Table 3-3 provides the average NO₂ concentration across the UUNN during 2025. It can be observed that the UUNN average NO₂ concentration is below the 40 µg/m³ limit value for all monthly periods within 2025, when taking the average across all sites in the network.

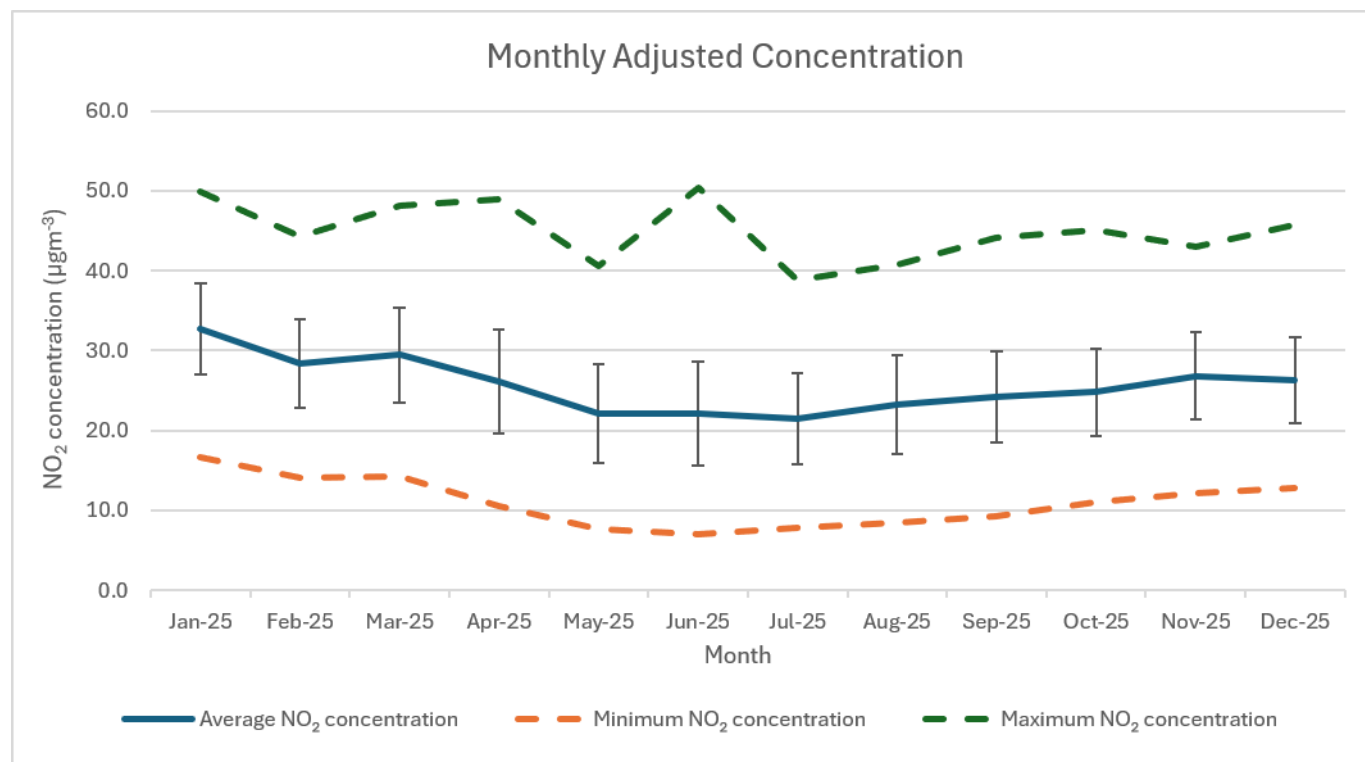
Table 3-3 Average NO₂ Concentration across all UUNN sites (2025)

NO ₂ concentration (ug/m ³)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Average NO ₂ concentration (ug/m ³)	32.7	28.4	29.4	26.1	22.2	22.1	21.5	23.2	24.1	24.8	26.8	26.2	25.6
Minimum NO ₂ concentration (ug/m ³)	16.7	14.1	14.2	10.6	7.6	7.0	7.7	8.5	9.2	11.0	12.1	12.8	N/A
Maximum NO ₂ concentration (ug/m ³)	49.9	44.4	48.2	49.0	40.6	50.4	38.9	40.7	44.1	45.1	43.0	45.7	N/A

Figure 3-1 displays the trend in average UUNN monthly NO₂ concentration throughout 2025, demonstrating a small level of seasonal variation, where concentrations through the summer months are often lower than those in winter months. Error bars showing the standard deviation are included for the average concentration.

⁶ [UK Air](#) website

Figure 3-1 Average NO₂ Concentration across UUNN sites (2025)



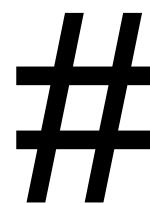
4. Summary

The UK Urban NO₂ Network (UUNN) is an air quality network that monitors concentrations of nitrogen dioxide (NO₂) at selected roadside locations. It has been designed and implemented to provide supplementary evidence for the national assessment for NO₂, alongside the Automatic Urban and Rural Network (AURN) and the national modelling.

Monitoring is completed using Palmes-type diffusion tubes, a monitoring method widely used for the measurement of NO₂ across the UK. The diffusion tubes used in the UUNN are modified to improve accuracy and are deployed in triplicate at each monitoring location to reduce the level of uncertainty, and therefore increase the data quality, associated with each monitored concentration.

The key statistics from the 2025 UUNN monitoring results are as follows:

- Monitoring was successfully undertaken at 308 locations during 2025. 270 of these are at roadside sites unique to the UUNN, with one located at the Manchester Air Quality Supersite located within the University of Manchester's Fallowfield campus, and 37 are located at existing AURN roadside monitoring stations (also known as 'co-locations');
- Across all 308 UUNN sites a data capture of 93.9% was achieved in 2025;
- 36 sites (35 UUNN sites and one co-location site at an AURN analyser) were removed from the compliance assessment due to being 'Red Flagged';
- The expanded uncertainty of the annual mean concentrations was found to be 11.49% which is well within the required 25% uncertainty level required for indicative monitoring;
- UUNN data were ratified and adjusted based upon data recorded at sites co-located with AURN monitors. This led to the slope and intercept correction factors of 1.134 and -1.407 µg/m³ respectively, derived from the AURN co-location study;
- Following slope and intercept correction one UUNN site exceeded the annual mean limit value for nitrogen dioxide (40 µg/m³), as required under the Air Quality Standards Regulations 2010;
- A further five UUNN sites were within 10% of the limit value in 2025.



Appendices



Appendix A – Overview of UUNN Diffusion Tubes

A.1 Overview of Diffusion Tubes

Diffusion tubes consist of small transparent plastic tubes approximately 7.1 cm long. They contain chemical reagent which absorbs nitrogen dioxide in the form of nitrite. The reagent in this case is triethanolamine (TEA), a solution of which is applied to fine stainless-steel mesh grids at one end of the tube, which is sealed with a coloured plastic cap (in this case, grey). The other end of the tube is also sealed with a removable white plastic cap.

When deploying at standard diffusion tube for monitoring, the white cap is removed, and the tube fixed to street furniture or another suitable structure. The tube is placed in a vertical position, with the coloured end cap (containing the absorbent reagent) pointing upwards, and the open end pointing downwards. It is left in place for 4/5 weeks, then re-sealed using the white cap and returned to the laboratory for analysis. It is then possible to calculate the average ambient concentration of NO₂ at the monitoring site over the tube exposure period, from the amount of nitrite ion remaining in the tube following exposure.

Because of their susceptibility to exposure-related sources of bias, the user must apply an ‘adjustment factor’ before comparing the annual mean NO₂ concentration with applicable limit values or objectives. The ‘adjustment factor’ is based on the results of a co-location study in which diffusion tubes are used alongside a reference chemiluminescent analyser.

Diffusion tubes rely on having a column of still, unmixed air, of a known length, inside the tube. Wind turbulence around the open end of the tube can cause the air in the bottom few millimetres of the tube to be mixed with the surrounding air. This shortens the diffusive path length (the effective length of tube), resulting in over-estimation of the ambient NO₂ concentration (positive bias).

A.2 Diffusion Tubes Used in UUNN

The tubes deployed on the UUNN have a modification in comparison to standard diffusion tubes in the form of a wind protection cap. This is intended to reduce potential positive bias resulting from the effects of wind turbulence and thereby improve the accuracy of the diffusion tube measurements. This wind protection cap (white) consists of a small disk of porous polyethylene filter material which is fitted over the lower end of the tube. Gases, such as nitrogen dioxide, can pass through the material and travel up the tube by molecular diffusion as would happen with an open tube, but the polyethylene filter prevents wind turbulence in what would otherwise be the open end of the tube. Martin et al (2014)⁷ tested various types of wind protection cap: the type which provided the best results in their trials has been adopted for use on the UUNN (this is referred to as ‘type III’ within the Martin et al (2014) paper).

The absorbent compound, TEA, is coated onto a fine stainless steel mesh and mounted in the grey end cap (which is at the top when the tube is in use). The other end of the tube (which is at the bottom when

⁷ Martin, N.A. et al (2014), Measurement of nitrogen dioxide diffusive sampling rates for Palmes diffusion tubes using a controlled atmospheric test facility (CATFAC), Atmospheric Environment 94 (2014), pp 529 – 537

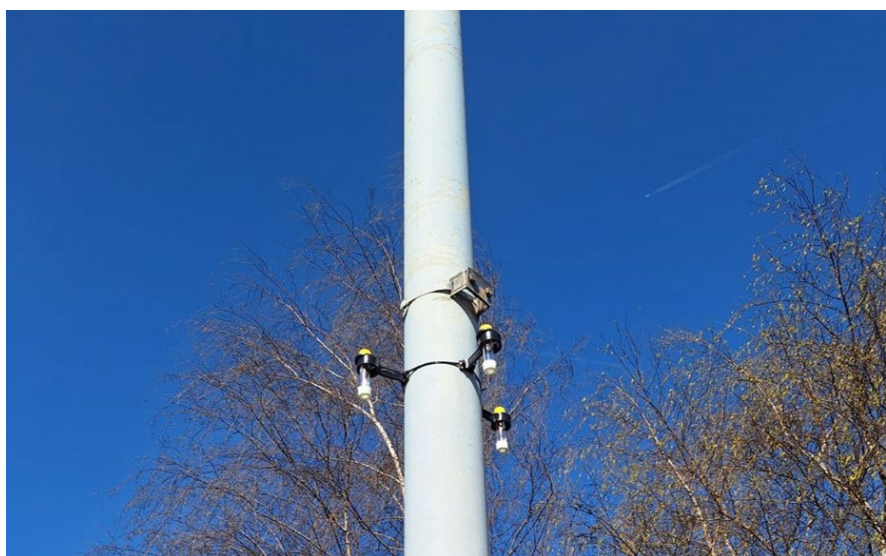
the tube is in use) contains the porous polyethylene filter (for wind protection) mounted in the white cap. The tubes are supplied with the wind caps fitted with each tube supplied in a plastic screw-topped vial. They are stored within the vials until deployment, and upon collection they are sealed by removing the wind protection cap and replacing it with a solid end cap, and then sealing back into the vial.

Figure A. 1 Diffusion Tube with Wind-Protection Cap



The tube on the right shows the separated components. The wind cap is the white cap on the base of the tube on the left and is shown separated into its components next to the tube on the right.

Figure A. 2 Example UUNN Monitoring Location



A.3 Laboratory Accreditation and QA/QC processes

The tubes are supplied, prepared, transported and analysed to meet the specification of BS EN 16339:2013⁸. Gradko International (Gradko) supplies and analyses the tubes deployed on the UUNN. Gradko International is accredited in accordance with International Standard ISO/IEC 17025:2017⁹. Gradko International participates in AIR PT¹⁰, an independent analytical proficiency-testing (PT) scheme.

⁸ BS EN 16339:2013 - Ambient air. Method for the determination of the concentration of nitrogen dioxide by diffusive sampling

⁹ International Standard ISO/IEC 17025:2017 - General Requirements for the competence of testing and calibration laboratories

¹⁰ [Air & Stack Emissions \(AIR PT\)](#)

Appendix B – 2025 UUNN Monitoring Calendar

Table B. 1 2025 UUNN Timetable for Tube Change

Month	Target Data (Acceptable Date)
January 2025	06-Jan (07-Jan)
February 2025	03-Feb (04-Feb)
March 2025	03-Mar (04-Mar)
April 2025	01-Apr (02-Apr)
May 2025	01-May (02-May)
June 2025	02-Jun (03-Jun)
July 2025	01-Jul (02-Jul)
August 2025	04-Aug (05-Aug)*
September 2025	01-Sep (02-Sep)
October 2025	01-Oct (02-Oct)
November 2025	03-Nov (04-Nov)
December 2025	01-Dec (02-Dec)*
January 2026	05-Jan (06-Jan)

* Where the Target Date falls on a Bank Holiday in Scotland, it is acceptable that tube changes for those sites in Scotland are undertaken on the date following the acceptable date also.

Appendix C – UUNN Exceedance Sites

Table C. 1 UUNN Sites in Exceedance of the 40 (µg/m³) Limit Value

Site ID	Local Authority	2025 Annual Mean NO ₂ Concentration (µg/m³)
UUNN_BRIS_009	Bristol	44.1

Table C. 2 UUNN Sites Within 10% of the 40 (µg/m³) Limit Value

Site ID	Local Authority	2025 Annual Mean NO ₂ Concentration (µg/m³)
UUNN_BIRM_003	Birmingham	38.1
UUNN_CVTR_009	Coventry	38.6
UUNN_LIVE_024	Liverpool	39.2
UUNN_MANC_029	Manchester	37.0
UUNN_VOWH_001	Vale of White Horse	39.4

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