2023 Air Quality Annual Status Report (ASR)

In fulfilment of Part IV of the Environment Act 1995 Local Air Quality Management, as amended by the Environment Act 2021

Date: June, 2023

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Executive Summary: Air Quality in Our Area

Air Quality in Luton

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

The mortality burden of air pollution within the UK is equivalent to 29,000 to 43,000 deaths at typical ages[3], with a total estimated healthcare cost to the NHS and social care of £157 million in 2017[4].

Luton Borough Council (LBC) is a unitary authority in Bedfordshire with an estimated population of 224,826 (ONS mid-year figure for 2021) in an area of 4,335 hectares. The borough is dominated by the population centre of Luton town, with the M1 motorway running north/south on its western side and London Luton Airport at the southeast of the borough.

Road traffic is the borough's main source of pollution, with the town and the motorway providing significant traffic volumes. Other sources include London Luton Airport and local industry, distributed in pockets around the borough. As of 2023, 39 industrial processes permitted by Luton Borough Council were operational within the borough.

At present, the main pollutant of concern is nitrogen dioxide (NO_2). The council monitors this pollutant and particulate matter; however, no exceedance of the objective for particulate matter (PM10) has been measured or modelled to date.

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[1] Public Health England. Air Quality: A Briefing for Directors of Public Health, 2017

[2] Defra. Air quality and social deprivation in the UK: an environmental inequalities analysis, 2006

[3] Defra. Air quality appraisal: damage cost guidance, January 2023

[4] Public Health England. Estimation of costs to the NHS and social care due to the health impacts of air pollution: summary report, May 2018

The introduction of *The Environmental Targets (Fine Particulate Matter) (England) Regulations 2023* has, for the first time, established two binding air quality targets for fine particulate matter ($PM_{2.5}$):

- Regulation 4: *"The annual mean concentration target is that by the end of 31st December 2040 the annual mean level of $PM_{2.5}$ in ambient air must be equal to or less than 10µg/m³ ("the target level")."*

- Regulation 7: *"The population exposure reduction target is that there is at least a 35% reduction in population exposure by the end of 31st December 2040 ("the target date"), as compared with the average population exposure in the three-year period from 1st January 2016 to 31st December 2018 ("the baseline period")…"*

Responding to growing concerns about the health effects of this pollutant, Luton Borough Council started measuring $PM_{2.5}$ levels at its town centre automatic monitoring station (*LN60 / HB007* - situated on Dunstable Road East) at the end of 2014. Since then, in 2019, *Luton Rising* (the trading name for *London Luton Airport Ltd*, the council-owned business and social enterprise that owns the airport) started monitoring $PM_{2.5}$ at its air quality monitoring station in Wigmore Valley Park (*LA001*). And in 2021, LBC deployed five new indicative sensor-based air quality monitors at sites across the borough to measure $PM_{2.5}$, PM_{10} and NO_2 in real-time (the annual datasets obtained by these monitors are included for the first time in Appendix G of this report). The monitoring data from all automatic and indicative sites within Luton is publicly available and can be accessed in near real-time via the *Herts & Beds Air Quality Network* web portal [https://tinyurl.com/5cdm2h43].

During 2022, the annual mean $PM_{2.5}$ concentration measured at LN60 / HB007 was 9.1µg/m³, which is 0.1µg/m³ (1.1%) lower than the previous year and still significantly reduced from pre-COVID levels (the four-year average between 2016 and 2019 was 9.8µg/m³). At LA001, the 2022 annual average was 8.4µg/m³, a decrease of 1µg/m³ (10.6%) compared with 2021. Consequently, during 2022, the annual mean concentrations at both of the borough's $PM_{2.5}$ continuous monitoring sites were below the incoming concentration target of 10µg/m³.

During 2022, LBC monitored NO_2 levels within the borough using an automatic analyser at its Dunstable Road East monitoring site (LN60 / HB007) and 94 diffusion tubes at 92 locations across the town. This represents an 80% increase in the number of passive monitoring sites when compared with the previous year, with:

- five additional tubes co-located with the new indicative monitors;
- six additional tubes deployed at new sites in Vauxhall and Wigmore wards to enhance monitoring at relevant receptors in the vicinity of the airport at the request of the Overview & Scrutiny Board;
- ten additional tubes deployed at potential congestion hotspots identified by LBC Highways at the direction of the Climate Change Advisory Board; and
- twenty additional tubes deployed in and around Bury Park at the direction of the Climate Change Advisory Board to support the development of future traffic interventions.

Changed and analysed monthly, the data from these tubes measures how NO_2 levels vary over time and is used to calculate an annual mean concentration at each monitoring location. Once corrected for measurement bias (and, if necessary, adjusted to consider the tubes' location relative to any likely human exposure), these annual values should not exceed the national air quality objective level of 40µg/m^3. If this level is expected to be exceeded consistently, Local Authorities must declare an Air Quality Management Area (AQMA) encompassing the relevant locations. Both nationally and locally, road transport is the main source of high levels of nitrogen dioxide.

In addition to the monitoring undertaken by LBC, London Luton Airport Operations Ltd. (LLAOL) and Luton Rising also operate air quality monitoring programmes. During 2022, the LLAOL programme consisted of a PM_{10} automatic analyser located on the airport site (*HB006)* and diffusion tubes at 19 unique locations in the vicinity of the airport and along the flightpath leading to and from it. During the same period, the Luton Rising programme consisted of a continuous multi-pollutant monitoring station in Wigmore Valley Park (*LA001*) and a network of passive monitoring sites, including 11 NO_2 diffusion tube monitoring locations distributed around Luton and the surrounding area. Nine of these 11 sites were equipped with duplicate NO_2 diffusion tubes, whilst the remaining two were triplicate co-location studies deployed at the continuous monitoring sites *LN60 / HB007* and *LA001* respectively.

To date, LBC has identified two main areas where past monitoring has shown that NO_2 concentrations either were or were likely to exceed the annual mean objective level:

- along the length of the M1 Motorway; and
- along the A505 (Dunstable Road) in part of Bury Park and the Town Centre.

Both areas have been declared as Air Quality Management Areas (AQMAs). For further information, please see the Council's website (https://tinyurl.com/y9zegeyj) or its page on the UK Air web portal (https://tinyurl.com/yd8t7ma2).

As shown in Figure A.1, no exceedance of the annual mean NO_2 objective has been recorded at any monitoring site in the vicinity of the M1 (AQMA N$^{os.}$ 1 & 2) for the last five years – continuing a pattern of compliance that pre-dates the subsequent pandemic-related decrease. In light of this apparent sustained compliance, LBC has sought guidance from the LAQM Helpdesk regarding the information required to support the revocation of these AQMAs. With the Helpdesk indicating that the obtained monitoring data is likely to be sufficient to avoid the need to undertake a modelling study, it is proposed that LBC will proceed with the revocation of AQMA N$^{os.}$ 1 & 2 pending the completion of a final period (6 - 12 months) of enhanced monitoring with additional passive sites at previously unmonitored locations – an approach approved by the Council's Climate Change Advisory Board, which now includes Air Quality within its purview.

Following its most recent Air Quality Management Area Declaration (Luton Air Quality Management Area N$^{o.}$ 3), Luton Borough Council developed and approved an Air Quality Action Plan (AQAP) to address the concentrations found. Following appraisal by Defra, in August 2019 the Council was advised to re-visit the source apportionment study that underpins the AQAP and to undertake additional work to quantify the likely impact of the proposed actions. In response to this feedback, the Council commissioned environmental consultants AECOM to undertake a new source apportionment and options appraisal study. In addition to this, AECOM was also tasked with undertaking a review of the boundary of AQMA N$^{o.}$ 3 in light of a persistent exceedance of the annual mean NO_2 objective that had been observed before the pandemic at a non-AQMA site at the junction of Castle, Windsor and Hibbert Streets (LN67). Appended to this report along with the source apportionment findings (Appendix J) and a supporting technical note (Appendix H), this review (Appendix I) recommends that the boundary of AQMA N$^{o.}$ 3 should be:

> *"extended along Castle Street Southward to the Stockwood Crescent / Castle Street / Cowper Street / London Road junction to ensure that all relevant hotspots are captured within the amended AQMA."*

Subsequently presented to the Climate Change Advisory Board, this recommendation was noted and approved in principle. As a result, the source apportionment output is currently being used to develop a revised AQAP for an expanded AQMA N$^{o.}$ 3.

As shown in Figure A.2, across the 52 passive sites in situ for at least five years, the 2022 NO_2 concentrations continue a gradually increasing trend evident since the historic lows experienced during 2020 due to the COVID lockdowns. However, thus far, the rate of increase has been relatively slow (an average increase of 0.5µg/m^3 [2.1%] since 2021), with the average concentration across all sites in 2022 still being approximately 25% lower than in 2019.

Across all three monitoring programmes (LBC, LLAOL and Luton Rising), for the third consecutive year, the annual mean NO_2 air quality objective level of 40µg/m^3 was only exceeded at a single site (*L7*, 51.4µg/m^3). A non-AQMA roadside site on Vauxhall Way, *L7* is not considered representative of relevant exposure due to being situated away from amenities and residential accommodation.

In addition to the previously discussed monitoring, Defra also undertakes NO_2 monitoring in Luton with an automatic analyser (*LUTR*) located on the A505 Dunstable Road as part of its *Automatic Urban and Rural Network* (AURN). Positioned at the roadside, the monitor's location does not represent relevant exposure. During 2022, the annual mean NO_2 concentration at the site was 30.0µg/m^3, 1.4µg/m^3 lower than in the previous year (a decrease of 4.5%). At the other two continuous NO_2 monitors within the town, at *LN60 / HB007* the annual mean concentration was 32.5µg/m^3 (2.3µg/m^3 higher than in 2021, an increase of 7.6%), and at *LA001* it was 14.1µg/m^3 (2.8µg/m^3 higher than in 2021, an increase of 24.8%). In all three cases, the average concentrations for 2022 remained lower than those obtained at the same locations in 2019.

In addition to monitoring compliance with relevant air quality objectives, this year, for the first time, the Annual Status Report also contains time variation plots of both the automatic (Appendix F) and indicative sensor-based (Appendix G) datasets. Showing average variation of NO_2, PM_{10} and $PM_{2.5}$ by:

i) day of the week and hour of the day combined;
ii) hour of the day;
iii) day of the week; and
iv) month of the year

these plots indicate the presence of a significant *"traffic diurnal",* with increased pollutant concentrations during distinct rush hour periods in the morning and afternoon. This characteristic pattern is particularly apparent in the NO_2 datasets.

As a member of the *Herts & Beds Air Quality Network*, Luton Borough Council works with colleagues in neighbouring authorities to ensure a consistent approach and to raise awareness of air quality in Luton and the surrounding area.

Where Air Quality Management Areas have been declared, appropriate actions are identified, working with partners within the Council (Public Health, Highways, Sustainability / Climate Change, Licensing, and Development Control) and externally as appropriate. Regular contact with these partners will ensure that the steps identified are progressed to reduce concentrations of air pollutants.

Actions to Improve Air Quality

Whilst air quality has improved significantly in recent decades, there are some areas where local action is needed to protect people and the environment from the effects of air pollution.

The Environmental Improvement Plan[5] sets out actions that will drive continued improvements to air quality and to meet the new national interim and long-term $PM_{2.5}$ targets. The National Air Quality Strategy, due to be published in 2023, will provide more information on local authorities' responsibilities to work towards these new targets and reduce $PM_{2.5}$ in their areas. The Road to Zero[6] details the approach to reduce exhaust emissions from road transport through a number of mechanisms; this is extremely important given that the majority of Air Quality Management Areas (AQMAs) are designated due to elevated concentrations heavily influenced by transport emissions.

[5] Defra. Environmental Improvement Plan 2023, January 2023

[6] DfT. The Road to Zero: Next steps towards cleaner road transport and delivering our Industrial Strategy, July 2018

During 2022, actions taken to improve air quality within Luton have included:

i) The official opening of the Luton DART (Direct Air-Rail Transit – https://www.lutondart.com) on 27th March 2023[7]. Connecting London Luton Airport with national rail services in under four minutes, this new airport transfer by fully automated and electrically powered shuttle aims to increase rail modal share by making travelling to the airport by public transport more convenient.

Figure 1 – The new Luton DART (Direct Air-Rail Transit)

[7] Luton Borough Council. Luton DART to officially open on Monday 27 March (https://tinyurl.com/ywm7xh8b), March 2023

ii) The launch of LBC's *"Engines off"* anti-idling campaign following a decision by Councillors in March 2022 to educate, engage with and, as a last resort, fine drivers to reduce engine idling. Supported by an awareness-raising promotional video (https://tinyurl.com/y5cwauhx), between July and October 2022, intervention by officers from the Council's Neighbourhood and Parking Enforcement Teams has resulted in almost 400 idling drivers switching off their engines[8].

Figure 2 - Promotional material for the LBC *"Engines Off"* campaign

iii) The launch of Cycling UK's "*Making cycling e-asier – National e-cycle scheme"* pilot in Luton & Dunstable (https://tinyurl.com/mr98cjmb). Funded by the Department for Transport:

> *"The scheme offers free skills and confidence sessions and e-cycle loans to encourage people to consider e-cycles as an active travel option for everyday journeys."*

iv) In November 2022, the adoption of the Council's new *Electric vehicle chargepoint strategy 2022 to 2025* (https://tinyurl.com/2tfwara4). Prepared in

[8] Luton Borough Council. Anti-idling campaign achieving results (https://tinyurl.com/ye259z3c), October 2022

partnership with the Energy Saving Trust, this strategy provides a policy framework from which EV chargepoint solutions will be brought forward over a three-year period[9]. Subsequent to its publication, the Office for Zero Emission Vehicles has provisionally allocated £1.2 million to the Council to support its ambition to increase the number of publicly available chargepoints in Luton from 45 to over 200 by 2025[10].

v) Public consultation on the Council's draft *Local Cycling and Walking Infrastructure Plan 2023-2033* (LCWIP - https://tinyurl.com/2p924fma). To make Luton:

> *"A greener, healthier more sustainable town with a connected, safe and inclusive active travel network that integrates effectively with wider sustainable transport options to create a town with cleaner air, increased mobility and more opportunities for all."*

A key objective of the plan is for half of all shorter journeys within the town (*i.e.* those less than 5km) to be made by either cycling or walking by 2033[11].

vi) Completion of the AQMA Nº. 3 review (Appendix I) and source apportionment (Appendix J).

vii) The expansion of the LBC diffusion tube monitoring network, with annual mean results for 92 unique locations reported for 2022, compared to 51 in the previous ASR (an increase of 80%). Included in this increase were six additional tubes deployed at new sites in Vauxhall and Wigmore wards at the request of the Overview & Scrutiny Board's London Luton Airport Air Quality Impact Task & Finish Group, and 20 additional tubes deployed in the vicinity of Bury Park at the direction of the Climate Change Advisory Board.

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[9] Luton Borough Council. Electric vehicles (https://tinyurl.com/3zk6hev9), [Accessed 23/06/2023]

[10] Luton Borough Council. Increase in Luton's electric vehicle chargepoints will improve access for all (https://tinyurl.com/mpcxkrj4), April 2023

[11] Luton Borough Council. Local Cycling and Walking Infrastructure Plan (LCWIP) Consultation (https://tinyurl.com/2p8xhr6s), [Accessed 23/06/2023]

viii) The time variation analysis of continuous monitoring data. With LBC's new network of five sensor-based indicative air pollution monitors completing their first full year of monitoring, this reporting year has seen a considerable increase in the amount of continuous data generated within the borough. To extract the maximum benefit from this data, a suite of plots similar to the Openair Time Variation tool used on the UK Air website (https://tinyurl.com/4zn5xfx2) has been prepared for each indicative monitor to explore the average variation of NO_2, PM_{10} and $PM_{2.5}$ levels over different reference periods (Appendix G). Similar plots have also been prepared for the borough's other continuous monitors (Appendix F). This analysis indicates the presence of a marked *"traffic diurnal"*, with increased pollutant concentrations during distinct rush hour periods in the morning and afternoon. This characteristic pattern is especially evident for the NO_2 datasets.

ix) The promotion of the Herts & Beds Air Pollution Alert System at the NHS Bedfordshire, Luton and Milton Keynes Integrated Care Board's *World Asthma Day 2023 – Children and Young People's Event* (https://tinyurl.com/2nt4u2ek).

Conclusions and Priorities

With overall NO_2 levels marginally up compared to 2021, no clear trend apparent across the three PM_{10} sites and modest decreases at both $PM_{2.5}$ monitoring locations, the 2022 results mark a continuation of the reduced pollutant levels observed in Luton since the COVID-induced lows of 2020.

With no exceedances at a relevant receptor in 2022, whilst continuing to maintain a watching brief to ascertain the extent to which pollutant levels will return to their pre-COVID concentrations, the main priorities for LBC in the coming year are:

i. As recommended by AECOM's review (Appendix I), to revise the boundary of AQMA N$^{o.}$ 3 to incorporate areas where elevated NO_2 levels have previously been observed (the proposed updated boundary is shown in Figure 8 of Appendix I);

ii. To revoke AQMA N$^{os.}$ 1 & 2 pending additional short-term passive monitoring at previously unmonitored AQMA sites to ensure that no NO_2 hotspots have persisted unobserved. New sites to be established in the vicinity of:

a. Gilderdale;
b. High Street / Manor Farm Close;
c. Eldon Road / Derby Road / Dunstable Road; and
d. Halfway Avenue / Dunstable Road.

iii. To use the findings of the source apportionment undertaken by AECOM (Appendix J) to deliver a new fit-for-purpose AQAP for AQMA No. 3; and

iv. To develop a borough-wide Air Quality Strategy to reduce pollutant levels across the whole town, focusing on $PM_{2.5}$ and achieving compliance with the new targets introduced by *The Environmental Targets (Fine Particulate Matter) (England) Regulations 2023*.

The principal challenge in delivering this work programme over the coming year will be the continued lack of resource within the Council's Environmental Protection Team, which has been subject to staff shortages for an appreciable period.

Local Engagement and How to get Involved

The potential for the residents and businesses of Luton to positively impact air quality is considerable. Poor air quality in the town has been shown to result from busy and congested roads.

By choosing sustainable methods of travel, there will be less pollution in the local atmosphere. Recommended travel methods are:

- Walking
- Cycling
- Public Transport
- Use of Electric Vehicles

Where these are not feasible, a newer vehicle that meets a higher emissions specification will produce less pollution than an older engine.

More information on journey planning, sustainable modes of travel and the local transport network can be found on the LBC *Transport and streets* webpages (https://tinyurl.com/yd8du68t).

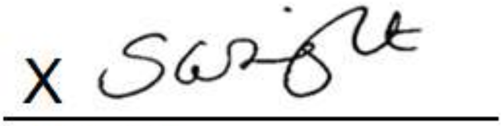
Additionally, members of the Public can help shape future policy by engaging in the public consultation process.

Local Responsibilities and Commitment

This ASR was prepared by the Environmental Protection Team at Luton Borough Council with the support and agreement of the following officers and departments:

- Andrew Loosley, Technical Officer (Environmental Protection)
- Nathan Burge, Electric Vehicle Chargepoint Project Officer (Strategy and Sustainability)

This ASR has been approved by:



Sally Cartwright
Director of Public Health

Sue Frost
Interim Corporate Director Inclusive Economy

This ASR has been signed off by a Director of Public Health.

If you have any comments on this ASR, please send them to Andrew Loosley at:

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1 Local Air Quality Management

This report provides an overview of air quality in Luton during 2022. It fulfils the requirements of Local Air Quality Management (LAQM) as set out in Part IV of the Environment Act (1995), as amended by the Environment Act (2021), and the relevant Policy and Technical Guidance documents.

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

The statutory air quality objectives applicable to LAQM in England are presented in Table E.1.

2 Actions to Improve Air Quality

2.1 Air Quality Management Areas

Air Quality Management Areas (AQMAs) are declared when there is an exceedance or likely exceedance of an air quality objective. After declaration, the authority should prepare an Air Quality Action Plan (AQAP) within 18 months. The AQAP should specify how air quality targets will be achieved and maintained, and provide dates by which measures will be carried out.

A summary of AQMAs declared by Luton Borough Council can be found in Table 2.1. The table presents a description of the three AQMAs that are currently designated within Luton. Appendix D: Map(s) of Monitoring Locations and AQMAs provides maps of AQMAs and also the air quality monitoring locations in relation to the AQMAs. The air quality objectives pertinent to the current AQMA designations are as follows:

- NO_2 annual mean.

As a result of no exceedance of the annual mean NO_2 objective being recorded within AQMA N^os.^ 1 & 2 for the last five years (see Figure A.1a)a.), pending the completion of a period (6 - 12 months) of enhanced passive monitoring to include previously unmonitored locations, we propose to revoke both AQMAs.

Following the recommendations of the *Luton Town Centre Air Quality Management Area Review* undertaken by AECOM (Appendix I), we propose to amend AQMA N^o.^ 3 by extending it:

> "*along Castle Street Southward to the Stockwood Crescent / Castle Street / Cowper Street / London Road junction to ensure that all relevant hotspots are captured within the amended AQMA."*

Table 2.1 – Declared Air Quality Management Areas

AQMA Name	Date of Declaration	Pollutants and Air Quality Objectives	One Line Description	Is air quality in the AQMA influenced by roads controlled by Highways England?	Level of Exceedance: Declaration	Level of Exceedance: Current Year	Number of Years Compliant with Air Quality Objective	Name, Date of Publication and Web Link for AQAP
Luton AQMA Nº1	Declared 03/11/2003	NO_2 Annual Mean	24 Residential properties on either side of the M1 Motorway, near Junction 11	YES	47.6µg/m³	28.2µg/m³ (LN86; AQO not exceeded)	5 years	Within Local Transport Plan 3 2011-2026 (March 2011) [https://tinyurl.com/y9r4vhkf]
Luton AQMA Nº2	Declared 31/03/2005	NO_2 Annual Mean	431 Residential properties on either side of the M1 Motorway, near Junction 11	YES	58.9µg/m³	28.2µg/m³ (LN86; AQO not exceeded)	5 years	Within Local Transport Plan 3 2011-2026 (March 2011) [https://tinyurl.com/y9r4vhkf]
Luton AQMA Nº3	Declared 01/05/2016	NO_2 Annual Mean	From Dunstable Road by Kenilworth Road through to Stuart Street and Chapel Viaduct by Latimer Road, including Castle Street to Holly Street and Telford Way	NO	54.6µg/m³	35.5µg/m³ (LN100; AQO not exceeded)	3 years	Initial AQAP approved by Council Executive June 2018 [https://tinyurl.com/ybftauns]. However, subsequently not accepted by Defra. New source apportionment (Appendix J), completed 2022. Revised draft AQAP currently being prepared, due for completion 2023

☒ **Luton Borough Council confirm the information on UK-Air regarding their AQMAs is up to date.**

☒ **Luton Borough Council confirm that all current AQAPs have been submitted to Defra.**

2.2 Progress and Impact of Measures to address Air Quality in Luton

Defra's appraisal of last year's ASR concluded that:

> *"On the basis of the evidence provided by the local authority the conclusions reached are accepted for all sources and pollutants… The report is well structured, detailed, and provides the information specified in the Guidance."*

Whilst the appended commentary made the following suggestion for future reports:

> *"The maps of monitoring locations within the Council's administrative area are clear, however it would be useful if there were more zoomed in versions so that street names could be read so locations can be more easily pinpointed."*

In responding to this feedback, including larger-scale maps of monitoring locations in this report has not been possible. This is because the large number of maps needed due to the increase in LBC passive sites would be impractical. However, as an alternative way of addressing this issue, tables containing the *what3words* addresses of all relevant sites have been appended to each map in Appendix D: Map(s) of Monitoring Locations and AQMAs. Hyperlinked to show their location on the *what3words.com* online map, clicking on these addresses allows the location of each site to be explored in detail.

Luton Borough Council has taken forward a number of direct measures during the current reporting year of 2022/23 in pursuit of improving local air quality. Details of all measures completed, in progress or planned are set out in Table 2.2. Twenty-five active measures are included within Table 2.2, with the type of measure and the progress Luton Borough Council has made during the reporting year of 2022/23 presented. Where there have been, or continue to be, barriers restricting the implementation of the measure, these are also shown in Table 2.2.

Further information on these measures will be included in the new town centre AQAP currently in development for AQMA Nº. 3. However, as many of the measures are shared with other policy areas where they offer co-benefits (*i.e.* Transport, Climate Change and Public Health), where appropriate, links to relevant documents in these areas have been included in Table 2.2

Over the past year, key completed measures have included:

- the official opening of the Luton DART (Direct Air-Rail Transit – https://www.lutondart.com) connecting London Luton Airport with national rail services in under four minutes;
- the launch of LBC's *"Engines off"* anti-idling campaign (https://tinyurl.com/4arsut6z), which between July and October 2022 resulted in almost 400 idling drivers being spoken to and switching off their engines;
- the launch of the Department for Transport and Cycling UK's "*Making cycling e-asier – National e-cycle scheme"* in Luton & Dunstable, offering free skill and confidence sessions and month-long e-cycle loans (https://tinyurl.com/mr98cjmb);
- the adoption of the Council's new *Electric vehicle chargepoint strategy 2022 to 2025* (https://tinyurl.com/2tfwara4);
- public consultation on the Council's draft *Local Cycling and Walking Infrastructure Plan 2023-2033* (LCWIP - https://tinyurl.com/2p924fma);
- completion of the AQMA N$^{o.}$ 3 review (Appendix I) and source apportionment (Appendix J);
- the expansion of the LBC diffusion tube monitoring network from 51 to 92 unique locations;
- the reporting of time variation analyses for continuous monitoring data; and
- the promotion of the *Herts & Beds Air Pollution Alert System* at the NHS Bedfordshire, Luton and Milton Keynes Integrated Care Board's *World Asthma Day 2023 – Children and Young People's Event* (https://tinyurl.com/2nt4u2ek).

Luton Borough Council expects the following to be completed over the course of the next reporting year: the deployment of additional NO_2 diffusion tubes at previously unmonitored sites in AQMA N$^{os.}$ 1 & 2 ahead of their possible revocation.

Luton Borough Council's priorities for the coming year are:

i. As recommended by AECOM's review (Appendix I), to revise the boundary of AQMA N$^{o.}$ 3 to incorporate areas where elevated NO_2 levels have previously been observed (the proposed updated boundary is shown in Figure 8 of Appendix I);
ii. To revoke AQMA N$^{os.}$ 1 & 2 pending additional short-term passive monitoring at previously unmonitored AQMA sites to ensure that no NO_2 hotspots have persisted unobserved;

iii. To use the findings of the source apportionment undertaken by AECOM (Appendix J) to deliver a new fit-for-purpose AQAP for AQMA N$^{o.}$ 3; and

iv. To develop a borough-wide Air Quality Strategy to reduce pollutant levels across the whole town, focusing on $PM_{2.5}$ and achieving compliance with the new targets introduced by *The Environmental Targets (Fine Particulate Matter) (England) Regulations 2023*.

The principal challenge in delivering this work programme over the coming year will be the continued lack of resource within the Council's Environmental Protection Team, which has been subject to staff shortages for an appreciable period. Indeed, these shortages have contributed to slower-than-expected progress in developing the new AQAP for AQMA N$^{o.}$3 during the last reporting year.

Luton Borough Council worked to implement these measures in partnership with the following stakeholders during 2022:

- the Energy Saving Trust; and
- the NHS Bedfordshire, Luton and Milton Keynes Integrated Care Board.

With no exceedance of the annual mean NO_2 objective observed at monitoring sites within either AQMA N$^{os.}$ 1 or 2 for the last five years, LBC proposes to revoke both AQMAs pending a brief period of enhanced passive monitoring. Similarly, no exceedances have been observed within the current boundary of AQMA N$^{o.}$ 3 for three years. However, the measures stated above and in Table 2.2 are currently being reviewed as part of the AQAP development process. This review will determine whether revised or additional measures not yet prescribed will be required in subsequent years to maintain the compliance seen post-COVID and enable revocation.

Table 2.2 – Progress on Measures to Improve Air Quality

Measure No.	Measure	Category	Classification	Year Measure Introduced in AQAP	Estimated / Actual Completion Date	Organisations Involved	Funding Source	Defra AQ Grant Funding	Funding Status	Estimated Cost of Measure	Measure Status	Reduction in Pollutant / Emission from Measure	Key Performance Indicator	Progress to Date	Comments / Barriers to Implementation
1	Implement Luton Park & Ride by securing delivery at identified locations	Alternatives to private vehicle use	Bus based Park & Ride	Introduced: 2018 Targeted start: 2025		LBC Strategy and Sustainability (action included in Climate Change Action Plan - https://tinyurl.com/5dta7zeu)		No	Not Funded	£1m - £10m	Planning	A Park & Ride would result in fewer cars driving into Luton Town Centre and the Airport	Monitor use of Park & Ride once up and running	Potential locations for Park & Ride sites identified. Design and development work is underway at Butterfield Business Park. Feasibility study completed (2016) Next step is to secure funding/delivery	Luton Local Plan 2011 - 2031 Policy LLP5 provides policy support for Park & Ride schemes at M1 junction 10A (Policy LLP5) and Butterfield Park (Policy LLP7) [https://tinyurl.com/3cjz6n8f] Supports LTP4 Policy 4 - *Improving Public Transport* [https://tinyurl.com/567k53pv] Sources of funding to be identified
2	Pilot Low Traffic Neighbourhoods which reduces motor vehicle traffic on residential streets through physical barriers	Traffic Management	Other	Targeted start: 2023		LBC Strategy and Sustainability Public Health Highways		No			Planning	Fewer vehicle movements will result in reduced emissions (NO_2 and particulate matter) and increased uptake of active modes of travel	Improvement in local air quality (reduction in NO_2 and particulate matter) Increased use of active modes of travel		
3	Deliver town-wide future cycling and walking network set out in the emerging local cycling and walking infrastructure plan	Transport Planning and Infrastructure	Cycle network	2022	2032	LBC Transport LBC Road Safety LBC Sustainable Development and Transport (action included in Climate Change Action Plan - https://tinyurl.com/5dta7zeu)		No	Not Funded		Planning	Increase in cycling creates modal shift away from the car, resulting in reduced emissions	Increased number of people using cycle routes to access the town centre	Ongoing Portfolio of suggested network amendments developed Public consultation on draft *Local Cycling and Walking Infrastructure Plan* (LCWIP) completed April 2023 (https://tinyurl.com/2p8xhr6s)	LTP4 Policy 5 - *Smarter Choices* supported by LTP4 Policy 2 - *Walking and Cycling* [https://tinyurl.com/567k53pv] Supports *Strategic Vision for Sport and Physical Activity 2018-22* Outcome 10 [https://tinyurl.com/3u5z65e5]
4	Implement a local delivery hub to maximise the efficiency of deliveries / enable green 'last mile' services.	Freight and Delivery Management	Freight Consolidation Centre	Targeted start: 2025		LBC Strategy and Sustainability (action included in draft *Luton Net Zero: Climate Policy & Action Plan*) Delivery Companies		No			Planning	Reduction in vehicle movements and emissions from LDV delivery vehicles	Volume of deliveries routed via the hub		
5	EV infrastructure across the council estate for both council and public charging	Promoting Low Emission Transport	Procuring alternative Refuelling infrastructure to promote Low Emission Vehicles, EV recharging, Gas fuel recharging	2018	2025	LBC Sustainable Development and Transport (action included in Climate Change Action Plan - https://tinyurl.com/5dta7zeu)	£1.2 million provisionally allocated by the Office for Zero Emission Vehicles	No	Funded		Planning	Increased EV use will result in a decrease in emissions	EV charging point usage data	Electric vehicle chargepoint strategy 2022 to 2025 adopted November 2022 (https://tinyurl.com/2tfwara4)	Supported by LTP4 Policy 6 - *Ultra Low Emission and Electric Vehicles* [https://tinyurl.com/567k53pv]

Measure No.	Measure	Category	Classification	Year Measure Introduced in AQAP	Estimated / Actual Completion Date	Organisations Involved	Funding Source	Defra AQ Grant Funding	Funding Status	Estimated Cost of Measure	Measure Status	Reduction in Pollutant / Emission from Measure	Key Performance Indicator	Progress to Date	Comments / Barriers to Implementation
6	Deliver bus priority measures	Traffic Management	Strategic highway improvements, Re-prioritising road space away from cars, inc Access management, Selective vehicle priority, bus priority, high vehicle occupancy lane	Targeted start: 2025		LBC Transport LBC Sustainable Development and Transport (action included in Climate Change Action Plan - https://tinyurl.com/5dta7zeu) Bus Operating Companies		No			Planning	Reduced congestion and journey time should result in higher uptake and reduced emissions	Congestion reduction Passengers numbers		
7	*New Ways of Working* adopted at LBC; promotion of a hybrid working model with employees in the office 40% of their hours	Promoting Travel Alternatives	Encourage / Facilitate home-working	2022	Ongoing	LBC		No			Ongoing	Reduction in car journeys commuting to work will result in reduced emissions (NO_2 and particulate matter)	Number of journeys avoided	Policy implemented and guidance published	
8	Exclusive *'Taxi Only'* EV infrastructure at taxi ranks	Promoting Low Emission Transport	Procuring alternative Refuelling infrastructure to promote Low Emission Vehicles, EV recharging, Gas fuel recharging	2018	2025	LBC Strategy and Sustainability (action included in Climate Change Action Plan - https://tinyurl.com/5dta7zeu)		No			Ongoing	Increased EV use will result in a decrease in emissions	Number of charge points installed Proportion of taxi fleet that are EVs	Four 55kW EV rapid charging units installed in taxi bays on Station Road, Park Street, Cheapside and Chaul End Lane during reporting year 2020/21	Supported by LTP4 Policy 6 - *Ultra Low Emission and Electric Vehicles* [https://tinyurl.com/567k53pv]
9	LBC and suppliers' fleets to be transitioned to EV	Promoting Low Emission Transport	Public Vehicle Procurement - Prioritising uptake of low emission vehicles		2028	LBC Fleet Management LBC Procurement LBC Strategy and Sustainability (action included in Climate Change Action Plan - https://tinyurl.com/5dta7zeu) Suppliers		No			Planning				
10	Improvement of Chapel viaduct / Castle Street roundabout	Traffic Management	Other	2018		LBC Transport		No		£500k - £1m	Planning	Less idling would result in reduced emissions	Improved traffic flow	Junction Mitigation Assessment Completed (2015) [https://tinyurl.com/y52t2hr7]	Included in Luton Local Plan 2011 - 2031 Policy LLP31 - *Sustainable Transport Strategy* [https://tinyurl.com/3cjz6n8f]

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(11)	Deployment of network of low cost pollution sensors to provide enhanced real time NO_2 and $PM_{2.5}$ monitoring data to public via online portal	Public Information	Via the Internet	2021	2021	LBC Transport LBC Environmental Protection LBC Sustainability	LBC Transport	No	Funded	£50k - £100k	Completed	Data to be used to inform targeted local interventions	Substantial improvement in geographical coverage of real time NO_2 and $PM_{2.5}$ monitoring data Improved public awareness	5 continuous indicative air quality monitors deployed Nov 2021 Real time data available via the Herts & Beds AQ Network website [https://tinyurl.com/3f78jc4c] Annual datasets included and analysed for the first time in this report (Appendix G).	
12	Deliver with support from communities, *'play streets'* where children can play freely outside their own front door by temporarily restricting vehicle access	Traffic Management	Other	Targeted start: 2023		LBC Strategy and Sustainability LBC Public Health LBC Highways		No			Planning				
13	Investigate expansion of pedestrianised area around Town Centre + High Town & Bury Park (either permanently or at peak times)	Traffic Management	Other	2018	2030	LBC Highways LBC Strategy and Sustainability (action included in Climate Change Action Plan - https://tinyurl.com/5dta7zeu) LBC Environmental Protection	Emergency Travel Fund £216k	No	Partially Funded		Planning	Wider pedestrianisation will reduce vehicle use in the Town Centre and hence result in improved air quality	Expansion of pedestrianised area will result in more people walking into the Town Centre		
14	Development of taxi and private hire zero (or low) emissions policy, adopting phased approach until 2040	Promoting Low Emission Transport	Taxi Licensing conditions		2040	LBC Strategy and Sustainability (action included in Climate Change Action Plan - https://tinyurl.com/5dta7zeu) LBC Licensing Taxi Companies		No			Planning	Increased use of zero emission vehicles will result in a decrease in traffic-related pollution	Proportion of taxi fleet that are EVs		Long timescale

Measure No.	Measure	Category	Classification	Year Measure Introduced in AQAP	Estimated / Actual Completion Date	Organisations Involved	Funding Source	Defra AQ Grant Funding	Funding Status	Estimated Cost of Measure	Measure Status	Reduction in Pollutant / Emission from Measure	Key Performance Indicator	Progress to Date	Comments / Barriers to Implementation
15	Work with schools and colleges to develop travel plans via Modeshift STARS which decrease use of the car and increase walking and cycling	Promoting Travel Alternatives	School Travel Plans		Ongoing	LBC Sustainable Development and Transport (action included in draft *Luton Net Zero: Climate Policy & Action Plan*) School Partners		No			Ongoing	Increased uptake of lift sharing or sustainable transport methods will reduce emissions	Number of new and updated school travel plans	Ongoing	LTP4 Policy 5 - *Smarter Choices* [https://tinyurl.com/567k53pv] Supports *Strategic Vision for Sport and Physical Activity 2018-22* Outcomes 10 & 17 [https://tinyurl.com/3u5z65e5] LBC information on School Travel Planning: [https://tinyurl.com/bdzy27jj] Accredited schools have to submit their travel plans annually to maintain accreditation
16	Work with large employers to develop workplace travel plans	Promoting Travel Alternatives	Workplace Travel Planning	2018	2025	LBC Sustainable Development and Transport (action included in draft *Luton Net Zero: Climate Policy & Action Plan*)		No			Ongoing	Increased uptake of lift sharing or sustainable transport methods will result in reduced emissions	Increase modal shift of staff using more sustainable modes	Planning phase	LTP4 Policy 5 - *Smarter Choices* [https://tinyurl.com/567k53pv] Potential measures to encourage sustainable travel include promotion of cycling and walking, discounted bus and rail travel, and car sharing Modeshift STARS to be used to manage process
17	Anti-idling awareness campaign and enforcement	Traffic Management	Anti-idling enforcement	2018	Ongoing	LBC Neighbourhood Enforcement LBC Parking Enforcement		No			Implementation	Reduced idling would result in lower emissions	Fewer drivers idling as a result of LBC intervention	*"Engines Off"* campaign launched June 2022 [https://tinyurl.com/4arsut6z] ~400 successful contacts with idling drivers between July and October 2022 [https://tinyurl.com/ye259z3c]	LTP4 calls for interventions to be directed at areas where there are greater concentrations of vulnerable people (*e.g.* schools, hospitals and day care centres). [https://tinyurl.com/567k53pv]
18	Engage with and promote travel schemes and discounted tickets *e.g.* Arriva discounted tickets for organisations participating in a travel club	Vehicle Fleet Efficiency	Promoting Low Emission Public Transport	Targeted start: 2025		LBC Sustainable Development and Transport (action included in draft *Luton Net Zero: Climate Policy & Action Plan*) Bus Operating Companies		No							
19	Promotion of car & lift sharing scheme via the council website	Alternatives to private vehicle use	Car & lift sharing schemes		Ongoing	LBC Sustainable Development and Transport		No			Ongoing	Lift sharing will result in fewer cars on the roads and hence reduced emissions	Number of lift share scheme users	Ongoing	Supports LTP4 Policy 1 - *Shared mobility and Mobility as a Service* [https://tinyurl.com/567k53pv] Travel Luton Liftshare: https://liftshare.com/uk

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20	E-Cargo Bike Rental Project	Promoting Travel Alternatives	Promotion of cycling	2023	2025	LBC Sustainable Development and Transport	DfT Capability Fund	No	Partially Funded (Project setup covered by DfT funding, however operation is currently unfunded)	£10k - £50k	Implementation	Reduction in emissions resulting from modal shift away from motorised transport, with increased use of cycling for both short journeys by families and for local deliveries by businesses.	Number of rentals Number of journeys made Increase in cycle usage after rental period		
21	Bikeability Cycle Training at Schools	Promoting Travel Alternatives	Promotion of cycling	2010	Ongoing	LBC Sustainable Development and Transport Outspoken (contractor delivering training)	Active Travel England - Bikeability Grant Funding	No	Funded	£10k - £50k	Ongoing	Modal shift away from the car, resulting in reduced emissions	Decrease in number of young people travelling to school by car Increase in number of children travelling actively Improved air quality at the school gate	1,002 children trained during reporting tear 2022/23	
22	Consider road user charging mechanisms to fund transport improvements	Traffic Management	Road User Charging (RUC)/ Congestion charging	Targeted start: 2025		LBC Strategy and Sustainability (action included in draft *Luton Net Zero: Climate Policy & Action Plan*)		No			Planning	Generate income stream to fund transport improvements that in turn will deliver emissions reductions Reduction in car use resulting in reduced emissions	Amount of funding generated and redistributed	Feasibility study completed (2019)	
23	Consider workplace parking levy to fund transport improvements	Traffic Management	Workplace Parking Levy, Parking Enforcement on highway	Targeted start: 2025		LBC Strategy and Sustainability (action included in draft *Luton Net Zero: Climate Policy & Action Plan*)		No			Planning	Generate income stream to fund transport improvements that in turn will deliver emissions reductions Reduction in car use resulting in reduced emissions	Amount of funding generated and redistributed		
24	Investigate implementing a Clean Air/Low Emissions Zone in the Town Centre	Promoting Low Emission Transport	Low Emission Zone (LEZ) or Clean Air Zone (CAZ)	2018	2023	LBC Transport Planning LBC Environmental Protection		No	Not Funded			Cleaner / greener transport options for staff and deliveries would reduce emissions in the town centre	Increased take up of clean energy vehicles / bikes by local businesses		To be reconsidered following the update of the AQMA Nº3 source appointment and development of new AQAP Feasibility study identified as a priority in LTP4, however currently still unfunded [https://tinyurl.com/567k53pv]

Measure No.	Measure	Category	Classification	Year Measure Introduced in AQAP	Estimated / Actual Completion Date	Organisations Involved	Funding Source	Defra AQ Grant Funding	Funding Status	Estimated Cost of Measure	Measure Status	Reduction in Pollutant / Emission from Measure	Key Performance Indicator	Progress to Date	Comments / Barriers to Implementation
25	Work with operators to introduce hybrid/low emission buses on routes within AQMA Nº3	Vehicle Fleet Efficiency	Promoting Low Emission Public Transport	2018		LBC Transport Bus Operating Companies		No	Not Funded			Improved Air Quality in AQMA Nº3	Reduced emissions from buses		To be reconsidered following the update of the AQMA Nº3 source appointment LTP4 encourages the use of low carbon buses as part of Bus Quality Partnerships [https://tinyurl.com/567k53pv] *[Target introduction of Hybrid/low emission buses through Bury Park and on Dunstable Road* *DfT funding opportunities to be explored]*
26	Review 20mph zones in and around AQMA Nº3 to encourage traffic calming and lower speeds	Traffic Management	Reduction of speed limits, 20mph zones	2018		LBC Transport LBC Road Safety		No				Vehicles travelling under 30mph generally emit less particulates and so improve air quality	Increase number of vehicles adhering to 20mph within the zones	20mph zones in place (Completed 2016/17)	To be reconsidered following the update of the AQMA Nº3 source appointment
(27)	Proposed project to replace a number of small town centre surface car parks with intelligent parking system enabled multi storey on Crawley Road site	Traffic Management	Other	2018		LBC Property & Construction		No			Aborted	Less engine idling and running time while drivers search for parking	Improved parking information and organisation	Planning application permitted	Work on project discontinued
(28)	Rollout of Schools Air Quality Workshops	Promoting Travel Alternatives	Promotion of cycling Promotion of walking	2022		LBC Sustainable Development and Transport		No	Not Funded		Aborted	Modal shift away from the car, resulting in reduced emissions	Decrease in number of young people travelling to school by car Increase in number of children travelling actively Improved air quality at the school gate	Successful pilot sessions held at Hillborough Junior and Bushmead Primary Exploring funding options	Project discontinued - unable to secure funding

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

As detailed in Policy Guidance LAQM.PG22 (Chapter 8), local authorities are expected to work towards reducing emissions and/or concentrations of $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5µm or less). There is clear evidence that $PM_{2.5}$ has a significant impact on human health, including premature mortality, allergic reactions, and cardiovascular diseases.

Responding to growing concerns about the health effects of fine particulate matter, Luton Borough Council started measuring $PM_{2.5}$ levels at its Dunstable Road East automatic monitoring station (*LN60 / HB007)* at the end of 2014. Since then, in 2019, Luton Rising started monitoring $PM_{2.5}$ at its new air quality monitoring station in Wigmore Valley Park (*LA001*). And in 2021, LBC deployed five new indicative air quality monitors at suspected congestion hotspots across the borough to measure $PM_{2.5}$ (as well as PM_{10} and NO_2) in real-time. Since coming into operation, the MCERTS-certified *Palas Fidas 200 Fine Dust Monitoring Device* located at *LN60 / HB007* has shown the annual mean $PM_{2.5}$ concentration at this site to have remained essentially constant at between 9 and 10µg/m^3 (in 2022, it was 9.1µg/m^3), with a single COVID-19 related deviation in 2020 when the level fell to 8.3µg/m^3.

Based on this monitoring, the measured annual mean $PM_{2.5}$ levels in the centre of Luton fall just within the new annual mean concentration target of 10µg/m^3 introduced by *The Environmental Targets (Fine Particulate) (England) Regulations 2023*. However, contrary to the result of this monitoring, Defra's modelled *LAQM Background Mapping Data* [https://tinyurl.com/2eb2urjd] consistently predicts that background levels will exceed 10µg/m^3 at this and the majority of other locations within the borough. Figure 3 shows the Defra modelled background $PM_{2.5}$ levels for each square kilometre in Luton for 2022, with 34 (74%) of the 46 grid squares being estimated to exceed the 10µg/m^3 concentration target that will come into force at the end of 2040.

Defra's modelling does not extend beyond 2030; however, Figure 4 shows the modelled background levels for 2028, when an interim concentration target of 12µg/m^3 is due to come into force. This later estimate predicts that the interim target will be met in all grid squares (as was already the case in 2022) and presents an improving picture with universally decreased concentrations and exceedances in 19 (41%) of the 46 grid squares.

Comparing 2022 modelled and monitored levels at *LN60 / HB007*, the predicted background was 11.2µg/m^3; however, the measured annual average at this roadside site was 9.1µg/m^3 - a difference of 21%. This difference is counterintuitive, as the measurements made at the roadside would be expected to be higher than the background level due to additional $PM_{2.5}$ contributed by the passing traffic.

Although measured using instrumentation not currently approved by Defra for use in the UK, comparing the 2022 annual mean $PM_{2.5}$ level recorded at Luton Rising's Wigmore Valley Park site (LA001) with the Defra modelled background value for this location, a similar discrepancy is apparent; the predicted background figure is 9.8µg/m^3, however the value measured at the monitoring station is 8.4µg/m^3 (a difference of 15%).

As the Defra modelled data is also used to calculate Public Health Outcomes Framework indicator *D01 – Fraction of mortality attributable to particulate air pollution* [https://tinyurl.com/d2duysv5], overestimation by the model could, to some extent, explain Luton's consistently poor performance in this metric. In 2021, with a value of 6.1%, along with St Albans, Three Rivers and Welwyn Hatfield, Luton had the joint third highest attributable mortality figure in the East of England - just behind both Hertsmere (6.2%) and Watford (6.3%) respectively. In 2021, the English national average was 5.5%. However, in practice, the high attributable mortality figure calculated for Luton largely results from its compact urban form and high population density. Dividing the mid-2021 population estimates (https://tinyurl.com/tjmn42rr) by the December 2022 Standard Area Measurements for administrative areas (https://tinyurl.com/5x72ahk9), Luton has the 21st highest population density of all UK local government administrative areas and is the most densely populated local authority outside of London.

Ultimately, as there is no evidence of a safe level of exposure to $PM_{2.5}$ or a threshold below which no adverse health effects occur[12], the case for action is undiminished regardless of which value best represents actual environmental concentrations. Although the actions listed in Table 2.2 were predominantly chosen with the reduction of NO_2 levels in mind, several will also be effective at securing reductions in $PM_{2.5}$ emissions and exposure. More specifically, these measures fall into three categories:

- Reducing the number of vehicles on the road (*e.g.* through public transport improvements and promotion, travel planning and the promotion of lift sharing);

[12] WHO. WHO global air quality guidelines, 2021 [https://tinyurl.com/rwcp7ady]

- Promoting modal shift to active forms of travel (*e.g.* improvements to cycle infrastructure and the prioritisation of active travel options through travel planning); and
- Improving the public provision of air quality information to enable individuals to manage their personal exposure more effectively (*e.g.* the *Herts & Beds Air Pollution Alert service* [https://tinyurl.com/mr3ptc3n] and the publication of near real-time air quality data via the *Herts & Beds Air Quality Network* web portal [https://tinyurl.com/5cdm2h43] and town centre CityTree electronic noticeboard).

In addition to the above, the whole of Luton Borough Council's administrative area has been a smoke control area since the 1970s [https://tinyurl.com/4k4hhzxe].

Figure 3 – Defra modelled annual average background $PM_{2.5}$ concentration (µg/m^3) per square kilometre for 2022

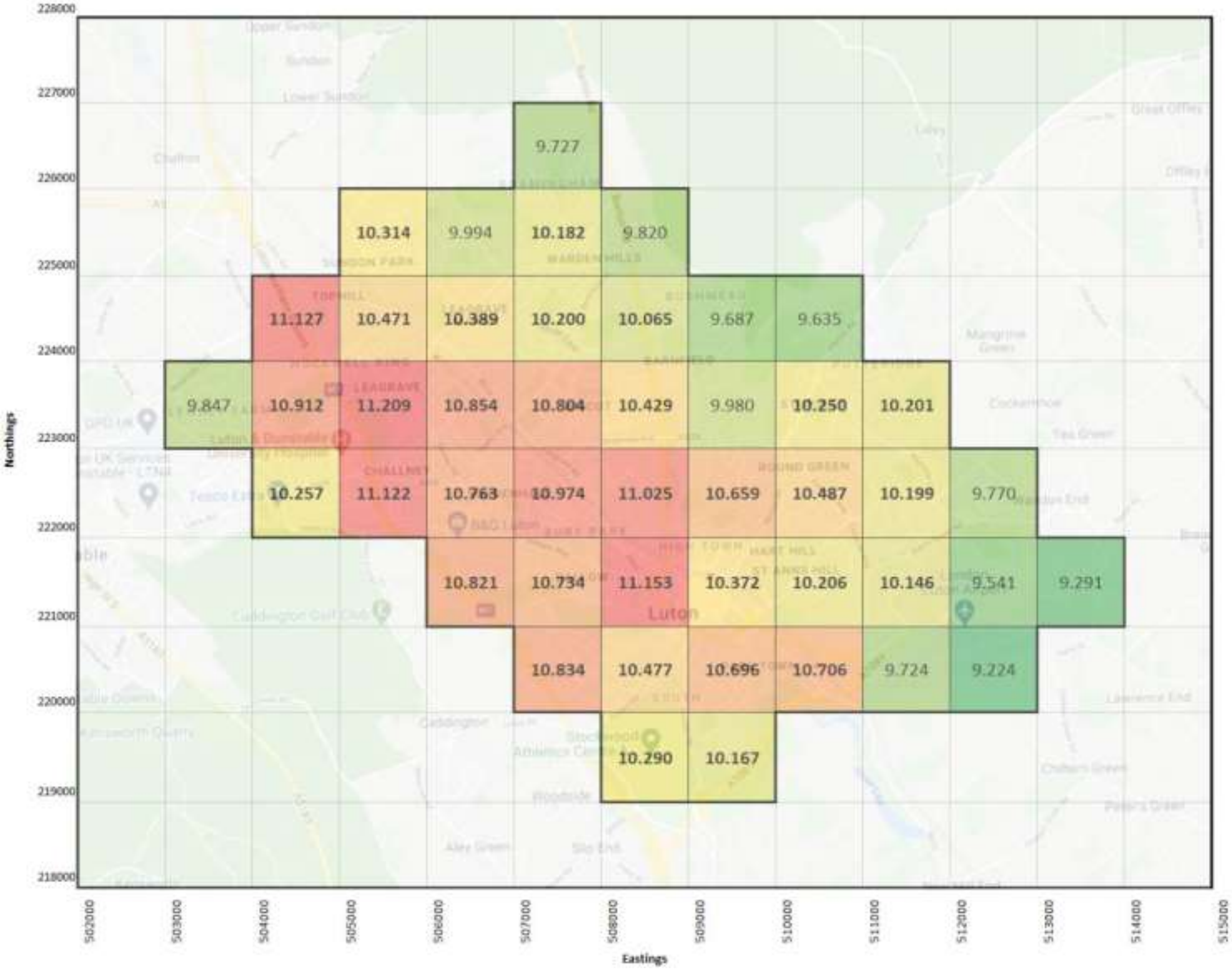
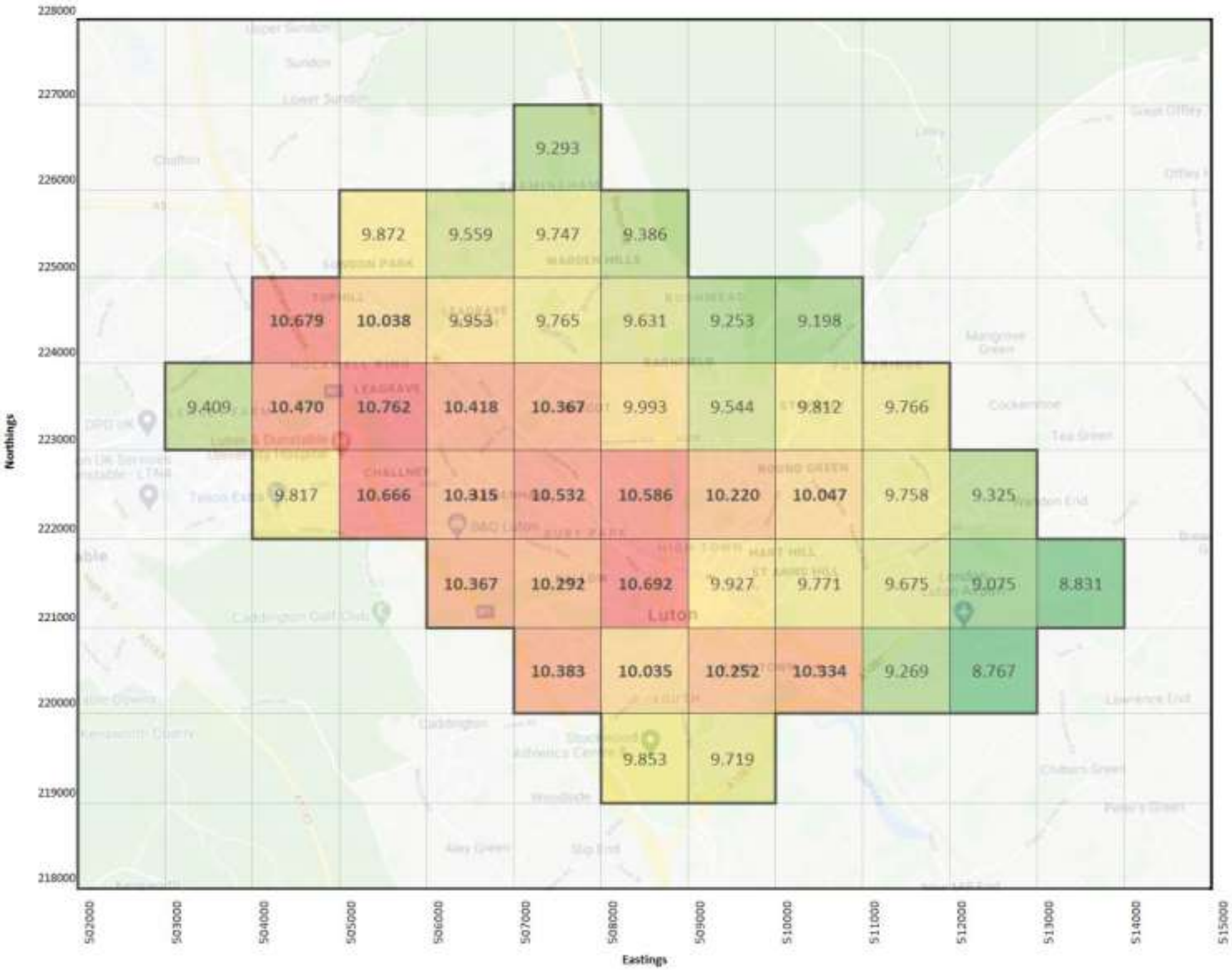


Figure 4 – Defra modelled annual average background $PM_{2.5}$ concentration (µg/m^3) per square kilometre for 2028



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

This section sets out the monitoring undertaken within 2022 by Luton Borough Council and how it compares with the relevant air quality objectives. In addition, monitoring results are presented for a five-year period between 2018 and 2022 to allow monitoring trends to be identified and discussed.

3.1 Summary of Monitoring Undertaken

3.1.1 Automatic Monitoring Sites

During 2022, Luton Borough Council (LBC) undertook automatic (continuous) monitoring of NO_2, PM_{10} and $PM_{2.5}$ at one reference site (using a ThermoScientific Model 42i Analyzer and Palas Fidas 200, respectively) and five additional sites using South Coast Science Praxis/Urban sensor-based indicative air quality monitors.

Positioned within AQMA N$^{o.}$ 3 and co-located with diffusion tubes LN61, LN62 and LN63, the reference site is located at *LN60 / HB007 – Dunstable Road*, with its monitoring data publicly available in near-real time via the Herts & Beds Air Quality Network web portal (https://tinyurl.com/w73r7gz). The details of the indicative sites are as follows:

- LN97 – Chaul End Road, co-located NO_2 passive site LN98, near-real-time data: https://tinyurl.com/mr2mh72j;
- LN99 – Dunstable Road – Bury Park 2, located in AQMA No. 3, co-located NO_2 passive site LN100, near-real-time data: https://tinyurl.com/22raz435;
- LN101 – Beech Hill Community Primary School, co-located NO_2 passive site LN102, near-real time data: https://tinyurl.com/2p8c5jcr;
- LN103 – L&D Hospital, Lewsey Road, co-located NO_2 passive site LN104, near-real time data: https://tinyurl.com/4tf2246y; and
- LN105 – Peoples Park, co-located NO_2 passive site LN106, near-real-time data: https://tinyurl.com/2p869b79.

In addition to the monitoring undertaken by Luton Borough Council during 2022:

- London Luton Airport Operations Ltd. (LLAOL) continuously monitored PM_{10} at its site within the airport (*LA08 / HB006 –* https://tinyurl.com/y32oqq5r);

- Defra continuously monitored nitrogen dioxide at its Luton A505 Roadside AURN site (*CM2 / LUTR* – https://tinyurl.com/yauuwns7); and
- Luton Rising continuously monitored multiple species, including nitrogen dioxide, PM_{10} and $PM_{2.5}$, at its air quality monitoring station in Wigmore Valley Park (*LA001* – https://tinyurl.com/y8o7oopg).

Table A.1 in Appendix A shows the details of the automatic monitoring sites, whilst Table G.1 in Appendix G provides similar information for the indicative sites. In addition to the links above, automatic monitoring results for these sites are available through the *UK-Air website* [https://uk-air.defra.gov.uk].

Maps showing the location of the monitoring sites are provided in Appendix D. Further details on how the automatic monitors are calibrated and how the data has been adjusted are included in Appendix C, with similar information for the indicative sites included in Appendix G.

3.1.2 Non-Automatic Monitoring Sites

Luton Borough Council undertook non- automatic (*i.e.* passive) monitoring of NO_2 at 92 sites during 2022. This represents an 80% increase in LBC passive monitoring sites compared to the previous year. In addition, LLAOL undertook similar monitoring at 19 sites, and Luton Rising deployed NO_2 diffusion tubes at a further 11. Table A.2 in Appendix A presents the details of the non-automatic sites.

Maps showing the location of the monitoring sites are provided in Appendix D. Further details on Quality Assurance/Quality Control (QA/QC) for the diffusion tubes, including bias adjustments and any other adjustments applied (*e.g.* annualisation and/or distance correction), are included in Appendix C.

3.2 Individual Pollutants

The air quality monitoring results presented in this section are, where relevant, adjusted for bias, annualisation (where the annual mean data capture is below 75% and greater than 25%), and distance correction. Further details on adjustments are provided in Appendix C.

3.2.1 Nitrogen Dioxide (NO_2)

Table A.3 and Table A.4 in Appendix A compare the ratified and adjusted monitored NO_2 annual mean concentrations for the past five years with the air quality objective of 40µg/m^3. Note that the concentration data presented represents the concentration at the location of the monitoring site, following the application of bias adjustment and annualisation, as required (*i.e.* the values are exclusive of any consideration to fall-off with distance adjustment).

For diffusion tubes, the full 2022 dataset of monthly mean values is provided in Appendix B. Note that the concentration data presented in Table B.1 includes distance-corrected values, only where relevant.

Table A.5 in Appendix A compares the ratified continuous monitored NO_2 hourly mean concentrations for the past five years with the air quality objective of 200µg/m^3, not to be exceeded more than 18 times per year.

As can be seen from the density plots presented in Figure A.2 in Appendix A: Monitoring Results, when considering diffusion tube sites across all three monitoring networks that have been in operation for the last five years, the distribution of annual mean NO_2 concentrations at these sites has remained relatively unchanged since 2020, with only a fairly modest increase in the value of the mean for each of the last two years as pollutant levels gradually increase from the historic lows resulting from the response to the COVID-19 pandemic.

In 2022, the population mean across all passive sites was 24.1µg/m^3. Although a slight increase from 2021 (up 2.1%), this still represents a 22.8% reduction from the pre-pandemic levels of 2019.

As a result of this continued reduction, similar to the previous year, during 2022, the annual mean NO_2 level was only found to have exceeded 40µg/m^3 at one monitoring location – *L7*, a Luton Rising roadside site on Vauxhall Way (51.4µg/m^3). Despite exceeding the annual mean objective level for each of the five years during which NO_2 has been monitored at this site (as well as exceeding the 1-hour mean objective during both 2018 and 2019 by having an annual mean NO_2 concentration above 60µg/m^3), *L7* is not located within an AQMA. The reason for this is that the site is not considered representative of relevant exposure due to its remote location away from both amenities and residential accommodation.

Excluding *L7*, during 2022, the measured annual mean NO_2 level only exceeded 90% of the air quality objective level (*i.e.* 36µg/m^3) at two other sites:

- *LLA7 – Drop-off Zone*, a roadside LLAOL site located in the airport's passenger set-down area (37.6µg/m^3). Similar to L7, this site is not considered to be representative of relevant exposure.
- *LN96 – Castle Street 3,* a roadside LBC site mounted on the façade of 115 Castle Street (37.3µg/m^3). Located outside a public house and directly adjacent to residential accommodation, this site is considered to be representative of relevant exposure.

Finally, no instances of the 1-hour mean exceeding 200µg/m^3 were observed at any of the three automatic NO_2 monitoring sites within the borough (*LN60 / HB007, LA001* or *LUTR*).

3.2.2 Particulate Matter (PM_{10})

Table A.6 in Appendix A: Monitoring Results compares the ratified and adjusted monitored PM_{10} annual mean concentrations for the past five years with the air quality objective of 40µg/m^3.

Table A.7 in Appendix A compares the ratified continuous monitored PM_{10} daily mean concentrations for the past five years with the air quality objective of 50µg/m^3, not to be exceeded more than 35 times per year.

During 2022, the annual mean PM_{10} concentration measured at *LN60* (*HB007*) was 15.1µg/m^3, which is 0.1µg/m^3 (0.7%) higher than the previous year but 0.7µg/m^3 (4.4%) lower than the pre-pandemic level of 2019. At *LA08 (HB006),* the annual average was 15.0µg/m^3, an increase of 2.7µg/m^3 (22.0%) relative to 2021 but still 1.3µg/m^3 (8.0%) lower than 2019. Finally, at *LA001,* the 2022 annual average was 9.3µg/m^3, a decrease of 1.0µg/m^3 (9.7%) compared with 2021 and 3.7µg/m^3 (31.1%) lower than in 2019.

During 2022, the monitored concentrations at all three sites were below the annual mean air quality objective level of 40µg/m^3, with the levels at both *LA08 / HB006* and *LA001* also falling within the relevant 2021 *WHO Global Air Quality Guideline* target of 15µg/m^3 (https://tinyurl.com/5f6fc8nz).

In 2022, the daily mean PM_{10} concentration remained below 50µg/m^3 at both *LA08* and *LA001* but was exceeded at *LN60* on three occasions. These isolated instances do not constitute a breach of the relevant air quality objective; as for PM_{10}, the 24-hour mean air quality objective stipulates that the daily mean PM_{10} concentration should not exceed 50µg/m³ more than 35 times a year.

It should be noted that, unlike the instruments used at *LN60 (HB007)* and *LA08 (HB006),* and although approved for use in other European countries, the GRIMM ED180 deployed at *LA001* to monitor PM_{10} is not approved by Defra for use in the UK (*LAQM.TG22 para 7.176*).

3.2.3 Particulate Matter ($PM_{2.5}$)

Table A.8 in Appendix A presents the ratified and adjusted monitored $PM_{2.5}$ annual mean concentrations for the past five years.

The introduction of *The Environmental Targets (Fine Particulate Matter) (England) Regulations 2023* (https://tinyurl.com/2cvjtsed) has, for the first time, established two binding air quality targets for fine particulate matter ($PM_{2.5}$), each with an associated interim target:

- Regulation 4 - *the annual mean concentration target*: 10µg/m³ annual mean concentration $PM_{2.5}$ nationwide by 2040, with an interim target of 12µg/m³ by January 2028; and
- Regulation 7 - *the population exposure reduction target*: 35% reduction in average population exposure by 2040, with an interim target of a 22% reduction by January 2028, both compared to a 2018 baseline.

As the initial calculations for the population exposure reduction target have not yet been published (Schedule 1 to the Regulations states that they are to be calculated by 15th July 2023), it is currently only possible to evaluate the 2022 monitoring data against the annual mean concentration target.

During 2022, the annual mean $PM_{2.5}$ concentration measured at *LN60 (HB007)* was 9.1µg/m³, which is 0.1µg/m³ (1.1%) lower than the previous year and 0.9µg/m³ (9.0%) lower than the 2019 pre-pandemic level. At *LA001,* the 2022 annual average was 8.4µg/m³, a decrease of 1.0µg/m³ (10.6%) compared with 2021 and 3.2µg/m³ (27.6%) lower than in 2019. Consequently, during 2021, the monitored annual mean concentrations at both sites were below the proposed concentration target of 10µg/m³.

It should be noted that, unlike the Palas Fidas 200 used at *LN60 (HB007*), and although approved for use in other European countries, the GRIMM ED180 deployed at LA001 to monitor $PM_{2.5}$ is not approved by Defra for use in the UK (*LAQM.TG22 para 7.176*).

3.2.4 Sulphur Dioxide (SO_2)

Table A.9 in Appendix A compares the ratified continuous monitored SO_2 concentrations for 2022 with the air quality objectives for SO_2. No exceedances of any of the relevant objectives were recorded during 2022.

Appendix A: Monitoring Results

Table A.1 – Details of Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Monitoring Technique	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Inlet Height (m)
LN60 *(HB007)*	Dunstable Road East (CRAQM2)	Roadside	508708	221352	NO_2; PM_{10}; PM_4; $PM_{2.5}$; PM_1	Yes AQMA 3	Chemiluminescent (ThermoScientific Model 42i) Light-Scattering Monitor (Palas Fidas 200)	6.2	3.24	2.15
LA08 *(HB006)*	London Luton Airport	Other	511868	221144	PM_{10}	No	Unheated Beta Attenuation Mass Monitor (BAM)	N/A	N/A	1.7
LA001	London Luton Airport FutureLuToN	Other	512578	222204	NO_2; PM_{10}; $PM_{2.5}$; PM_1; SO_2; O_3; CO; Black Carbon; Benzene; Toluene; Ethylbenzene; m,p-Xylene; o-Xylene; Naphthalene	No	Chemiluminescent Light-Scattering Monitor (GRIMM EDM180)(3)	N/A	N/A	
LUTR *(UKA00605)*	Luton A505 Roadside (AURN)	Roadside	505927	222644	NO_2	No	Chemiluminescent	17.1	1.5	1.7

Notes:

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

(2) N/A if not applicable

(3) Instrument not approved by Defra (LAQM.TG22 para 7.176)

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

a) Luton Borough Council

Diffusion Tube ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LN07	Guildford Street/Bute Street	Roadside	509227	221455	NO_2	No	1.5	3.1	No	2.6
LN11	Upper George Street	Roadside	508910	221321	NO_2	No	20.0	2.7	No	2.9
LN15	Armitage Garden	Roadside	505557	222325	NO_2	Yes AQMAs 1 & 2	7.0	2.1	No	2.8
LN16	Belper Road	Roadside	505492	222607	NO_2	Yes AQMA 2	5.0	2.5	No	2.7
LN17	Wyndham Road	Roadside	505324	222812	NO_2	Yes AQMA 2	4.0	1.8	No	2.8
LN18	Copperfield	Roadside	505014	223538	NO_2	Yes AQMA 2	2.0	1.6	No	2.8
LN22	1 Mistletoe Hill	Urban Background	511341	221864	NO_2	No	0.0	9.3	No	2.5
LN23	Eaton Green Road 1	Roadside	511377	221814	NO_2	No	18.0	6.4	No	2.3
LN24	19 Barnston Close	Urban Background	511902	222144	NO_2	No	0.0	7.0	No	2.5
LN25	Eaton Green Road 2	Roadside	511893	222068	NO_2	No	17.0	1.9	No	2.9
LN26	8 Keeble Close	Urban Background	512109	222234	NO_2	No	0.0	11.5	No	2.7

Diffusion Tube ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LN27	Eaton Green Road 3	Roadside	512134	222198	NO_2	No	6.0	2.3	No	2.7
LN28	Caddington Road	Roadside	507798	219832	NO_2	No	15.0	1.7	No	2.6
LN52	Dunstable Rd/Cardigan St Residential	Roadside	508689	221379	NO_2	Yes AQMA 3	0.0	4.3	No	2.8
LN53	3rd Floor Bagshawe Court F.F.	Suburban	507717	219923	NO_2	No	0.0	23.0	No	9.8
LN54	M1 Corner Bagshawe Court F.F.	Suburban	507712	219915	NO_2	No	0.0	12.0	No	2.0
LN55	M1 Corner Wyatt Court FF	Suburban	507732	219886	NO_2	No	0.0	13.0	No	2.9
LN56	20 Wyatt Court FF	Suburban	507747	219894	NO_2	No	0.0	30.0	No	2.9
LN61, LN62, LN63	Dunstable Road East (CRAQM 2)	Roadside	508708	221352	NO_2	Yes AQMA 3	6.0	2.5	Yes (Reference)	2.0
LN64	Park Viaduct – Park Street	Roadside	509563	220952	NO_2	No	0.2	2.9	No	2.7
LN65	Park Viaduct – Queens Close	Roadside	509486	220865	NO_2	No	1.9	8.8	No	1.9
LN66	Park Viaduct	Roadside	509288	220925	NO_2	Yes AQMA 3	4.9	3.7	No	2.7
LN67	Castle Street	Roadside	509083	220709	NO_2	No	0.0	2.3	No	2.7
LN68	London Road	Roadside	508969	220487	NO_2	No	0.0	8.4	No	2.6

Diffusion Tube ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LN69	John Street	Roadside	509326	221357	NO_2	No	0.0	1.7	No	2.7
LN70	Crawley Green Road	Roadside	509813	221161	NO_2	No	0.0	6.0	No	2.6
LN71	Crescent Road	Urban Background	509549	221623	NO_2	No	0.0	10.3	No	2.4
LN72	Hucklesby Way	Urban Background	508937	221745	NO_2	No	0.0	8.7	No	2.5
LN73	Mill Street	Roadside	508959	221633	NO_2	No	0.0	3.9	No	2.9
LN74	Dunstable Road – Bury Park	Roadside	508165	222002	NO_2	No	0.0	4.8	No	2.5
LN75	New Bedford Road	Roadside	508745	222122	NO_2	No	0.0	5.2	No	2.5
LN76	Leagrave Road	Urban Background	507574	222948	NO_2	No	0.0	8.8	No	2.3
LN77	Marsh Road	Roadside	506496	224018	NO_2	No	0.0	4.8	No	2.5
LN78	Hibbert Street	Roadside	509109	220676	NO_2	No	0.2	1.4	No	2.4
LN79*	Castle Street 2	Roadside	509050	220634	NO_2	No		2.1	No	3.0
LN80	Windsor Street	Roadside	509038	220719	NO_2	No	0.5	1.0	No	2.3
LN81	Bank Close	Suburban	505034	223729	NO_2	Yes AQMA 2		1.7	No	2.6

Diffusion Tube ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LN82	11 Withy Close	Suburban	504828	223999	NO_2	Yes AQMAs 1 & 2	0.0	8.5	No	2.5
LN83	b/h 9 Copperfields	Suburban	505116	223467	NO_2	Yes AQMA 2	13.0	26.0	No	2.5
LN84	97 Lime Avenue	Suburban	505230	223304	NO_2	Yes AQMA 2	8.5	1.8	No	2.5
LN85	26 Belper Road	Suburban	505481	222545	NO_2	Yes AQMA 2	0.0	17.0	No	2.0
LN86	Bradley Road (by M1 Bridge)	Roadside	505586	222235	NO_2	Yes AQMAs 1 & 2		2.3	No	2.6
LN87	Shelton Way Alleyway	Suburban	510170	223162	NO_2	No	0.0	13.0	No	2.7
LN88	510 Hitchin Rd	Roadside	510107	223087	NO_2	No	0.0	8.5	No	2.7
LN89	13 Saywell Road	Suburban	510515	222612	NO_2	No	4.5	17.0	No	2.7
LN90	304 Crawley Green Road	Roadside	510846	222209	NO_2	No	0.0	14.1	No	2.7
LN91	International House	Urban Background	511122	221721	NO_2	No	0.0	22.3	No	2.7
LN92	Harrowden Court	Suburban	511037	221657	NO_2	No	0.0	11.5	No	2.7
LN93	Someries Junior School	Suburban	511332	223069	NO_2	No	0.0	35.6	No	2.4
LN94	Ashcroft High School	Suburban	511327	222588	NO_2	No	0.0	78.4	No	2.6

Diffusion Tube ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LN95	Wigmore Primary School	Suburban	511996	222534	NO_2	No	0.0	44.3	No	2.4
LN96	Castle Street 3	Roadside	509059	220656	NO_2	No	0.0	2.5	No	2.4
LN98	Chaul End Road	Roadside	506411	222554	NO_2	No		2.2	Yes (Indicative)	
LN100	Dunstable Road - Bury Park 2	Roadside	508380	221764	NO_2	Yes AQMA 3	6.5	3.2	Yes (Indicative)	2.3
LN102	Beech Hill Community Primary School	Roadside	508000	222078	NO_2	No	9.0	3.5	Yes (Indicative)	
LN104	L&D Hospital, Lewsey Road	Roadside	504987	222805	NO_2	No	12.5	2.0	Yes (Indicative)	2.3
LN106	Peoples Park	Urban Background	509339	222128	NO_2	No		5.4	Yes (Indicative)	2.3
LN107	2 Chertsey Close	Urban Background	511573	221897	NO_2	No	0.0	18.8	No	2.2
LN108	Laxton Close	Suburban	512473	222295	NO_2	No		N/A	No	2.3
LN109	59 Malthouse Green	Suburban	512915	222308	NO_2	No		N/A	No	2.4
LN110	Hedley Rise	Suburban	512738	222385	NO_2	No	4.5	2.2	No	2.4
LN111	61 Lalleford Road	Roadside	511521	222203	NO_2	No	6.7	4.2	No	2.6
LN112	140 Prospect Way	Industrial	511254	221466	NO_2	No	0.0	N/A	No	2.3

Diffusion Tube ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LN113	786 Dunstable Road	Roadside	505005	222696	NO_2	No	0.0	10.0	No	2.3
LN114	20 Bradgers Hill Road	Roadside	509293	223741	NO_2	No	0.0	8.0	No	2.2
LN115	69 Windmill Road	Roadside	509995	220892	NO_2	No	0.0	7.2	No	2.1
LN116	85 Hitchin Road	Roadside	509655	221842	NO_2	No	0.0	1.3	No	2.3
LN117	258 Stockingstone Road	Roadside	509136	223217	NO_2	No	0.0	10.0	No	2.2
LN118	Fulbourne Close	Roadside	506407	222732	NO_2	No		12.5	No	2.3
LN119	Challney High School for Boys	Urban Background	505588	222871	NO_2	No	0.0	41.6	No	2.5
LN120	20 High Street	Roadside	505723	223787	NO_2	No	0.0	4.1	No	2.4
LN121	4c Marsh Road	Roadside	506990	223425	NO_2	No	0.0	12.8	No	2.4
LN122	404 - 410 Selbourne Road	Roadside	506918	223295	NO_2	No	0.0	10.0	No	2.1
LN123	34 Bury Park Road	Roadside	508413	221918	NO_2	No	3.2	1.7	No	2.4
LN124	114 Bury Park Road	Roadside	508253	222053	NO_2	No	0.0	5.0	No	2.5
LN125	Bury Park Community Centre	Roadside	508321	221839	NO_2	No	0.0	10.0	No	2.7

Diffusion Tube ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LN126	30 Leagrave Road	Roadside	508140	222103	NO_2	No	0.0	6.4	No	2.5
LN127	33 Leagrave Road	Roadside	508095	222127	NO_2	No	0.0	4.4	No	2.4
LN128	McKenzie House	Roadside	508065	222182	NO_2	No	0.0	6.8	No	2.1
LN129	3 Selbourne Road	Roadside	507973	222289	NO_2	No	0.0	4.4	No	2.5
LN130	218 Leagrave Road	Roadside	507918	222560	NO_2	No	0.0	3.8	No	2.5
LN131	265 Dunstable Road (Learning Corner Daycare Nursery)	Roadside	507666	222143	NO_2	No	0.0	6.9	No	2.6
LN132	1A Maidenhall Road	Roadside	507228	222511	NO_2	No	0.7	2.2	No	2.6
LN133	80 Dunstable Road	Roadside	508381	221795	NO_2	No	0.0	7.0	No	2.4
LN134	172 Nadeem Plaza	Roadside	508156	222053	NO_2	No	0.0	4.9	No	2.5
LN135	Units 5-6, The Arcade	Roadside	508136	222040	NO_2	No	0.0	6.0	No	2.4
LN136	182 Dunstable Road	Roadside	508059	222080	NO_2	No	0.0	4.7	No	2.5
LN137	10 Selbourne Road	Roadside	507948	222337	NO_2	No	0.0	4.4	No	2.3

Diffusion Tube ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LN138	132 Leagrave Road	Roadside	508021	222248	NO_2	No	0.0	6.4	No	2.4
LN139	132 Dunstable Road	Roadside	508270	221939	NO_2	No	0.0	6.0	No	2.4
LN140	173 Dunstable Road	Roadside	508279	221903	NO_2	No	0.0	6.7	No	2.4
LN141	9 Moor Street	Roadside	508450	221790	NO_2	No	1.7	2.0	No	2.4
LN142	Crawley Road	Roadside	508751	221714	NO_2	No	0.0	2.2	No	

Notes:

(1) 0m if the monitoring site is at a location of exposure (*e.g.* installed on the façade of a residential property).
(2) N/A if not applicable.

* Site closed – included for legacy purposes.

b) London Luton Airport Operations td (LLAOL) sites

Diffusion Tube ID	Site Name	Site Type *[LLAOL Site Group]*	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LLA 1*	Outside Zone 2 *(prior to 2019)*	Other *[Car Park & Drop-Off Zones]*	511903	221278	NO_2	No			No	
LLA 1	Terminal front [canopy] *(from 2019)*	Other *[Car Park & Drop-Off Zones]*	511920	221334	NO_2	No			No	
LLA 2*	Airport Approach Road *(prior to 2021)*	Roadside *[Access Road]*	511579	220960	NO_2	No	880	3	No	1.9
LLA 2	Airport Approach Road *(from 2021)*	Roadside *[Access Road]*	511586	220978	NO_2	No			No	
LLA 3*	Runway Threshold Western *(prior to 2021)*	Other *[Runway & Flightpath]*	511170	220436	NO_2	No	1000	N/A	No	1.8
LLA 3	Runway Threshold Western *(from 2021)*	Other *[Runway & Flightpath]*	511156	220437	NO_2	No		N/A	No	
LLA 4*	Runway Threshold Eastern *(prior to 2021)*	Other *[Runway & Flightpath]*	513644	221207	NO_2	No	550	N/A	No	2

Diffusion Tube ID	Site Name	Site Type *[LLAOL Site Group]*	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LLA 4	Runway Threshold Eastern *(from 2021)*	Other *[Runway & Flightpath]*	513634	221198	NO_2	No		N/A	No	
LLA 5*	Airside - Stand 5 *(prior to 2021)*	Other *[Airfield]*	511711	221337	NO_2	No	585	N/A	No	1
LLA 5	Airside - Stand 5 *(from 2021)*	Other *[Airfield]*	511703	221320	NO_2	No		N/A	No	
LLA 6*	President Way Jct *(prior to 2021)*	Roadside *[Access Road]*	511682	221727	NO_2	No	230	3	No	2.3
LLA 6	President Way Jct *(from 2021)*	Roadside *[Access Road]*	511645	221679	NO_2	No			No	
LLA 7*	Drop-off Zone *(prior to 2020)*	Roadside *[Car Park & Drop-Off Zones]*	512166	221226	NO_2	No			No	
LLA 7	Drop-off Zone *(from 2020)*	Roadside *[Car Park & Drop-Off Zones]*	512105	221168	NO_2	No			No	
LLA 8*	BAM Co-located *(prior to 2021)*	Other *[Airfield]*	511867	221148	NO_2	No	820	N/A	No	1.7

Diffusion Tube ID	Site Name	Site Type *[LLAOL Site Group]*	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LLA 8	BAM Co-located *(from 2021)*	Other *[Airfield]*	511871	221142	NO_2	No		N/A	No	
LLA 9*	Stagenhoe Bottom Farm *(prior to 2021)*	Rural *[Runway & Flightpath]*	517602	222572	NO_2	No	30	N/A	No	1.2
LLA 9	Stagenhoe Bottom Farm *(from 2021)*	Rural *[Runway & Flightpath]*	517637	222554	NO_2	No		N/A	No	
LLA 10*	Grove Farm Slip End *(prior to 2021)*	Rural *[Runway & Flightpath]*	507667	217744	NO_2	No	30	N/A	No	1.2
LLA 10	Grove Farm Slip End *(from 2021)*	Rural *[Runway & Flightpath]*	507623	217724	NO_2	No		N/A	No	
LLA 11*	Dane Street *(prior to 2021)*	Roadside *[Runway & Flightpath]*	513140	220669	NO_2	No	130	1	No	2.1
LLA 11	Dane Street *(from 2021)*	Roadside *[Runway & Flightpath]*	513125	220664	NO_2	No			No	
LLA 12*	Adjacent to Stand 60 *(prior to 2021)*	Roadside *[Airfield]*	511886	221566	NO_2	No	420	N/A	No	1

Diffusion Tube ID	Site Name	Site Type *[LLAOL Site Group]*	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LLA 12	Airside - Stand 61 *(from 2021)*	Roadside *[Airfield]*	511861	221579	NO_2	No		N/A	No	
LLA 13*	Eaton Green Road *(prior to 2021)*	Roadside *[Access Road]*	511902	222055	NO_2	No	35	8	No	2
LLA 13	Eaton Green Road *(from 2021)*	Roadside *[Access Road]*	511899	222051	NO_2	No			No	
LLA 14*	Undercroft Access *(prior to 2021)*	Kerbside *[Car Park & Drop-Off Zones]*	511995	221316	NO_2	No			No	
LLA 14	Undercroft Access *(from 2021)*	Kerbside *[Car Park & Drop-Off Zones]*	511954	221313	NO_2	No			No	
LLA 15	Eaton Green Road - Lower	Kerbside *[Access Road]*	511168	221706	NO_2	No			No	
LLA 16*	Exit Road Plaza *(prior to 2019)*	Roadside	512158	221087	NO_2	No		N/A	No	
LLA 16	Airside - South Stands *(from 2019)*	Other *[Airfield]*	512275	221115	NO_2	No		N/A	No	

Diffusion Tube ID	Site Name	Site Type *[LLAOL Site Group]*	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
LLA 17	A1081 Southbound Carriage Way	Roadside *[Access Road]*	509489	219237	NO_2	No			No	
LLA 18*	A1081 New Airport Way 2 *(prior to 2019)*	Roadside *[Access Road]*	510991	220497	NO_2	No			No	
LLA 18	A1081 New Airport Way *(from 2019)*	Roadside *[Access Road]*	510779	220279	NO_2	No			No	
LLA 19	Breachwood Green Community Hall	Rural *[Runway & Flightpath]*	515109	221933	NO_2	No			No	

Notes:

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

(2) N/A if not applicable.

* Previous location where tube has been relocated within the last 5 years.

c) Luton Rising sites

Diffusion Tube ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
L1(i), L1(ii), L1(iii)	Dunstable Road East	Roadside	508710	221353	NO_2	Yes AQMA 3	6.0	2.4	Yes	2.0
L2(i), L2(ii)	Crawley Green Road	Roadside	511155	222445	NO_2	No		1.2	No	2.1
L3(i), L3(ii)	Wigmore Lane	Roadside	511780	222760	NO_2	No		1.0	No	2.0
L4(i), L4(ii)	Eaton Green Road / Darley Road	Rural	513223	222397	NO_2	No		1.5	No	2.0
L5(i), L5(ii)	Chapel Road, Breachwood	Rural	515047	221904	NO_2	No		2.8	No	2.0
L6(i), L6(ii)	Winch Hill	Rural	513773	221752	NO_2	No		1.2	No	1.9
L7(i), L7(ii)	Vauxhall Way	Roadside	511057	221386	NO_2	No		2.1	No	2.0
L8(i), L8(ii)	Kimpton Road	Roadside	510543	220706	NO_2	No		2.1	No	2.0
L9*	Luton Parkway Station Exit (North) *(Before 03/12/2020)*	Other	510529	220598	NO_2	No		N/A	No	1.8
L9†	Luton Parkway Station Exit (North) *(During 2021)*	Other	510552	220660	NO_2	No		N/A	No	1.8
L9(i), L9(ii)	Luton Parkway Station Exit (North) *(From 2022)*	Other	510553	220682	NO_2	No		N/A	No	1.6
L10(i), L10(ii)	Luton Road, Caddington	Roadside	506541	219854	NO_2	No		1.0	No	2.1

Diffusion Tube ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
L11(i), L11(ii), L11(iii)	Wigmore Valley Park	Rural	512569	222207	NO_2	No		N/A	Yes	1.6

Notes:

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

(2) N/A if not applicable.

*,† Previous locations where tube has been relocated within the last 5 years.

Table A.3 – Annual Mean NO_2 Monitoring Results: Automatic Monitoring (µg/m^3)

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LN60 *(HB007)*	508708	221352	Roadside	99.8	99.8	37.2	**40.4**	28.3	30.2	32.5
LA001	512578	222204	Other	87.9	87.9	-	16.2	11.9	11.3	14.1
LUTR (UKA00605)	505927	222644	Roadside	97.8	97.8	**42.9**	39.3	30.7	31.4	30.0

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

☒ **Reported concentrations are those at the location of the monitoring site (annualised, as required), i.e. prior to any fall-off with distance correction.**

Notes:

The annual mean concentrations are presented as µg/m^3.

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

All means have been *"annualised"* as per LAQM.TG22 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Concentrations are those at the location of monitoring and not those following any fall-off with distance adjustment.

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

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

Table A.4 – Annual Mean NO_2 Monitoring Results: Non-Automatic Monitoring ($\mu g/m^3$)

a) Luton Borough Council (LBC) sites

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LN07	509227	221455	Roadside	100.0	100.0	27.5	28.4	20.3	20.9	21.5
LN11	508910	221321	Roadside	100.0	100.0	33.6	34.3	27.3	30.6	28.8
LN15	505557	222325	Roadside	100.0	100.0	26.2	27.0	20.2	20.1	20.3
LN16	505492	222607	Roadside	100.0	100.0	29.5	31.1	25.0	23.9	23.8
LN17	505324	222812	Roadside	100.0	100.0	33.5	33.1	25.5	24.1	25.7
LN18	505014	223538	Roadside	100.0	100.0	23.9	22.1	16.9	18.4	17.2
LN22	511341	221864	Urban Background	84.7	84.7	21.3	23.1	16.0	16.1	17.9
LN23	511377	221814	Roadside	100.0	100.0	29.4	34.9	24.9	24.2	27.6
LN24	511902	222144	Urban Background	92.3	92.3	20.0	22.0	16.2	16.8	17.1
LN25	511893	222068	Roadside	100.0	100.0	27.5	29.6	20.9	20.0	22.7
LN26	512109	222234	Urban Background	100.0	100.0	20.1	19.9	13.8	13.7	15.3
LN27	512134	222198	Roadside	92.3	92.3	27.5	28.3	20.1	20.4	23.2

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LN28	507798	219832	Roadside	100.0	100.0	**40.3**	38.5	29.6	29.3	28.5
LN52	508689	221379	Roadside	100.0	100.0	39.5	**42.8**	33.0	35.7	32.9
LN53	507717	219923	Suburban	100.0	100.0	27.9	28.2	21.6	20.5	21.8
LN54	507712	219915	Suburban	40.3	40.3	26.6	28.2	21.4	21.2	22.7
LN55	507732	219886	Suburban	100.0	100.0	28.8	27.4	22.5	21.0	21.7
LN56	507747	219894	Suburban	92.3	92.3	29.0	28.4	21.8	20.1	21.8
LN61, LN62, LN63	508708	221352	Roadside	100.0	100.0	39.4	**40.7**	30.8	32.2	32.2
LN64	509563	220952	Roadside	100.0	100.0	28.1	31.2	21.9	22.2	21.8
LN65	509486	220865	Roadside	100.0	100.0	23.3	24.0	17.5	19.6	19.4
LN66	509288	220925	Roadside	100.0	100.0	32.9	36.7	27.6	28.6	28.8
LN67	509083	220709	Roadside	90.4	90.4	**41.1**	**43.0**	32.7	32.9	33.2
LN68	508969	220487	Roadside	100.0	100.0	30.8	31.9	24.0	26.0	25.4
LN69	509326	221357	Roadside	100.0	100.0	29.1	30.8	22.5	24.7	25.5
LN70	509813	221161	Roadside	100.0	100.0	30.8	32.8	24.1	26.8	25.8

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LN71	509549	221623	Urban Background	100.0	100.0	30.6	31.3	23.5	25.1	24.9
LN72	508937	221745	Urban Background	100.0	100.0	30.7	29.8	23.5	24.0	24.4
LN73	508959	221633	Roadside	100.0	100.0	37.1	38.4	28.9	30.6	31.5
LN74	508165	222002	Roadside	100.0	100.0	34.8	36.8	29.5	29.7	27.4
LN75	508745	222122	Roadside	100.0	100.0	35.8	36.5	22.0	30.8	32.3
LN76	507574	222948	Urban Background	100.0	100.0	31.5	31.3	23.8	26.4	26.0
LN77	506496	224018	Roadside	100.0	100.0	32.9	35.6	27.2	26.7	27.1
LN78	509109	220676	Roadside	81.1	81.1	28.7	31.2	23.3	23.7	22.8
LN80	509038	220719	Roadside	92.3	92.3	36.8	33.3	24.3	25.8	25.7
LN81	505034	223729	Suburban	91.8	91.8	31.6	30.8	21.8	22.7	23.2
LN82	504828	223999	Suburban	100.0	100.0	27.0	27.6	20.9	19.7	19.9
LN83	505116	223467	Suburban	100.0	100.0	24.5	22.5	16.3	19.5	18.0
LN84	505230	223304	Suburban	100.0	100.0	25.2	25.3	16.8	19.4	19.1
LN85	505481	222545	Suburban	84.1	84.1	28.2	30.0	22.8	21.9	21.7

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) [(1)]	Valid Data Capture 2022 (%) [(2)]	2018	2019	2020	2021	2022
LN86	505586	222235	Roadside	84.7	84.7	36.8	38.8	28.4	27.4	28.2
LN87	510170	223162	Suburban	82.7	82.7			16.3	17.9	18.2
LN88	510107	223087	Roadside	100.0	100.0			19.9	21.2	21.8
LN89	510515	222612	Suburban	100.0	100.0			16.6	18.5	19.2
LN90	510846	222209	Roadside	92.3	92.3			20.5	22.0	22.8
LN91	511122	221721	Urban Background	100.0	100.0			17.5	18.5	20.4
LN92	511037	221657	Suburban	100.0	100.0			16.1	17.4	19.0
LN93	511332	223069	Suburban	75.1	75.1			11.1	12.1	13.8
LN94	511327	222588	Suburban	91.8	91.8			12.8	12.6	14.2
LN95	511996	222534	Suburban	92.3	92.3			13.2	13.2	15.3
LN96	509059	220656	Roadside	92.3	92.3				35.1	37.3
LN98	506411	222554	Roadside	83.0	83.0					28.1
LN100	508380	221764	Roadside	100.0	100.0					35.5
LN102	508000	222078	Roadside	100.0	100.0					24.8

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LN104	504987	222805	Roadside	84.7	84.7					32.8
LN106	509339	222128	Urban Background	92.3	92.3					17.8
LN107	511573	221897	Urban Background	100.0	100.0					19.5
LN108	512473	222295	Suburban	100.0	100.0					16.8
LN109	512915	222308	Suburban	100.0	100.0					12.7
LN110	512738	222385	Suburban	100.0	100.0					14.8
LN111	511521	222203	Roadside	100.0	100.0					16.9
LN112	511254	221466	Industrial	84.7	84.7					15.9
LN113	505005	222696	Roadside	100.0	100.0					23.9
LN114	509293	223741	Roadside	100.0	100.0					12.9
LN115	509995	220892	Roadside	100.0	100.0					23.8
LN116	509655	221842	Roadside	100.0	100.0					35.6
LN117	509136	223217	Roadside	100.0	100.0					27.8
LN118	506407	222732	Roadside	100.0	100.0					21.7

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LN119	505588	222871	Urban Background	91.8	91.8					18.6
LN120	505723	223787	Roadside	100.0	100.0					23.8
LN121	506990	223425	Roadside	100.0	100.0					22.5
LN122	506918	223295	Roadside	100.0	100.0					23.2
LN123	508413	221918	Roadside	100.0	42.5					29.7
LN124	508253	222053	Roadside	100.0	42.5					23.3
LN125	508321	221839	Roadside	100.0	42.5					29.1
LN126	508140	222103	Roadside	100.0	42.5					28.0
LN127	508095	222127	Roadside	100.0	42.5					25.4
LN128	508065	222182	Roadside	100.0	42.5					29.3
LN129	507973	222289	Roadside	100.0	42.5					27.6
LN130	507918	222560	Roadside	100.0	42.5					25.5
LN131	507666	222143	Roadside	100.0	42.5					18.0
LN132	507228	222511	Roadside	100.0	42.5					29.0

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LN133	508381	221795	Roadside	100.0	40.0					29.3
LN134	508156	222053	Roadside	80.8	32.3					31.4
LN135	508136	222040	Roadside	100.0	40.0					28.8
LN136	508059	222080	Roadside	100.0	40.0					26.4
LN137	507948	222337	Roadside	100.0	40.0					25.5
LN138	508021	222248	Roadside	100.0	40.0					28.8
LN139	508270	221939	Roadside	100.0	40.0					31.6
LN140	508279	221903	Roadside	100.0	40.0					29.9
LN141	508450	221790	Roadside	100.0	40.0					23.8
LN142	508751	221714	Roadside	100.0	38.1					29.4

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

☒ **Diffusion tube data has been bias adjusted.**

☒ **Reported concentrations are those at the location of the monitoring site (bias adjusted and annualised, as required), *i.e.* prior to any fall-off with distance correction.**

Notes:

The annual mean concentrations are presented as µg/m^3.

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

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

Means for diffusion tubes have been corrected for bias. All means have been *"annualised"* as per LAQM.TG22 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Concentrations are those at the location of monitoring and not those following any fall-off with distance adjustment.

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

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

b) London Luton Airport Operations Ltd. (LLAOL) sites

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type *[LLAOL Site Group]*	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LLA 1*	511903	221278	Other *[Car Park & Drop-Off Zones]*	0	0	**45.8**				
LLA 1	511920	221334	Other *[Car Park & Drop-Off Zones]*	100.0	89.8		37.4	20.6	19.7	28.1
LLA 2*	511579	220960	Roadside *[Access Road]*	0	0	37.8	34.2	20.5		
LLA 2	511586	220978	Roadside *[Access Road]*	100.0	89.8				18.6	25.3
LLA 3*	511170	220436	Other *[Runway & Flightpath]*	0	0	24.6	22.1	15.6		
LLA 3	511156	220437	Other *[Runway & Flightpath]*	100.0	89.8				14.6	15.8
LLA 4*	513644	221207	Other *[Runway & Flightpath]*	0	0	18.4	17.5	11.3		
LLA 4	513634	221198	Other *[Runway & Flightpath]*	100.0	89.8				10.5	12.0
LLA 5*	511711	221337	Other *[Airfield]*	0	0	**40.4**	36.7	21.6		
LLA 5	511703	221320	Other *[Airfield]*	100.0	89.8				21.9	32.1
LLA 6*	511682	221727	Roadside *[Access Road]*	0	0	35.1	33.8	21.7		
LLA 6	511645	221679	Roadside *[Access Road]*	91.4	82.1				20.2	24.9
LLA 7*	512166	221226	Roadside *[Car Park & Drop-Off Zones]*	0	0	**43.5**	**45.9**			

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type *[LLAOL Site Group]*	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LLA 7	512105	221168	Roadside *[Car Park & Drop-Off Zones]*	100.0	89.8			26.1	25.6	37.6
LLA 8*	511867	221148	Other *[Airfield]*	0	0	32.2	31.5	19.5		
LLA 8	511871	221142	Other *[Airfield]*	89.3	80.2				20.2	25.1
LLA 9*	517602	222572	Rural *[Runway & Flightpath]*	0	0	11.2	9.7	7.6		
LLA 9	517637	222554	Rural *[Runway & Flightpath]*	89.3	80.2				7.3	7.1
LLA 10*	507667	217744	Rural *[Runway & Flightpath]*	0	0	12.3	10.9	7.8		
LLA 10	507623	217724	Rural *[Runway & Flightpath]*	91.4	82.1				8.0	8.6
LLA 11*	513140	220669	Roadside *[Runway & Flightpath]*	0	0	15.1	13.4	9.4		
LLA 11	513125	220664	Roadside *[Runway & Flightpath]*	100.0	89.8				7.3	11.4
LLA 12*	511886	221566	Roadside *[Airfield]*	0	0	37.6	35.8	21.7		
LLA 12	511861	221579	Roadside *[Airfield]*	100.0	89.8				21.9	33.0
LLA 13*	511901	222055	Roadside *[Access Road]*	0	0	25.6	23.9	16.2		
LLA 13	511899	222051	Roadside *[Access Road]*	100.0	89.8				15.5	18.5
LLA 14*	511995	221316	Kerbside *[Car Park & Drop-Off Zones]*	0	0	**42.4**	**41.9**	23.2		

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type *[LLAOL Site Group]*	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LLA 14	511954	221313	Kerbside *[Car Park & Drop-Off Zones]*	100.0	89.8				21.0	28.4
LLA 15	511168	221706	Kerbside *[Access Road]*	100.0	89.8	32.2	31.2	20.9	22.7	25.6
LLA 16*	512158	221087	Roadside	0	0	**43.5**				
LLA 16	512275	221115	Other *[Airfield]*	92.0	82.7		32.3	19.7	18.1	23.1
LLA 17	509489	219237	Roadside *[Access Road]*	100.0	89.8	**40.4**	32.1	20.2	21.5	25.4
LLA 18*	510991	220497	Roadside *[Access Road]*	0	0	37.5				
LLA 18	510779	220279	Roadside *[Access Road]*	100.0	89.8		29.1	20.2	20.8	24.4
LLA 19	515109	221933	Rural *[Runway & Flightpath]*	80.7	72.5		15.6	9.2	8.8	9.9

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

☒ **Diffusion tube data has been bias adjusted.**

☒ **Reported concentrations are those at the location of the monitoring site (bias adjusted and annualised, as required), *i.e.* prior to any fall-off with distance correction.**

Notes:

The annual mean concentrations are presented as µg/m^3.

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

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

Means for diffusion tubes have been corrected for bias. All means have been “annualised” as per LAQM.TG22 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Concentrations are those at the location of monitoring and not those following any fall-off with distance adjustment.

(1) Data capture for the monitoring period, *i.e*. excluding the December 2022 exposure, which has been discounted due to significantly exceeding the maximum recommended exposure period of 5 weeks.

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

* Previous location where tube has been relocated within the last 5 years.

c) London Rising sites

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
L1(i), L1(ii), L1(iii)	508710	221353	Roadside	100	97.0	37.0	**40.6**	30.5	32.2	34.3
L2(i), L2(ii)	511155	222445	Roadside	86.1	87.6	30.9	29.6	22.9	23.4	23.0
L3(i), L3(ii)	511780	222760	Roadside	83.7	89.3	25.5	29.7	20.9	21.7	22.6
L4(i), L4(ii)	513223	222397	Rural	100	97.0	16.2	20.4	13.9	12.5	14.1
L5(i), L5(ii)	515047	221904	Rural	100	97.0	11.2	14.5	10.3	9.1	9.9
L6(i), L6(ii)	513773	221752	Rural	100	97.0	14.2	17.3	11.6	10.2	11.5
L7(i), L7(ii)	511057	221386	Roadside	81.3	82.1	**68.9**	**69.4**	**48.0**	**49.7**	**51.4**
L8(i), L8(ii)	510543	220706	Roadside	89.6	86.8	27.6	35.1	23.5	22.3	22.1
L9*	510529	220598	Other	0	0	24.8	30.7	22.4		
L9†	510552	220660	Other	0	0				19.5	
L9(i), L9(ii)	510553	220682	Other	77.2	74.9					20.6
L10(i), L10(ii)	506541	219854	Roadside	100	97.0	19.0	25.1	17.7	19.1	19.9
L11(i), L11(ii), L11(iii)	512569	222207	Rural	100	97.0		20.0	13.0	11.5	13.1

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

☒ **Diffusion tube data has been bias adjusted.**

☒ **Reported concentrations are those at the location of the monitoring site (bias adjusted and annualised, as required), *i.e.* prior to any fall-off with distance correction.**

Notes:

The annual mean concentrations are presented as µg/m^3.

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

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

Means for diffusion tubes have been corrected for bias. All means have been *"annualised"* as per LAQM.TG22 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Concentrations are those at the location of monitoring and not those following any fall-off with distance adjustment.

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

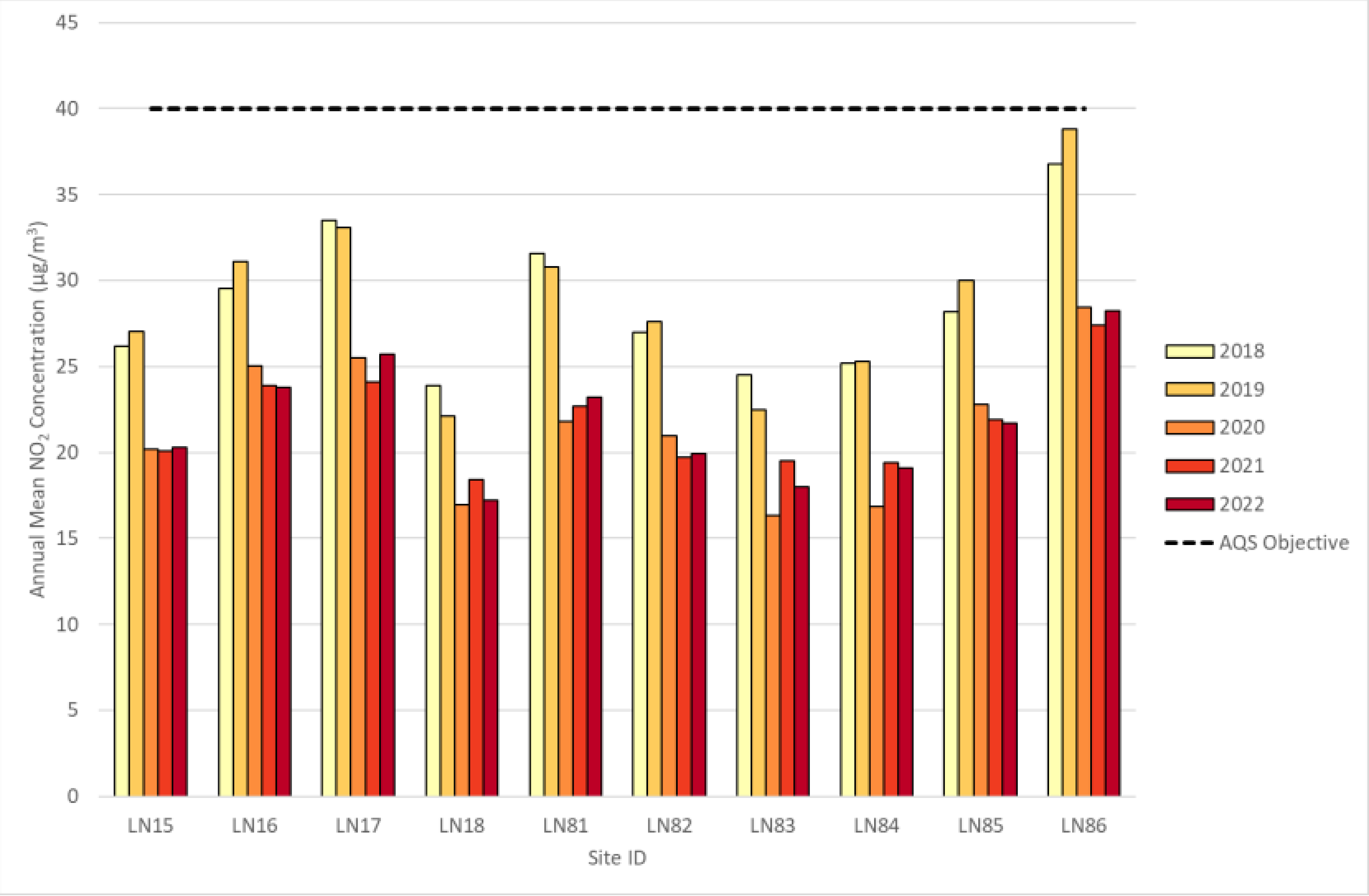
(2) Data capture for the full calendar year (*e.g.* if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

*,† Previous locations where tube has been relocated within the last 5 years.

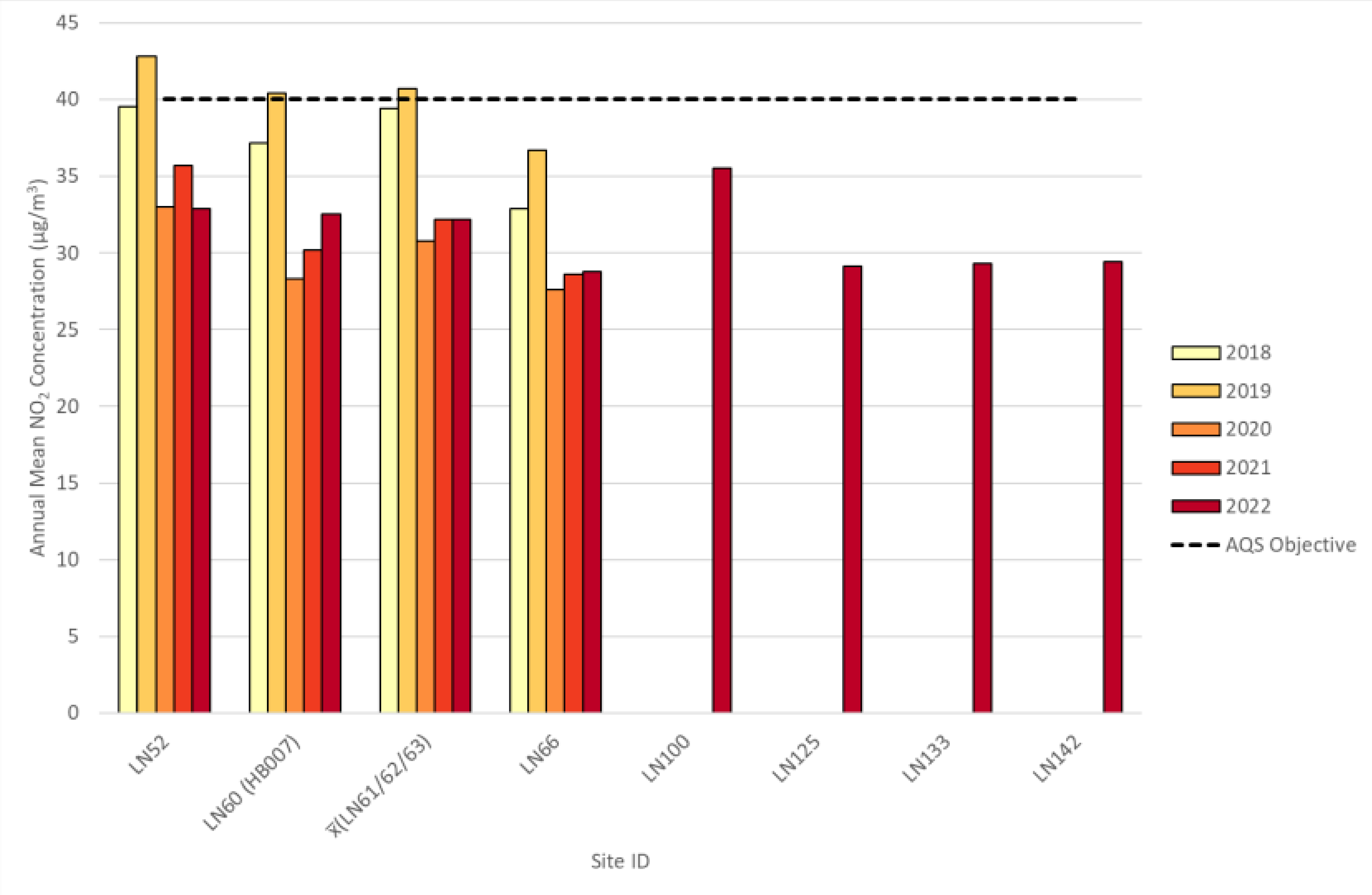
Figure A.1 – Trends in Annual Mean NO_2 Concentrations

a) **Luton Borough Council (LBC) sites**

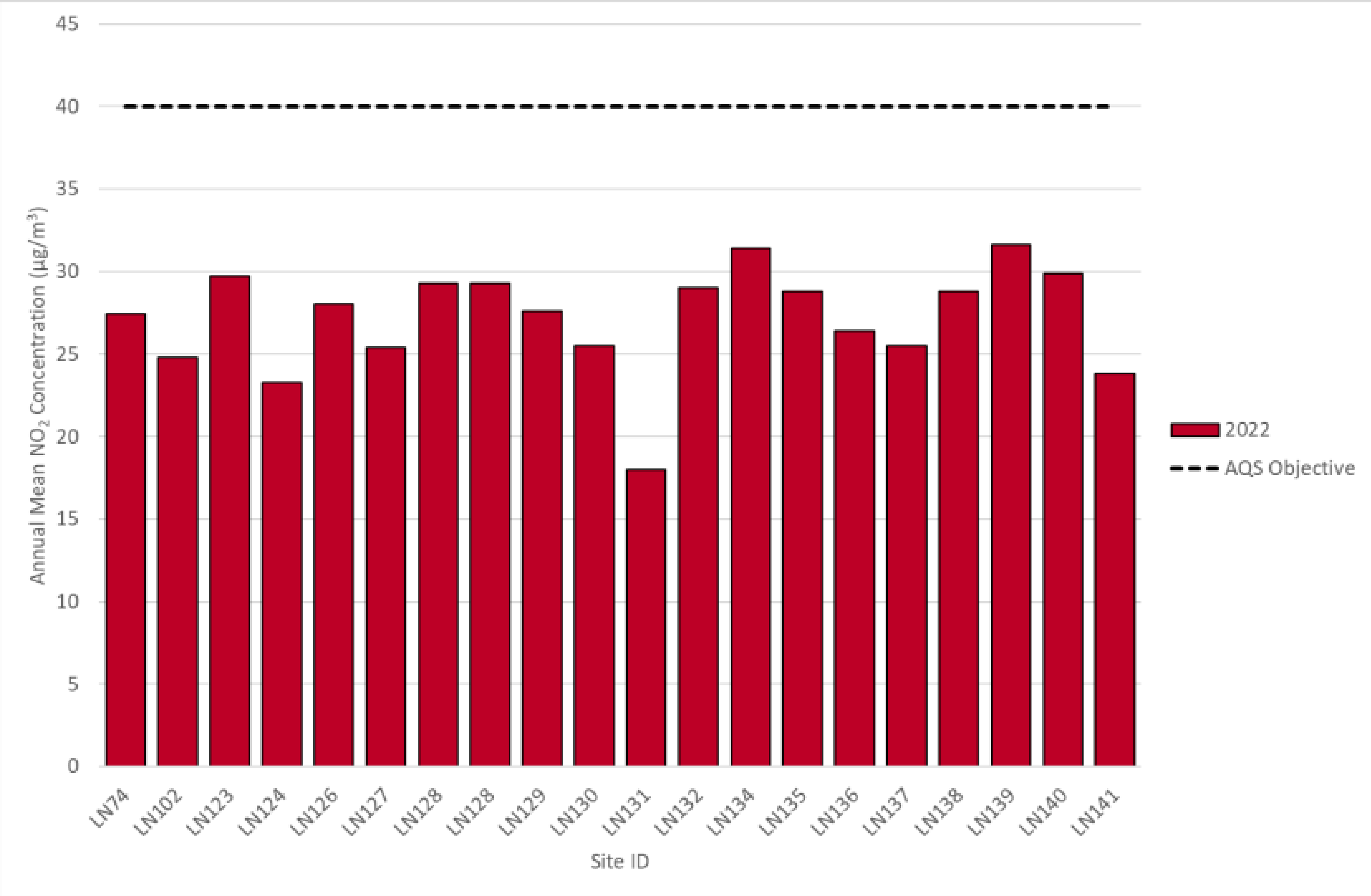
a. **Within Luton AQMA N$^{os.}$ 1 & 2 (Located in Challney, Leagrave & Poets Wards)**



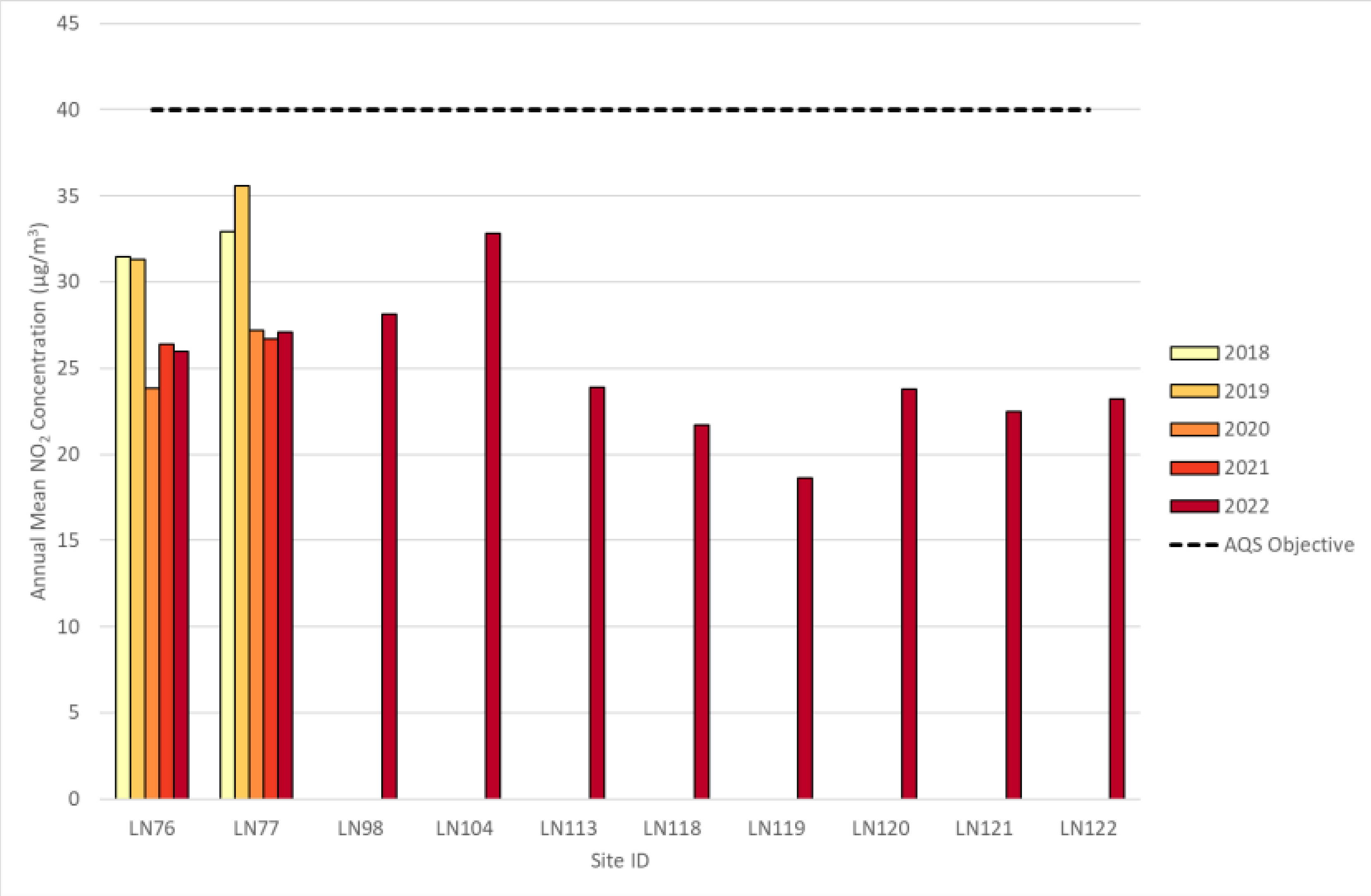
b. Within Luton AQMA Nº· 3 (Located in Beech Hill & Central Wards)



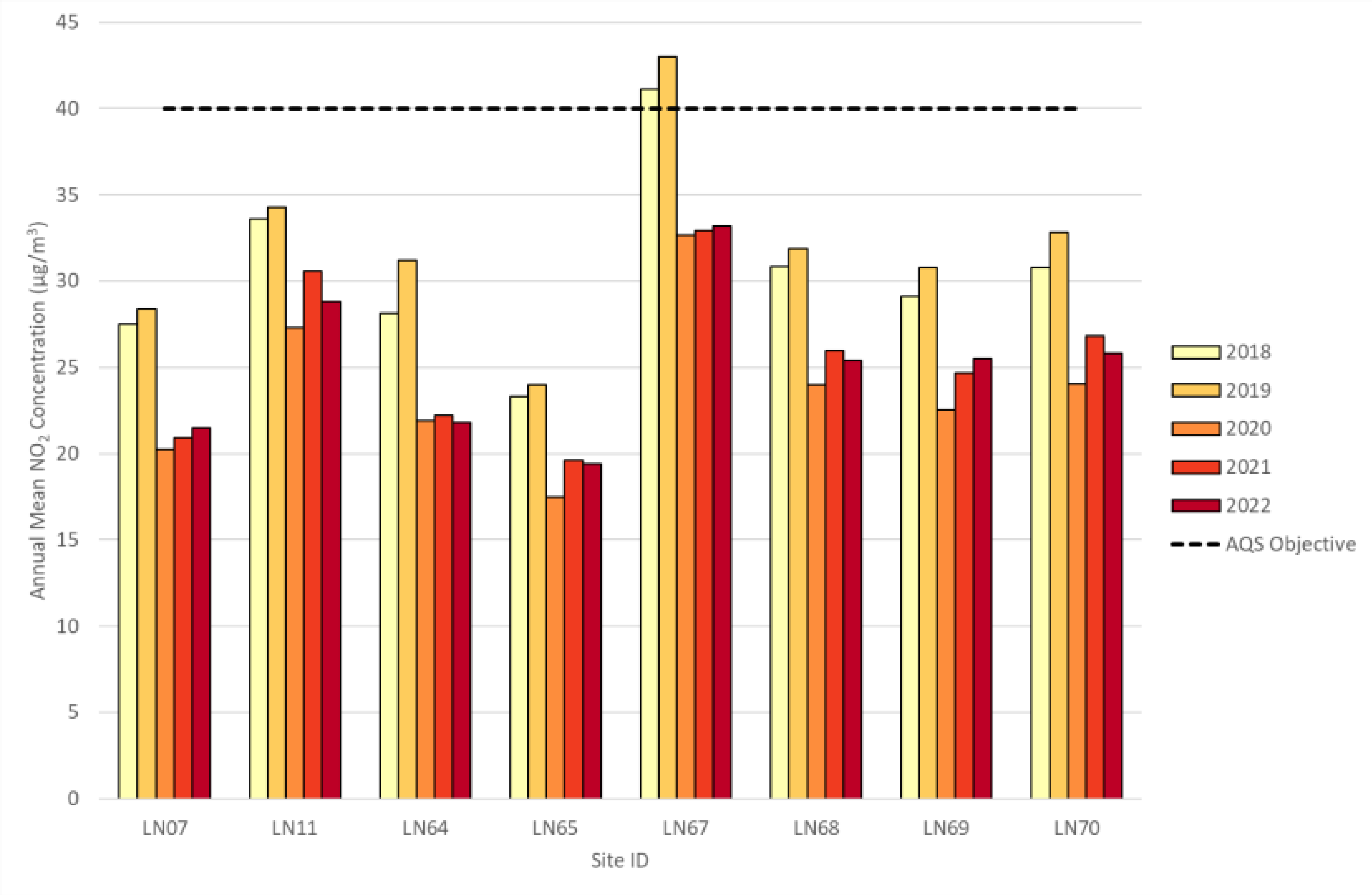
c. New non-AQMA locations in and around Bury Park (Located in Beech Hill, Biscot & Central Wards)



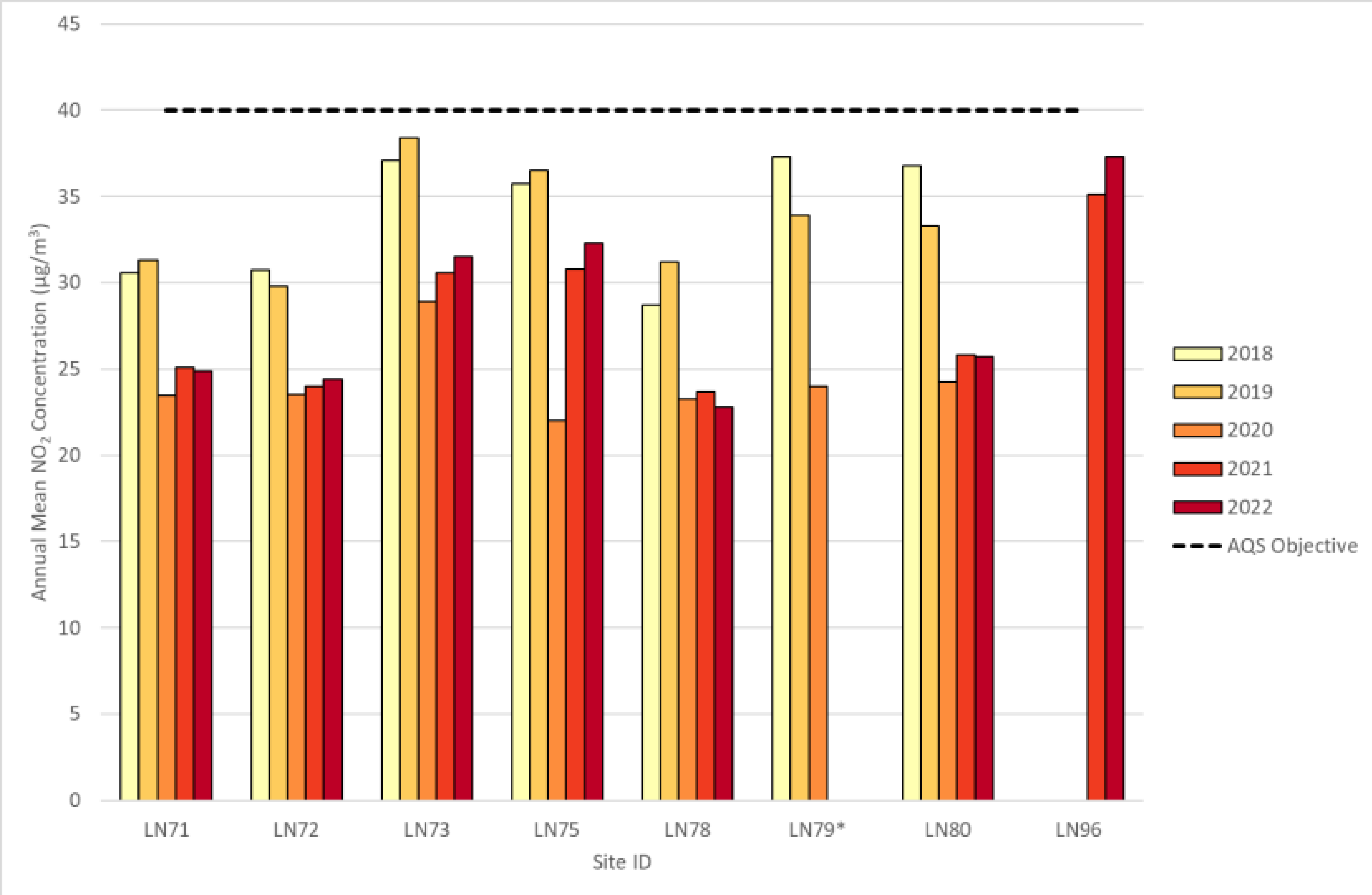
d. Non-AQMA locations in Northwest Luton (Located in Challney, Leagrave, Northwell, Poets & Saints Wards)



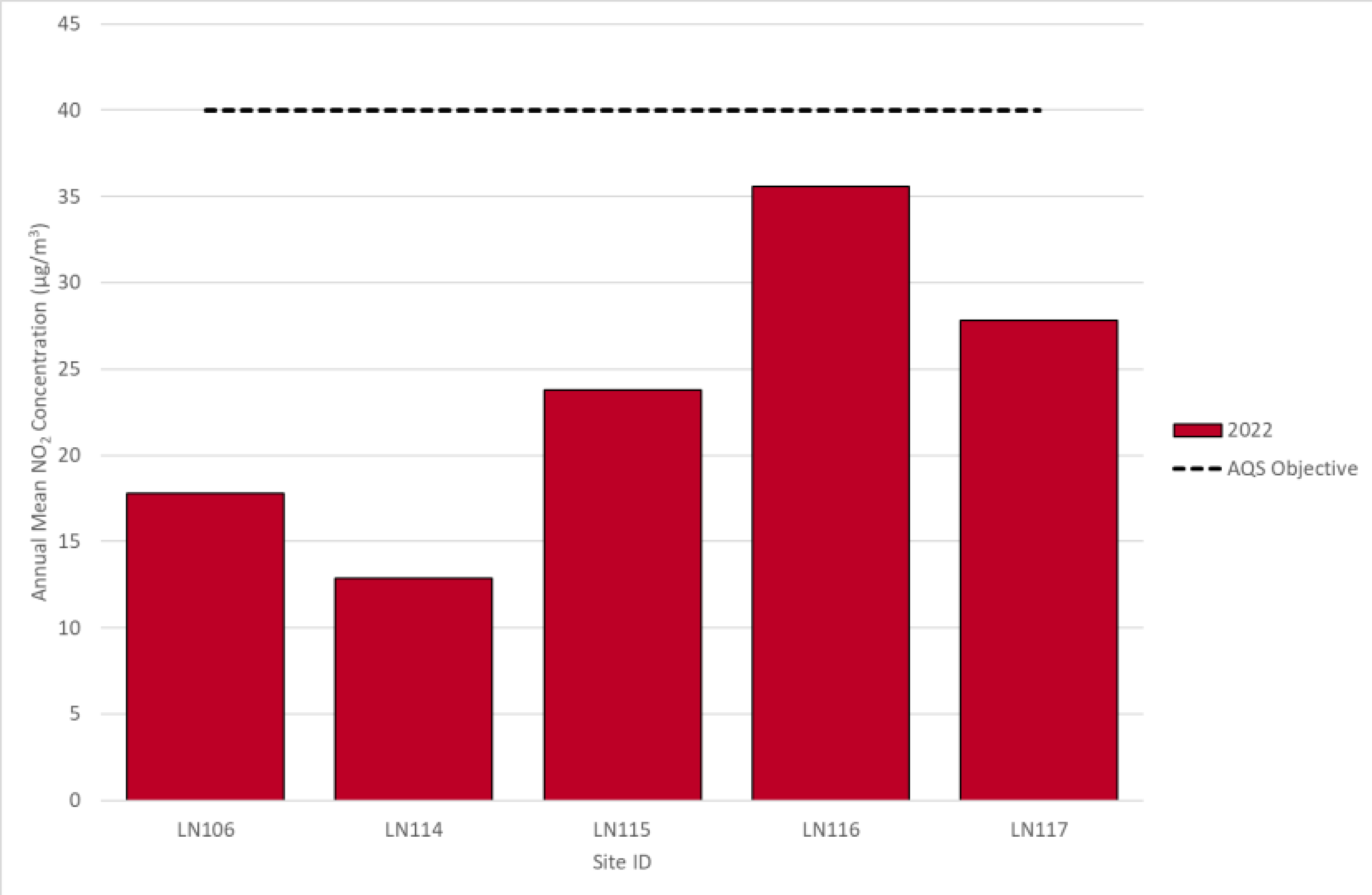
e. Non-AQMA locations in Central / North Luton – Part 1 (Located in Central & South Wards)



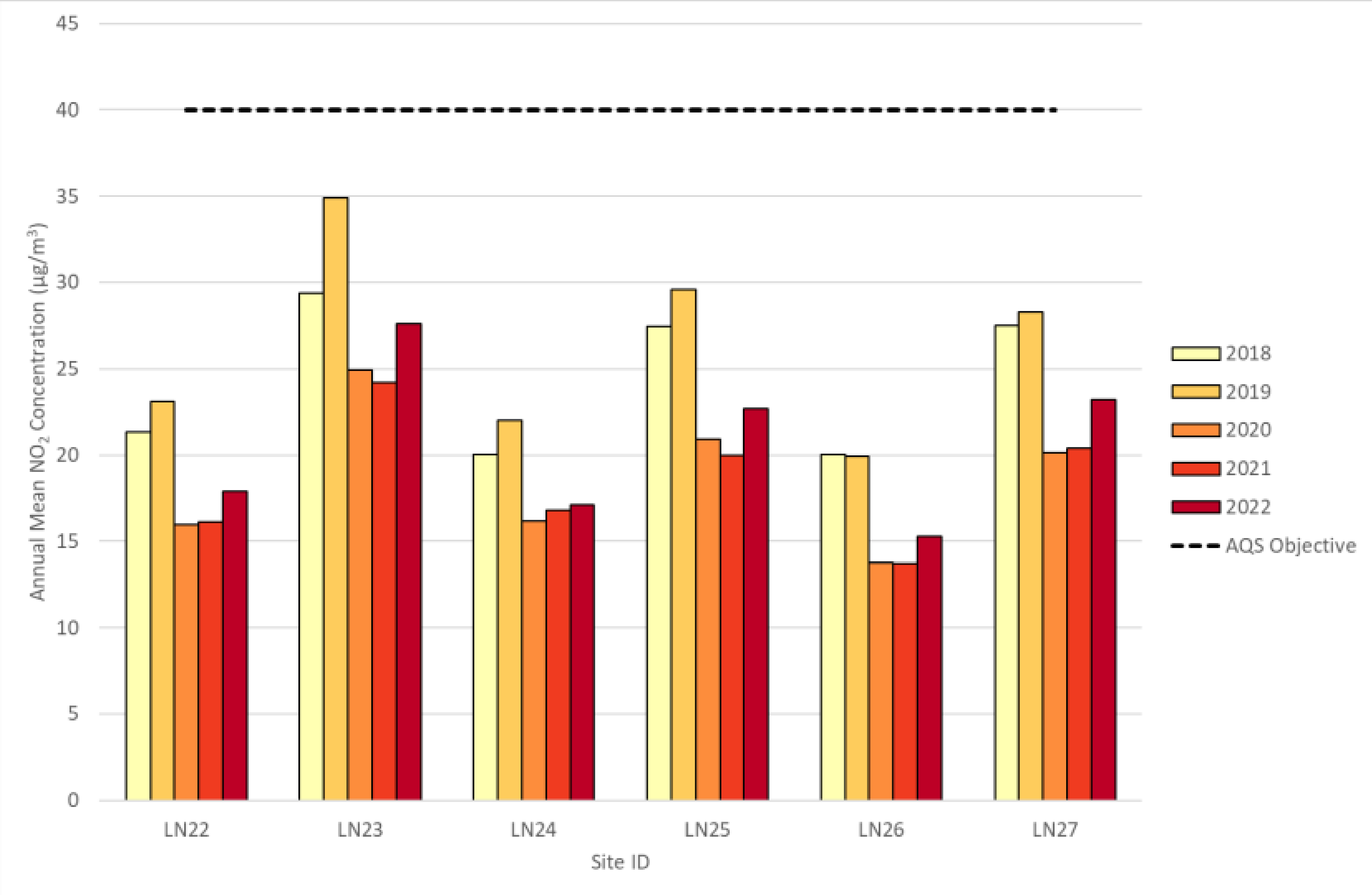
f. Non-AQMA locations in Central / North Luton – Part 2 (Located in Central, High Town & South Wards)



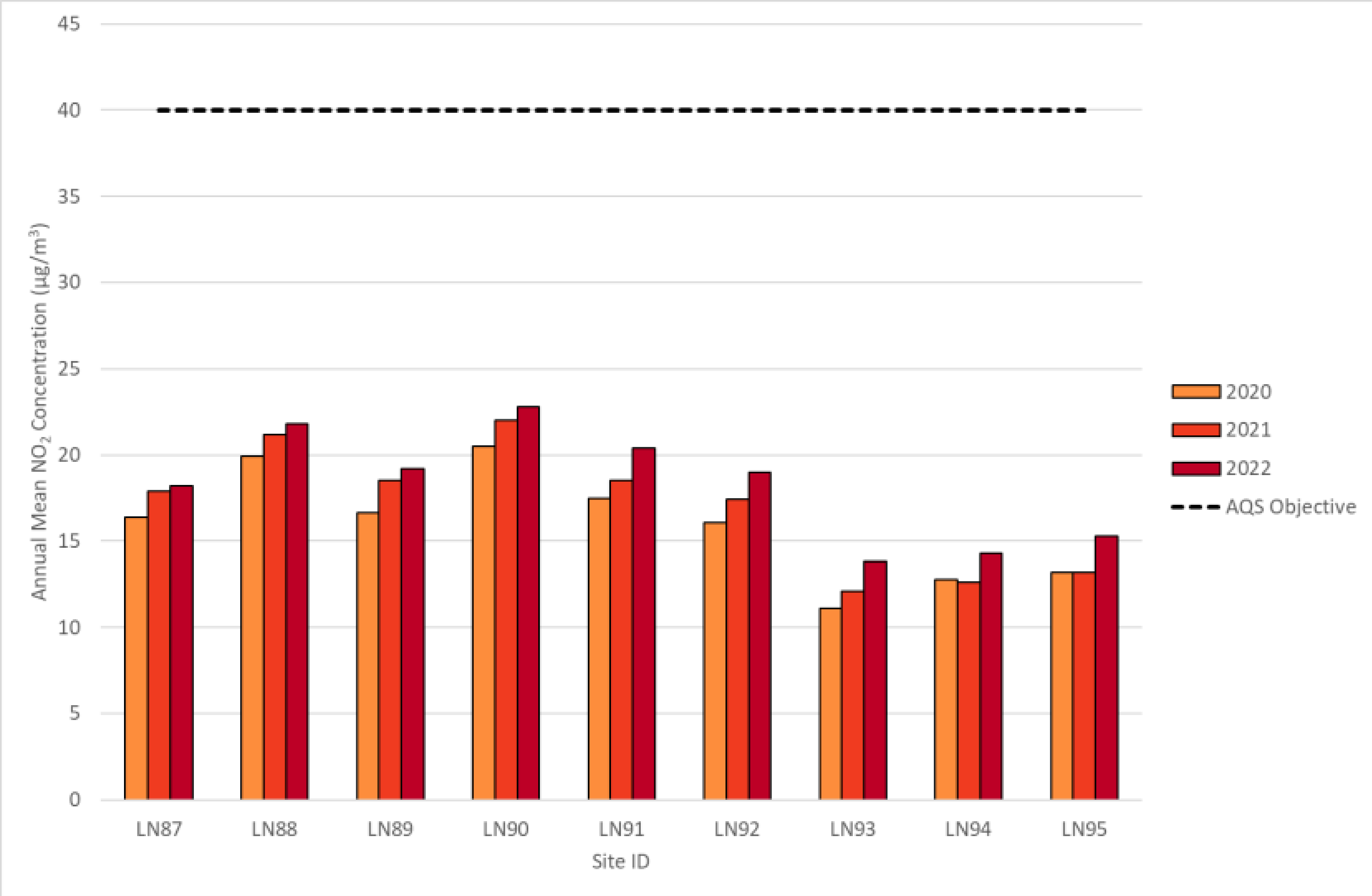
g. New non-AQMA locations in Central / North Luton (Located in Barnfield, High Town & South Wards)



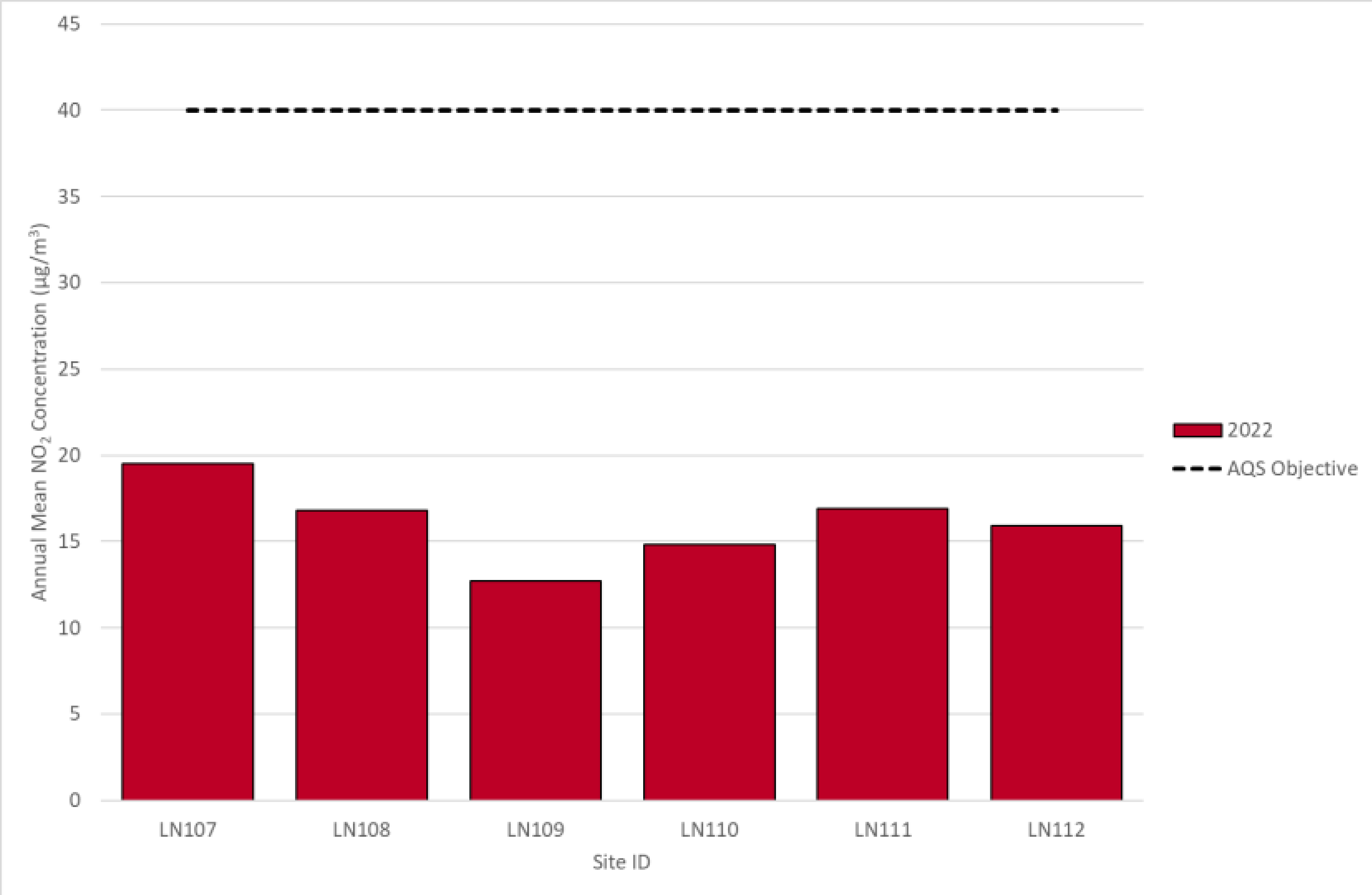
h. Non-AQMA locations in East Luton – Part 1 (Located in Vauxhall & Wigmore Wards)



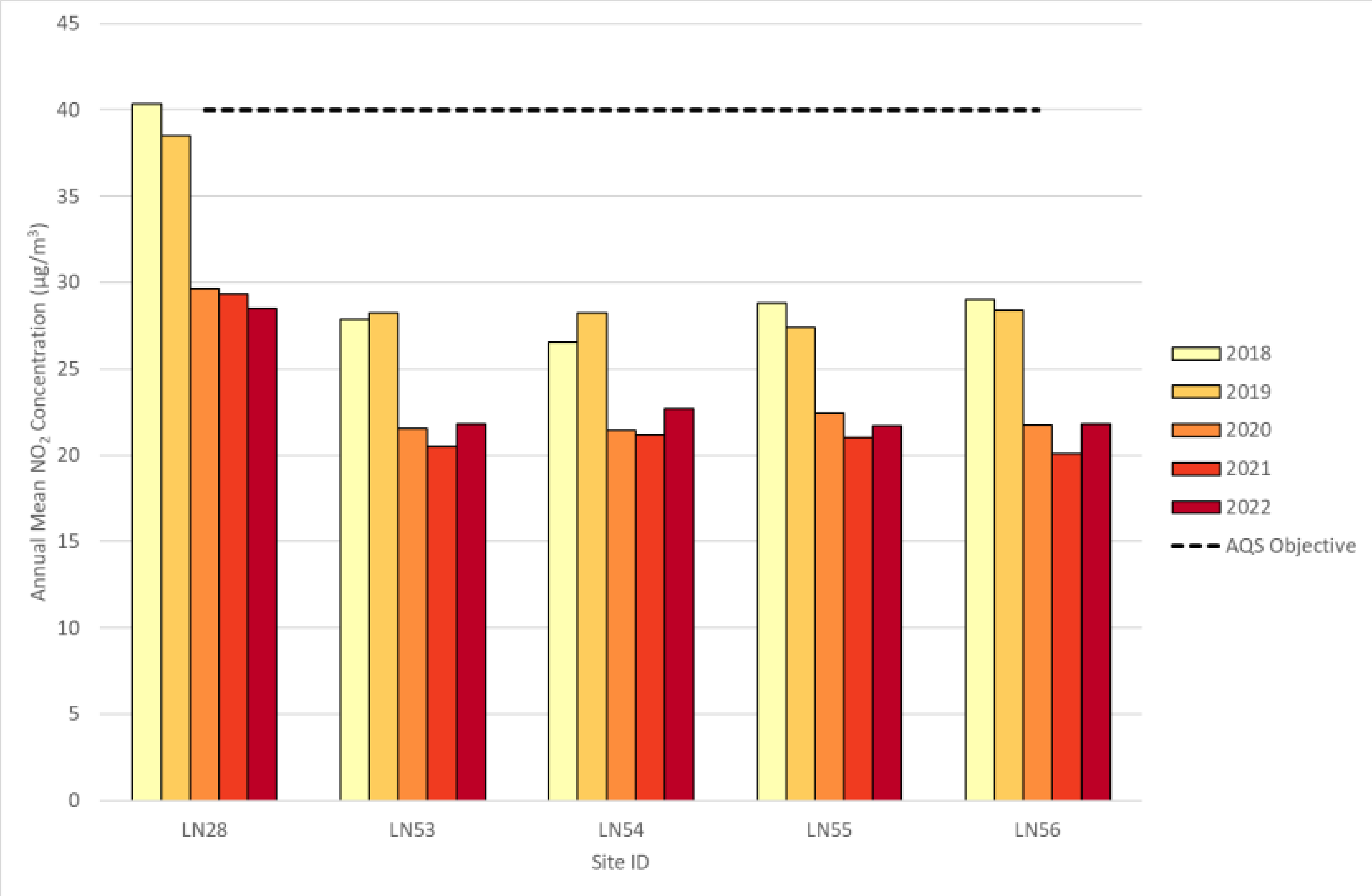
i. Non-AQMA locations in East Luton – Part 2 (Located in Round Green, Stopsley, Vauxhall & Wigmore Wards)



j. New non-AQMA locations in East Luton (Located in Vauxhall & Wigmore Wards)

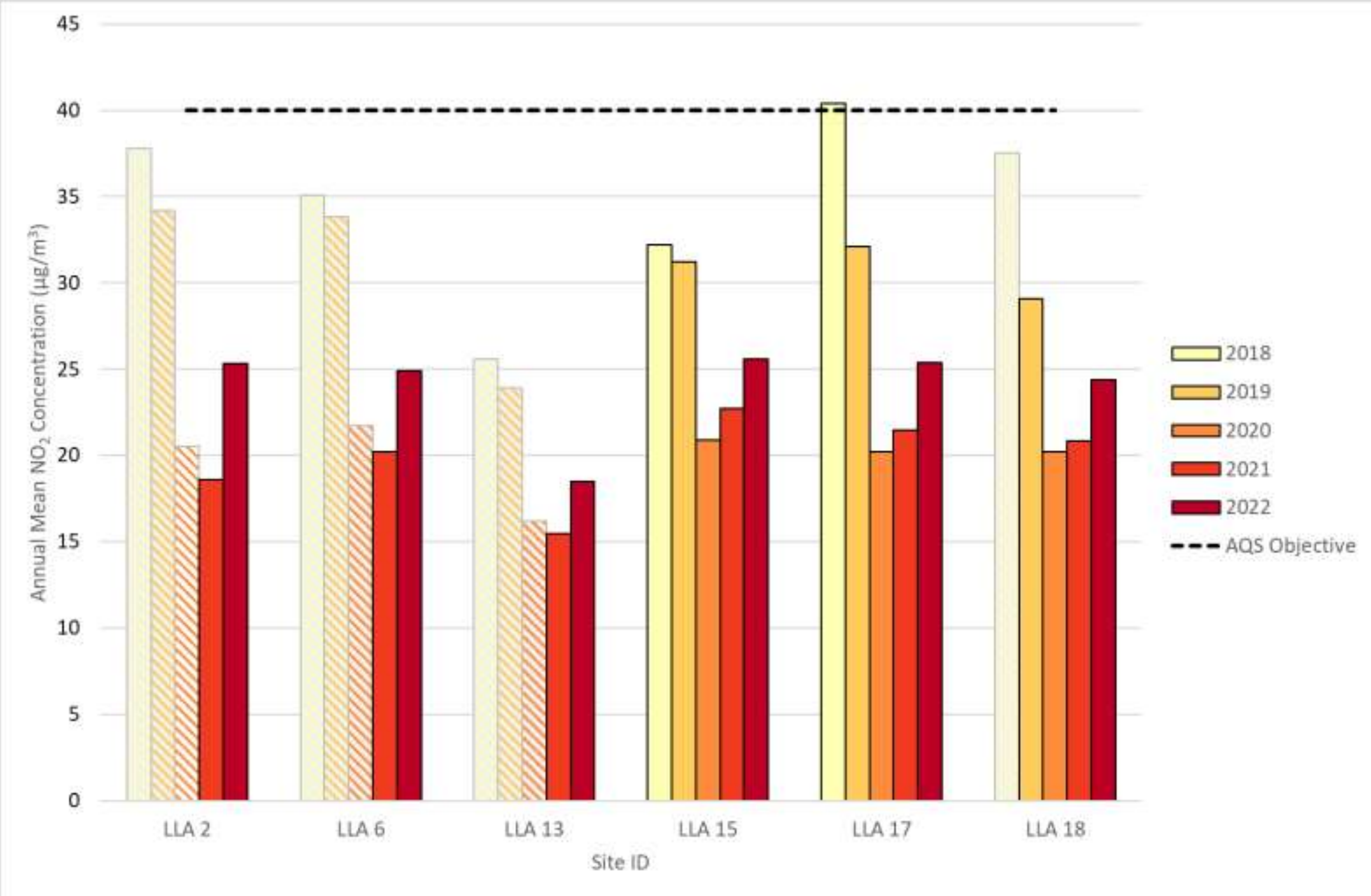


k. Non-AQMA locations in West Luton (Located in Farley Ward)



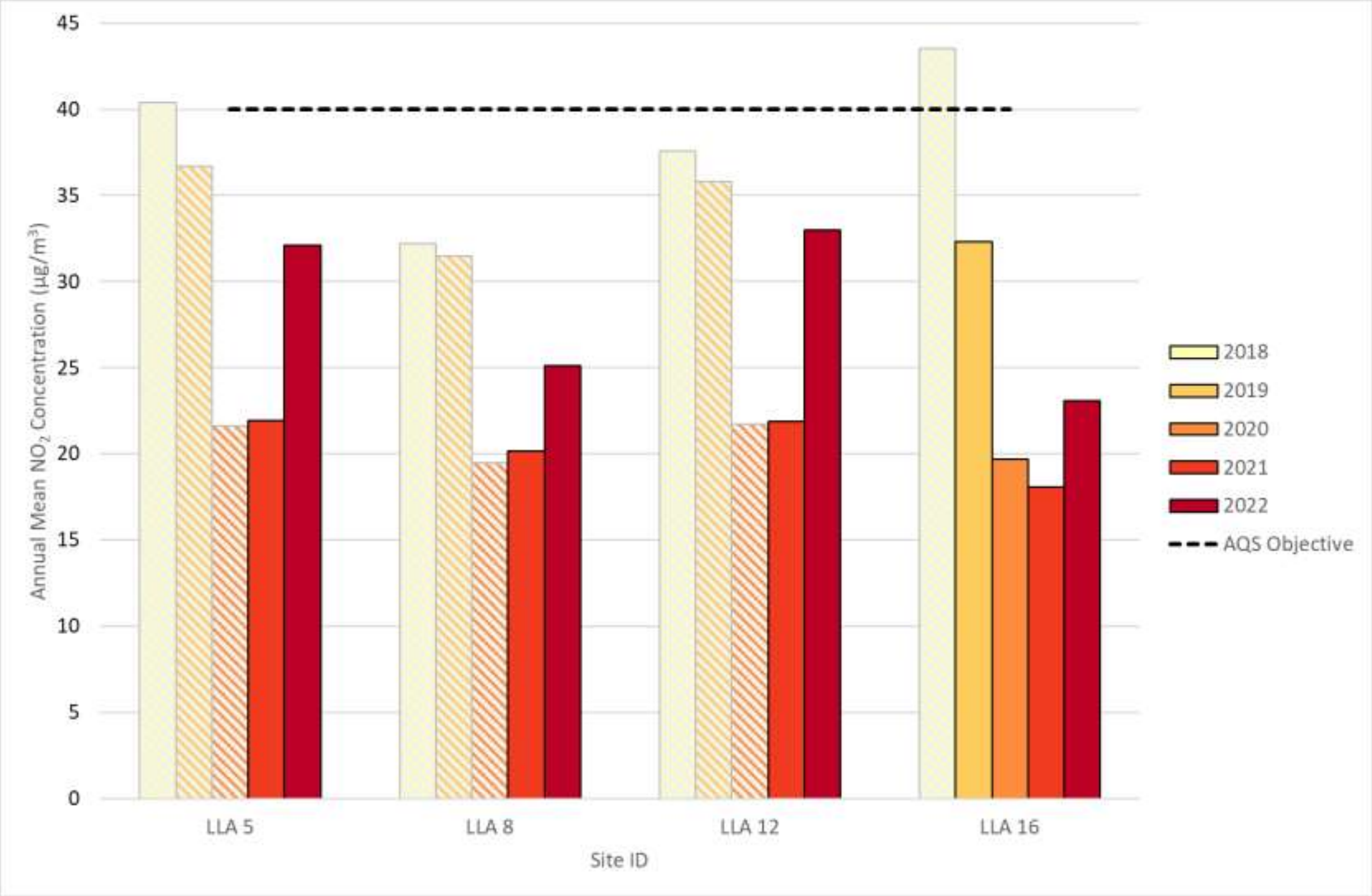
b) London Luton Airport Operations Ltd. (LLAOL) sites

a. LLAOL Site Group: Access Road



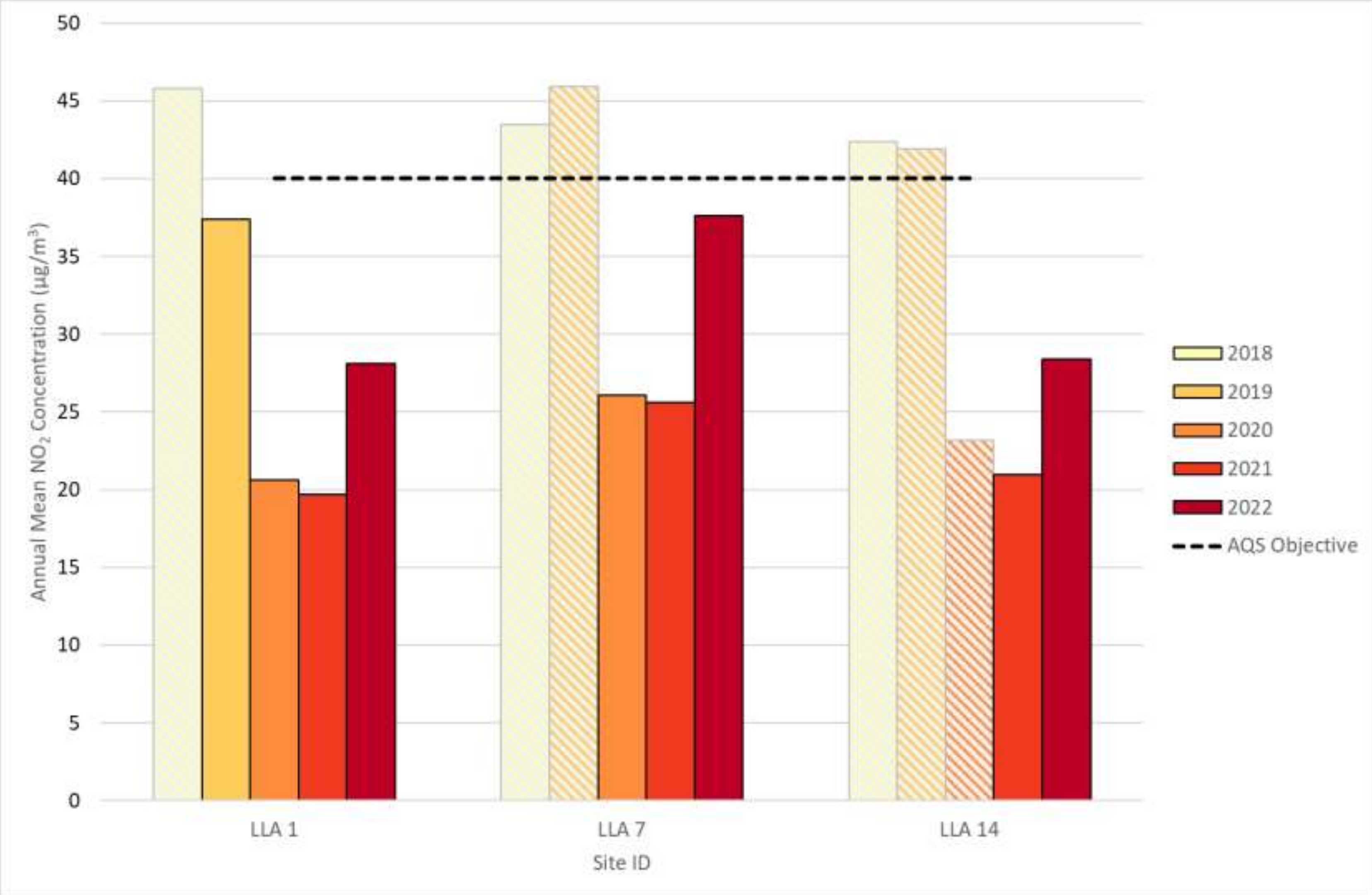
Note: Hatching indicates data from a previous location(s) where tube has been relocated within the last 5 years.

b. LLAOL Site Group: Airfield



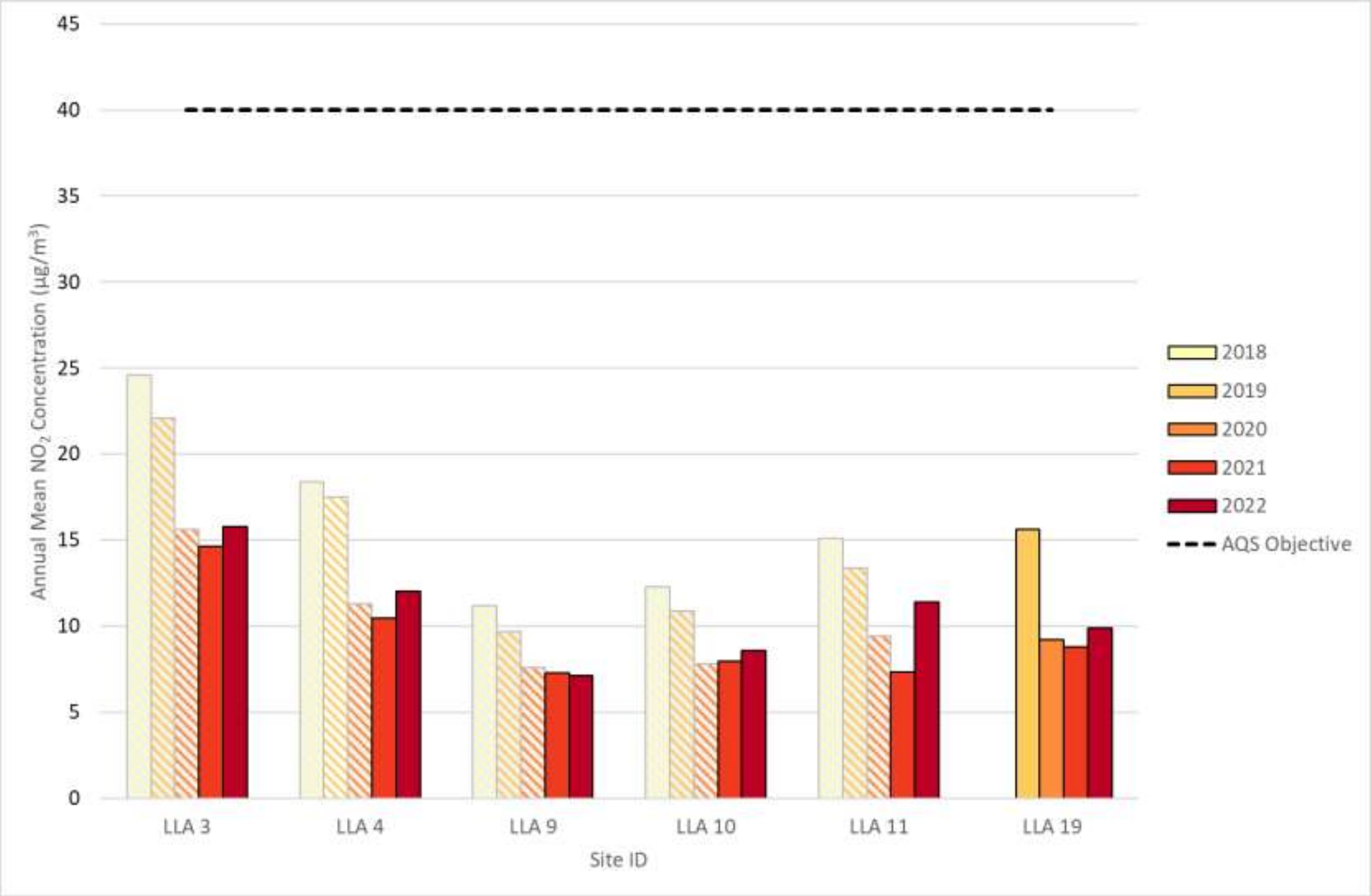
Note: Hatching indicates data from a previous location(s) where tube has been relocated within the last 5 years.

c. LLAOL Site Group: Car Park & Drop-Off



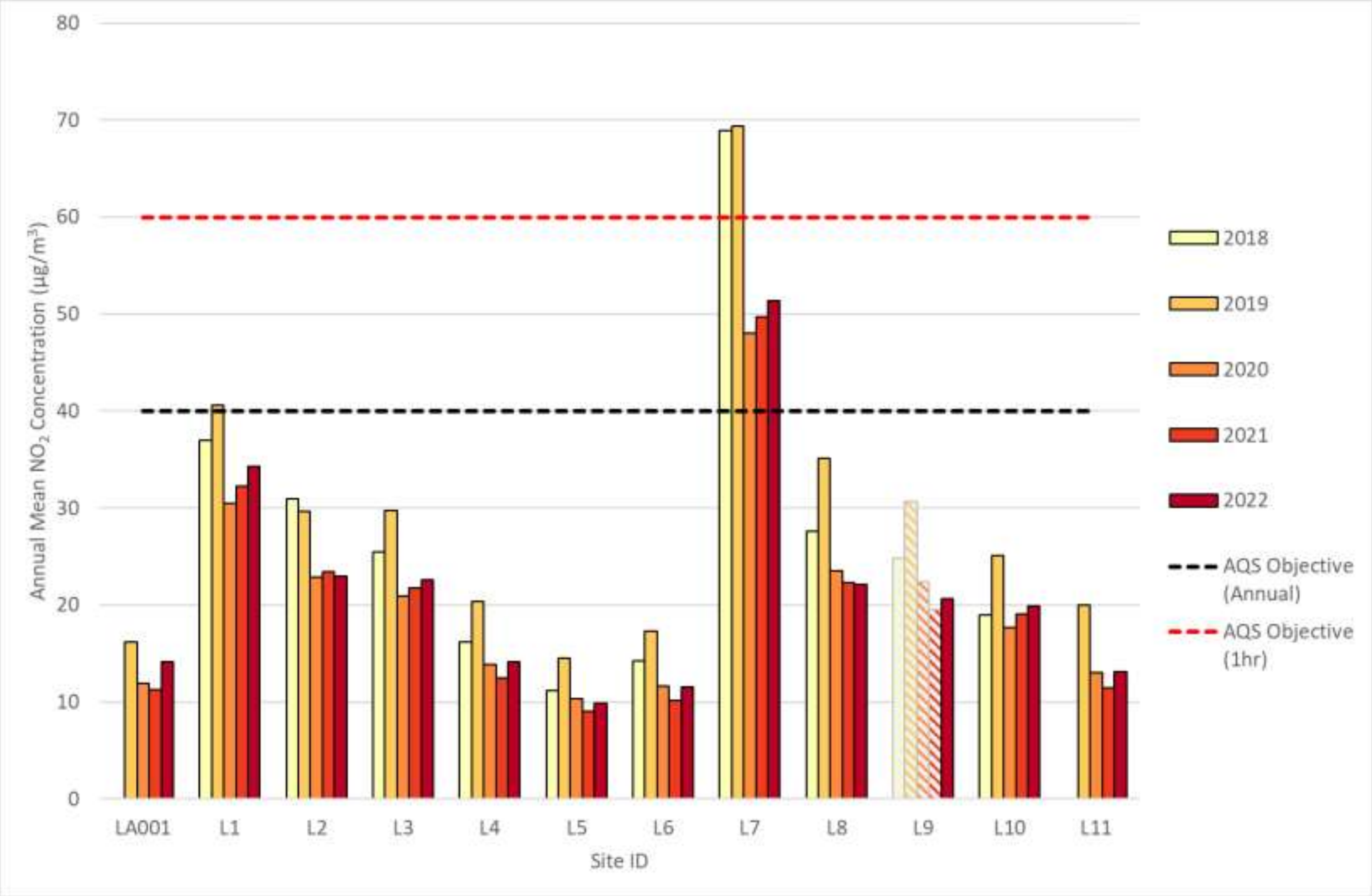
Note: Hatching indicates data from a previous location(s) where tube has been relocated within the last 5 years.

d. LLAOL Site Group: Runway & Flightpath



Note: Hatching indicates data from a previous location(s) where tube has been relocated within the last 5 years.

c) Luton Rising sites



Note: Hatching indicates data from a previous location(s) where tube has been relocated within the last 5 years.

d) Defra AURN sites

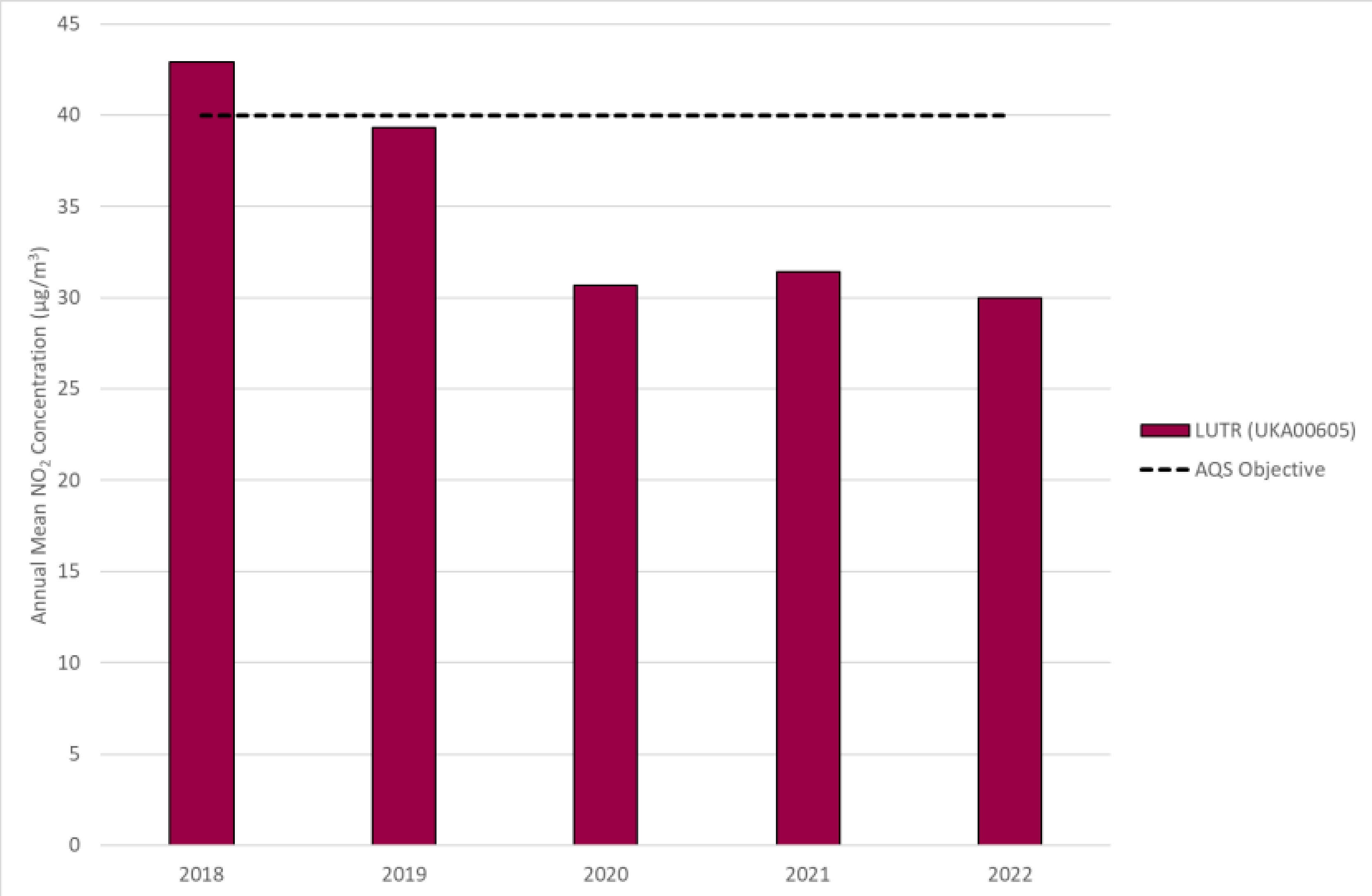


Figure A.2 - Descriptive Statistics and Histogram / Density Plots comparing the distribution of the annual mean NO_2 concentrations at all LBC, LLAOL and Luton Rising diffusion tube sites in operation at unchanged locations for each of the last five years

Descriptives

A total of 52 sites have been in operation at the same location for each of the last five years.

Descriptives

	Year	Annual mean NO_2 Concentration ($\mu g/m^3$)
Mean	2018	30.1
	2019	31.2
	2020	22.9
	2021	23.6
	2022	24.1
Median	2018	29.3
	2019	31.0
	2020	22.5
	2021	22.7
	2022	23.2
Standard deviation	2018	8.58
	2019	8.26
	2020	6.19
	2021	6.69
	2022	6.55
Range	2018	57.7
	2019	54.9
	2020	37.7
	2021	40.6
	2022	41.5
Minimum	2018	11.2
	2019	14.5
	2020	10.3
	2021	9.10
	2022	9.90
Maximum	2018	68.9
	2019	69.4
	2020	48.0
	2021	49.7
	2022	51.4

Plots

Annual mean NO_2 Concentration (µg/m³)

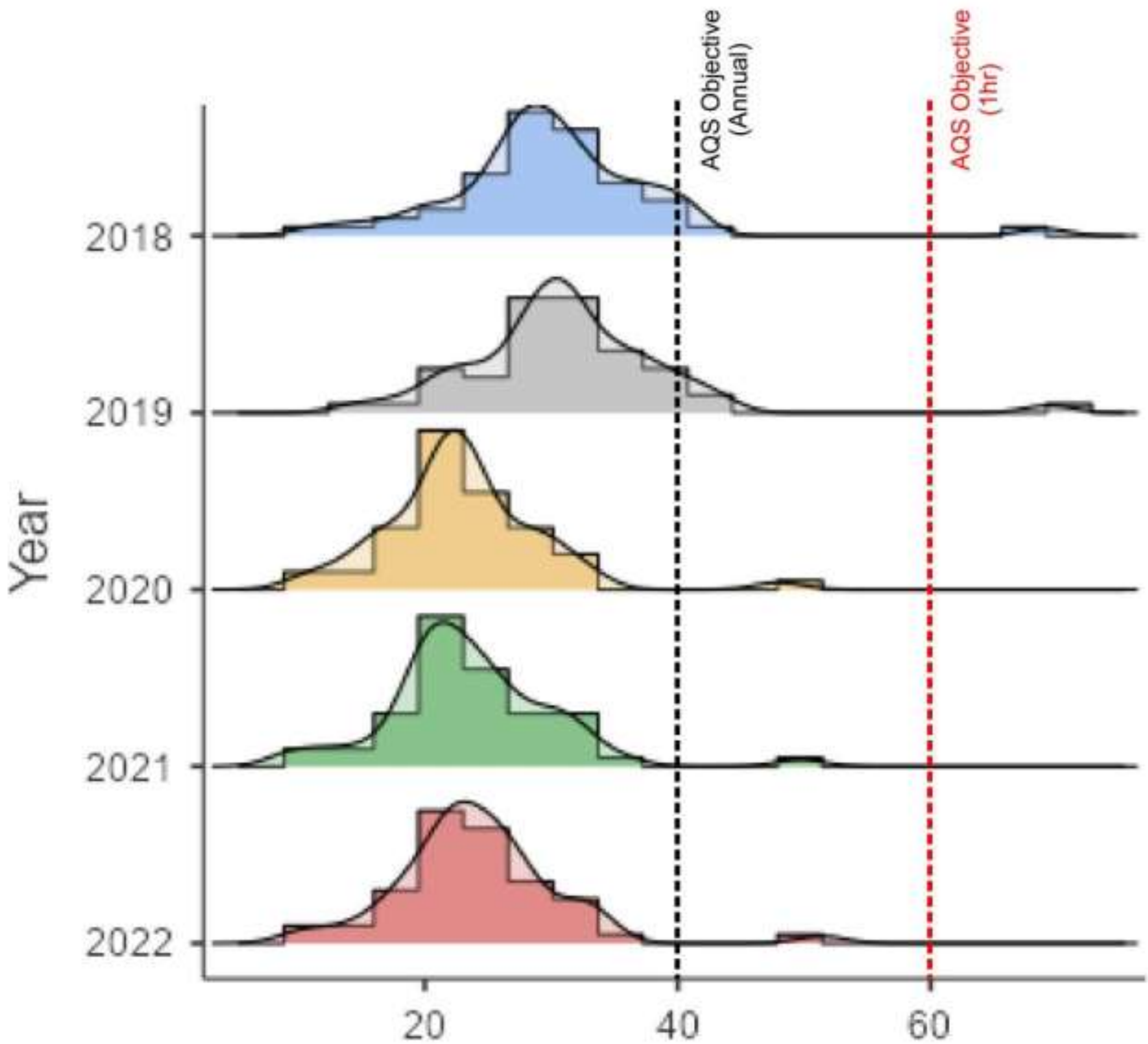


Table A.5 – 1-Hour Mean NO_2 Monitoring Results, Number of 1-Hour Means > 200µg/m^3

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LN60 *(HB007)*	508708	221352	Roadside	99.8	99.8	0	0	0 (114.0)	0	0
LA001	512578	222204	Other	87.9	87.9		0 (65.4)	0	0	0
LUTR *(UKA00605)*	505927	222644	Roadside	97.8	97.8	0	0	0	0	0

Notes:

Results are presented as the number of 1-hour periods where concentrations greater than 200µg/m^3 have been recorded.

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

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

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

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

Figure A.3 – Trends in Number of NO_2 1-Hour Means > 200µg/m^3

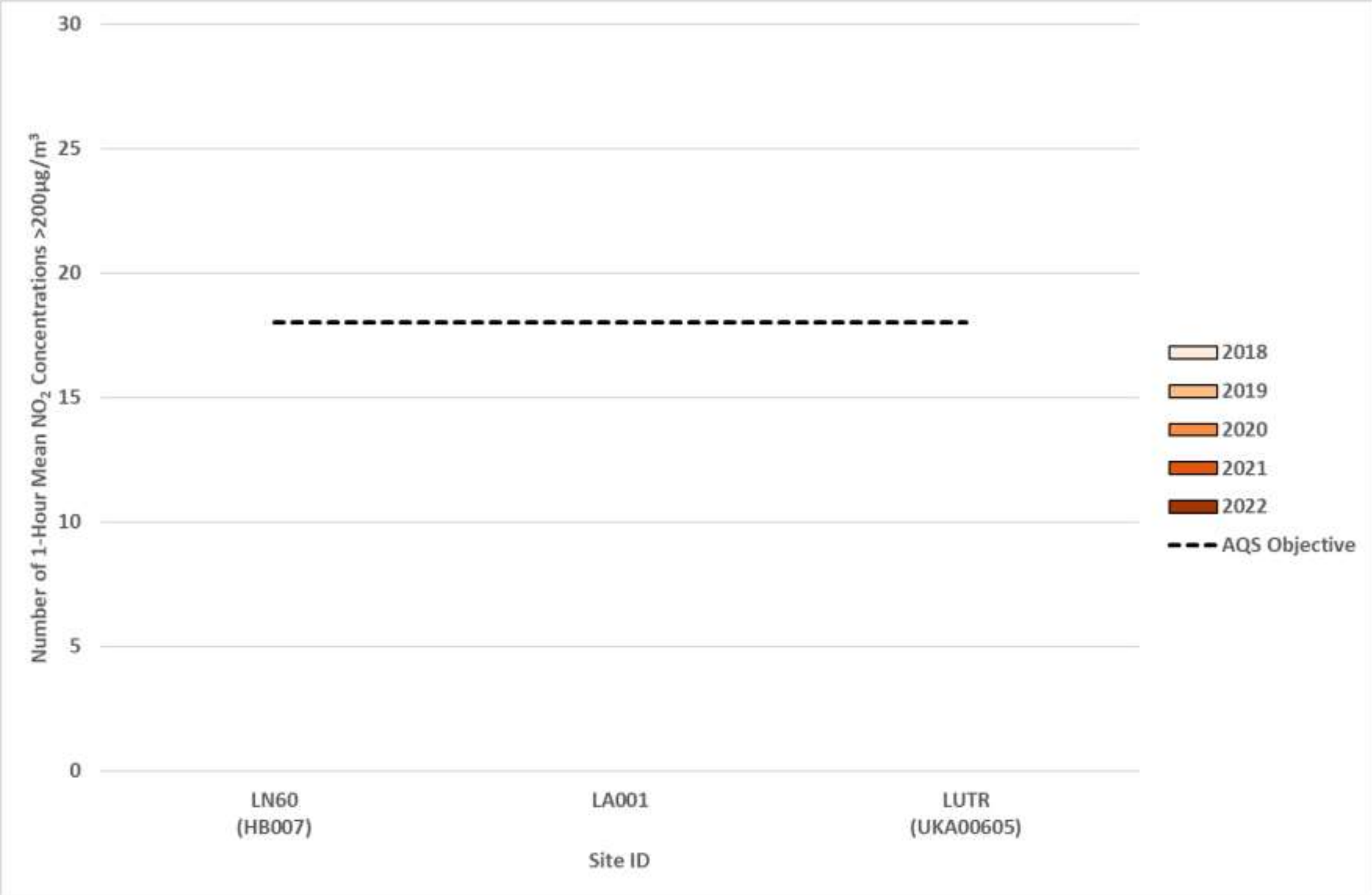


Table A.6 – Annual Mean PM_{10} Monitoring Results ($\mu g/m^3$)

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LN60 *(HB007)*	508708	221352	Roadside	94.6	94.6	15.6	15.8	13.8	15.0	15.1
LA08 *(HB006)*	511868	221144	Other	85.7	85.7	17.3	16.3	13.7	12.3	15.0
LA001	512578	222204	Other	99.7	99.7		13.5	11.7	10.3	9.3

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with *LAQM.TG22*.**

Notes:

The annual mean concentrations are presented as $\mu g/m^3$.

Exceedances of the PM_{10} annual mean objective of $40\mu g/m^3$ are shown in **bold**.

All means have been *"annualised"* as per *LAQM.TG22* if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.
(2) Data capture for the full calendar year (*e.g.* if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

Figure A.4 – Trends in Annual Mean PM_{10} Concentrations

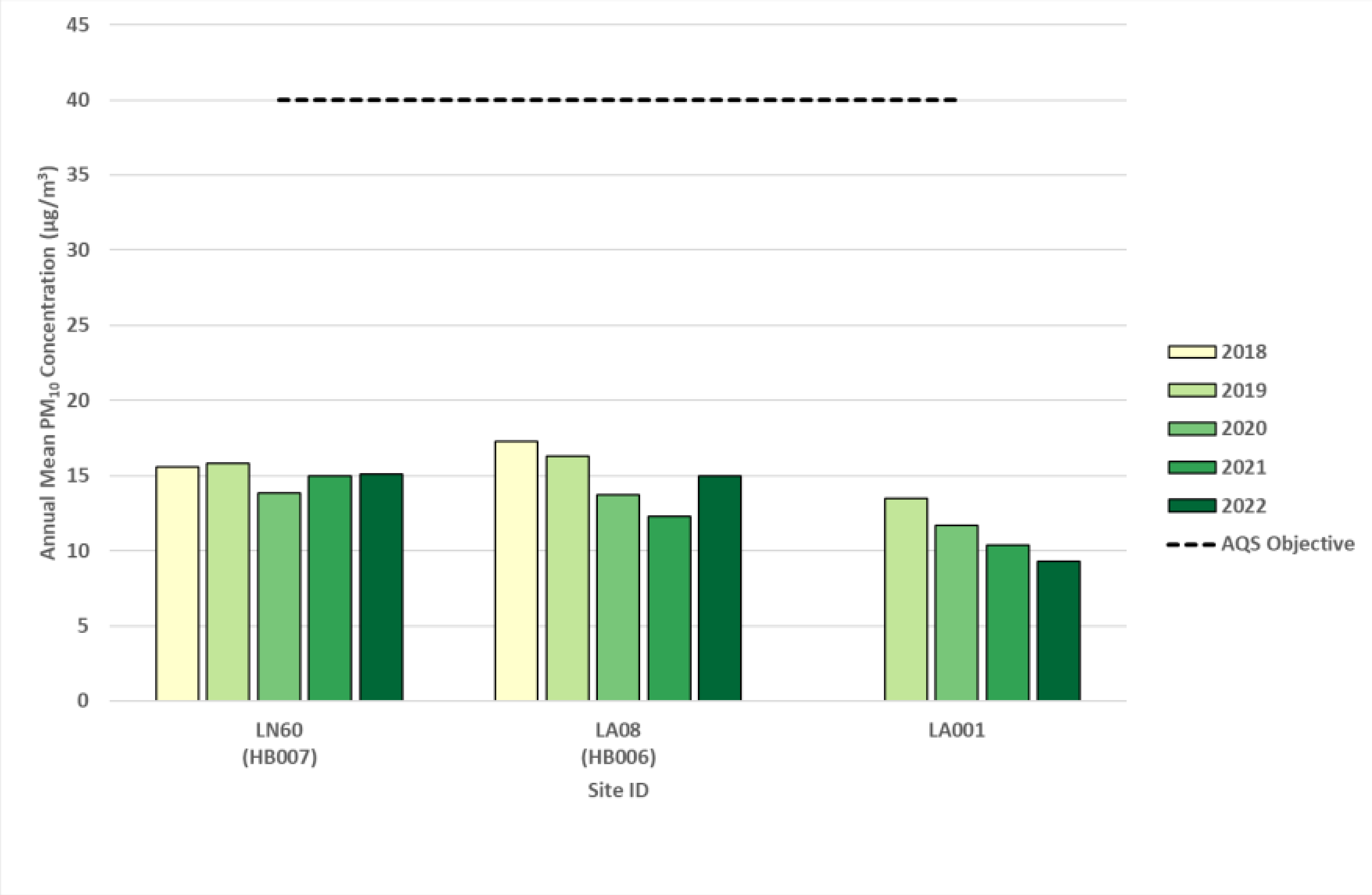


Table A.7 – 24-Hour Mean PM_{10} Monitoring Results, Number of PM_{10} 24-Hour Means > 50µg/m^3

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LN60 *(HB007)*	508708	221352	Roadside	94.6	94.6	1	8	0	2	3
LA08 *(HB006)*	511868	221144	Other	85.7	85.7	1	1	0	0	0
LA001	512578	222204	Other	99.7	99.7		0 (19.6)	1 (23.1)	0	0

Notes:

Results are presented as the number of 24-hour periods where daily mean concentrations greater than 50µg/m^3 have been recorded.

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

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

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

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

Figure A.5 – Trends in Number of 24-Hour Mean PM_{10} Results > 50µg/m^3

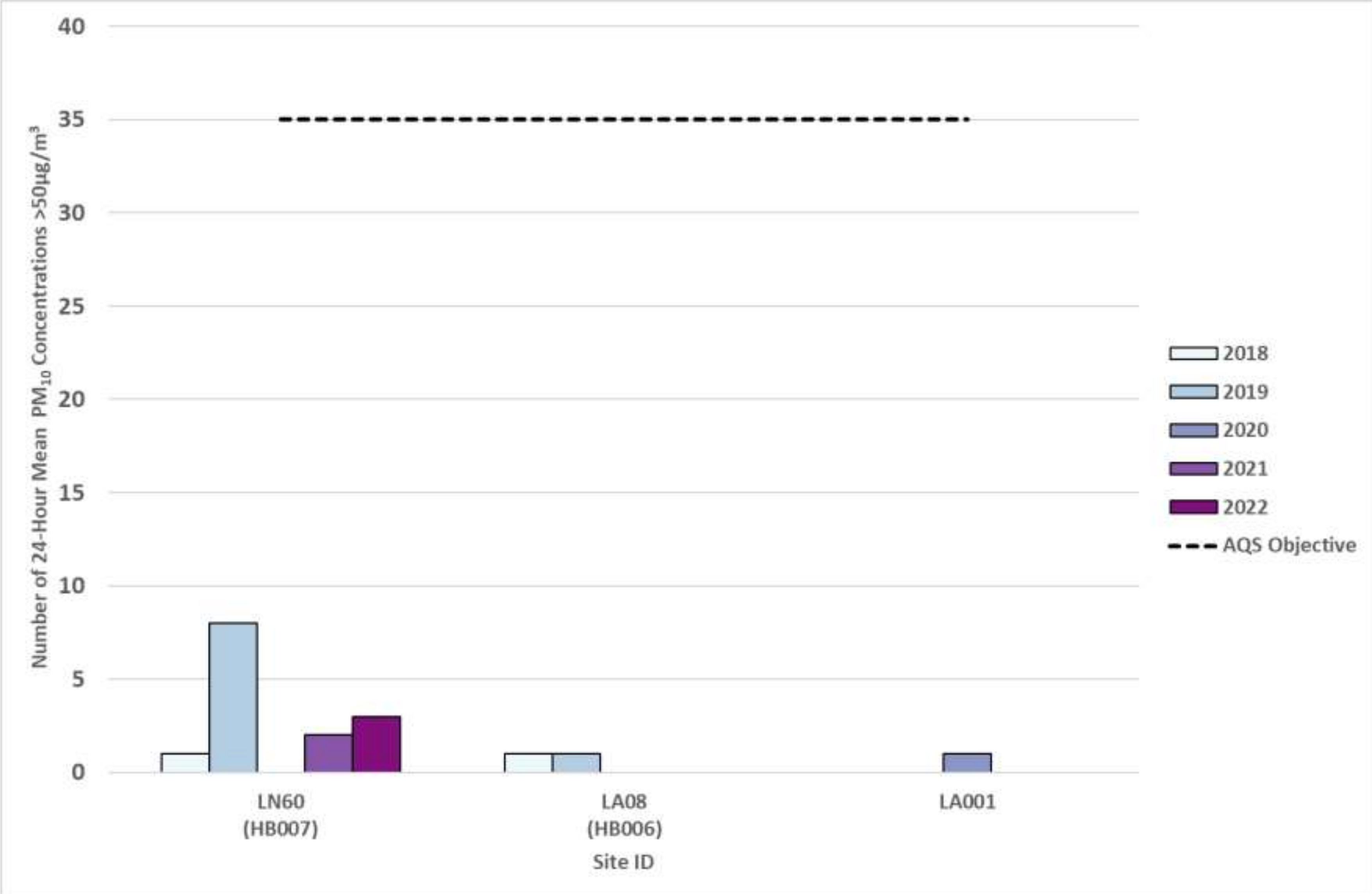


Table A.8 – Annual Mean $PM_{2.5}$ Monitoring Results ($\mu g/m^3$)

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2018	2019	2020	2021	2022
LN60 *(HB007)*	508708	221352	Roadside	94.6	94.6	9.6	10.0	8.3	9.2	9.1
LA001	512578	222204	Other	99.7	99.7		11.6	10.1	9.4	8.4

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

Notes:

The annual mean concentrations are presented as $\mu g/m^3$.

All means have been *"annualised"* as per *LAQM.TG22* if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.
(2) Data capture for the full calendar year (*e.g.* if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

Figure A.6 – Trends in Annual Mean $PM_{2.5}$ Concentrations

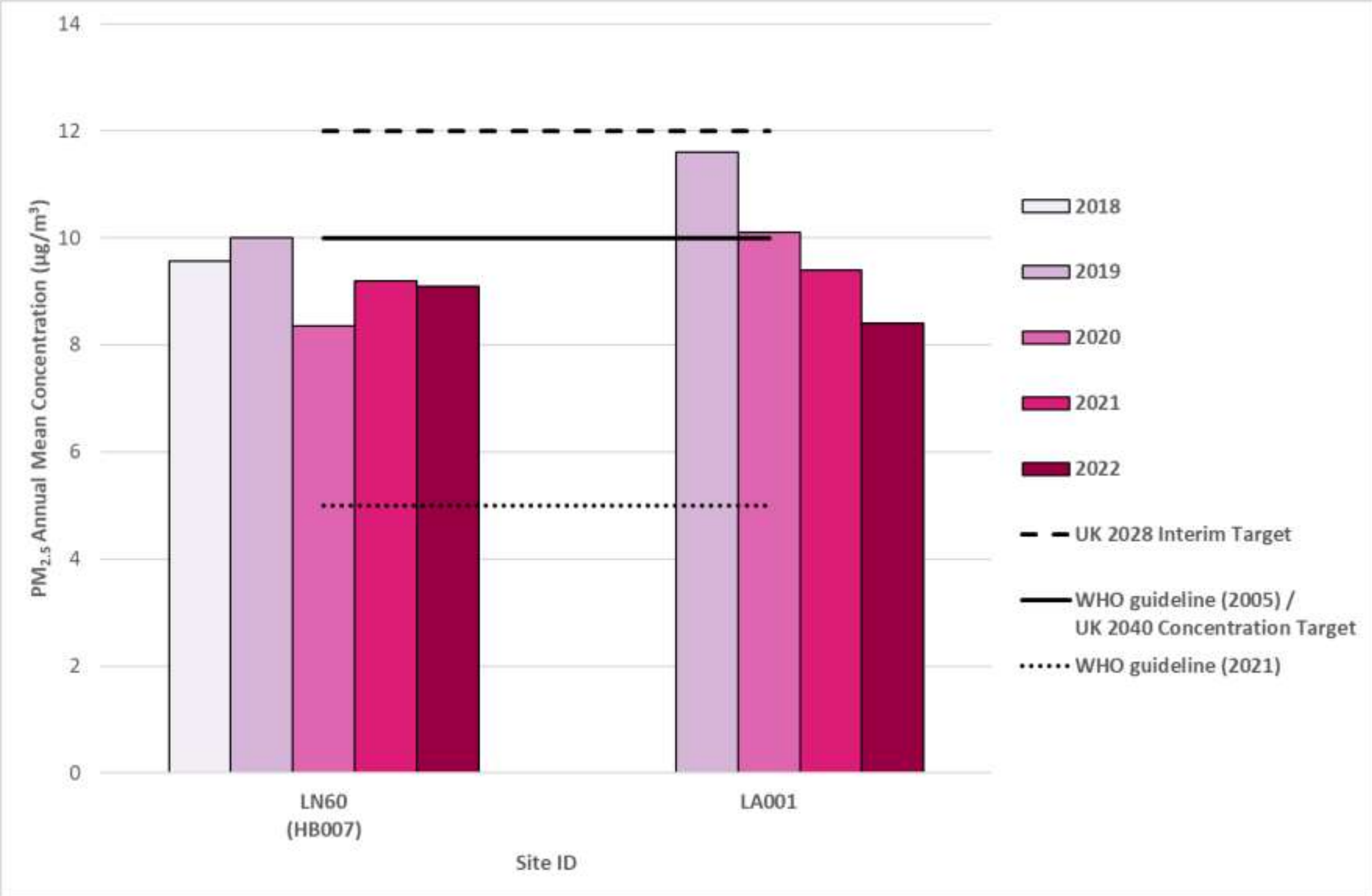


Table A.9 – SO_2 2022 Monitoring Results, Number of Relevant Instances

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	Number of 15-minute Means > 266µg/m^3	Number of 1-hour Means > 350µg/m^3	Number of 24-hour Means > 125µg/m^3
LA001	512578	222204	Other	98.2	98.2	0	0	0

Notes:

Results are presented as the number of instances where monitored concentrations are greater than the objective concentration.

Exceedances of the SO_2 objectives are shown in **bold** (15-min mean = 35 allowed a year, 1-hour mean = 24 allowed a year, 24-hour mean = 3 allowed a year).

If the period of valid data is less than 85%, the relevant percentiles are provided in brackets.

(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.
(2) Data capture for the full calendar year (*e.g.* if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

Appendix B: Full Monthly Diffusion Tube Results for 2022

Table B.1 – NO_2 2022 Diffusion Tube Results ($\mu g/m^3$)

a) Luton Borough Council (LBC) sites

DT ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data	Annual Mean: Annualised and Bias Adjusted (0.85)	Annual Mean: Distance Corrected to Nearest Exposure	Comment
LN07	509227	221455	36.0	21.1	27.7	22.0	20.0	19.5	21.3	21.3	27.1	27.7	29.3	30.8	25.3	21.5	-	
LN11	508910	221321	44.5	25.0	37.5	33.1	30.4	27.5	29.0	32.3	37.9	35.0	35.4	38.4	33.8	28.8	-	
LN15	505557	222325	34.8	23.6	26.0	17.2	21.1	17.9	21.6	18.8	23.4	26.5	25.8	29.2	23.8	20.3	-	
LN16	505492	222607	38.1	26.8	30.4	21.8	23.2	21.6	23.0	23.1	30.3	31.8	31.4	34.7	28.0	23.8	-	
LN17	505324	222812	33.7	23.3	41.7	30.9	24.6	22.6	23.0	33.2	30.6	31.6	31.2	36.1	30.2	25.7	-	
LN18	505014	223538	25.0	15.9	29.8	20.1	16.8	13.4	15.3	18.7	21.0	17.7	21.2	27.8	20.2	17.2	-	
LN22	511341	221864	28.9	19.4	22.1	16.9	14.8		14.4		19.1	25.9	24.3	25.4	21.1	17.9	-	
LN23	511377	221814	38.2	29.1	31.4	27.0	30.0	26.3	29.1	31.0	37.5	38.8	35.8	35.0	32.4	27.6	-	
LN24	511902	222144	34.1		20.0	12.5	13.9	15.1	13.0	12.0	20.3	24.9	26.2	29.8	20.2	17.1	-	
LN25	511893	222068	33.8	27.7	25.0	22.2	21.4	21.0	21.6	21.0	27.6	34.4	33.1	32.1	26.7	22.7	-	
LN26	512109	222234	24.0	17.5	18.0	12.9	13.1	15.2	13.9	13.6	19.3	22.8	22.3	23.9	18.0	15.3	-	
LN27	512134	222198	33.5	26.1	26.8	22.3	22.2		22.2	23.1	28.6	31.4	31.5	33.0	27.3	23.2	-	
LN28	507798	219832	39.0	34.1	36.6	29.5	30.3	25.7	34.1	30.9	34.6	36.4	35.0	36.4	33.5	28.5	-	
LN52	508689	221379	40.0	27.4	42.9	45.9	36.3	35.8	36.1	43.1	46.4	37.1	35.3	38.7	38.8	32.9	-	
LN53	507717	219923	34.5	25.4	27.4	19.8	22.5	22.4	22.9	20.3	26.9	28.1	29.1	29.2	25.7	21.8	-	
LN54	507712	219915	38.4		27.6				27.3	22.2	30.9				29.3	22.7	-	
LN55	507732	219886	36.3	23.3	25.7	20.5	22.8	22.1	21.3	20.8	27.7	27.6	28.5	29.9	25.5	21.7	-	

DT ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data	Annual Mean: Annualised and Bias Adjusted (0.85)	Annual Mean: Distance Corrected to Nearest Exposure	Comment
LN56	507747	219894	34.9	24.7	27.0	20.1	21.3	22.0	22.5	19.9		29.3	30.2	30.4	25.7	21.8	-	
LN61	508708	221352	48.1	26.7	40.9	34.1	37.7	32.5	36.5	38.1	45.6	46.2	40.5	40.1	-	-	-	Triplicate Site with LN61, LN62 and LN63 - Annual data provided for LN63 only
LN62	508708	221352	45.1		41.6	34.8	35.3	33.4	33.6	37.2	43.0	40.6	41.3	42.5	-	-	-	Triplicate Site with LN61, LN62 and LN63 - Annual data provided for LN63 only
LN63	508708	221352	47.8		36.7	29.9	35.5	31.4	33.4	35.6	44.2	40.1	39.9	39.3	37.9	32.2	-	Triplicate Site with LN61, LN62 and LN63 - Annual data provided for LN63 only
LN64	509563	220952	33.9	19.2	32.0	24.9	19.9	20.5	21.1	23.7	28.9	27.7	26.0	30.4	25.7	21.8	-	
LN65	509486	220865	33.1	18.2	27.3	23.3	19.4	15.6	19.1	20.5	26.2	21.8	21.8	27.0	22.8	19.4	-	
LN66	509288	220925	49.9	32.9	31.6	37.6	31.0	29.1	28.6	28.3	30.7	32.9	34.8	38.8	33.9	28.8	-	
LN67	509083	220709	41.4	27.6	48.7	29.9	35.2	35.2	38.7	41.9	40.5		46.5	43.4	39.0	33.2	-	
LN68	508969	220487	36.9	28.7	28.6	27.9	29.2	27.0	26.9	26.6	30.5	31.8	31.3	32.9	29.9	25.4	-	
LN69	509326	221357	38.6	25.0	34.9	24.6	26.7	26.4	25.6	28.9	32.1	33.4	26.6	36.6	30.0	25.5	-	
LN70	509813	221161	35.3	27.7	31.8	29.0	27.9	27.4	27.3	28.2	31.5	32.6	32.5	33.5	30.4	25.8	-	
LN71	509549	221623	38.3	27.3	30.6	26.3	26.5	27.4	27.1	26.9	29.2	30.2	29.9	31.7	29.3	24.9	-	
LN72	508937	221745	37.7	27.9	30.6	26.0	26.0	26.0	24.2	25.8	28.8	31.5	31.0	29.5	28.8	24.4	-	
LN73	508959	221633	43.2	34.3	44.8	31.3	32.8	34.9	34.9	32.7	37.7	39.8	41.1	37.2	37.1	31.5	-	
LN74	508165	222002	41.6	30.1	35.5	33.4	34.1	31.4	33.9	33.7	35.7	37.9	36.9	2.3	32.2	27.4	-	
LN75	508745	222122	45.4	33.8	40.0	35.6	34.9	33.3	34.5	36.4	46.2	38.7	36.8	40.2	38.0	32.3	-	
LN76	507574	222948	37.9	23.0	38.5	32.2	27.4	22.9	26.3	29.8	31.7	30.0	31.2	36.4	30.6	26.0	-	
LN77	506496	224018	45.2	25.5	33.6	24.6	28.3	28.7	30.1	27.4	33.8	35.6	35.1	34.5	31.9	27.1	-	
LN78	509109	220676	39.0	26.2	27.3	23.5	22.6	23.3	23.6	23.1	27.9		31.4		26.8	22.8	-	
LN80	509038	220719	36.7	22.0	34.5	28.3	24.5	23.5		29.1	34.7	32.1	30.9	35.8	30.2	25.7	-	
LN81	505034	223729	40.4	30.0	26.7	21.1	23.4	22.8	22.7	20.3	28.0	31.9		32.7	27.3	23.2	-	

DT ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data	Annual Mean: Annualised and Bias Adjusted (0.85)	Annual Mean: Distance Corrected to Nearest Exposure	Comment
LN82	504828	223999	34.1	21.3	24.8	16.8	21.8	18.8	20.1	17.9	23.0	26.1	27.2	29.6	23.5	19.9	-	
LN83	505116	223467	25.1	15.7	33.5	19.8	16.7	13.9	15.8	21.0	22.6	20.8	20.7	28.5	21.2	18.0	-	
LN84	505230	223304	27.7	15.4	32.1	24.5	15.1	13.9	15.7	22.8	23.5	23.0	24.4	31.0	22.4	19.1	-	
LN85	505481	222545	35.8	27.0	24.4	19.1	23.5	22.3	20.9		24.4	29.6		28.3	25.5	21.7	-	
LN86	505586	222235	45.0	31.5	36.2	27.2	29.8	26.6			34.5	33.8	33.8	33.5	33.2	28.2	-	
LN87	510170	223162	35.2			17.6	16.2	17.4	15.5	16.4	21.8	22.2	24.7	27.5	21.5	18.2	-	
LN88	510107	223087	35.4	24.4	24.5	23.4	21.4	22.0	21.3	22.9	25.5	27.5	28.1	31.7	25.7	21.8	-	
LN89	510515	222612	36.6	18.4	26.0	20.4	15.7	14.3	17.6	20.6	22.8	24.8	24.4	29.1	22.5	19.2	-	
LN90	510846	222209	33.9	26.3	30.8		21.2	20.8	24.6	24.8	29.1	28.0	26.2	28.9	26.8	22.8	-	
LN91	511122	221721	30.9	22.4	24.4	18.4	20.3	20.8	21.6	21.4	24.0	27.4	29.3	27.1	24.0	20.4	-	
LN92	511037	221657	28.9	21.2	25.0	19.7	17.4	18.5	17.8	18.9	24.6	25.5	26.3	25.1	22.4	19.0	-	
LN93	511332	223069	25.0	14.0		13.8	10.5	10.2			15.4	17.4	18.6	21.4	16.3	13.8	-	
LN94	511327	222588	26.3	18.0	16.4	11.2	12.5	12.1	11.9	10.2	17.3	22.4		25.3	16.7	14.2	-	
LN95	511996	222534	29.0		17.5	10.6	11.6	13.5	12.2	10.4	17.8	24.1	24.4	26.7	18.0	15.3	-	
LN96	509059	220656	39.9		49.8	43.8	41.9	37.1	39.3	47.3	47.2	47.6	45.5	42.8	43.8	37.3	-	
LN98	506411	222554	35.2	25.3	41.8		27.2	25.9	26.9	34.5	39.0	37.8	37.3		33.1	28.1	-	
LN100	508380	221764	43.9	40.1	41.2	32.3	40.5	39.5	38.8	36.9	43.2	48.0	47.1	49.3	41.8	35.5	-	
LN102	508000	222078	35.3	27.2	30.9	28.8	25.1	24.3	26.0	27.4	31.1	30.6	29.6	33.9	29.2	24.8	-	
LN104	504987	222805	42.2	32.9	47.1	37.5	30.1		38.2	39.3		39.6	37.0	42.5	38.6	32.8	-	
LN106	509339	222128	25.0		22.3	15.5	16.8	17.8	16.4	15.8	20.4	25.2	26.8	28.3	20.9	17.8	-	
LN107	511573	221897	30.6	22.3	24.2	17.4	16.8	18.8	17.8	17.0	24.6	29.5	27.6	28.3	22.9	19.5	-	

DT ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data	Annual Mean: Annualised and Bias Adjusted (0.85)	Annual Mean: Distance Corrected to Nearest Exposure	Comment
LN108	512473	222295	30.7	20.6	17.3	13.9	15.1	13.8	15.3	12.7	17.6	24.7	25.8	30.0	19.8	16.8	-	
LN109	512915	222308	24.5	16.2	14.4	9.3	9.7	10.6	11.3	9.6	13.2	18.7	18.1	24.0	15.0	12.7	-	
LN110	512738	222385	26.3	19.0	16.8	12.3	11.9	13.2	13.6	12.8	16.6	20.6	21.1	24.5	17.4	14.8	-	
LN111	511521	222203	30.2	17.1	22.2	14.8	13.8	13.7	14.2	14.2	21.2	24.1	25.6	27.0	19.8	16.9	-	
LN112	511254	221466	24.4		18.8	14.3	13.9	13.2		14.6	19.2	21.6	22.3	24.9	18.7	15.9	-	
LN113	505005	222696	31.8	24.5	34.2	26.4	23.9	23.2	24.2	29.0	26.9	30.4	28.7	33.4	28.1	23.9	-	
LN114	509293	223741	24.9	15.7	17.2	9.7	11.3	10.6	9.5	9.7	14.7	17.0	19.5	22.4	15.2	12.9	-	
LN115	509995	220892	34.8	21.1	33.1	30.6	20.4	22.2	25.4	28.7	32.7	29.0	28.0	30.1	28.0	23.8	-	
LN116	509655	221842	49.0	32.6	40.6	37.6	42.9	38.7	42.2	42.0	46.0	44.4	44.4	41.4	41.8	35.6	-	
LN117	509136	223217	38.0	27.5	35.7	33.9	33.0	29.2	30.3	32.7	32.8	23.3	30.9	45.3	32.7	27.8	-	
LN118	506407	222732	37.4	24.3	27.0	18.5	19.7	20.9	20.6	19.6	25.8	30.8	29.8	32.5	25.6	21.7	-	
LN119	505588	222871	32.5	22.0	24.7	17.4	17.6	16.5	16.1	16.5	21.0	26.6		29.5	21.9	18.6	-	
LN120	505723	223787	32.8	22.7	33.0	27.4	25.0	23.2	22.8	26.8	26.5	32.0	31.1	32.7	28.0	23.8	-	
LN121	506990	223425	32.8	24.8	27.0	19.0	26.0	24.3	26.0	20.7	26.9	29.9	29.5	30.1	26.4	22.5	-	
LN122	506918	223295	37.4	20.6	31.0	28.6	23.8	22.0	21.4	26.5	29.4	27.7	29.2	30.6	27.4	23.2	-	
LN123	508413	221918								35.5	37.1	36.4	33.7	40.9	36.7	29.7	-	
LN124	508253	222053								26.1	28.6	29.4	28.5	31.6	28.9	23.3	-	
LN125	508321	221839								29.9	36.5	37.0	38.0	38.3	35.9	29.1	-	
LN126	508140	222103								35.0	35.6	33.3	32.9	36.0	34.6	28.0	-	
LN127	508095	222127								30.0	32.5	31.1	30.5	32.6	31.4	25.4	-	
LN128	508065	222182								33.9	39.4	34.1	33.5	39.9	36.2	29.3	-	

DT ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data	Annual Mean: Annualised and Bias Adjusted (0.85)	Annual Mean: Distance Corrected to Nearest Exposure	Comment
LN129	507973	222289								32.2	35.5	34.1	34.6	34.3	34.1	27.6	-	
LN130	507918	222560								30.0	33.1	30.7	29.6	33.9	31.5	25.5	-	
LN131	507666	222143								24.8	27.0	29.2	29.8	0.5	22.3	18.0	-	
LN132	507228	222511								20.8	26.0	35.6	52.0	45.0	35.9	29.0	-	
LN133	508381	221795								38.8	38.9	35.5	34.1	38.8	37.2*	29.3*	-	August exposure shorter than recommended 4 week period (actual duration 20 days)
LN134	508156	222053								36.7	37.9	42.9		40.9	39.6*	31.4*	-	August exposure shorter than recommended 4 week period (actual duration 20 days)
LN135	508136	222040								40.2	39.8	34.6	33.0	36.6	36.8*	28.8*	-	August exposure shorter than recommended 4 week period (actual duration 20 days)
LN136	508059	222080								35.4	35.3	29.9	30.5	36.5	33.5*	26.4*	-	August exposure shorter than recommended 4 week period (actual duration 20 days)
LN137	507948	222337								30.0	35.3	30.2	29.7	35.5	32.1*	25.5*	-	August exposure shorter than recommended 4 week period (actual duration 20 days)
LN138	508021	222248								38.5	38.5	33.7	34.5	38.0	36.6*	28.8*	-	August exposure shorter than recommended 4 week period (actual duration 20 days)
LN139	508270	221939								46.7	44.3	38.2	31.2	41.8	40.4*	31.6*	-	August exposure shorter than recommended 4 week period (actual duration 20 days)
LN140	508279	221903								36.0	37.7	38.0	35.7	40.7	37.6*	29.9*	-	August exposure shorter than recommended 4 week period (actual duration 20 days)
LN141	508450	221790								24.6	30.4	31.8	29.8	32.0	29.7*	23.8*	-	August exposure shorter than recommended 4 week period (actual duration 20 days)
LN142	508751	221714								35.2	25.1	42.6	39.5	40.0	36.5*	29.4*	-	August exposure shorter than recommended 4 week period (actual duration 13 days)

☒ **All erroneous data has been removed from the NO_2 diffusion tube dataset presented in Table B.1.a**

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with *LAQM.TG22*.**

☒ **Local bias adjustment factor used.**

☐ **National bias adjustment factor used.**

☒ **Where applicable, data has been distance corrected for relevant exposure in the final column.**

☒ **Luton Borough Council confirm that all 2022 diffusion tube data has been uploaded to the Diffusion Tube Data Entry System.**

Notes:

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

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

See Appendix C for details on bias adjustment and annualisation.

* Time weighted annual mean

b) London Luton Airport Operations Ltd (LLAOL) sites

DT ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec[1]	Annual Mean: Raw Data	Annual Mean: Annualised and Bias Adjusted (0.76)	Annual Mean: Distance Corrected to Nearest Exposure	Comment
LLA 1	511920	221334	39.8	31.2	39.3	33.2	34.3	36.5	35.5	40.5	42.6	38.2	36.0	*~~(40.5)~~*	37.0	28.1	-	
LLA 2	511586	220978	42.7	29.9	34.4	32.1	30.5	28.8	31.3	33.8	38.4	32.7	32.0	*~~(37.4)~~*	33.3	25.3	-	
LLA 3	511156	220437	36.0	15.5	25.6	20.6	16.8	14.5	14.5	19.2	26.2	19.2	20.2	*~~(15.8)~~*	20.8	15.8	-	
LLA 4	513634	221198	28.7	17.0	17.9	11.8	13.8	12.7	12.3	12.0	14.6	17.3	15.9	*~~(17.5)~~*	15.8	12.0	-	
LLA 5	511703	221320	44.1	33.6	43.9	43.9	37.5	38.9	43.3	44.9	49.0	49.8	36.4	*~~(52.8)~~*	42.3	32.1	-	
LLA 6	511645	221679	46.3	34.2	33.5	25.4	29.5	27.4	29.0	28.1		35.4	38.4	*~~(40.2)~~*	32.7	24.9	-	
LLA 7	512105	221168	47.9	36.1	38.5	49.1	53.4	56.3	57.6	61.7	58.8	47.2	37.8	*~~(42.2)~~*	49.5	37.6	-	
LLA 8	511871	221142	39.7	29.1	32.7	30.7	30.0	28.7	30.1	31.3	38.4		39.3	*~~(35.8)~~*	33.0	25.1	-	
LLA 9	517637	222554	16.2	10.5	13.2	7.1	7.5	5.5	7.8	6.2	8.6		10.7	*~~(10.4)~~*	9.3	7.1	-	
LLA 10	507623	217724	17.4		18.1	9.8	7.0	5.5	6.8	8.3	10.4	11.7	17.6	*~~(14.1)~~*	11.3	8.6	-	
LLA 11	513125	220664	24.7	11.8	16.2	11.6	10.2	10.2	11.0	15.5	21.5	15.3	16.6	*~~(20.0)~~*	15.0	11.4	-	
LLA 12	511861	221579	41.5	36.4	46.8	43.8	39.6	39.5	40.0	47.2	44.7	52.6	45.4	*~~(47.9)~~*	43.4	33.0	-	
LLA 13	511899	222051	27.4	25.7	27.8	20.1	20.1	21.5	19.7	19.2	26.6	31.0	29.0	*~~(29.5)~~*	24.4	18.5	-	
LLA 14	511954	221313	45.9	30.6	33.4	39.5	35.6	34.4	35.0	41.8	44.6	34.5	36.4	*~~(40.6)~~*	37.4	28.4	-	
LLA 15	511168	221706	45.2	30.7	39.9	30.9	30.9	30.5	31.3	31.5	35.6	34.4	29.2	*~~(34.5)~~*	33.6	25.6	-	
LLA 16	512275	221115		27.1	26.7	24.1	24.9	27.7	29.7	25.0	35.1	44.6	38.5		30.3	23.1	-	
LLA 17	509489	219237	43.5	31.9	39.0	29.4	30.1	28.3	30.8	34.4	36.3	31.5	32.3	*~~(31.5)~~*	33.4	25.4	-	
LLA 18	510779	220279	38.6	23.7	42.6	34.3	26.1	25.3	30.2	34.8	37.1	32.5	27.5	*~~(36.4)~~*	32.1	24.4	-	
LLA 19	515109	221933	21.0	12.8			9.0	7.6	8.2	7.9	11.4	15.6	15.5	*~~(8.4)~~*	12.1	9.9	-	

☒ **All erroneous data has been removed from the NO_2 diffusion tube dataset presented in Table B.1.**

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

☐ **Local bias adjustment factor used.**

☒ **National bias adjustment factor used.**

☒ **Where applicable, data has been distance corrected for relevant exposure in the final column.**

☒ **Luton Borough Council confirm that all 2022 diffusion tube data has been uploaded to the Diffusion Tube Data Entry System.**

Notes:

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

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

See Appendix C for details on bias adjustment and annualisation.

(1) Data from December 2022 exposure discounted due to the diffusion tube exposure significantly exceeding the recommended period of 5 weeks: tubes deployed between 30/11/2022 and 01/02/2023, for a total of 63 days (*i.e.* 9 weeks).

c) Luton Rising sites

DT ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Time Weighted Annual Mean: Raw Data	Time Weighted Annual Mean: Annualised and Bias Adjusted (0.83)	Time Weighted Annual Mean: Distance Corrected to Nearest Exposure	Comment
L1(i)	508710	221353	49.3	35.2	53.7	35.8	36.5	33.5	36.8	44.0	47.5	42.3	44.0	43.1	-	-	-	Triplicate Site with L1(i), L1(ii) and L1(iii) - Annual data provided for L1(iii) only
L1(ii)	508710	221353	56.7	34.0	55.1	36.4	36.5	33.4	34.8	41.2	47.3	42.2	43.6	43.8	-	-	-	Triplicate Site with L1(i), L1(ii) and L1(iii) - Annual data provided for L1(iii) only
L1(iii)	508710	221353	51.3	35.8	54.2	33.8	37.0	34.1	34.3	40.9	43.8	41.6	44.9	42.6	41.3	34.3	-	Triplicate Site with L1(i), L1(ii) and L1(iii) - Annual data provided for L1(iii) only
L2(i)	511155	222445	38.1	30.1	35.4	25.2	23.0	22.3	20.3	23.0	27.1		32.0	31.5	-	-	-	Duplicate Site with L2(i) and L2(ii) - Annual data provided for L2(ii) only
L2(ii)	511155	222445	35.7	28.7	35.4	24.4	22.7	23.8		22.6	26.5		31.6	33.6	27.7	23.0	-	Duplicate Site with L2(i) and L2(ii) - Annual data provided for L2(ii) only
L3(i)	511780	222760	32.9	26.7	34.5	20.1	15.8		19.3	20.0	27.7	32.2	35.9	36.5	-	-	-	Duplicate Site with L3(i) and L3(ii) - Annual data provided for L3(ii) only
L3(ii)	511780	222760	34.6	27.9	35.4	20.4			17.6	19.1		29.7	34.3	37.7	27.2	22.6	-	Duplicate Site with L3(i) and L3(ii) - Annual data provided for L3(ii) only
L4(i)	513223	222397	22.9	17.1	20.2	11.9	13.3	11.1	12.5	11.0	16.0	21.5	21.0	24.7	-	-	-	Duplicate Site with L4(i) and L4(ii) - Annual data provided for L4(ii) only
L4(ii)	513223	222397	23.2	18.1	18.0	11.3	13.2	11.2	12.2	11.3	16.3	21.9	21.5	24.4	17.0	14.1	-	Duplicate Site with L4(i) and L4(ii) - Annual data provided for L4(ii) only
L5(i)	515047	221904	18.7	12.0	14.6	8.5	8.8	7.3	7.4	7.2	10.8	13.6	15.1	18.3	-	-	-	Duplicate Site with L5(i) and L5(ii) - Annual data provided for L5(ii) only
L5(ii)	515047	221904	19.7	13.5	15.5	8.8	9.2	5.5	7.2	7.6	10.5	12.5	15.1	17.4	11.9	9.9	-	Duplicate Site with L5(i) and L5(ii) - Annual data provided for L5(ii) only
L6(i)	513773	221752	19.8	14.6	15.6	9.9	11.1	8.4	10.1	9.3	11.6	16.0	16.0	20.6	-	-	-	Duplicate Site with L6(i) and L6(ii) - Annual data provided for L6(ii) only
L6(ii)	513773	221752	20.6	15.0	15.0	10.5	11.1	9.1	9.6	9.5	12.4	15.4	17.6	21.1	13.8	11.5	-	Duplicate Site with L6(i) and L6(ii) - Annual data provided for L6(ii) only
L7(i)	511057	221386	73.1	62.6	75.5	55.4	59.5	60.5	54.7	66.1		62.7		60.7	-	-	-	Duplicate Site with L7(i) and L7(ii) - Annual data provided for L7(ii) only
L7(ii)	511057	221386	77.0	59.8		50.9	56.1	50.6	64.1	65.5		62.9		58.2	62.0	**51.4**	-	Duplicate Site with L7(i) and L7(ii) - Annual data provided for L7(ii) only
L8(i)	510543	220706	36.2	26.8	36.1	23.6	20.5	20.3	19.6	23.1	27.8	28.4	31.0		-	-	-	Duplicate Site with L8(i) and L8(ii) - Annual data provided for L8(ii) only
L8(ii)	510543	220706	37.8	27.0	35.2	24.1	21.1	20.5	20.4	22.0	27.7	30.6	31.2		26.6	22.1	-	Duplicate Site with L8(i) and L8(ii) - Annual data provided for L8(ii) only

DT ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Time Weighted Annual Mean: Raw Data	Time Weighted Annual Mean: Annualised and Bias Adjusted (0.83)	Time Weighted Annual Mean: Distance Corrected to Nearest Exposure	Comment
L9(i)	510553	220682	39.2	26.6		17.7	18.5	18.4			24.8	26.9	28.9	28.6	-	-	-	Duplicate Site with L9(i) and L9(ii) - Annual data provided for L9(ii) only
L9(ii)	510553	220682	35.8	28.1		19.3	19.0	17.4			27.1	25.7	27.2	27.4	25.2	20.6	-	Duplicate Site with L9(i) and L9(ii) - Annual data provided for L9(ii) only
L10(i)	506541	219854	34.0	24.3	32.4	21.7	20.2	19.6	20.2	20.2	26.1	22.9	26.9	21.1	-	-	-	Duplicate Site with L10(i) and L10(ii) - Annual data provided for L10(ii) only
L10(ii)	506541	219854	32.5	24.3	29.8	22.5	18.9	19.2	19.6	18.9	27.5	24.1	27.1	28.5	24.0	19.9	-	Duplicate Site with L10(i) and L10(ii) - Annual data provided for L10(ii) only
L11(i)	512569	222207	27.2	16.0	15.5	10.1	11.2	9.8	10.4	9.8	15.8	21.4	22.0	24.1	-	-	-	Triplicate Site with L11(i), L11(ii) and L11(iii) - Annual data provided for L11(iii) only
L11(ii)	512569	222207	23.6	15.0	15.6	10.1	12.5	8.1	10.4	9.4	17.1	19.9	19.2	22.9	-	-	-	Triplicate Site with L11(i), L11(ii) and L11(iii) - Annual data provided for L11(iii) only
L11(iii)	512569	222207	24.6	15.1	14.1	10.1	11.3	8.4	10.8	9.5	15.1	19.8	18.9	28.3	15.8	13.1	-	Triplicate Site with L11(i), L11(ii) and L11(iii) - Annual data provided for L11(iii) only

☒ **All erroneous data has been removed from the NO_2 diffusion tube dataset presented in Table B.1.**

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

☐ **Local bias adjustment factor used.**

☒ **National bias adjustment factor used.**

☐ **Where applicable, data has been distance corrected for relevant exposure in the final column.**

☒ **Luton Borough Council confirm that all 2022 diffusion tube data has been uploaded to the Diffusion Tube Data Entry System.**

Notes:

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

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

See Appendix C for details on bias adjustment and annualisation.

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

New or Changed Sources Identified Within Luton During 2022/2023

The ongoing proposals to increase passenger numbers and expand London Luton Airport have been identified as potentially impacting air quality (primarily through the generation of additional road traffic). Consequently, the application to increase the current passenger cap from 18 million passengers per annum (mppa) to 19 million and the ongoing Development Consent Order application to increase passenger throughput to 32mppa and develop a second terminal have both been required to produce comprehensive Environmental Impact Assessments for consideration via the relevant planning process. At time of writing, the former is awaiting the outcome of a Planning Inquiry after being called in by the Secretary of State for Levelling Up, Housing and Communities [https://tinyurl.com/4p22ufuh]) and the latter is currently ongoing (https://tinyurl.com/mrxaexhm).

Additional Air Quality Works Undertaken by Luton Borough Council During 2022/2023

During the reporting year 2022/2023, Luton Borough Council has significantly increased its passive monitoring programme. Establishing an additional 41 NO_2 diffusion tube sites (representing an increase of 80.4%), LBC now passively monitors NO_2 at 92 unique locations. Included among these new sites are:

- six additional tubes deployed at new sites in Vauxhall and Wigmore wards to enhance monitoring at relevant receptors in the vicinity of the airport at the request of the Overview & Scrutiny Board's London Luton Airport Air Quality Impact Task & Finish Group; and
- twenty additional tubes deployed in the vicinity of Bury Park at the direction of the Climate Change Advisory Board to support the development of future traffic interventions.

It should be noted that during 2022, the measured annual mean NO_2 concentration at all 41 newly established sites remained below 36µg/m^3 (*i.e.* 90% of the air quality objective level).

In addition to seeing increased passive monitoring, 2022 was also the first full year for which data is available from LBC's five South Coast Science Praxis/Urban sensor-based indicative air quality monitors. Not currently approved for compliance monitoring purposes, this data has instead been processed in a similar manner to the Openair Time Variation tool available for AURN data on the UK Air website to analyse short-term trends (https://tinyurl.com/4zn5xfx2). The output of this analysis is documented in Appendix G of this report, and the application of the same treatment to the data obtained at Luton's existing continuous monitoring sites is shown in Appendix F. In both cases, there is evidence of a *"traffic diurnal",* with pollutant concentrations peaking twice a day during the morning and afternoon/evening rush hours; this is particularly evident for NO_2 levels.

Finally, having commissioned AECOM to review the boundary of AQMA N$^{o.}$ 3 and complete a new source apportionment and options appraisal study, during 2022/2023, LBC took receipt of three reports summarising their findings.

Without suitable traffic survey data, the *Central Bedfordshire and Luton Transport Model* (CBLTM) provided traffic flow information to support required air dispersion modelling. The caveats, limitations and methodology involved in using this updated strategic transport model are set out in the *Luton Air Quality Study – Traffic Data Technical Note*, which is appended to this report as Appendix H.

In light of annual mean NO_2 levels at *LN67 – Castle Street* (a non-AQMA roadside site approximately 130 metres outside of AQMA N$^{o.}$ 3) exceeding 40µg/m^3 for the five years between 2015 and 2019, AECOM was tasked with investigating this persistent exceedance and reviewing the current AQMA boundary.

Using a base year of 2018, undertaking air dispersion modelling to determine annual mean NO_2 concentrations across the town centre, the resulting *Luton Town Centre Air Quality Management Area Review* (appended to this report as Appendix I) recommended that:

> *"AQMA N$^{o.}$ 3 is extended along Castle Street southwards to the Stockwood Crescent / Castle Street / Cowper Street / London Road junction to ensure that all relevant hotspots are captured within the amended AQMA."*

Pollutant levels during the pre-pandemic baseline year of 2018 were significantly higher than those observed in 2022. Consequently, the annual mean NO_2 concentration at *LN67* has not exceeded 40µg/m^3 for the last three years, and in 2022, it was 33.2µg/m3, 19.2% lower than in 2018. However, despite this improvement, it is notable that the highest NO_2 concentration recorded at an LBC passive site during 2022 and the only site representative of a relevant receptor to exceed 36µg/m^3 (90% of the air quality objective level) was *LN96 - Castle Street 3.* A roadside site at a relevant receptor only 58 metres further along London Road to the south of *LN67*, recording higher levels than anywhere currently within the AQMA boundary, the elevated level at *LN96* would appear to support the general findings of the review. Consequently, the recommendation to extend AQMA N$^{o.}$ 3 was presented to the Climate Change Advisory Board for comment and approval at the beginning of 2023.

Again using 2018 as a base year, the *Source Apportionment of Local Emissions of Nitrogen Dioxide in the Luton Town Centre Air Quality Management Area* (appended to this report as Appendix J) provides a new source apportionment for AQMA N$^{o.}$ 3 that addresses the deficiencies identified in the LAQM Appraisal Team's assessment of the LBC 2018 Air Quality Action Plan, *i.e.*

- the use of old data in the road oxides of nitrogen (NOx) calculations;
- a limited source apportionment breakdown (*i.e.* by vehicle type only);
- uncertainty regarding the necessary level of improvement; and
- no quantification of expected improvement secured by recommended measures.

The updated and enhanced information provided by this study is currently being used to develop a new AQAP.

QA/QC of Diffusion Tube Monitoring

The tubes deployed by both Luton Borough Council and Luton Rising are supplied by Gradko International Ltd. and use a preparation of 20% Triethanolamine (TEA) in deionised water. The exposed tubes are analysed following Gradko's documented in-house *Laboratory Method GLM7,* which complies with the guidelines set out in Defra's *'Diffusion Tubes for Ambient NO_2 Monitoring: Practical Guidance'* [https://tinyurl.com/j6976rah]. The analysis of diffusion tube samples to determine the amount of nitrogen dioxide present on the tubes is within the scope of their UKAS schedule. Gradko participates in the AIR NO_2 PT scheme, with the most recently published results at the time of writing indicating that during the first half of 2022, 100% of

QC samples were analysed satisfactorily[13]. For the whole year, reported nitrogen dioxide diffusion tube co-location studies indicate that the laboratory achieved good precision in all 27 studies where tubes prepared with 20% TEA in water were used[14].

The tubes deployed by LLAOL are supplied by SOCOTEC Didcot and use a preparation of 50% TEA in acetone. Analysed following SOCOTEC's standard operating procedure ANU/SOP/1015, during 2022, the laboratory achieved good precision in all 26 reported co-location studies where 50% TEA in acetone tubes were used[14]. Also a participant in the AIR NO_2 PT scheme, during the first half of 2022, all 100% of the QC samples tested by SOCOTEC were deemed to have been analysed satisfactorily[13].

Using the *Diffusion Tube Data Processing Tool v3.0* [https://tinyurl.com/e9zdbnxr] to check the precision of replicate tube data, the results for the triplicate LBC tubes (LN61/62/63) co-located with the continuous analyser on Dunstable Road East were shown to demonstrate *"Good Overall Precision"* [Table C.5(a)]. Undertaking a similar check on the triplicate sets of Luton Rising tubes co-located with the continuous analysers on both Dunstable Road East (*L1*) and Wigmore Valley Park (*L11*), a similar result was obtained with both sets also being shown to have *"Good Overall Precision"* [Table C.5(b)].

During 2022, all LBC diffusion tubes at sites already in situ at the start of the year were exposed in adherence with that year's *Diffusion Tube Monitoring Calendar* [https://tinyurl.com/kawdzjmu], with one exception. Due to staff sickness, the Period 3/4 (March/April) changeover was delayed by one week. As a result, the Period 3 (March) exposure was five weeks in duration and Period 4 (April) four weeks, the opposite of how they were scheduled in the Monitoring Calendar (*i.e.* Period 3: four weeks, Period 4: five weeks). This enforced deviation is not considered significant, as all exposure periods remained four or five weeks as recommended in *LAQM.TG22 Para 7.199*. Except for the Period 3/4 changeover, all tubes at existing sites were exposed and collected within ±2 days of the scheduled date in accordance with both *LAQM.TG22 Para 7.199* and the ±2 day tolerance referred to in the *Important Notes* tab of the *Diffusion Tube Processing Tool*.

[13] Defra / LGC (June 2022) - Summary of Laboratory Performance in AIR NO_2 Proficiency Testing Scheme (May 2020 – June 2022); https://tinyurl.com/bdfwc8w4

[14] Defra (March 2023) – National Diffusion Tube Bias Adjustment Factor Spreadsheet version 03/23; https://tinyurl.com/3d26fnnu

Deploying additional LBC diffusion tubes at new sites in and around Bury Park in August 2022 (tubes LN123 to LN142 inclusive), it was not possible to complete the deployment within the scheduled Period 7/8 changeover window (8th August 2022 ±2 days). Consequently, for Period 8, tubes LN133 to LN142 inclusive were exposed for less than the recommended four-week minimum; as a result of these shortened exposures, which are noted in the comments field of Table B.1(a) and may affect the reliability of that month's data, time-weighted annual means were calculated for the affected sites.

Like LBC, LLAOL also adhered to the 2022 Diffusion Tube Monitoring Calendar with just one exception. After exposing and collecting their tubes within ±2 days of the scheduled date for the first eleven consecutive monitoring periods (January to November inclusive), the Period 12 tubes were left in situ for an additional 28 days after the designated collection date and were not retrieved until 1st February 2023. With a nine-week exposure, Period 12 (December) was significantly longer than the four or five-week recommendation. Consequently, as this may reduce the reliability of the collected data (as the diffusion rate may not have been accurately defined - *LAQM.TG22 Para 7.199*), a decision was made to exclude this period from the 2022 dataset, as noted in Table B.1(b).

Finally, the exposure information supplied by Luton Rising (which is compared with the Diffusion Tube Monitoring Calendar in Table C.1) shows that despite maintaining exposure period durations of four to five weeks (±4 days) throughout the year as stipulated in the *Important Notes* tab of the *Diffusion Tube Processing Tool*, sample changeover occurred more than ±2 days from the scheduled calendar date on several occasions. Consequently, the *Diffusion Tube Data Processing Tool* has output time-weighted annual means for this dataset.

Table C.1 - Comparison of Luton Rising Diffusion Tube Deployment Dates and Exposure Durations (as supplied) with 2022 Diffusion Tube Monitoring Calendar

Month	Calendar ON date	Calendar OFF date	Calendar Exposure (Days)	Calendar Exposure (Weeks)	Luton Rising ON date (as supplied)	Luton Rising OFF date (as supplied)	Luton Rising Exposure (Days) (as supplied)	Luton Rising Exposure (Weeks)	Deviation From Calendar ON date (Days)	Deviation From Calendar OFF date (Days)
Jan	05/01/2022	02/02/2022	28	4.00	10/01/2022	06/02/2022	28	4.0	**5**	**4**
Feb	02/02/2022	02/03/2022	28	4.00	07/02/2022	06/03/2022	28	4.0	**5**	**4**
Mar	02/03/2022	30/03/2022	28	4.00	07/03/2022	30/03/2022	24	3.4	**5**	0
Apr	30/03/2022	04/05/2022	35	5.00	31/03/2022	03/05/2022	34	4.9	1	-1
May	04/05/2022	08/06/2022	35	5.00	04/05/2022	05/06/2022	33	4.7	0	**-3**
Jun	08/06/2022	06/07/2022	28	4.00	06/06/2022	04/07/2022	29	4.1	-2	-2
Jul	06/07/2022	03/08/2022	28	4.00	05/07/2022	04/08/2022	31	4.4	-1	1
Aug	03/08/2022	31/08/2022	28	4.00	05/08/2022	01/09/2022	28	4.0	2	1
Sep	31/08/2022	28/09/2022	28	4.00	02/09/2022	29/09/2022	28	4.0	2	1
Oct	28/09/2022	02/11/2022	35	5.00	30/09/2022	03/11/2022	35	5.0	2	1
Nov	02/11/2022	30/11/2022	28	4.00	04/11/2022	01/12/2022	28	4.0	2	1
Dec	30/11/2022	04/01/2023	35	5.00	02/12/2022	08/01/2023	38	5.4	2	**4**

Note:

ON/OFF deployment date deviations in excess of the ±2 days deemed acceptable by *LAQM.TG22 Para 7.199* shown in **bold**.

Diffusion Tube Annualisation

Annualisation was required for sites with between 25% and 75% annual data capture in each of the LBC, LLAOL and Luton Rising datasets. This was undertaken using whole-year data sets obtained from the *UK Air Data Selector* [https://tinyurl.com/s6fpm8xx] for the following *Automatic Urban & Rural Network* (AURN) monitoring sites (all of which are within a 50-mile radius of Luton and have data capture rates of over 85% for the calendar year):

- London N. Kensington (*UKA00253*) – Type: Urban Background
- London Hillingdon (*UKA00266*) – Type: Urban Background
- Oxford St Ebbes (*UKA00518*) – Type: Urban Background
- London Haringey Priory Park South (*UKA00568*) – Type: Urban Background

The annualisation of the LBC and Luton Rising data was undertaken using the *Diffusion Tube Processing Tool v3.0* (https://tinyurl.com/bd2bz5bb), whilst a similar calculation was undertaken for the identified LLAOL site (*LLA19*) using the process set out in *LAQM.TG22 Box 7-10*. The output of these corrections is presented in Table C.2.

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

a) Luton Borough Council (LBC) sites

Site ID	Annualisation Factor London Haringey Priory Park South	Annualisation Factor London Hillingdon	Annualisation Factor London N. Kensington	Annualisation Factor Oxford St Ebbes	Average Annualisation Factor	Raw Data Annual Mean	Annualised Annual Mean
LN54	0.9211	0.9656	0.9148	0.8548	0.9141	29.3	26.7
LN123	0.9449	0.9484	0.9519	0.9623	0.9519	36.7	34.9
LN124	0.9449	0.9484	0.9519	0.9623	0.9519	28.9	27.5
LN125	0.9449	0.9484	0.9519	0.9623	0.9519	35.9	34.2
LN126	0.9449	0.9484	0.9519	0.9623	0.9519	34.6	32.9
LN127	0.9449	0.9484	0.9519	0.9623	0.9519	31.4	29.8
LN128	0.9449	0.9484	0.9519	0.9623	0.9519	36.2	34.4
LN129	0.9449	0.9484	0.9519	0.9623	0.9519	34.1	32.5
LN130	0.9449	0.9484	0.9519	0.9623	0.9519	31.5	30.0
LN131	0.9449	0.9484	0.9519	0.9623	0.9519	22.3	21.2
LN132	0.9449	0.9484	0.9519	0.9623	0.9519	35.9	34.1
LN133	0.9191	0.9226	0.9223	0.9490	0.9283	37.1*	34.5*
LN134	0.9217	0.9363	0.9221	0.9081	0.9221	40.1*	37.0*

Site ID	Annualisation Factor London Haringey Priory Park South	Annualisation Factor London Hillingdon	Annualisation Factor London N. Kensington	Annualisation Factor Oxford St Ebbes	Average Annualisation Factor	Raw Data Annual Mean	Annualised Annual Mean
LN135	0.9191	0.9226	0.9223	0.9490	0.9283	36.5*	33.9*
LN136	0.9191	0.9226	0.9223	0.9490	0.9283	33.4*	31.0*
LN137	0.9191	0.9226	0.9223	0.9490	0.9283	32.3*	30.0*
LN138	0.9191	0.9226	0.9223	0.9490	0.9283	36.5*	33.9*
LN139	0.9191	0.9226	0.9223	0.9490	0.9283	40.1*	37.2*
LN140	0.9191	0.9226	0.9223	0.9490	0.9283	37.9*	35.2*
LN141	0.9191	0.9226	0.9223	0.9490	0.9283	30.2*	28.0*
LN142	0.9216	0.9288	0.9155	0.9671	0.9332	37.1*	34.6*

Notes:

* Time weighted annual mean

b) London Luton Airport Operations Ltd (LLAOL) sites

Site ID	Annualisation Factor London Haringey Priory Park South	Annualisation Factor London Hillingdon	Annualisation Factor London N. Kensington	Annualisation Factor Oxford St Ebbes	Average Annualisation Factor	Raw Data Annual Mean	Annualised Annual Mean
LLA 19	1.0820	1.0467	1.0924	1.0931	1.0786	12.1	13.1

c) London Rising sites

Site ID	Annualisation Factor London Haringey Priory Park South	Annualisation Factor London Hillingdon	Annualisation Factor London N. Kensington	Annualisation Factor Oxford St Ebbes	Average Annualisation Factor	Raw Data Time Weighted Annual Mean	Annualised Time Weighted Annual Mean
L9(i)	0.9908	0.9934	0.9527	1.0103	0.9868	25.3	25.0
L9(ii)	0.9908	0.9934	0.9527	1.0103	0.9868	25.0	24.7

Annualised Time Weighted Annual Mean across both duplicate sites [L9(i) and L9(ii)]:	**24.8**

Diffusion Tube Bias Adjustment Factors

The diffusion tube data presented within the 2023 ASR have been corrected for bias using an adjustment factor. Bias represents the overall tendency of the diffusion tubes to under or over-read relative to the reference chemiluminescence analyser. *LAQM.TG22* provides guidance with regard to the application of a bias adjustment factor to correct diffusion tube monitoring. Triplicate co-location studies can be used to determine a local bias factor based on the comparison of diffusion tube results with data taken from NO_x/NO_2 continuous analysers. Alternatively, the national database of diffusion tube co-location surveys provides bias factors for the relevant laboratory and preparation method.

Luton Borough Council have applied a local bias adjustment factor of 0.85 to their 2022 monitoring data. Adopting a precautionary approach, this locally derived factor was selected in preference to the slightly lower national value of 0.83 (Gradko; 20% TEA in water; based on 27 studies) published in version 03/23 of the *National Diffusion Tube Bias Adjustment Factor Spreadsheet* (https://tinyurl.com/3d26fnnu). By selecting the higher of the two values, the correction output presents a worst-case picture of NO_2 concentrations. Comparing the local factor of 0.85 with the values obtained for the 27 co-location studies reported in version 03/23 of the spreadsheet (Figure C.1), the factor was found to be in the 59th percentile with a z-score of 0.14. The impact of applying the local factor in preference to the national figure has been characterised (Table C.3) and shown graphically relative to last year's results (Figure C.2). The selection of the national factor has no effect in terms of compliance, with all sites remaining below 40µg/m^3 regardless of which factor was applied.

When processing the Luton Rising data, a bias adjustment factor of 0.83 was used due to this being equal to both the nationally published value (Gradko; 20% TEA in water; based on 27 studies) and the mean local factor obtained across the two triplicate co-location studies undertaken by Luton Rising during 2022.

The analysis of co-location study data to calculate local bias adjustment factors for both the LBC and Luton Rising monitoring programmes was undertaken using the *Diffusion Tube Data Processing Tools v3.0* (https://tinyurl.com/4dy6jpf4). The output from this analysis is presented in Table C.5.

As it does not include a co-location study, the 2022 LLAOL monitoring data has been bias-corrected using a national factor of 0.76. This factor was also obtained from version 03/23 of the spreadsheet and is based on 26 co-location studies using 50% TEA in acetone tubes prepared and analysed by SOCOTEC Didcot.

A summary of bias adjustment factors used by Luton Borough Council over the past five years is presented in Table C.4.

Figure C.1 - Descriptive Statistics and Histogram / Density Plot for the results of the 27 co-location studies for Gradko 20% TEA in water tubes reported in version 03/23 of the National Diffusion Tube Bias Adjustment Factor Spreadsheet.

Descriptives

Descriptives

	03/23 Gradko (aq) Bias Adjustment Factors
N	27
Missing	0
Mean	0.835
Median	0.810
Standard deviation	0.106
Range	0.550
Minimum	0.610
Maximum	1.16

Plots

03/23 Gradko (aq) Bias Adjustment Factors

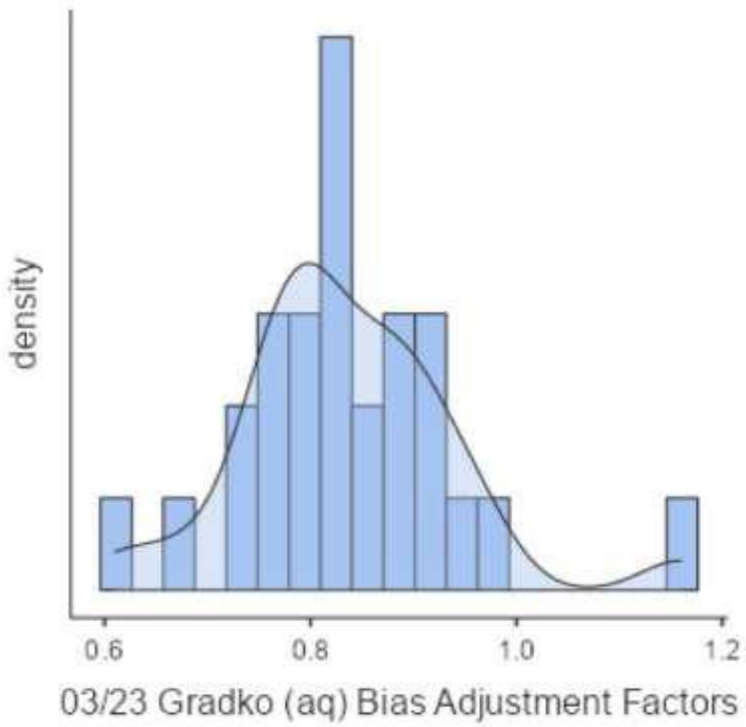
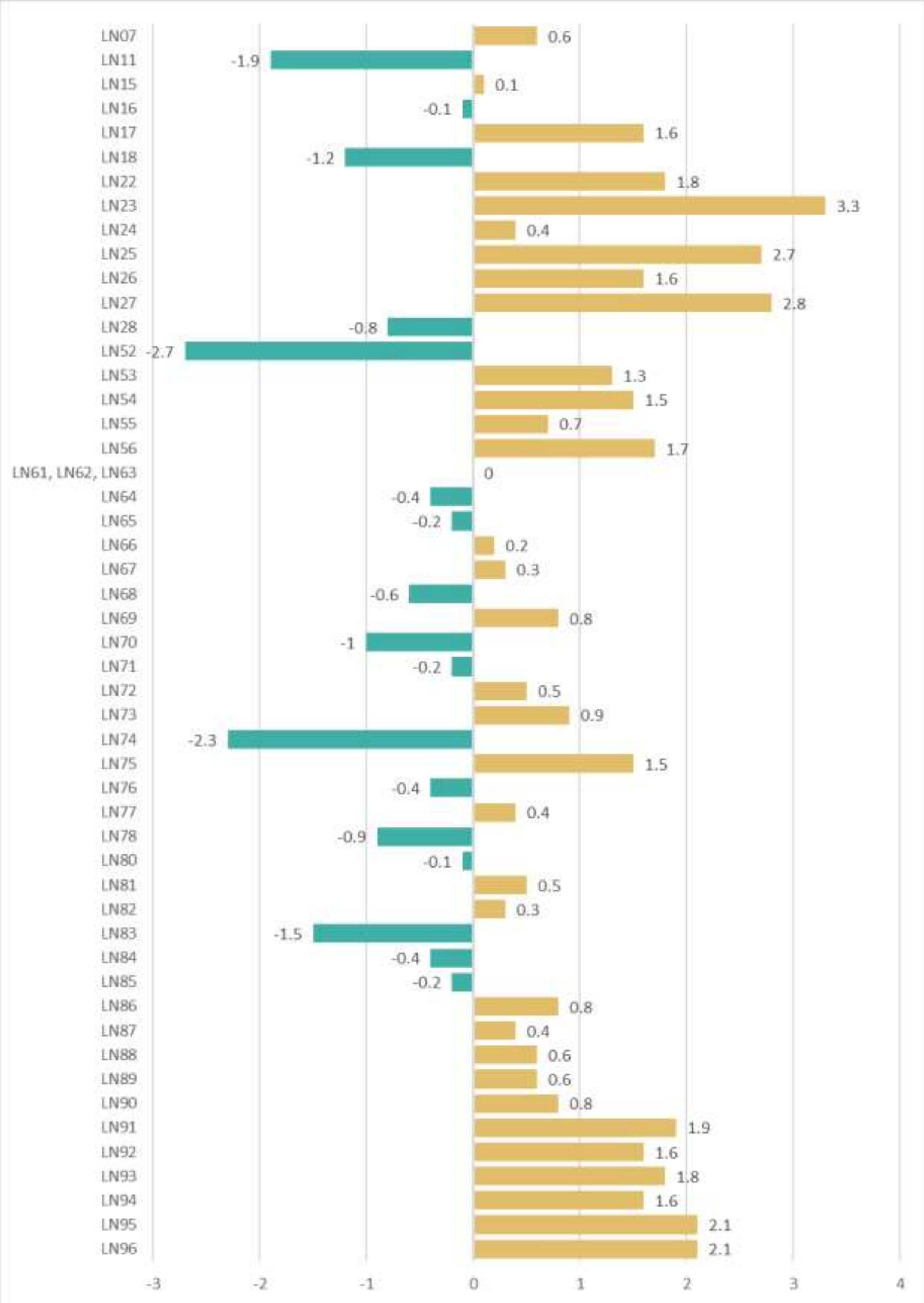


Table C.3 – Comparison of LBC diffusion tube output obtained using local and national bias correction factors

	Local	National
Bias Correction Factor	0.85	0.83
Percentage Difference	2.4%	2.4%
Number of exceedances (excluding co-location sites)	0	0
Number of sites above 36µg/m³ (excluding co-location sites)	1	1
Number of sites above 10µg/m³ (excluding co-location sites)	91	91
Max	37.2µg/m³	36.4µg/m³
Min	12.8µg/m³	12.5µg/m³
Range	24.5µg/m³	23.9µg/m³
Average	24.1µg/m³	23.5µg/m³
Median	23.8µg/m³	23.2µg/m³
Standard Deviation	5.56µg/m³	5.43µg/m³
Higher than previous year (when rounded to 1 decimal place)	33 (64.7%)	24 (47.1%)
Lower than previous year (when rounded to 1 decimal place)	17 (33.3%)	25 (49.0%)
Unchanged (when rounded to 1 decimal place)	1 (2.0%)	2 (3.9%)
Max increase (cf. 2021)	3.3µg/m³ (LN23, 13.6%)	2.7µg/m³ (LN23, 11.2%)
Max decrease (cf. 2021)	-2.7µg/m³ (LN52, -7.6%)	-3.5µg/m³ (LN52, -9.8%)
Average change (cf. 2021)	0.5µg/m³	-0.1µg/m³
Median change (cf. 2021)	0.5µg/m³	0.0µg/m³

Figure C.2 - Differences in 2022 LBC NO_2 concentrations relative to reported 2021 annual mean values

a) 2022 data adjusted using locally derived correction factor (0.85)



b) 2022 data adjusted using national correction factor (0.83)

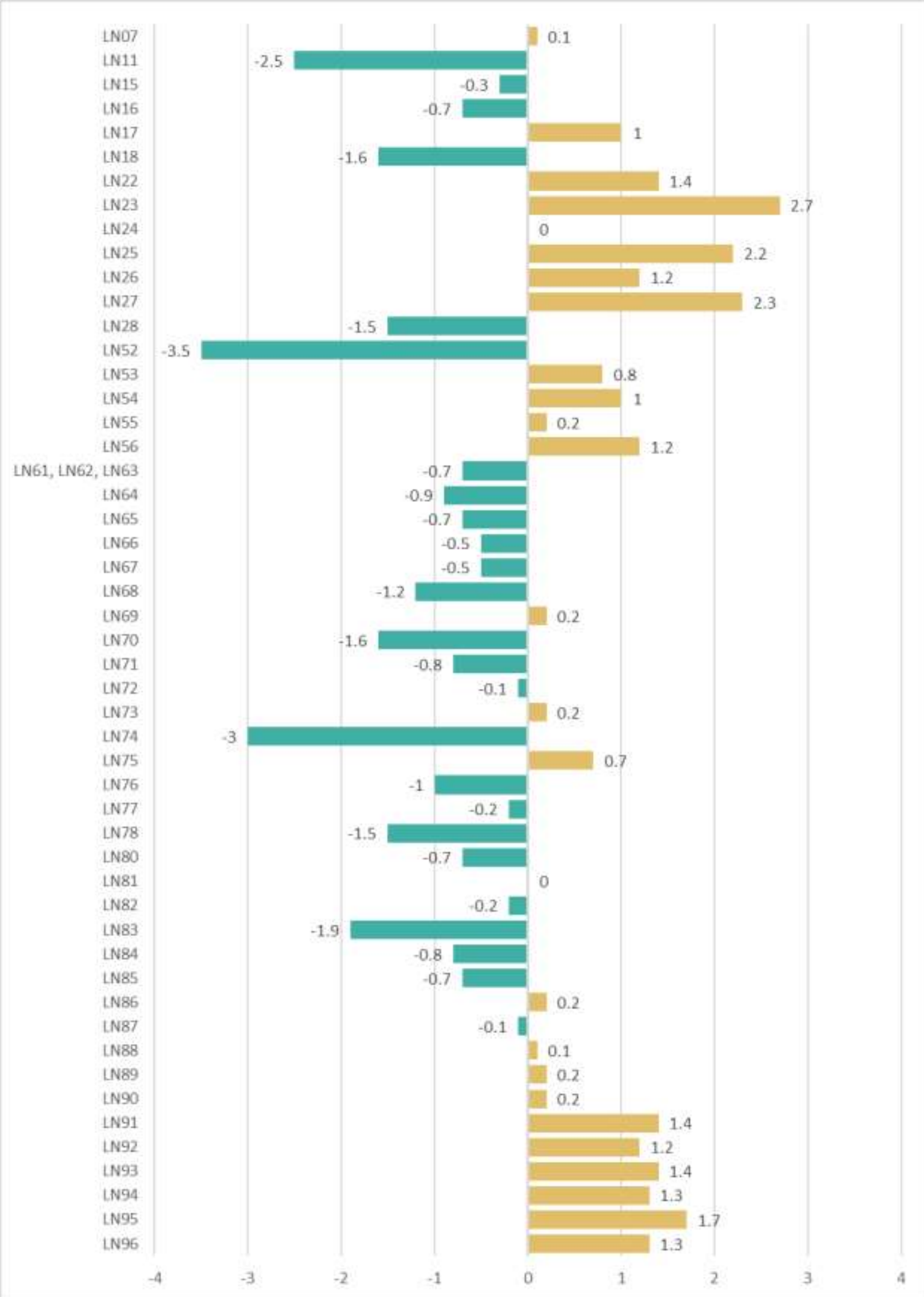


Table C.4 – Bias Adjustment Factor

a) Luton Borough Council (LBC) sites

Monitoring Year	Local or National	If National, Version of National Spreadsheet	Adjustment Factor
2022	Local	-	0.85
2021	National	03/22	0.84
2020	National	03/21	0.81
2019	National	03/20	0.93
2018	National	03/19	0.93

b) London Luton Airport Operations Ltd. (LLAOL) sites

Monitoring Year	Local or National	If National, Version of National Spreadsheet	Adjustment Factor
2022	National	03/23	0.76
2021	National	03/22	0.78
2020	National	03/21	0.82 (Gradko) 0.77 (SOCOTEC)
2019	National	03/20	0.87
2018	National	03/19	0.92

c) Luton Rising sites

Monitoring Year	Local or National	If National, Version of National Spreadsheet	Adjustment Factor
2022	Local / National*	03/23	0.83
2021	National	03/22	0.84
2020	National	03/21	0.81
2019	National	03/20	0.93
2018	National	03/19	0.93

* Local and National adjustment factors are equal

Table C.5 – Local Bias Adjustment Calculation

a) Luton Borough Council (LBC) co-location study

	Local Bias Adjustment Input 1 (HB007)	Local Bias Adjustment Input 2	Local Bias Adjustment Input 3	Local Bias Adjustment Input 4	Local Bias Adjustment Input 5
Periods used to calculate bias	11	-	-	-	-
Bias Factor A	0.85 (0.8 - 0.92)	-	-	-	-
Bias Factor B	17% (9% - 26%)	-	-	-	-
Diffusion Tube Mean (µg/m³)	38.9	-	-	-	-
Mean CV (Precision)	4.6%	-	-	-	-
Automatic Mean (µg/m³)	33.2	-	-	-	-
Data Capture	100%	-	-	-	-
Adjusted Tube Mean (µg/m³)	33 (31 - 36)	-	-	-	-

Overall Diffusion Tube Precision	**Good Overall Precision**	-	-	-	-
Overall Continuous Monitor Data Capture	**Good Overall Data Capture**	-	-	-	-

Local Bias Adjustment Factor	**0.85**

Notes:

A single local bias adjustment factor of 0.85 has been used to bias adjust the 2022 LBC diffusion tube results.

b) Luton Rising co-location studies

	Local Bias Adjustment Input 1 (HB007)	Local Bias Adjustment Input 2 (LA001)	Local Bias Adjustment Input 3	Local Bias Adjustment Input 4	Local Bias Adjustment Input 5
Periods used to calculate bias	12	10	-	-	-
Bias Factor A	0.79 (0.75 – 0.82)	0.87 (0.79 - 0.96)	-	-	-
Bias Factor B	27% (22% - 33%)	15% (4% - 26%)	-	-	-
Diffusion Tube Mean (µg/m³)	41.7	16.3	-	-	-
Mean CV (Precision)	2.8%	6.2%	-	-	-
Automatic Mean (µg/m³)	32.8	14.1	-	-	-
Data Capture	100%	96%	-	-	-
Adjusted Tube Mean (µg/m³)	33 (31 - 34)	14 (13 -16)	-	-	-

Overall Diffusion Tube Precision	**Good Overall Precision**	**Good Overall Precision**	-	-	-
Overall Continuous Monitor Data Capture	**Good Overall Data Capture**	**Good Overall Precision**	-	-	-

Local Bias Adjustment Factor	**0.83**

Notes:

A bias adjustment factor of 0.83 has been used to bias correct the 2022 Luton Rising diffusion tube results. This value equals the combined local bias adjustment factor obtained for the co-location studies at HB007 & LA001 and the relevant national factor published in version 03/23 of the *National Diffusion Tube Bias Adjustment Factor Spreadsheet.*

NO_2 Fall-off with Distance from the Road

Wherever possible, monitoring locations are representative of exposure. However, where this is not possible, the NO_2 concentration at the nearest location relevant for exposure has been estimated using the Diffusion Tube Data Processing Tool / NO_2 fall-off with distance calculator available on the LAQM Support website. Where appropriate, non-automatic annual mean NO_2 concentrations corrected for distance are presented in Table B.1.

No diffusion tube NO_2 monitoring locations within Luton Borough Council required distance correction during 2022.

QA/QC of Automatic Monitoring

The nitrogen dioxide analyser on Dunstable Road East (*LN60 / HB007*) is subject to fortnightly routine calibration by a Luton Borough Council Officer. The co-located FIDAS particulate analyser does not require calibration. Both instruments are maintained by Acoem and are routinely serviced on a six-monthly basis.

All automatic monitoring data collected at the Dunstable Road East, London Luton Airport *(LA08)* and Luton A505 Roadside *(LUTR)* sites is managed by Ricardo Energy & Environment using the quality control procedures utilised by Defra's national air quality network stations. These procedures represent best practice and fully meet the requirements set out in *LAQM.TG22*. Ricardo Energy & Environment provides UKAS-accredited quality control audits and data management services to all Defra national network (AURN) air quality monitoring stations.

All data collected at the above sites is screened and scaled (based on site calibrations). The final data sets presented within this report (Figure C.3, Figure C.4 and Figure C.5) have benefitted from a full process of data ratification, including thorough additional data quality checks and a ratification process that corrects data for instrument sensitivity drift between routine calibrations.

All automatic monitoring data collected at Luton Rising's London Luton Airport FutureLuToN (LA001) site during 2022 has been validated and ratified to the standards described in *LAQM.TG22*. The site datasets published online (summarised in Figure C.6) are managed by Ricardo Energy & Environment in full compliance with the requirements of *LAQM.TG22*, which includes the screening, validation and ratification of the raw data.

Live and historical data for all automatic monitoring sites is available via the Herts & Beds Air Quality Network pages on the Air Quality England website [https://tinyurl.com/khvpphd5].

Figure C.3- 2022 Air Pollution Report - LN60: Luton Dunstable Road East (Site ID: HB007)

Source: https://tinyurl.com/mrycaavr

Air Pollution Report

1st January to 31st December 2022

Air Quality England

Luton Dunstable Road East (Site ID: HB007)

These data have been fully ratified

Only relevant statistics for LAQM are presented in the table. Cells with - indicate no data available or calculated.

Pollutant	NO µg/m³	NO_2 µg/m³	NO_x as NO_2 µg/m³	PM_{10} µg/m³	$PM_{2.5}$ µg/m³
Number Days Low	-	365	-	343	342
Number Days Moderate	-	0	-	3	4
Number Days High	-	0	-	0	0
Number Days Very High	-	0	-	0	0
Max Daily Mean	234	87	446	68	46
Annual Max	573	136	1,014	103	70
Annual Mean	27	33	74	15	9
98th Percentile of daily mean	-	-	-	36	-
90th Percentile of daily mean	-	-	-	23	-
99.8th Percentile of hourly mean	-	116	-	-	-
98th Percentile of hourly mean	145	84	301	44	32
95th Percentile of hourly mean	84	70	194	33	23
50th Percentile of hourly mean	16	29	55	13	7
% Annual data capture	**99.81**	**99.81**	**99.81**	**94.65**	**94.65**

Instruments:
PM_{10}: FIDAS
PM_{25}: FIDAS

All gaseous pollutant mass units are at 20°C and 1013mb. Particulate matter concentrations are reported at ambient temperature and pressure. NO_X mass units are NO_X as NO_2 µg m-3

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Pollutant	Air Quality Standards regulations 2010	Exceedances	Days
PM_{10} particulate matter (Hourly measured)	daily mean > 50 micrograms per metre cubed	3	3
PM_{10} particulate matter (Hourly measured)	Annual mean > 40 micrograms per metre cubed	0	-
$PM_{2.5}$ particulate matter (Hourly measured)	Annual mean > 25 micrograms per metre cubed	0	-
Nitrogen dioxide	Hourly Mean > 200 micrograms per metre cubed	0	0
Nitrogen dioxide	**Annual Mean > 40 micrograms per metre cubed**	**0**	**-**

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Annual Graph

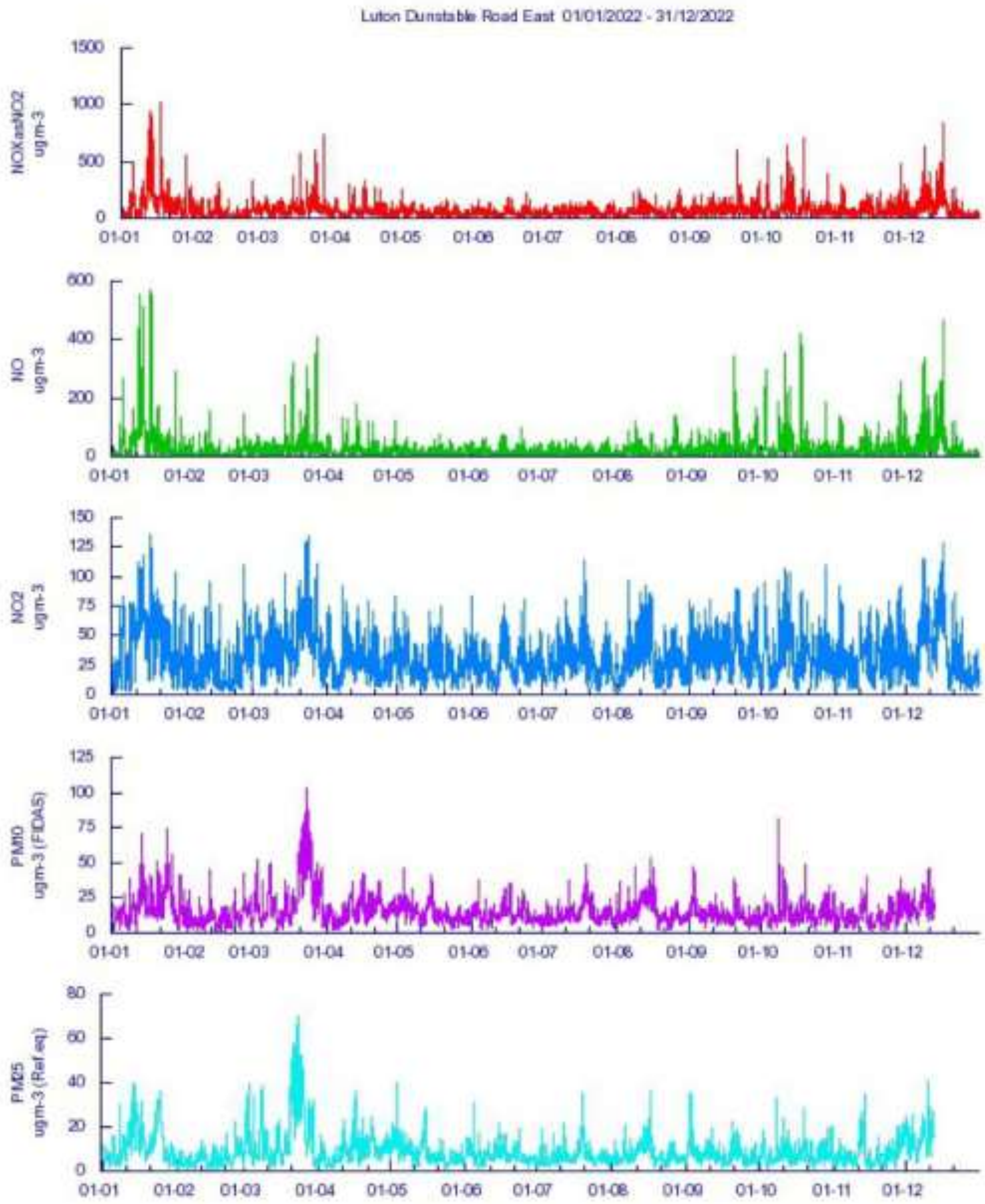

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Figure C.4 - 2022 Air Pollution Report - LA08: London Luton Airport (Site ID: HB006)

Source: https://tinyurl.com/mjhs2m4c

Air Pollution Report

1st January to 31st December 2022

Air Quality England

London Luton Airport (Site ID: HB006)

These data have been fully ratified

Only relevant statistics for LAQM are presented in the table. Cells with - indicate no data available or calculated.

Pollutant	PM_{10} µg/m³
Number Days Low	305
Number Days Moderate	0
Number Days High	0
Number Days Very High	0
Max Daily Mean	49
Annual Max	225
Annual Mean	15
98th Percentile of daily mean	30
90th Percentile of daily mean	21
98th Percentile of hourly mean	36
95th Percentile of hourly mean	29
50th Percentile of hourly mean	13
% Annual data capture	**85.65**

Instruments:

PM_{10}: BAM Gravimetric Equivalent (correction applied)

All gaseous pollutant mass units are at 20°C and 1013mb. Particulate matter concentrations are reported at ambient temperature and pressure. NO_X mass units are NO_X as NO_2 µg m-3

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Pollutant	Air Quality Standards regulations 2010	Exceedances	Days
PM_{10} particulate matter (Hourly measured)	daily mean > 50 microgrammes per metre cubed	0	0
PM_{10} particulate matter (Hourly measured)	**Annual mean > 40 microgrammes per metre cubed**	**0**	**-**

Annual Graph

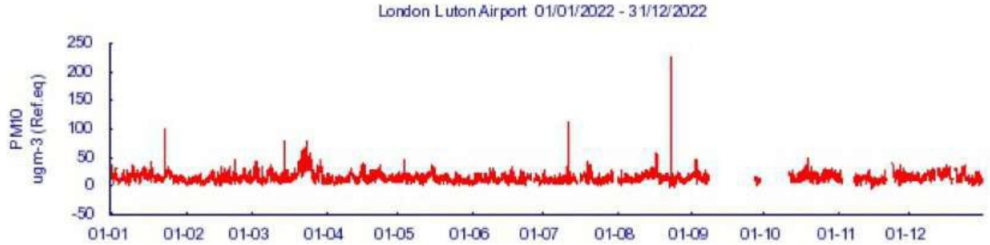

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Figure C.5 - 2022 Air Pollution Report - Luton A505 Roadside (Site ID: LUTR)

Source: https://tinyurl.com/4j26dxu3

Air Pollution Report

1st January to 31st December 2022

Air Quality England

Luton A505 Roadside (Site ID: LUTR)

These data have been fully ratified
Only relevant statistics for LAQM are presented in the table. Cells with - indicate no data available or calculated.

Pollutant	NO µg/m³	NO_2 µg/m³	NO_x as NO_2 µg/m³
Number Days Low	-	363	-
Number Days Moderate	-	0	-
Number Days High	-	0	-
Number Days Very High	-	0	-
Max Daily Mean	233	88	444
Annual Max	633	163	1,133
Annual Mean	34	30	82
99.8th Percentile of hourly mean	-	117	-
98th Percentile of hourly mean	161	84	326
95th Percentile of hourly mean	112	70	239
50th Percentile of hourly mean	19	26	55
% Annual data capture	**98.97**	**97.82**	**97.82**

All gaseous pollutant mass units are at 20°C and 1013mb. Particulate matter concentrations are reported at ambient temperature and pressure. NO_X mass units are NO_X as NO_2 µg m-3

Pollutant	Air Quality Standards regulations 2010	Exceedances	Days
Nitrogen dioxide	Hourly Mean > 200 microgrammes per metre cubed	0	0
Nitrogen dioxide	**Annual Mean > 40 microgrammes per metre cubed**	**0**	**-**

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Annual Graph

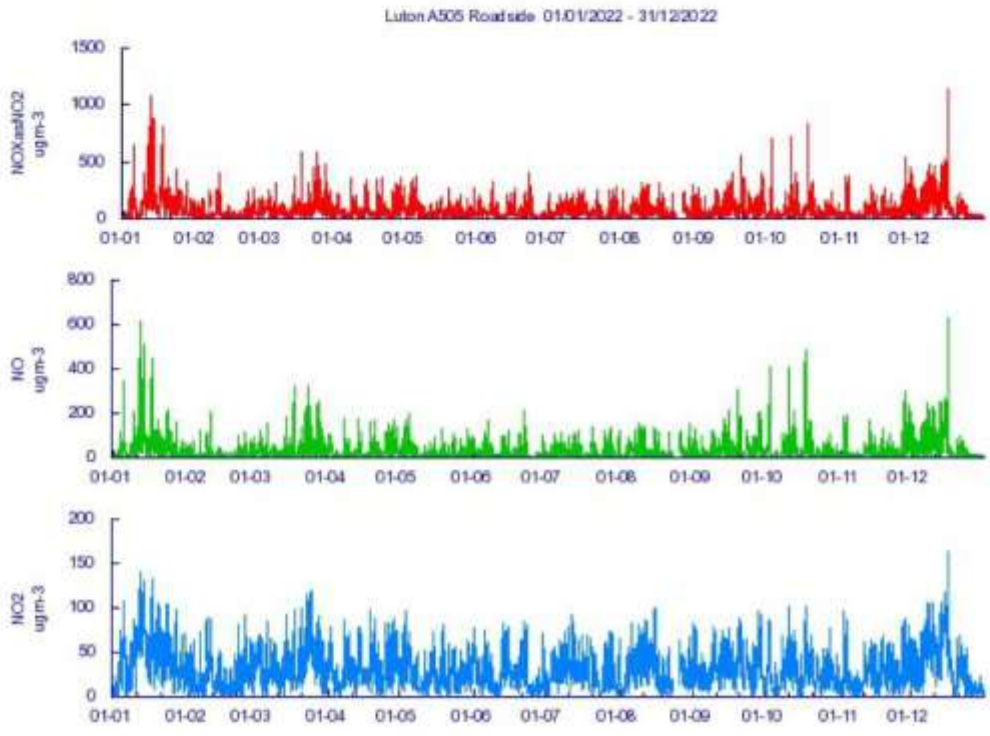

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Figure C.6 - 2022 Air Pollution Report - LA001: London Luton Airport FutureLuToN

Source: https://tinyurl.com/4787abwm

Air Pollution Report

1st January to 31st December 2022

Luton Airport FutureLuToN (Site ID: LA001)

These data have been fully ratified

Only relevant statistics for LAQM are presented in the table. Cells with - indicate no data available or calculated.

Pollutant	O_3 µg/m³	NO µg/m³	NO_2 µg/m³	NO_xasNO_2 µg/m³	SO_2 µg/m³	CO mg/m³	PM_{10} µg/m³	PM_{25} µg/m³	BC µg/m³	C_6H_6 µg/m³	TOLUENE µg/m³	ETHBENZ µg/m³	mpXYLENE µg/m³	oXYLENE µg/m³
Number Days Low	364	-	327	-	365	0	363	361	0	0	0	0	0	0
Number Days Moderate	27	-	0	-	0	0	0	2	0	0	0	0	0	0
Number Days High	2	-	0	-	0	0	0	0	0	0	0	0	0	0
Number Days Very High	0	-	0	-	0	0	0	0	0	0	0	0	0	0
Max 15 min SO2	-	-	-	-	8	-	-	-	-	-	-	-	-	-
Max 8 Hour CO	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Max 8 Hour Ozone	166	-	-	-	-	-	-	-	-	-	-	-	-	-
Max Daily Mean	126	50	62	116	2	0	43	38	2	1	3	4	15	5
Annual Max	185	213	90	406	7	1	77	71	6	10	10	40	129	44
Annual Mean	55	2	14	18	1	0	9	8	0	0	1	0	1	0
98th Percentile of daily mean	-	-	-	-	-	-	28	-	-	-	-	-	-	-
90th Percentile of daily mean	-	-	-	-	-	-	17	-	-	-	-	-	-	-

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99.9th Percentile of 15 minute mean	-	-	-	-	5	-	-	-	-	-	-	-	-	-
99.8th Percentile of hourly mean	-	-	74	-	-	-	-	-	-	-	-	-	-	-
99.7th Percentile of hourly mean	-	-	-	-	3	-	-	-	-	-	-	-	-	-
98th Percentile of hourly mean	110	20	54	81	2	0	32	31	1	1	3	2	7	3
95th Percentile of hourly mean	93	7	41	51	2	0	24	23	1	1	2	1	3	1
50th Percentile of hourly mean	55	1	10	12	1	0	7	6	0	0	0	0	0	0
% Annual data capture	**99.06**	**87.95**	**87.95**	**87.95**	**98.16**	**98.94**	**99.67**	**99.67**	**99.69**	**71.12**	**71.12**	**71.13**	**71.12**	**71.13**

Instruments:
PM_{10}: GRIMM EDM 180
PM_{25}: GRIMM EDM 180

All gaseous pollutant mass units are at 20°C and 1013mb. Particulate matter concentrations are reported at ambient temperature and pressure. NO_X mass units are NO_X as NO_2 µg m-3

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Pollutant	Air Quality Standards regulations 2010	Exceedances	Days
Carbon monoxide	Daily maximum 8-hour running mean > 10 milligrammes per metre cubed	0	0
PM_{10} particulate matter (Hourly measured)	daily mean > 50 microgrammes per metre cubed	0	0
PM_{10} particulate matter (Hourly measured)	Annual mean > 40 microgrammes per metre cubed	0	-
$PM_{2.5}$ particulate matter (Hourly measured)	Annual mean > 25 microgrammes per metre cubed	0	-
Nitrogen dioxide	Hourly Mean > 200 microgrammes per metre cubed	0	0
Nitrogen dioxide	Annual Mean > 40 microgrammes per metre cubed	0	-
Ozone	8-hour running mean > 100 microgrammes per metre cubed	228	26
Sulphur dioxide	15 Minute mean > 266 microgrammes per metre cubed	0	0
Sulphur dioxide	Hourly mean > 350 microgrammes per metre cubed	0	0
Sulphur dioxide	Daily Mean > 125 microgrammes per metre cubed	0	0
Sulphur dioxide	Annual mean > 20 microgrammes	0	-

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	per metre cubed		
Sulphur dioxide	**Winter Mean > 20 microgrammes per metre cubed**	**0**	**-**

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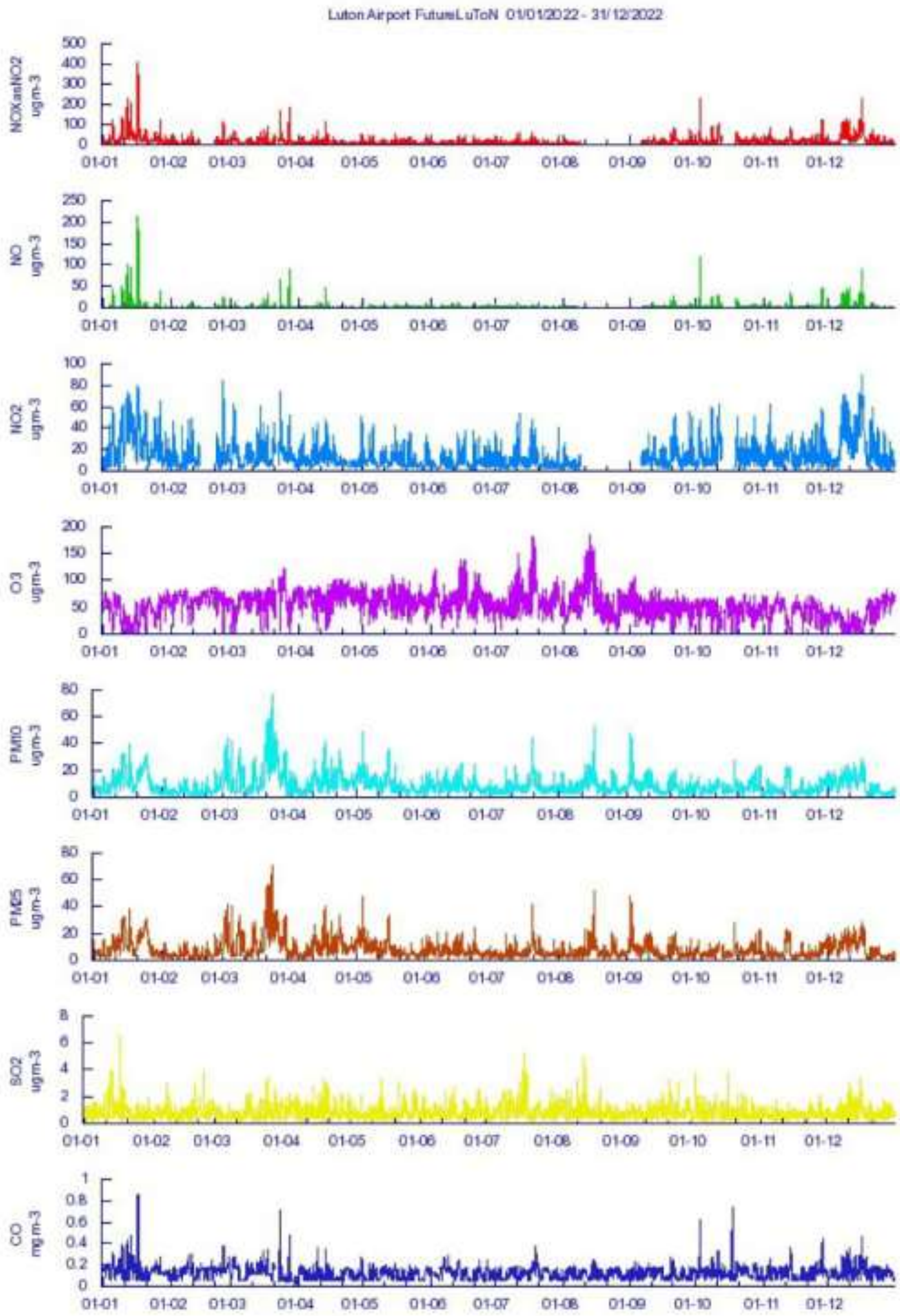
Annual Graph



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

Particulate monitoring is undertaken at three sites within Luton:

i) *LN60 (HB007)* – Dunstable Road East [https://w3w.co/final.much.shots]; LBC operated Palas Fidas 200 measuring both PM_{10} and $PM_{2.5}$. No correction was applied to PM_{10} data. Correction factor of 0.9434 applied to $PM_{2.5}$ data (*i.e.* divide by 1.06).

ii) *LA08 (HB006)* – London Luton Airport [https://w3w.co/client.taxi.super]; LLAOL operated unheated Beta Attenuation Mass Monitor (BAM) measuring PM_{10}, correction factor of 0.8333 applied (*i.e.* divide by 1.2).

iii) *LA001* – London Luton Airport FutureLuTon (Wigmore Valley Park) [https://w3w.co/feared.same.format]; LLAL operated GRIMM EDM 180 measuring both PM_{10} and $PM_{2.5}$. No correction factor applied to either PM_{10} or $PM_{2.5}$ data. It should be noted that the instrument used at this location is not of a type approved by Defra (as detailed in *LAQM.TG22 Para 7.176*).

Automatic Monitoring Annualisation

All automatic monitoring locations within Luton recorded data capture of greater than 75%; therefore, it was not required to annualise any monitoring data. In addition, any sites with a data capture below 25% do not require annualisation.

NO_2 Fall-off with Distance from the Road

No automatic NO_2 monitoring locations within Luton required distance correction during 2022.

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

Figure D.1 – Overview of Luton

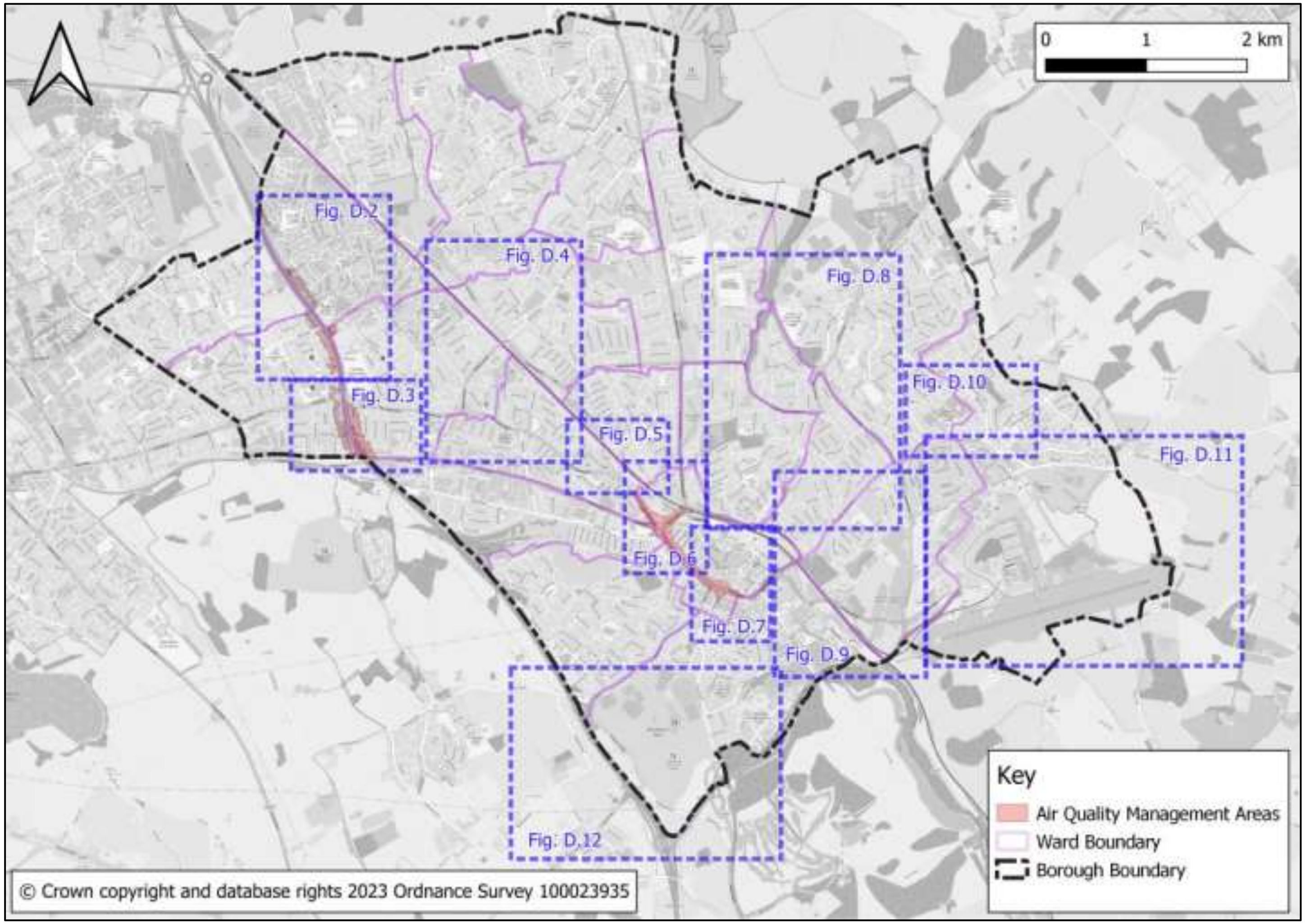
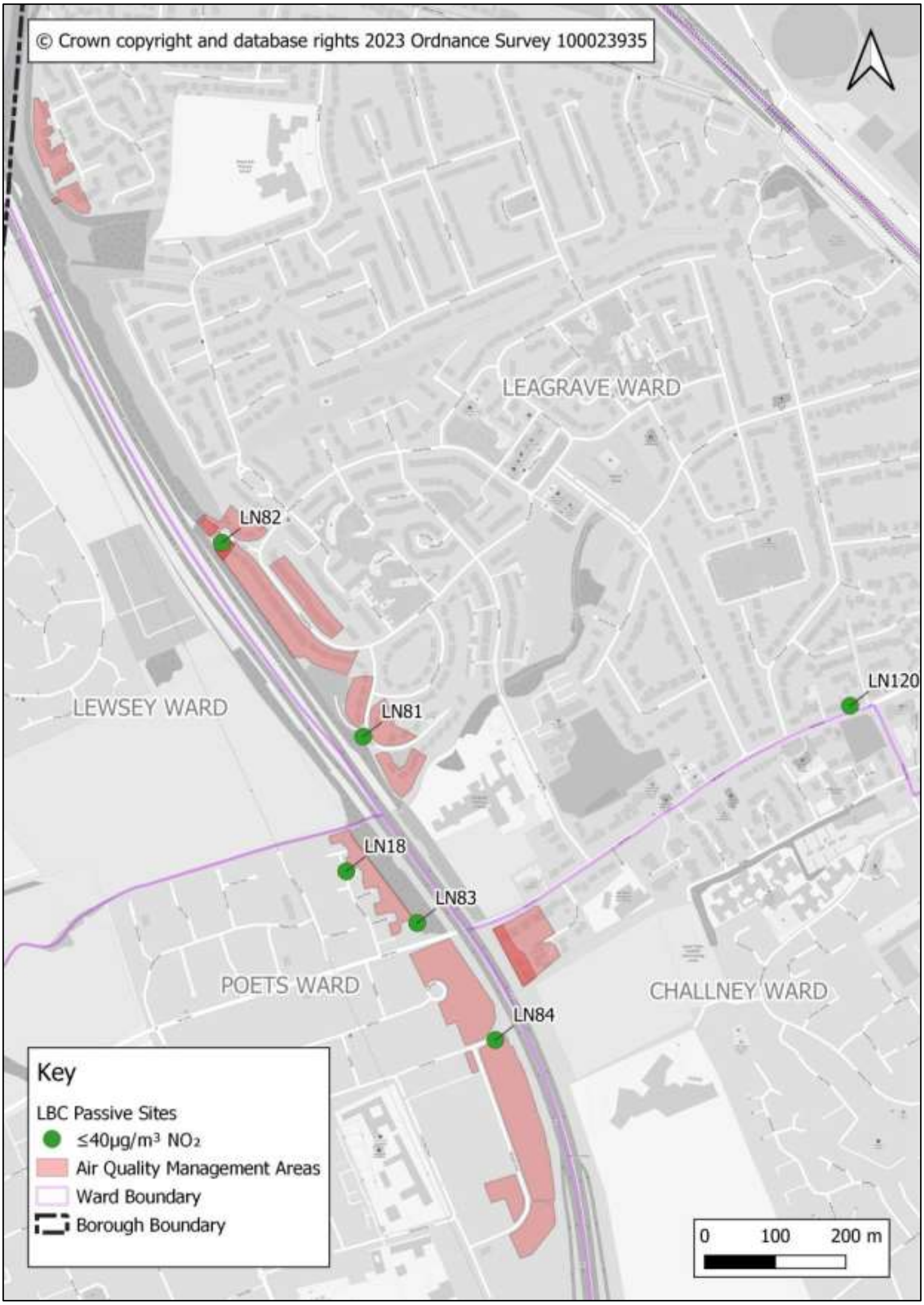


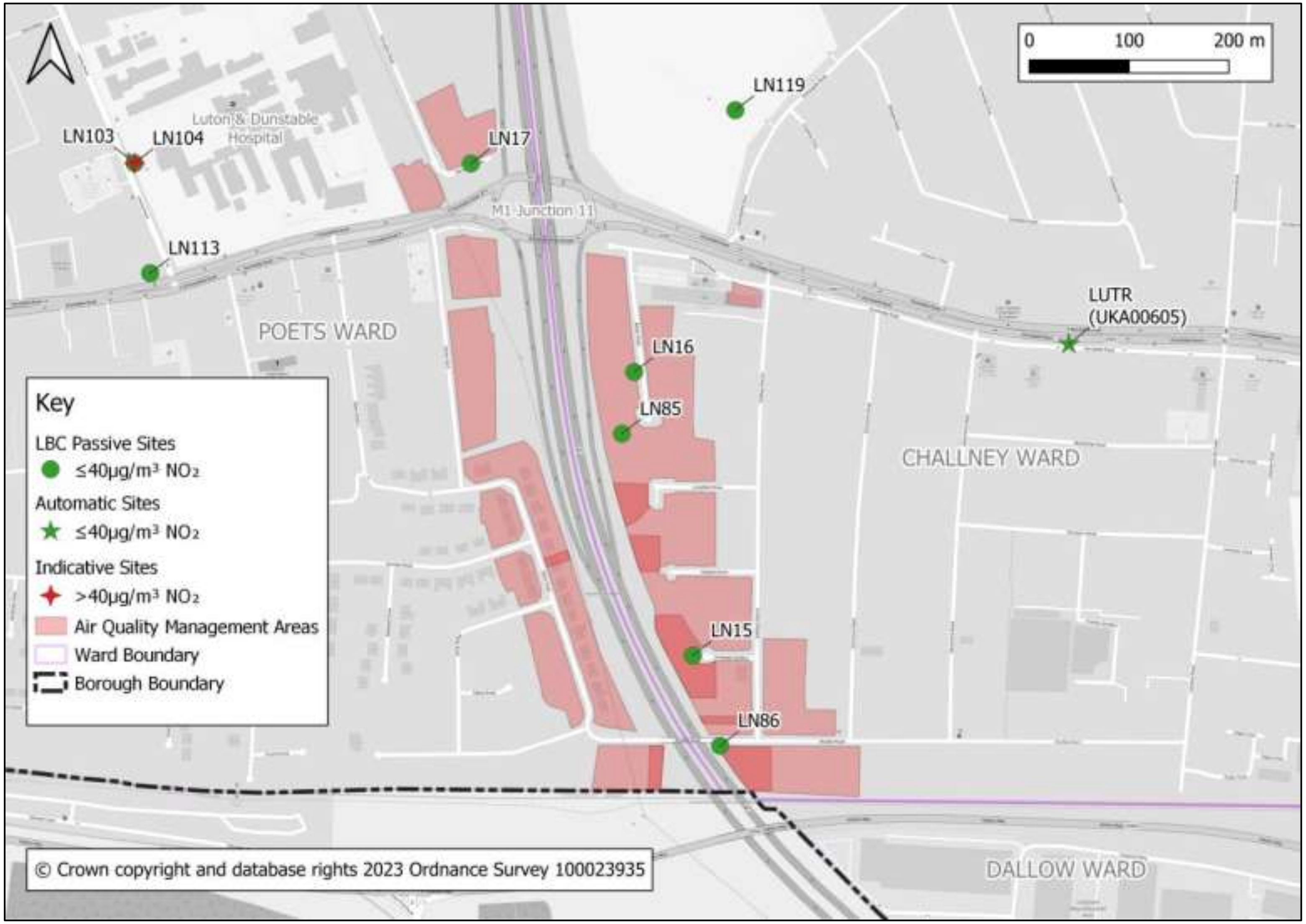
Figure D.2 - NO_2 monitoring locations in the vicinity of Luton AQMA N^os.^ 1 & 2 along the route of the M1 *(Monitoring locations in Leagrave & Poets wards)*



LBC Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN18	Copperfields	Poets	mimic.wings.sofa
LN81	Bank Close	Leagrave	phones.kings.cubes
LN82	11 Withy Close	Leagrave	patch.scuba.motor
LN83	Path Behind 9 Copperfields	Poets	plenty.plots.bits
LN84	97 Lime Avenue	Poets	pots.breath.such
LN120	20 High Street	Leagrave	unit.page.people

Figure D.3 - NO$_2$ monitoring locations in the vicinity of Luton AQMA N$^{os.}$ 1 & 2 along the route of the M1 *(Monitoring locations in Challney & Poets wards)*



LBC Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN15	Armitage Garden	Challney	broad.bubble.marker
LN16	Belper Road	Challney	beams.hugs.amuse
LN17	Wyndham Road	Poets	foil.hears.wink
LN85	26 Belper Road	Challney	brands.forget.cage
LN86	Bradley Road	Challney	bells.defend.order
LN104	L&D Hospital, Lewsey Road	Poets	exists.hint.taxi
LN113	786 Dunstable Road	Poets	beams.bottom.gender
LN119	Challney High School for Boys	Challney	bands.fell.wants

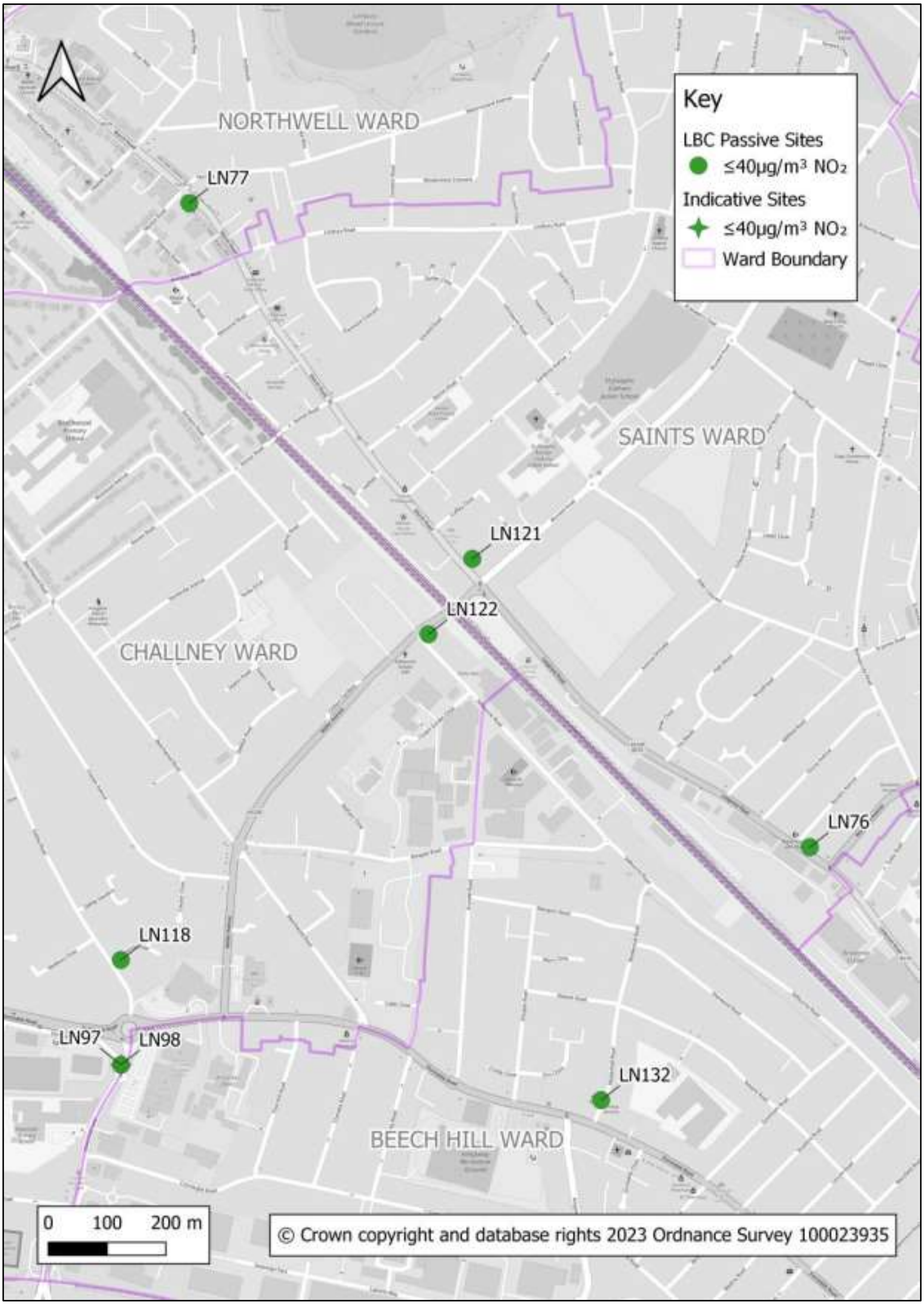
Automatic Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LUTR *(UKA00605)*	Luton A505 Roadside (AURN)	Challney	bared.jazzy.sling

Indicative Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN103	L&D Hospital, Lewsey Road	Poets	exists.hint.taxi

Figure D.4 - NO_2 monitoring locations in Beech Hill, Challney, Northwell & Saints wards



LBC Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN76	Leagrave Road	Saints	quarrel.hats.frost
LN77	Marsh Road	Northwell	lion.successes.brass
LN98	Chaul End Road	Challney	digit.ending.sailor
LN118	Fulbourne Close	Challney	book.sorters.candy
LN121	4c Marsh Road	Saints	shops.noises.oval
LN122	404 - 410 Selbourne Road	Challney	stews.loss.lodge
LN132	1A Maidenhall Road	Beech Hill	reveal.dined.issued

Indicative Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN97	Chaul End Road	Challney	digit.ending.sailor

Figure D.5 - NO_2 monitoring locations in the vicinity of Bury Park *(Monitoring locations in Beech Hill, Biscot & Central wards)*

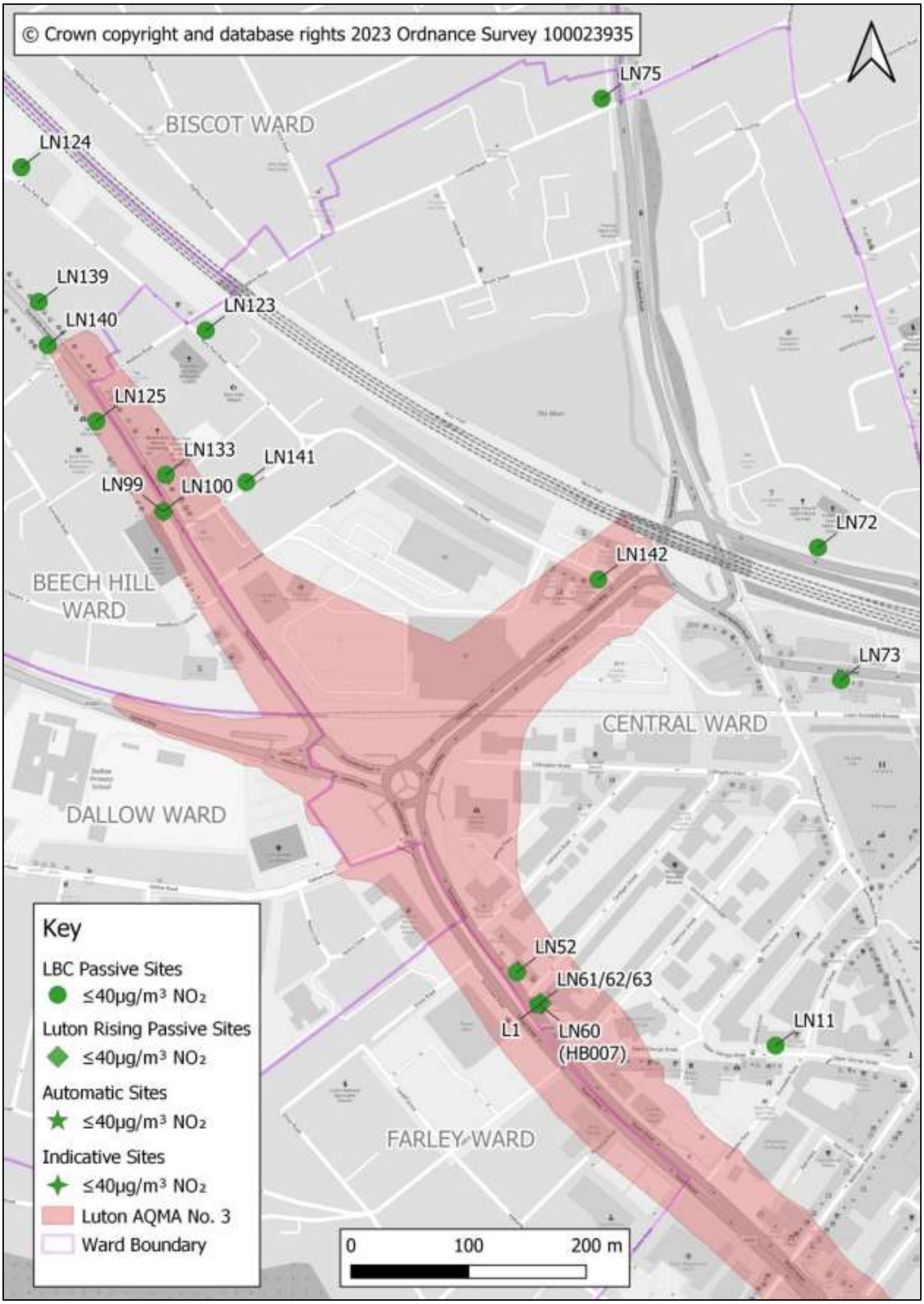
LBC Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN74	Dunstable Road - Bury Park	Beech Hill	dated.heat.hooked
LN102	Beech Hill Community Primary School	Beech Hill	atomic.punch.inches
LN123	34 Bury Park Road	Central	digit.leap.soup
LN124	114 Bury Park Road	Beech Hill	doors.leads.fake
LN126	30 Leagrave Road	Beech Hill	slate.finest.tops
LN127	33 Leagrave Road	Beech Hill	stews.loss.lodge
LN128	McKenzie House	Beech Hill	exit.shack.engine
LN129	3 Selbourne Road	Beech Hill	matter.eating.herds
LN130	218 Leagrave Road	Biscot	shin.jumps.deflection
LN131	265 Dunstable Road	Beech Hill	cheek.tuned.silly
LN134	172 Nadeem Plaza	Beech Hill	steer.loss.shadow
LN135	Units 5-6, The Arcade	Beech Hill	backed.blitz.pets
LN136	182 Dunstable Road	Beech Hill	lives.chain.hardly
LN137	10 Selbourne Road	Beech Hill	canny.wires.detail
LN138	132 Leagrave Road	Beech Hill	trains.envy.client
LN139	132 Dunstable Road	Beech Hill	dream.stack.idea
LN140	173 Dunstable Road	Beech Hill	cheese.view.spring

Indicative Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN101	Beech Hill Community Primary School	Beech Hill	atomic.punch.inches

Figure D.6 - Town centre NO_2 monitoring locations in the vicinity of Luton AQMA Nº·3 *(Monitoring locations in Beech Hill & Central wards)*



LBC Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN11	Upper George Street	Central	strong.clouds.moods
LN52	Dunstable Rd/Cardigan St Residential	Central	sector.boots.successes
LN61/62/63	Dunstable Road East (CRAQM 2)	Central	final.much.shots
LN72	Hucklesby Way	Central	gives.regard.curl
LN73	Mill Street	Central	sank.lied.pets
LN75	New Bedford Road	Central	souk.wash.boat
LN100	Dunstable Road - Bury Park 2	Beech Hill	last.muddy.petal
LN123	34 Bury Park Road	Central	digit.leap.soup
LN124	114 Bury Park Road	Beech Hill	doors.leads.fake
LN125	Bury Park Community Centre	Beech Hill	error.mirror.lines
LN133	80 Dunstable Road	Central	afford.term.spirit
LN139	132 Dunstable Road	Beech Hill	dream.stack.idea
LN140	173 Dunstable Road	Beech Hill	cheese.view.spring
LN141	9 Moor Street	Central	aware.lakes.tribal
LN142	Crawley Road	Central	chimp.linen.crest

Luton Rising Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
L1	Dunstable Road East	Central	final.much.shots

Automatic Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN60 (HB007)	Dunstable Road East	Central	final.much.shots

Indicative Sites

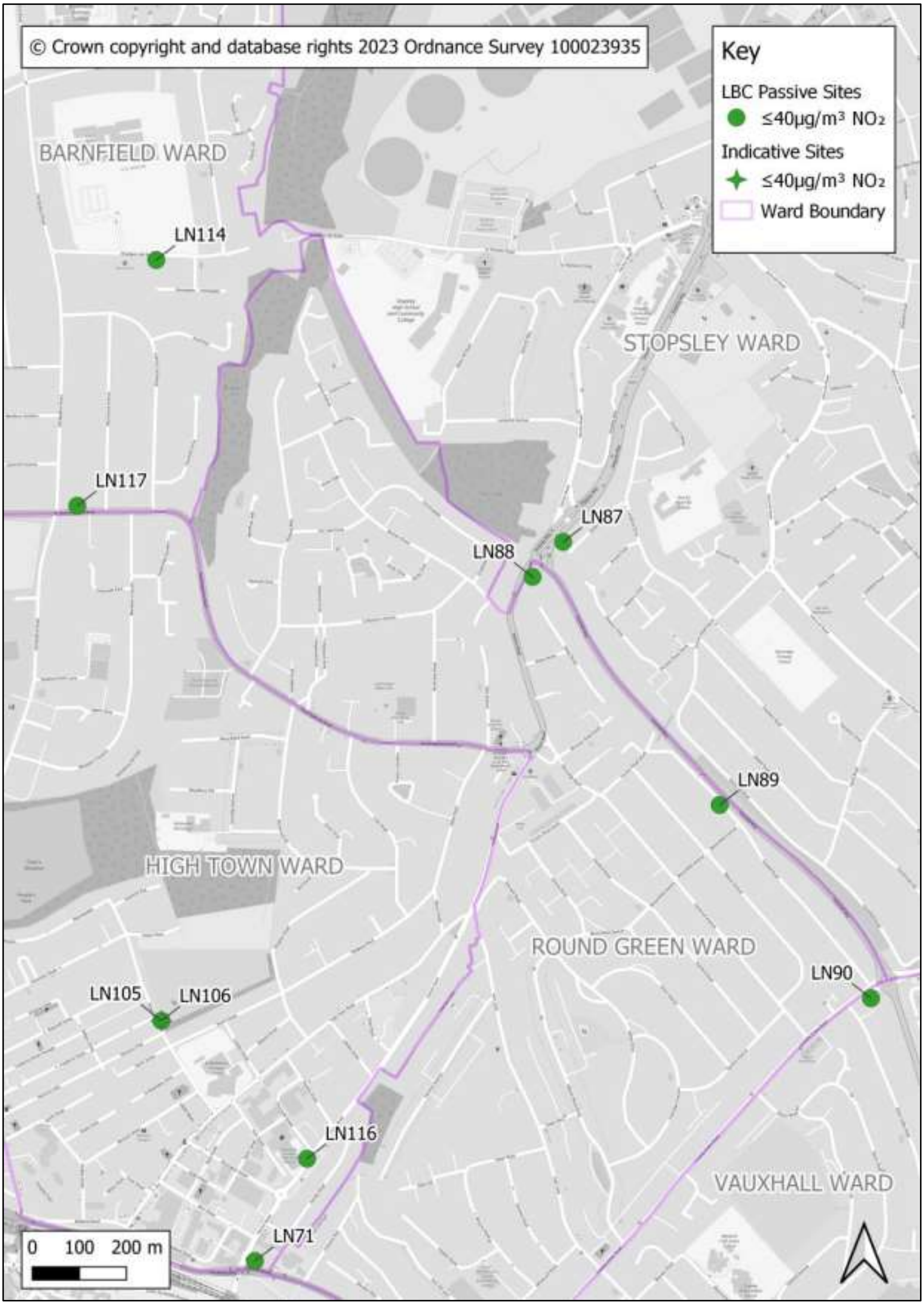
Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN99	Dunstable Road - Bury Park 2	Beech Hill	last.muddy.petal

Figure D.7 - Town centre NO_2 monitoring locations in the vicinity of Luton AQMA Nº 3 *(Monitoring locations in Central & South wards)*

LBC Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN07	Guildford Street/Bute Street	Central	track.could.tile
LN11	Upper George Street	Central	strong.clouds.moods
LN64	Park Viaduct - Park Street	Central	intervals.before.market
LN65	Park Viaduct - Queens Close	South	detail.zone.paths
LN66	Park Viaduct	Central	jumped.frogs.risky
LN67	Castle Street	Central	alien.pipes.puns
LN68	London Road	South	fight.cigar.judges
LN69	John Street	Central	bunks.total.nods
LN78	Hibbert Street	South	theme.feed.fantastic
LN80	Windsor Street	Central	bumps.join.casual
LN96	Castle Street 3	South	poker.ankle.cape

Figure D.8 – NO_2 monitoring locations in Barnfield, High Town, Round Green, Stopsley & Vauxhall wards



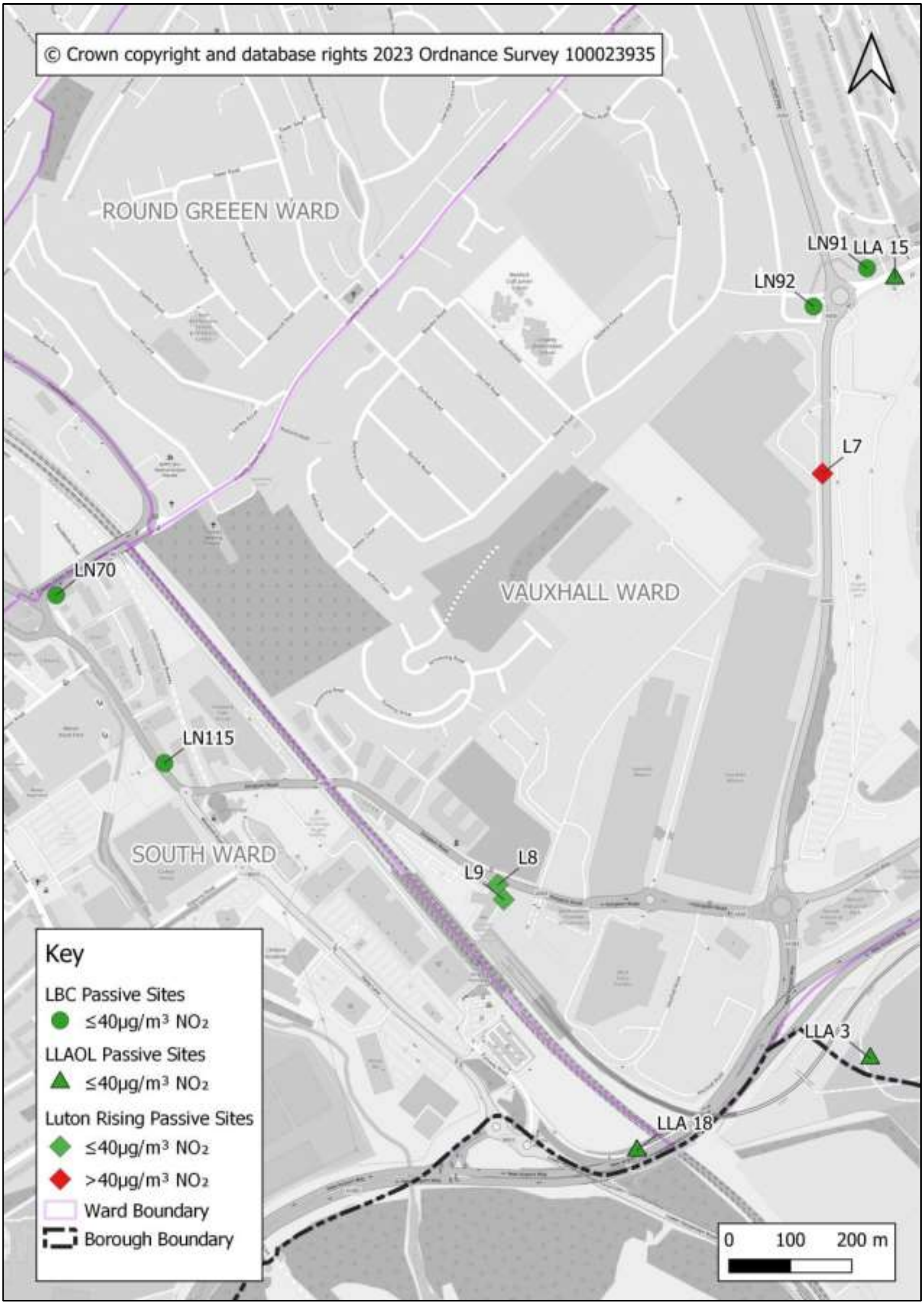
LBC Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN71	Crescent Road	High Town	precautions.fish.rocks
LN87	Shelton Way Alleyway	Stopsley	shady.spill.traded
LN88	510 Hitchin Road	Round Green	listed.works.undulation
LN89	13 Saywell Road	Round Green	stared.glove.risk
LN90	304 Crawley Green Road	Vauxhall	deep.camp.chase
LN106	Peoples Park	High Town	reject.rabble.medium
LN114	20 Bradgers Hill Road	Barnfield	labels.shave.appeal
LN116	85 Hitchin Road	High Town	upper.pools.secret
LN117	258 Stockingstone Road	Barnfield	orange.head.worry

Indicative Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN105	Peoples Park	High Town	reject.rabble.medium

Figure D.9 – NO_2 monitoring locations in South, Vauxhall & Wigmore wards



LBC Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN70	Crawley Green Road	South	axed.ended.advice
LN91	International House	Vauxhall	mostly.images.sudden
LN92	Harrowden Court	Vauxhall	solid.tell.garden
LN115	69 Windmill Road	South	phones.lost.ending

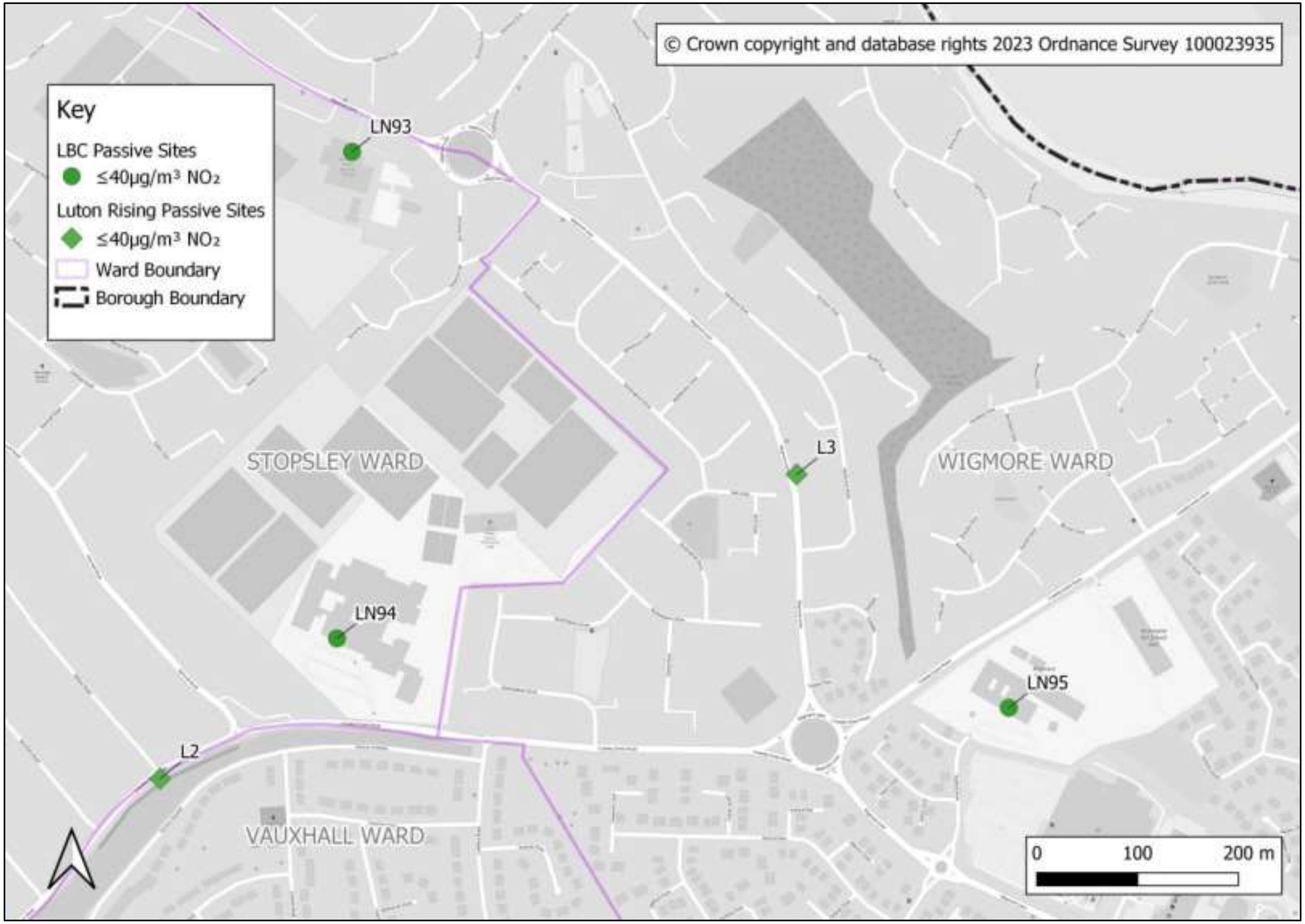
LLAOL Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LLA 3	Runway Threshold Western	Wigmore	cliff.edge.broom
LLA 15	Eaton Green Road – Lower	Vauxhall	wants.forest.only
LLA 18	A1081 New Airport Way	South	dreams.mass.scenes

Luton Rising Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
L7	Vauxhall Way	Vauxhall	spins.storm.skip
L8	Kimpton Road	Vauxhall	grapes.shops.jeeps
L9	Luton Parkway Station Exit (North)	Vauxhall	risky.gates.spaces

Figure D.10 – NO_2 monitoring locations in Stopsley, Vauxhall & Wigmore wards



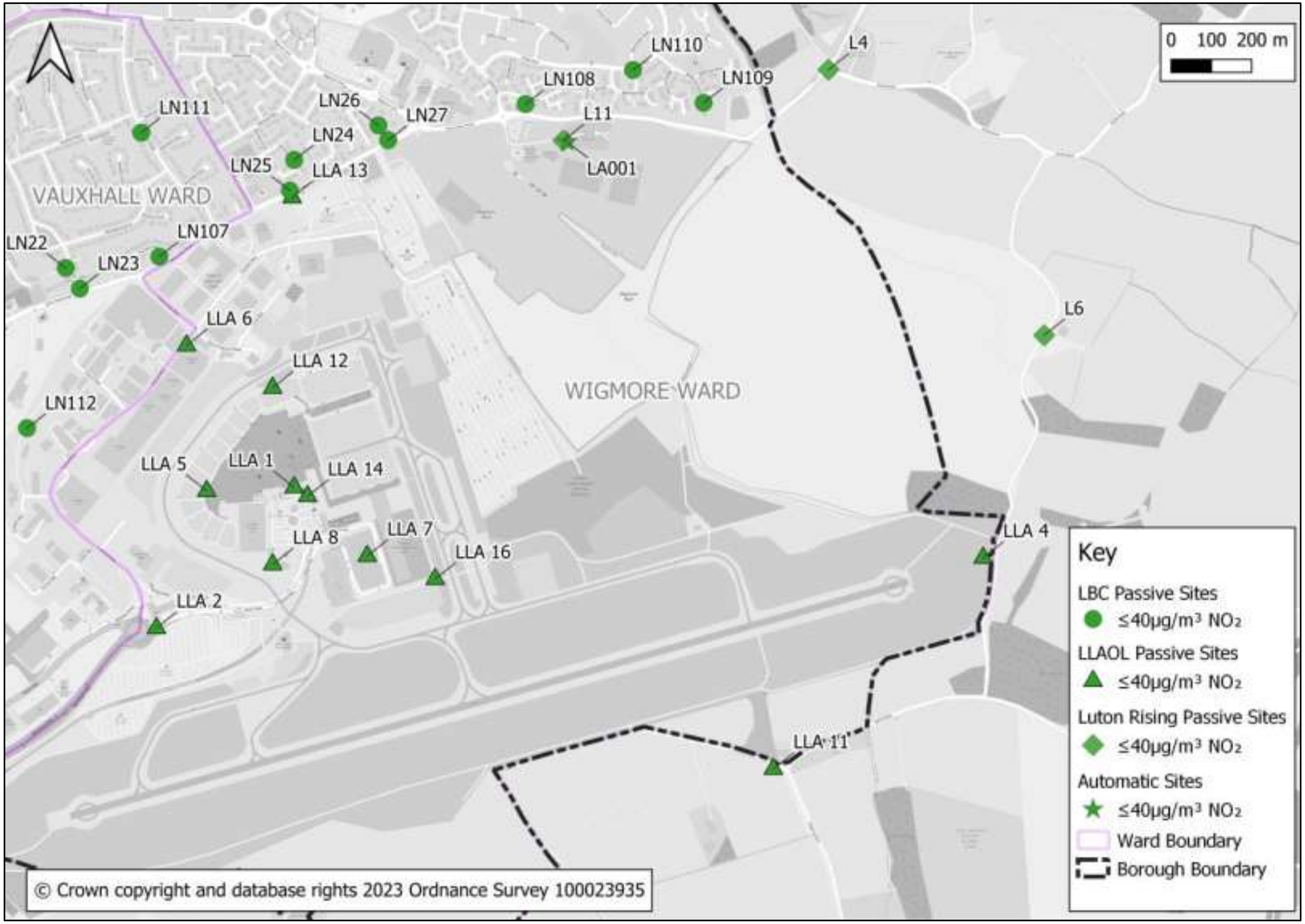
LBC Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN93	Someries Junior School	Stopsley	beyond.hatch.float
LN94	Ashcroft High School	Stopsley	ends.nights.heats
LN95	Wigmore Primary School	Wigmore	stop.pass.bolt

Luton Rising Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
L2	Crawley Green Road	Vauxhall	event.clown.saving
L3	Wigmore Lane	Wigmore	areas.transmitted.kicked

Figure D.11 – NO_2 monitoring locations in the vicinity of London Luton Airport *(Monitoring locations in Vauxhall & Wigmore wards)*



LBC Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN22	1 Mistletoe Hill	Vauxhall	herb.either.foam
LN23	Eaton Green Road 1	Vauxhall	plants.speech.sides
LN24	19 Barnston Close	Wigmore	moral.park.builds
LN25	Eaton Green Road 2	Wigmore	move.green.drank
LN26	8 Keeble Close	Wigmore	tree.dark.notion
LN27	Eaton Green Road 3	Wigmore	bumps.wedge.boil
LN107	2 Chertsey Close	Vauxhall	begins.lied.mouth
LN108	Laxton Close	Wigmore	shaped.nerve.pinks
LN109	59 Malthouse Green	Wigmore	intervals.tops.giving
LN110	Hedley Rise	Wigmore	sudden.lunch.across
LN111	61 Lalleford Road	Vauxhall	chair.shadow.loaf
LN112	140 Prospect Way	Vauxhall	reject.filer.party

LLAOL Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LLA 1	Terminal front [canopy]	Wigmore	jolly.soak.fast
LLA 2	Airport Approach Road	Wigmore	space.reveal.wicked
LLA 4	Runway Threshold Eastern	Wigmore	glue.defeat.casual
LLA 5	Adjacent to Stand 5	Wigmore	galaxy.middle.stove

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LLA 6	President Way Jct	Wigmore	bulb.peanut.singer
LLA 7	Drop Off Zone	Wigmore	speaks.bells.pipes
LLA 8	BAM Co-located	Wigmore	sank.quit.mull
LLA 11	Dane Street	Caddington [out of borough]	likes.builds.zebra
LLA 12	Airside - Stand 61	Wigmore	common.first.tides
LLA 13	Eaton Green Road	Wigmore	tigers.stress.supply
LLA 14	Undercroft Access	Wigmore	across.leads.claim
LLA 16	Airside - South Stands	Wigmore	clap.fake.feared

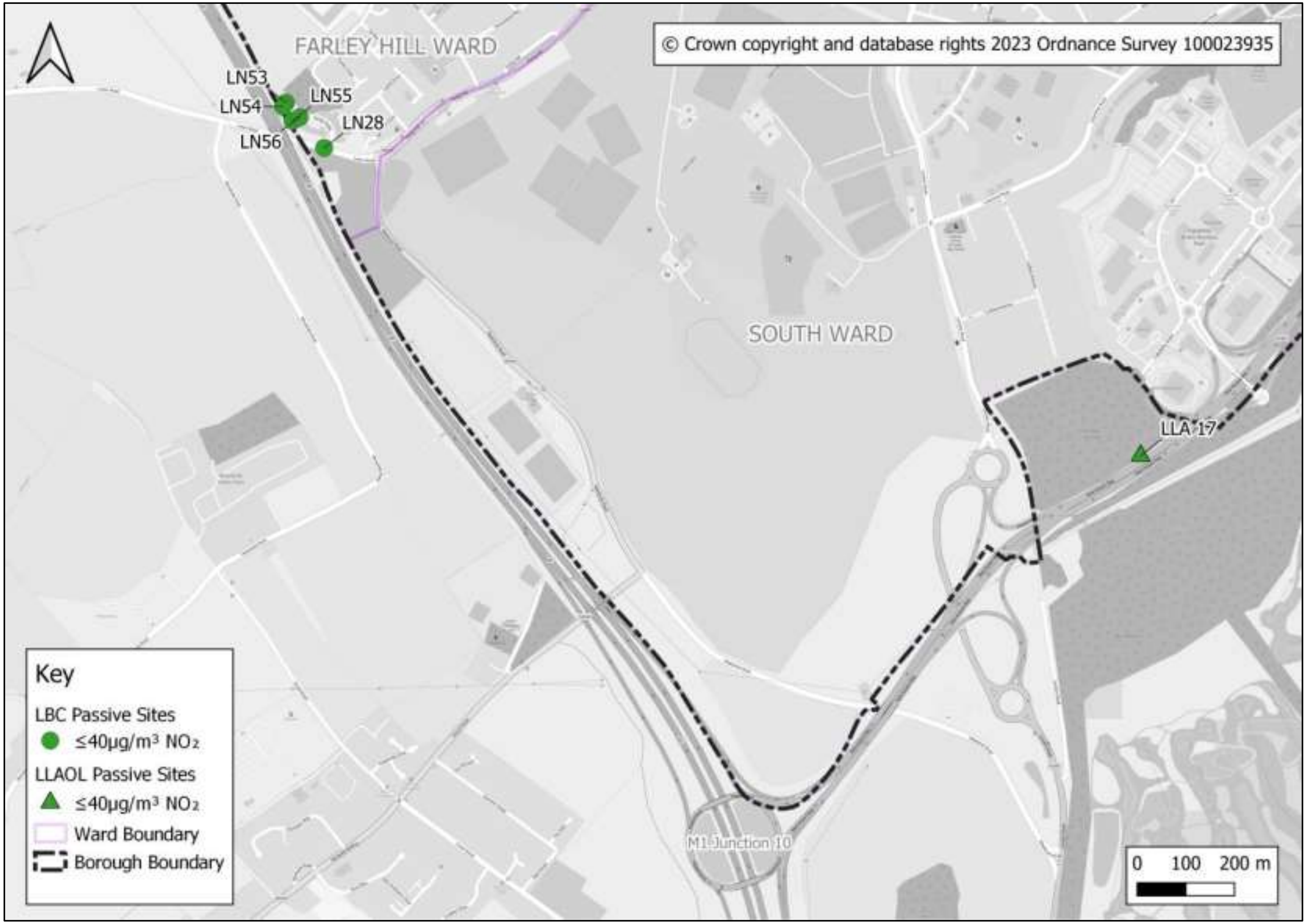
Luton Rising Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
L4	Eaton Green Road / Darley Road	Hitchwood, Offa and Hoo [out of borough]	cost.exit.keeps
L6	Winch Hill	Hitchwood, Offa and Hoo [out of borough]	fact.exists.dame
L11	Wigmore Valley Park	Wigmore	feared.same.format

Automatic Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LA001	London Luton Airport FutureLuToN	Wigmore	puzzle.spine.rocket

Figure D.12 - NO_2 monitoring locations in South Luton in the vicinity of the M1 *(Monitoring locations in Farley Hill ward)*



LBC Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LN28	Caddington Road	Farley	shine.spent.next
LN53	3rd Floor Bagshawe Court F.F.	Farley	class.first.expose
LN54	M1 Corner Bagshawe Court F.F.	Farley	stones.insist.modern
LN55	M1 Corner Wyatt Court FF	Farley	causes.clubs.places
LN56	20 Wyatt Court FF	Farley	expand.bossy.pose

LLAOL Passive Sites

Site ID	Site Name	Ward	what3words address (https://what3words.com)
LLA 17	A1081 New Airport Way 1	Caddington [out of borough]	cliff.valid.beast

Appendix E: Summary of Air Quality Objectives in England

Table E.1 – Air Quality Objectives in England[15]

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

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

Appendix F: Time Variation Plots for Automatic Monitoring Sites

Consistent with the output of the Openair Time Variation tool implemented on the UK Air website for AURN monitoring site data (https://tinyurl.com/4zn5xfx2), for each automatic monitoring site within the borough the following panel charts show the average variation of either NO_2, PM_{10} or $PM_{2.5}$ by:

(i) day of the week and hour of the day combined (the uppermost pane);
(ii) hour of the day (diurnal variation, lower left pane);
(iii) day of the week (lower middle pane); and
(iv) month of the year (seasonal variation, centre right pane).

Additionally, the charts also include:

(v) a plot of monthly percentage data capture (lower right pane).

For each chart, the shading on panes (i) to (iv) shows the 95% confidence intervals of the mean and the line of the mean.

Finally, the plot showing seasonal variation in NO_2 levels at *HB007* also shows the average uncorrected value obtained for the three co-located diffusion tubes for the same month (shown in orange).

Nitrogen Dioxide (NO_2)

Figure F.1 – NO_2 data trends at LN60 (HB007) – Luton Dunstable Road East during 2022

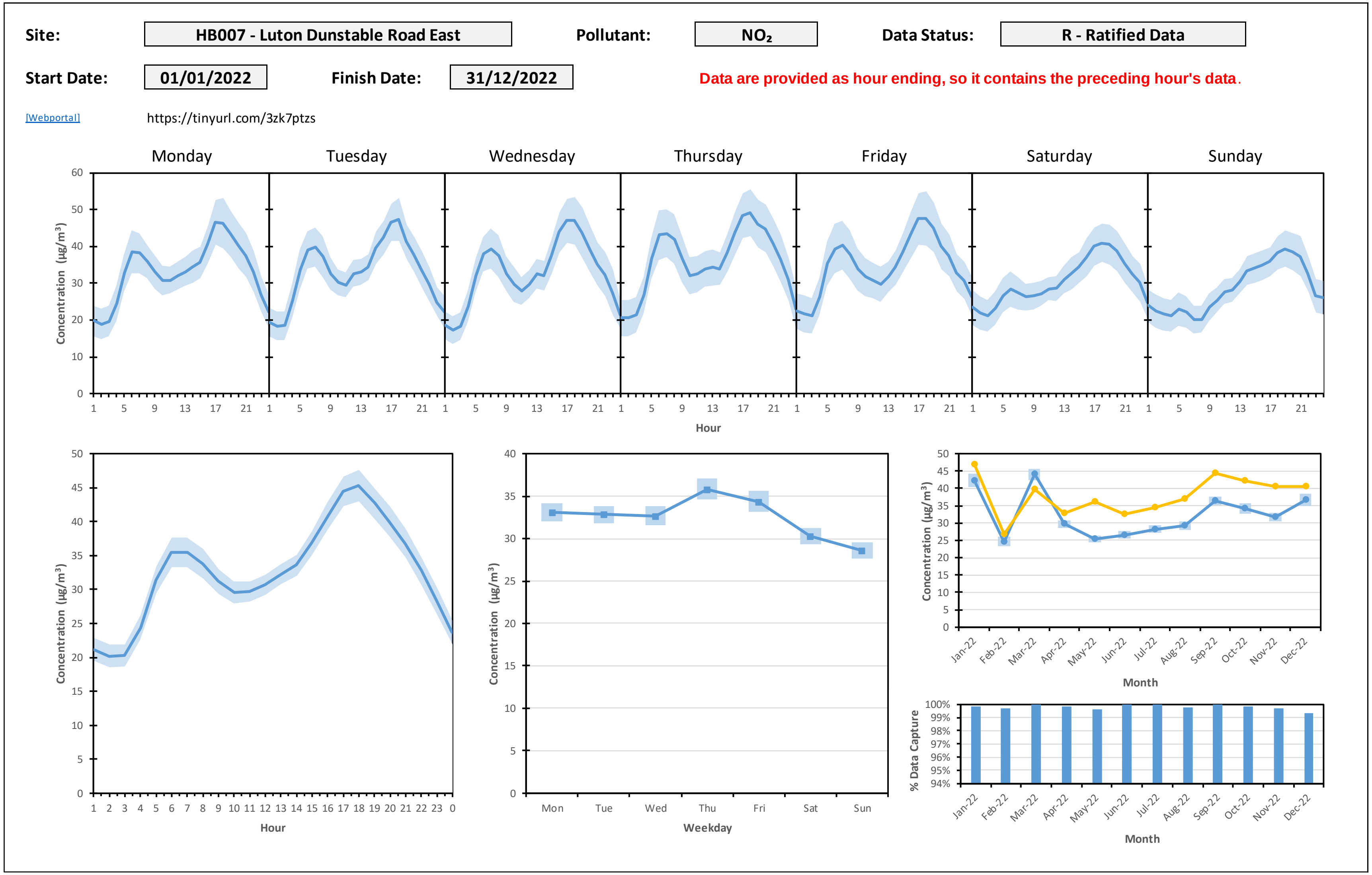


Figure F.2 – NO_2 data trends at LA001 – Luton Airport FutureLuToN during 2022

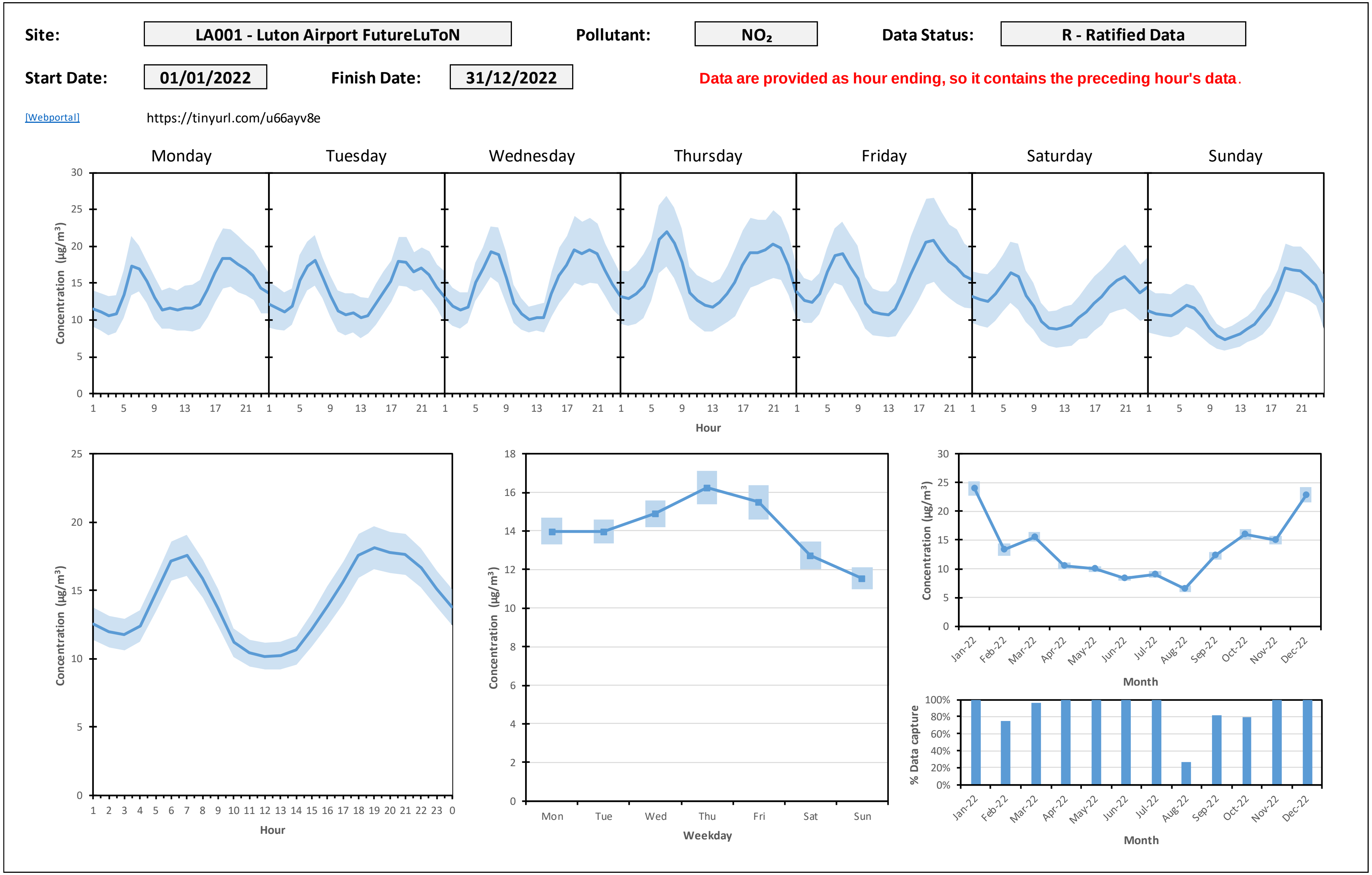
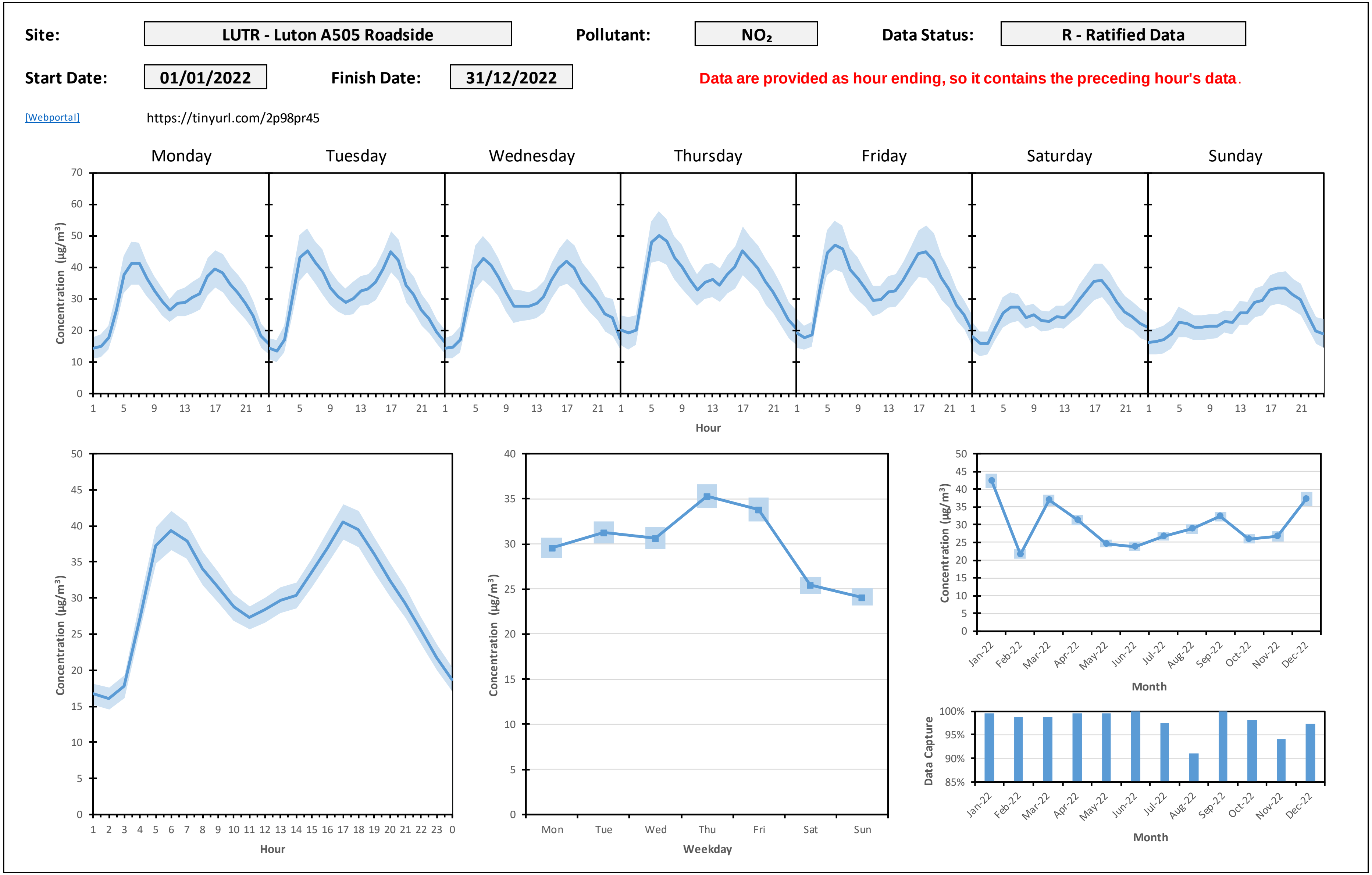


Figure F.3 – NO_2 data trends at LUTR – Luton A505 Roadside during 2022



Particulate Matter (PM_{10})

Figure F.4 - PM_{10} data trends at LN60 (HB007) – Luton Dunstable Road East during 2022

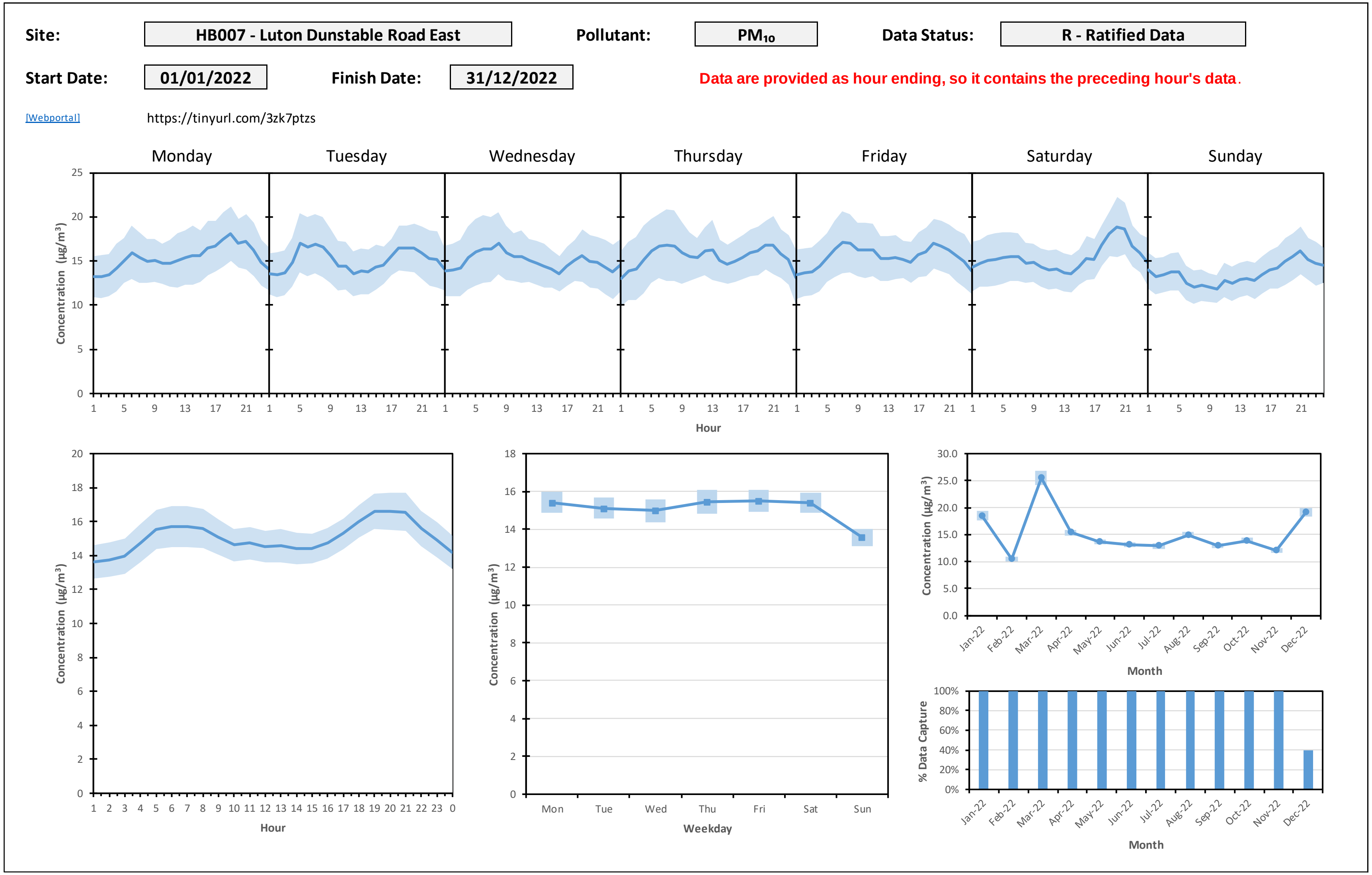


Figure F.5 – PM_{10} data trends at LA08 (HB006) – London Luton Airport during 2022

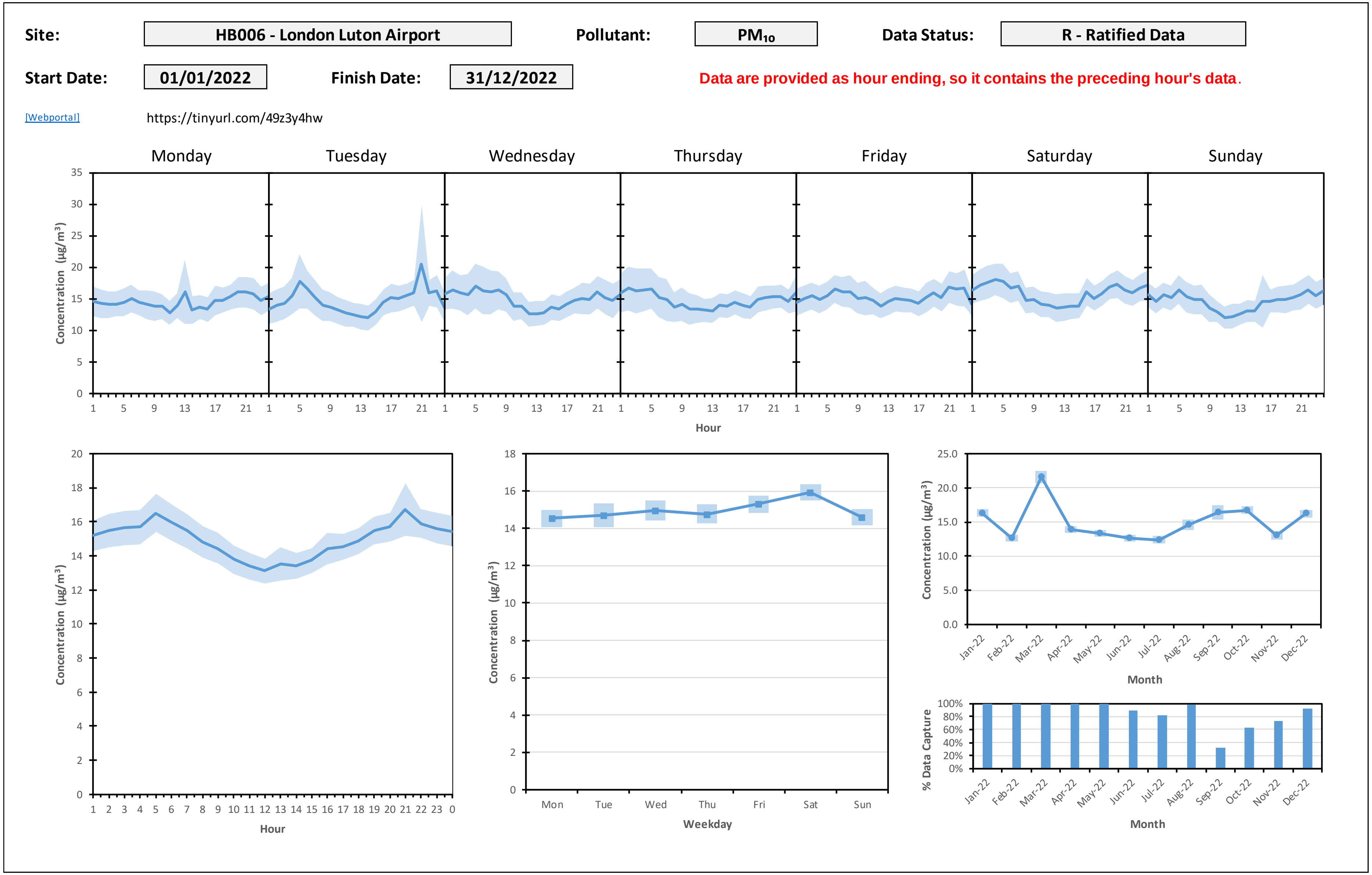
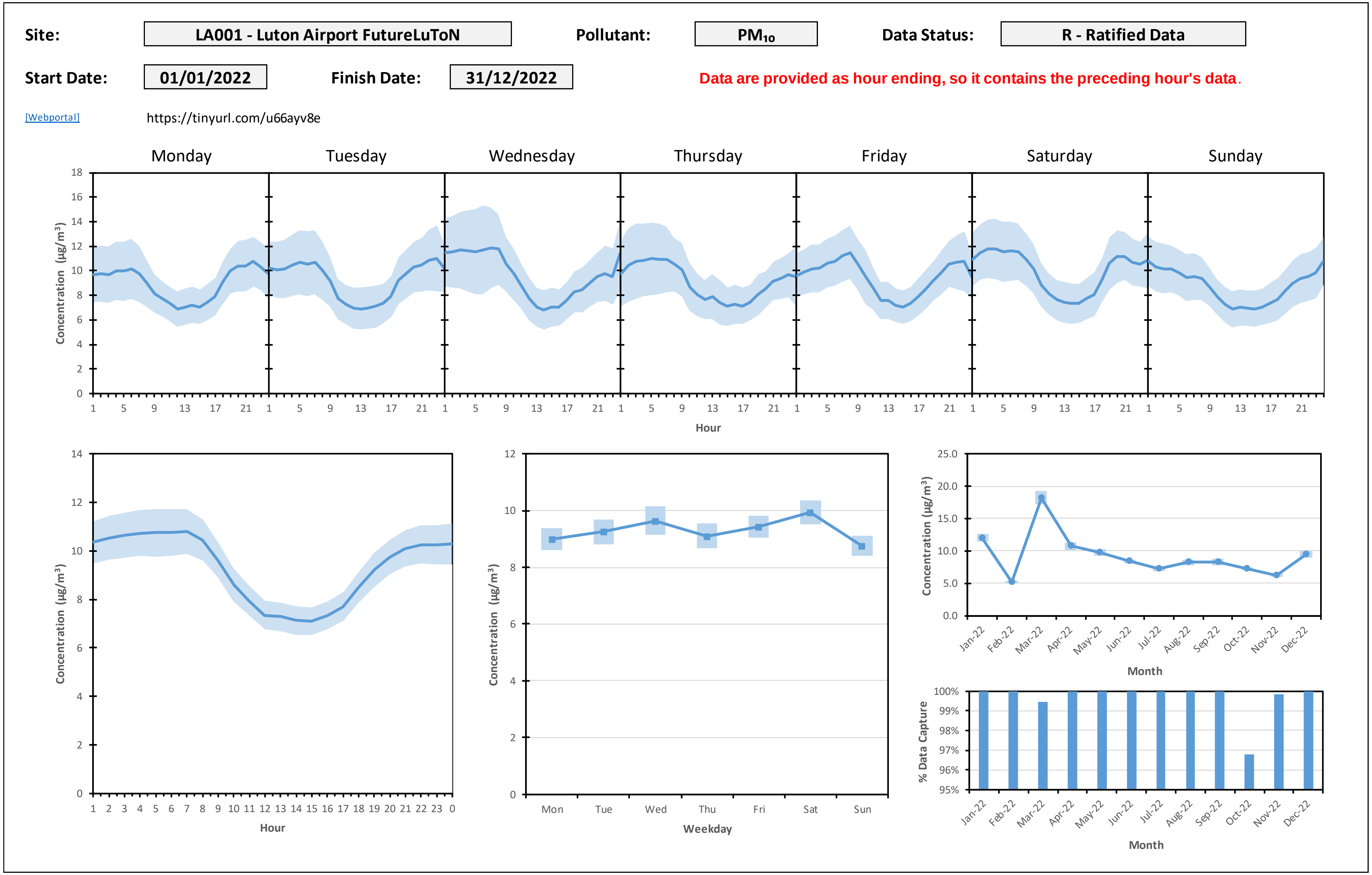


Figure F.6 – PM_{10} data trends at LA001 – Luton Airport FutureLuToN during 2022



Particulate Matter ($PM_{2.5}$)

Figure F.7 – $PM_{2.5}$ data trends at LN60 (HB007) – Luton Dunstable Road East during 2022

Site: HB007 - Luton Dunstable Road East **Pollutant:** $PM_{2.5}$ **Data Status:** R - Ratified Data

Start Date: 01/01/2022 **Finish Date:** 31/12/2022 **Data are provided as hour ending, so it contains the preceding hour's data.**

[Webportal] https://tinyurl.com/3zk7ptzs

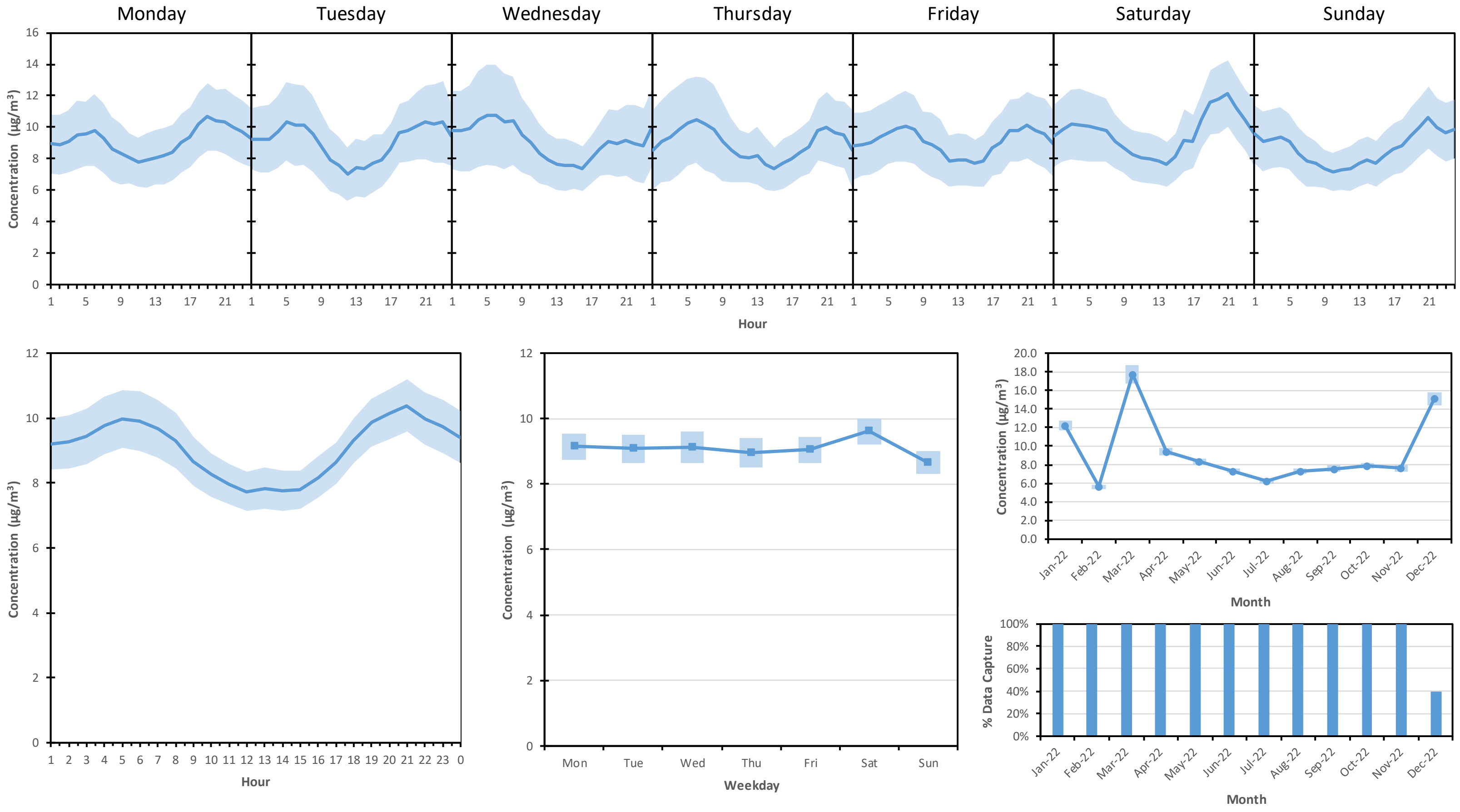
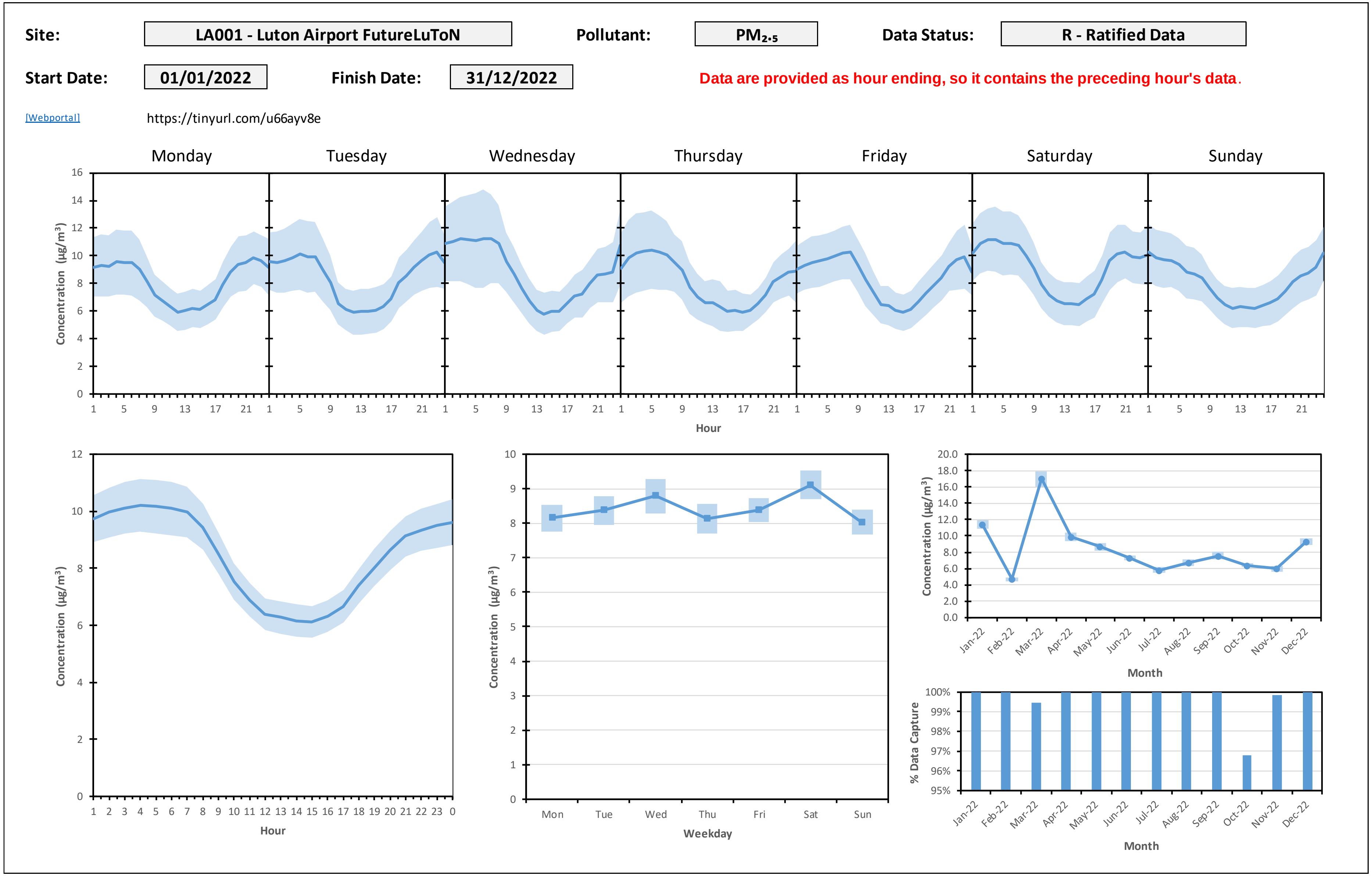


Figure F.8 – $PM_{2.5}$ data trends at LA001 – Luton Airport FutureLuToN during 2022



Appendix G: Indicative Low Cost Sensor-based monitoring

Funded by LBC Highways, at the end of 2021, Luton Borough Council installed a network of five South Coast Praxis/Urban sensor-based indicative air quality monitors to measure NO_2, PM_{10} and $PM_{2.5}$ levels in near real-time. With one monitor deployed in an urban background location and the remainder installed at roadside sites flagged for investigation by the Highways Team, full details of these sites are presented in Table G.1.

Due variously to equipment failure, tampering and removal for calibration by co-location at reference sites, for all three pollutants, annual data capture was less than 75% at more than one location (see Table G.2, Table G.4 and Table G.6). Consequently, in these cases an annualisation has been conducted following the methodology set out in Box 7-9 of *LAQM.TG22* using whole-year data sets obtained from the *UK Air Data Selector* [https://tinyurl.com/s6fpm8xx] (see Table G.7, Table G.8 and Table G.9). Data from the following Automatic Urban & Rural Network (AURN) monitoring sites was used, all of which are within a 50-mile radius of Luton and have calendar year data capture rates of over 85% for the pollutant of interest:

- London N. Kensington (*UKA00253*) – Type: Urban Background - Pollutants: NO_2; PM_{10}; $PM_{2.5}$
- London Hillingdon (*UKA00266*) – Type: Urban Background - Pollutants: NO_2
- Reading New Town (*UKA00462*) – Type: Urban Background - Pollutants: PM_{10}; $PM_{2.5}$
- Oxford St Ebbes (*UKA00518*) – Type: Urban Background - Pollutants: NO_2; PM_{10}; $PM_{2.5}$
- London Haringey Priory Park South (*UKA00568*) – Type: Urban Background - Pollutants: NO_2
- London Honor Oak Park (*UKA00656*) – Type: Urban Background - Pollutants: PM_{10}; $PM_{2.5}$

After annualisation as appropriate, comparing the mean annual concentrations obtained at each site for each pollutant with the relevant air quality objective levels, it would appear that at *LN103* (*L&D Hospital, Lewsey Road*) both the current NO_2 and the future $PM_{2.5}$ targets have been exceeded, with recorded levels of 44.9µg/m^3 NO_2 and 11.3µg/m^3 $PM_{2.5}$ respectively (compared to objective levels of 40µg/m^3 and 10µg/m^3).

However, it should be noted that both *LAQM.TG22* and the current Air Quality Expert Group (AQEG) advice on the use of *'low-cost'* pollution sensors [https://tinyurl.com/mstdzpyv] advise that indicative sensor-based monitors are not sufficiently accurate for compliance monitoring purposes and are instead more suited to short-term (*e.g.* diurnal) trend analysis. To enable the NO_2 level at each indicative monitoring site to be assessed against the air quality objective and to indicate how the sensor-derived NO_2 concentrations compare with passive-derived values, NO_2 diffusion tubes were co-located with each monitor (Table G.10).

Reviewing the diffusion tube data, none of the passively derived annual mean NO_2 concentrations exceeded the objective level of 40µg/m^3. To explore the degree of equivalence between the two monitoring techniques, the results obtained for each monitoring site were plotted on a scatter plot (Figure G.1), and the difference between the two values visualised using a Bland-Altman plot (Figure G.2). Although the latter shows all values to fall within the limits of agreement, the range of differences between the two methods is fairly high, with the points quite spread out across the interval between the upper and lower limits of agreement.

Similar to the treatment of the automatic monitoring site data sets detailed in Appendix F and consistent with the output of the Openair Time Variation tool implemented on the UK Air website for AURN monitoring site data (https://tinyurl.com/4zn5xfx2), for each indicative sensor-based monitoring site panel charts (Figure G.8 to Figure G.22) have been generated showing the average variation of either NO_2, PM_{10} or $PM_{2.5}$ by:

(i) day of the week and hour of the day combined (the uppermost pane);
(ii) hour of the day (diurnal variation, lower left pane);
(iii) day of the week (lower middle pane); and
(iv) month of the year (seasonal variation, centre right pane).

Additionally, the charts also include:

(v) a plot of monthly percentage data capture (lower right pane).

For each chart, the shading on panes (i) to (iv) shows the 95% confidence intervals of the mean and the line of the mean.

Finally, the plots showing seasonal variation in NO_2 levels also show the uncorrected value obtained from the co-located diffusion tube for the same month (shown in orange).

Table G.1 – Details of Indicative Low-Cost Sensor-based Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Co-located NO_2 Diffusion Tube?	Inlet Height (m)
LN97	Chaul End Road	Roadside	506411	222554	NO_2; PM_{10}; $PM_{2.5}$	No	N/A		Yes (LN98)	
LN99	Dunstable Road – Bury Park 2	Roadside	508380	221764	NO_2; PM_{10}; $PM_{2.5}$	Yes AQMA 3	6.5	3.2	Yes (LN100)	2.6
LN101	Beech Hill Community Primary School	Roadside	508000	222078	NO_2; PM_{10}; $PM_{2.5}$	No	9.0	3.5	Yes (LN102)	
LN103	L&D Hospital, Lewsey Road	Roadside	504987	222805	NO_2; PM_{10}; $PM_{2.5}$	No	12.5	2.0	Yes (LN104)	2.6
LN105	Peoples Park	Urban Background	509339	222128	NO_2; PM_{10}; $PM_{2.5}$	No	N/A		Yes (LN106)	2.6

Notes:

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

(2) N/A if not applicable

(3) Instrument not approved by Defra (*LAQM.TG22 para 7.176*)

Table G.2 - Annual Mean NO_2 Monitoring Results: Indicative Low-Cost Sensor-based monitoring

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2022 Annual Mean NO_2
LN97	506411	222554	Roadside	68.4	68.4	21.1
LN99	508380	221764	Roadside	51.2	51.2	37.6
LN101	508000	222078	Roadside	72.5	72.5	20.4
LN103	504987	222805	Roadside	90.7	90.7	**44.9**
LN105	509339	222128	Urban Background	80.1	80.1	22.7

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with *LAQM.TG22*.**

☒ **Reported concentrations are those at the location of the monitoring site (annualised, as required), *i.e.* prior to any fall-off with distance correction.**

Notes:

The annual mean concentrations are presented as µg/m^3.

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

All means have been *“annualised”* as per *LAQM.TG22* if valid data capture for the full calendar year is less than 75%. See Table G.7 for details.

Concentrations are those at the location of monitoring and not those following any fall-off with distance adjustment.

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

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

Table G.3 – 1-Hour Mean NO_2 Monitoring Results, Number of 1-Hour Means > 200µg/m^3: Indicative Low Cost Sensor-based monitoring

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2022 Number of 1-Hour Means >200µg/m^3
LN97	506411	222554	Roadside	68.4	68.4	0 (76.4)
LN99	508380	221764	Roadside	51.2	51.2	0 (86.4)
LN101	508000	222078	Roadside	72.5	72.5	0 (68.6)
LN103	504987	222805	Roadside	90.7	90.7	0
LN105	509339	222128	Urban Background	80.1	80.1	0 (87.9)

Notes:

Results are presented as the number of 1-hour periods where concentrations greater than 200µg/m^3 have been recorded.

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

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

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

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

Table G.4 – Annual Mean PM_{10} Monitoring Results: Indicative Low Cost Sensor-based monitoring

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2022 Annual Mean PM_{10}
LN97	506411	222554	Roadside	68.4	68.4	16.0
LN99	508380	221764	Roadside	65.9	65.9	17.0
LN101	508000	222078	Roadside	72.5	72.5	13.8
LN103	504987	222805	Roadside	90.7	90.7	15.4
LN105	509339	222128	Urban Background	73.6	73.6	12.0

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

Notes:

The annual mean concentrations are presented as µg/m^3.

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

All means have been *"annualised"* as per LAQM.TG22 if valid data capture for the full calendar year is less than 75%. See Table G.8 for details.

(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.
(2) Data capture for the full calendar year (*e.g.* if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

Table G.5 – 24-Hour Mean PM_{10} Monitoring Results, Number of PM_{10} 24-Hour Means > 50µg/m^3: Indicative Low Cost Sensor-based monitoring

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2022 Number of 24-Hour Means >50µg/m^3
LN97	506411	222554	Roadside	68.4	68.4	2 (26.7)
LN99	508380	221764	Roadside	65.9	65.9	2 (29.5)
LN101	508000	222078	Roadside	72.5	72.5	0 (23.4)
LN103	504987	222805	Roadside	90.7	90.7	0
LN105	509339	222128	Urban Background	73.6	73.6	0 (19.8)

Notes:

Results are presented as the number of 24-hour periods where daily mean concentrations greater than 50µg/m^3 have been recorded.

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

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

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

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

Table G.6 – Annual Mean $PM_{2.5}$ Monitoring Results: Indicative Low Cost Sensor-based monitoring

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2022 (%) (2)	2022 Annual Mean $PM_{2.5}$
LN97	506411	222554	Roadside	68.4	68.4	8.8
LN99	508380	221764	Roadside	65.9	65.9	9.8
LN101	508000	222078	Roadside	72.5	72.5	7.3
LN103	504987	222805	Roadside	90.7	90.7	11.3
LN105	509339	222128	Urban Background	81.1	81.1	6.1

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

Notes:

The annual mean concentrations are presented as µg/m^3.

All means have been *"annualised"* as per LAQM.TG22 if valid data capture for the full calendar year is less than 75%. See Table G.9 for details.

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

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

Table G.7 – Annualisation Summary, Indicative Low Cost Sensor-based NO_2 Monitoring (concentrations presented in µg/m^3)

Site ID	Annualisation Factor London Haringey Priory Park South	Annualisation Factor London Hillingdon	Annualisation Factor London N. Kensington	Annualisation Factor Oxford St Ebbes	Average Annualisation Factor	Raw Data Annual Mean	Annualised Annual Mean
LN97	1.0530	1.0394	1.1002	1.0119	1.0511	20.1	21.1
LN99	1.1647	1.1450	1.2517	1.0902	1.1629	32.3	37.6
LN101	1.0594	1.0558	1.1016	1.0096	1.0566	19.3	20.4

Table G.8 – Annualisation Summary, Indicative Low Cost Sensor-based PM_{10} Monitoring (concentrations presented in µg/m^3)

Site ID	Annualisation Factor London N. Kensington	Annualisation Factor Oxford St Ebbes	Annualisation Factor Reading New Town	Annualisation Factor London Honor Oak Park	Average Annualisation Factor	Raw Data Annual Mean	Annualised Annual Mean
LN97	0.9770	0.9758	0.9813	0.9665	0.9751	16.4	16.0
LN99	0.9966	0.9966	1.0149	0.9808	0.9972	17.0	17.0
LN101	0.9963	0.9957	0.9988	0.9878	0.9947	13.9	13.8
LN105	1.0426	1.0407	1.0178	1.0352	1.0341	11.7	12.0

Table G.9 – Annualisation Summary, Indicative Low Cost Sensor-based $PM_{2.5}$ Monitoring (concentrations presented in µg/m³)

Site ID	Annualisation Factor London N. Kensington	Annualisation Factor Oxford St Ebbes	Annualisation Factor Reading New Town	Annualisation Factor London Honor Oak Park	Average Annualisation Factor	Raw Data Annual Mean	Annualised Annual Mean
LN97	0.9812	0.9813	1.0029	0.9681	0.9834	9.0	8.8
LN99	1.0018	0.9916	0.9994	0.9783	0.9928	9.9	9.8
LN101	1.0065	1.0071	1.0177	0.9948	1.0065	7.3	7.3

Table G.10 - Comparison of Co-located Sensor and Passively Derived Annual Mean NO_2 Levels (concentrations presented in µg/m³)

Site Name	Site ID (Sensor)	2022 Annual Mean NO_2 (Sensor)	Site ID (Passive)	2022 Annual Mean NO_2 (Passive)	Difference (%)
Chaul End Road	LN97	21.1	LN98	28.1	28.5
Dunstable Road - Bury Park 2	LN99	37.6	LN100	35.5	5.7
Beech Hill Community Primary School	LN101	20.4	LN102	24.8	19.3
L&D Hospital, Lewsey Road	LN103	**44.9**	LN104	32.8	31.1
Peoples Park	LN105	22.7	LN106	17.8	24.4

Figure G.1 - Scatter Plot Comparing Diffusion Tube and Sensor Derived 2022 Annual Mean NO_2 at Each Co-located Site

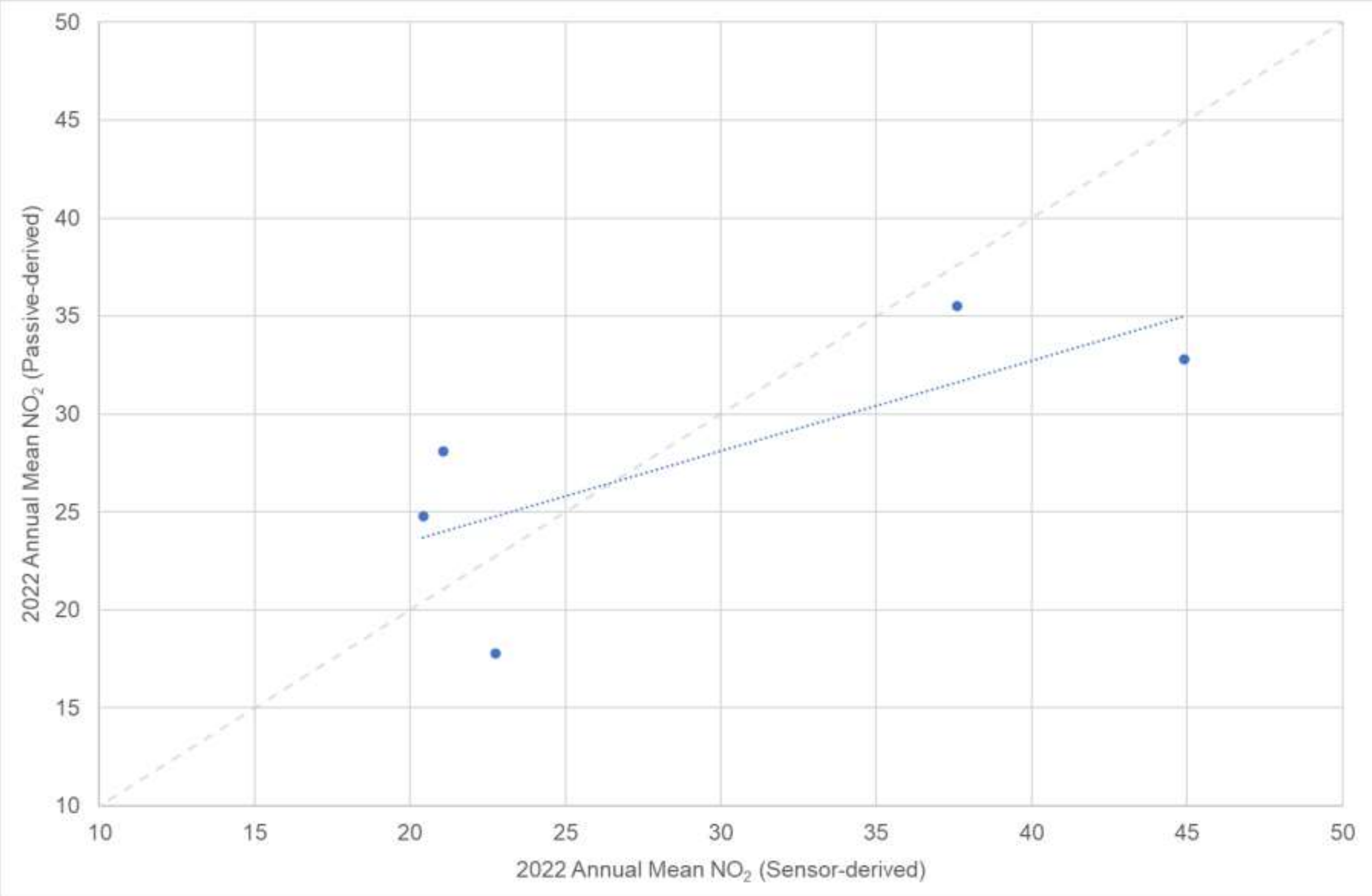


Figure G.2 - Bland-Altman Plot Showing the Difference Between the Diffusion Tube and Sensor Derived 2022 Annual Mean NO_2 at the Co-located Sites

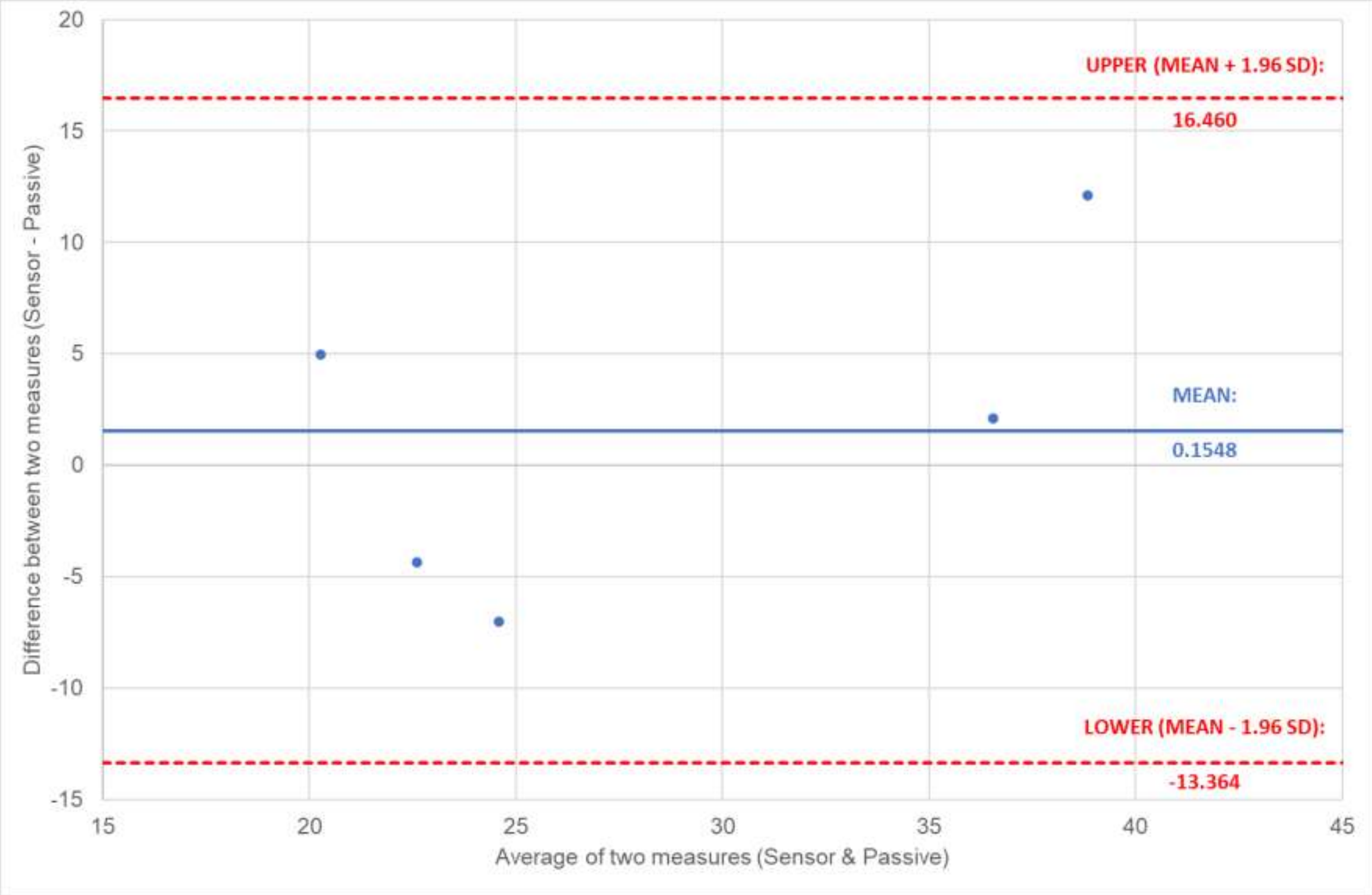


Figure G.3 - 2022 Air Pollution Report – LN97: Chaul End Road

Air Pollution Report

1st January to 31st December 2022

Air Quality England

Downside Primary School (Chaul Lane) (Site ID: scsbgx656)

These data have been fully ratified
Only relevant statistics for LAQM are presented in the table. Cells with - indicate no data available or calculated.

Pollutant	NO µg/m³	NO_2 µg/m³	PM_{10} µg/m³	PM_{25} µg/m³
Number Days Low	-	251	247	248
Number Days Moderate	-	0	2	1
Number Days High	-	0	0	0
Number Days Very High	-	0	0	0
Max Daily Mean	-	56	56	38
Annual Max	-	101	71	59
Annual Mean	-	20	16	9
98th Percentile of daily mean	-	-	42	-
90th Percentile of daily mean	-	-	25	-
99.8th Percentile of hourly mean	-	76	-	-
98th Percentile of hourly mean	-	53	43	31
95th Percentile of hourly mean	-	43	33	24
50th Percentile of hourly mean	-	17	15	7
% Annual data capture	**-**	**68.42**	**68.42**	**68.42**

Instruments:
PM_{10}: PRAXIS URBAN
PM_{25}: PRAXIS URBAN

All gaseous pollutant mass units are at 20°C and 1013mb. Particulate matter concentrations are reported at ambient temperature and pressure. NO_X mass units are NO_X as NO_2 µg m-3

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Pollutant	Air Quality Standards regulations 2010	Exceedances	Days
PM_{10} particulate matter (Hourly measured)	daily mean > 50 microgrammes per metre cubed	2	2
PM_{10} particulate matter (Hourly measured)	Annual mean > 40 microgrammes per metre cubed	0	-
$PM_{2.5}$ particulate matter (Hourly measured)	Annual mean > 25 microgrammes per metre cubed	0	-
Nitrogen dioxide	Hourly Mean > 200 microgrammes per metre cubed	0	0
Nitrogen dioxide	**Annual Mean > 40 microgrammes per metre cubed**	**0**	**-**

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Annual Graph

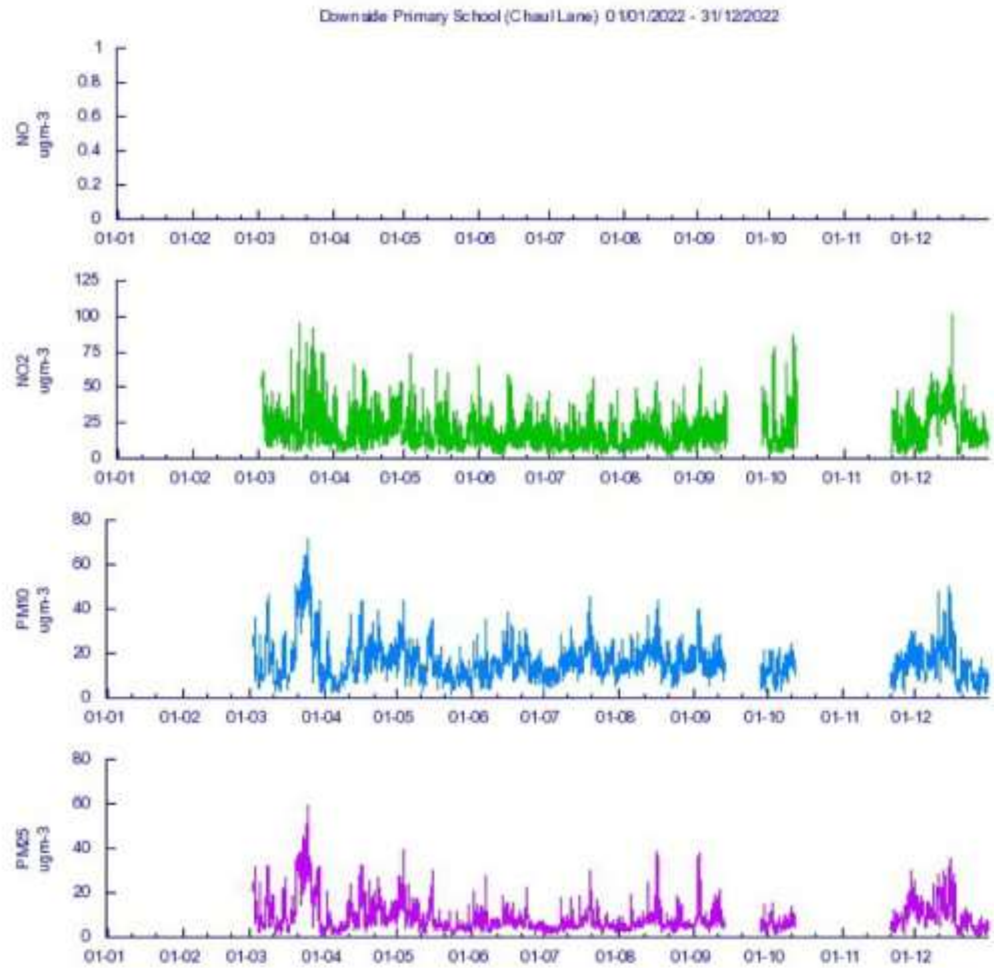

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Figure G.4 - 2022 Air Pollution Report – LN99: Dunstable Road – Bury Park 2

Air Pollution Report

1st January to 31st December 2022

Air Quality England

Dunstable Road (Bury Park) (Site ID: scsbgx657)

These data have been fully ratified
Only relevant statistics for LAQM are presented in the table. Cells with - indicate no data available or calculated.

Pollutant	NO µg/m³	NO_2 µg/m³	PM_{10} µg/m³	PM_{25} µg/m³
Number Days Low	-	189	237	238
Number Days Moderate	-	0	2	1
Number Days High	-	0	0	0
Number Days Very High	-	0	0	0
Max Daily Mean	-	58	55	37
Annual Max	-	101	70	51
Annual Mean	-	32	17	10
98th Percentile of daily mean	-	-	44	-
90th Percentile of daily mean	-	-	25	-
99.8th Percentile of hourly mean	-	86	-	-
98th Percentile of hourly mean	-	65	45	34
95th Percentile of hourly mean	-	55	36	27
50th Percentile of hourly mean	-	30	15	7
% Annual data capture	**-**	**51.15**	**65.91**	**65.91**

Instruments:
PM_{10}: PRAXIS URBAN
PM_{25}: PRAXIS URBAN

All gaseous pollutant mass units are at 20°C and 1013mb. Particulate matter concentrations are reported at ambient temperature and pressure. NO_X mass units are NO_X as NO_2 µg m-3

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Pollutant	Air Quality Standards regulations 2010	Exceedances	Days
PM_{10} particulate matter (Hourly measured)	daily mean > 50 micrograms per metre cubed	2	2
PM_{10} particulate matter (Hourly measured)	Annual mean > 40 micrograms per metre cubed	0	-
$PM_{2.5}$ particulate matter (Hourly measured)	Annual mean > 25 micrograms per metre cubed	0	-
Nitrogen dioxide	Hourly Mean > 200 micrograms per metre cubed	0	0
Nitrogen dioxide	**Annual Mean > 40 micrograms per metre cubed**	**0**	**-**

Annual Graph

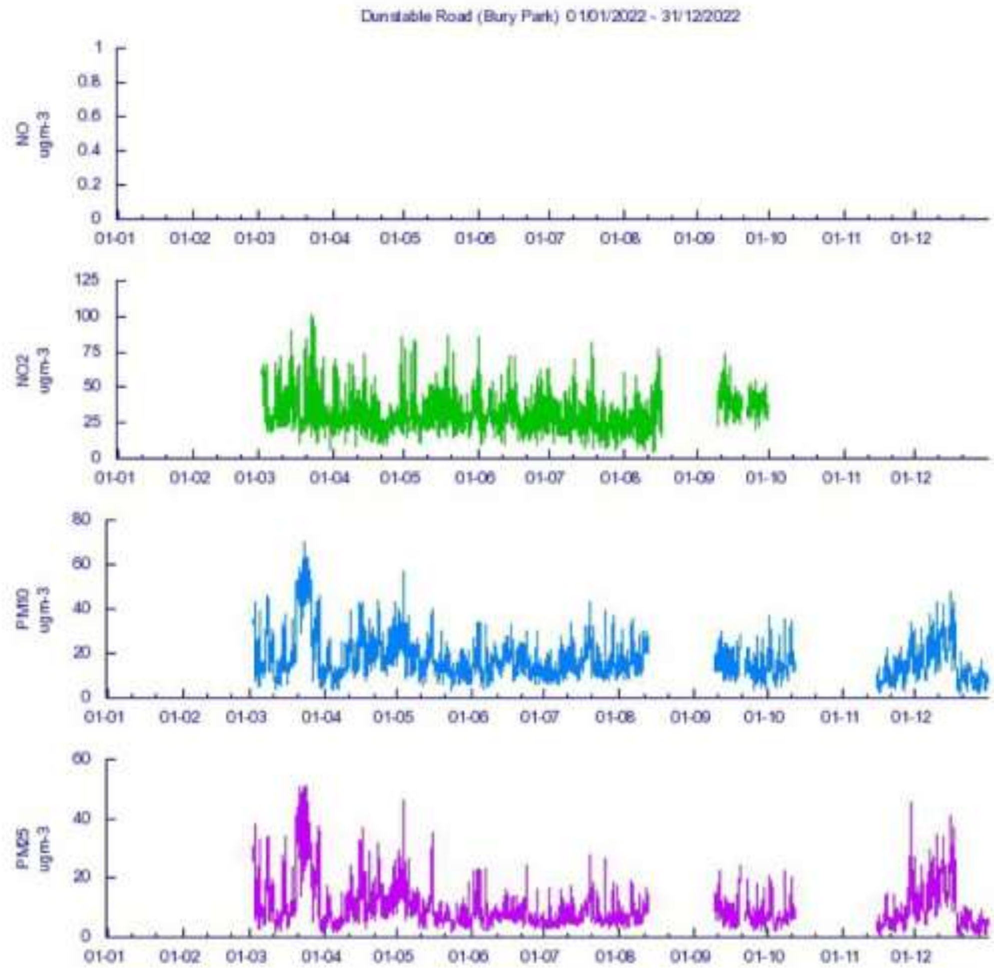

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Figure G.5 - 2022 Air Pollution Report – LN101: Beech Hill Community Primary School

Air Pollution Report

1st January to 31st December 2022

Air Quality England

Beech Hill (Site ID: scsbgx655)

These data have been fully ratified
Only relevant statistics for LAQM are presented in the table. Cells with - indicate no data available or calculated.

Pollutant	NO µg/m³	NO_2 µg/m³	PM_{10} µg/m³	PM_{25} µg/m³
Number Days Low	-	265	264	264
Number Days Moderate	-	0	0	0
Number Days High	-	0	0	0
Number Days Very High	-	0	0	0
Max Daily Mean	-	56	44	29
Annual Max	-	91	62	52
Annual Mean	-	19	14	7
98th Percentile of daily mean	-	-	35	-
90th Percentile of daily mean	-	-	21	-
99.8th Percentile of hourly mean	-	69	-	-
98th Percentile of hourly mean	-	55	36	27
95th Percentile of hourly mean	-	46	29	21
50th Percentile of hourly mean	-	16	12	5
% Annual data capture	**-**	**72.47**	**72.47**	**72.47**

Instruments:
PM_{10}: PRAXIS URBAN
PM_{25}: PRAXIS URBAN

All gaseous pollutant mass units are at 20°C and 1013mb. Particulate matter concentrations are reported at ambient temperature and pressure. NO_X mass units are NO_X as NO_2 µg m-3

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Pollutant	Air Quality Standards regulations 2010	Exceedances	Days
PM_{10} particulate matter (Hourly measured)	daily mean > 50 microgrammes per metre cubed	0	0
PM_{10} particulate matter (Hourly measured)	Annual mean > 40 microgrammes per metre cubed	0	-
$PM_{2.5}$ particulate matter (Hourly measured)	Annual mean > 25 microgrammes per metre cubed	0	-
Nitrogen dioxide	Hourly Mean > 200 microgrammes per metre cubed	0	0
Nitrogen dioxide	**Annual Mean > 40 microgrammes per metre cubed**	**0**	**-**

Annual Graph

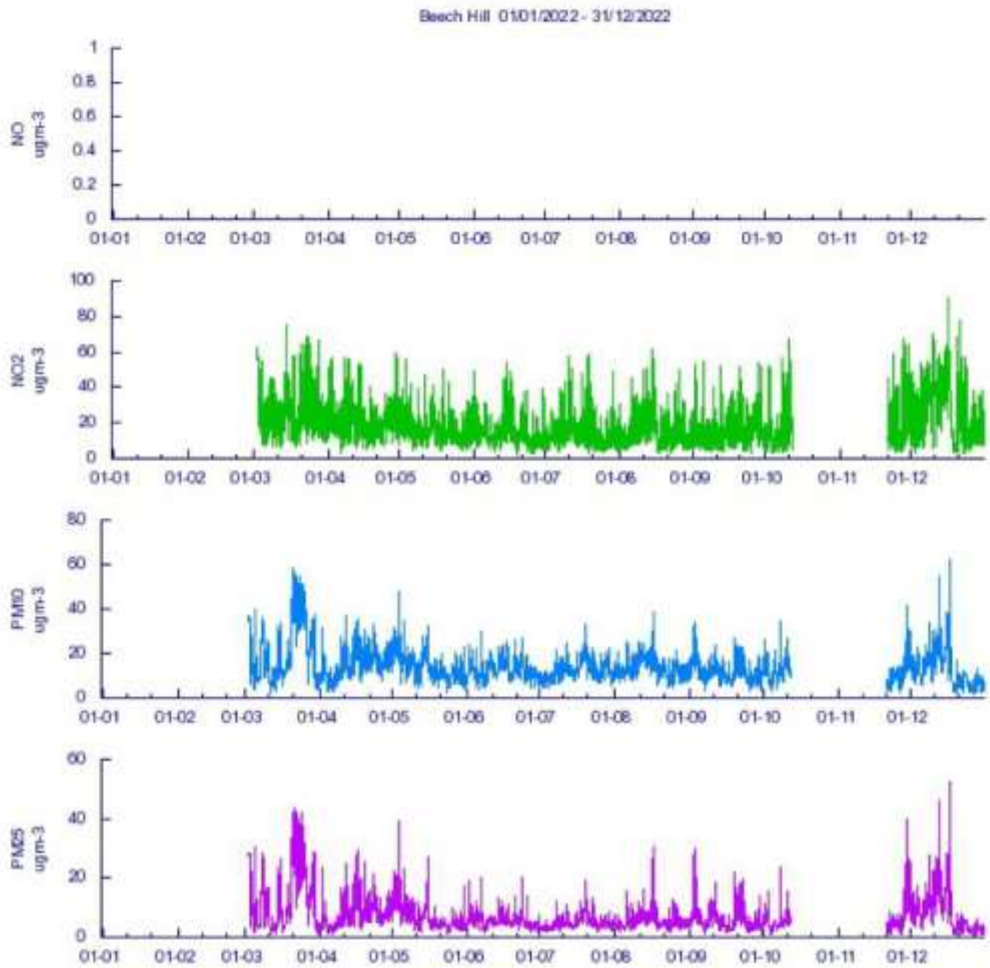

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Figure G.6 - 2022 Air Pollution Report – LN103: L&D Hospital, Lewsey Road

Air Pollution Report

1st January to 31st December 2022

Air Quality England

Luton & Dunstable Hospital (Lewsey Road) (Site ID: scsbgx654)

These data have been fully ratified
Only relevant statistics for LAQM are presented in the table. Cells with - indicate no data available or calculated.

Pollutant	NO µg/m³	NO_2 µg/m³	PM_{10} µg/m³	PM_{25} µg/m³
Number Days Low	-	331	331	318
Number Days Moderate	-	0	0	13
Number Days High	-	0	0	0
Number Days Very High	-	0	0	0
Max Daily Mean	-	69	49	53
Annual Max	-	105	66	78
Annual Mean	-	45	15	11
98th Percentile of daily mean	-	-	41	-
90th Percentile of daily mean	-	-	25	-
99.8th Percentile of hourly mean	-	91	-	-
98th Percentile of hourly mean	-	80	43	45
95th Percentile of hourly mean	-	73	34	34
50th Percentile of hourly mean	-	43	13	8
% Annual data capture	**-**	**90.68**	**90.68**	**90.68**

Instruments:
PM_{10}: PRAXIS URBAN
PM_{25}: PRAXIS URBAN

All gaseous pollutant mass units are at 20°C and 1013mb. Particulate matter concentrations are reported at ambient temperature and pressure. NO_X mass units are NO_X as NO_2 µg m-3

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Pollutant	Air Quality Standards regulations 2010	Exceedances	Days
PM_{10} particulate matter (Hourly measured)	daily mean > 50 microgrammes per metre cubed	0	0
PM_{10} particulate matter (Hourly measured)	Annual mean > 40 microgrammes per metre cubed	0	-
$PM_{2.5}$ particulate matter (Hourly measured)	Annual mean > 25 microgrammes per metre cubed	0	-
Nitrogen dioxide	Hourly Mean > 200 microgrammes per metre cubed	0	0
Nitrogen dioxide	**Annual Mean > 40 microgrammes per metre cubed**	**1**	**-**

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Annual Graph

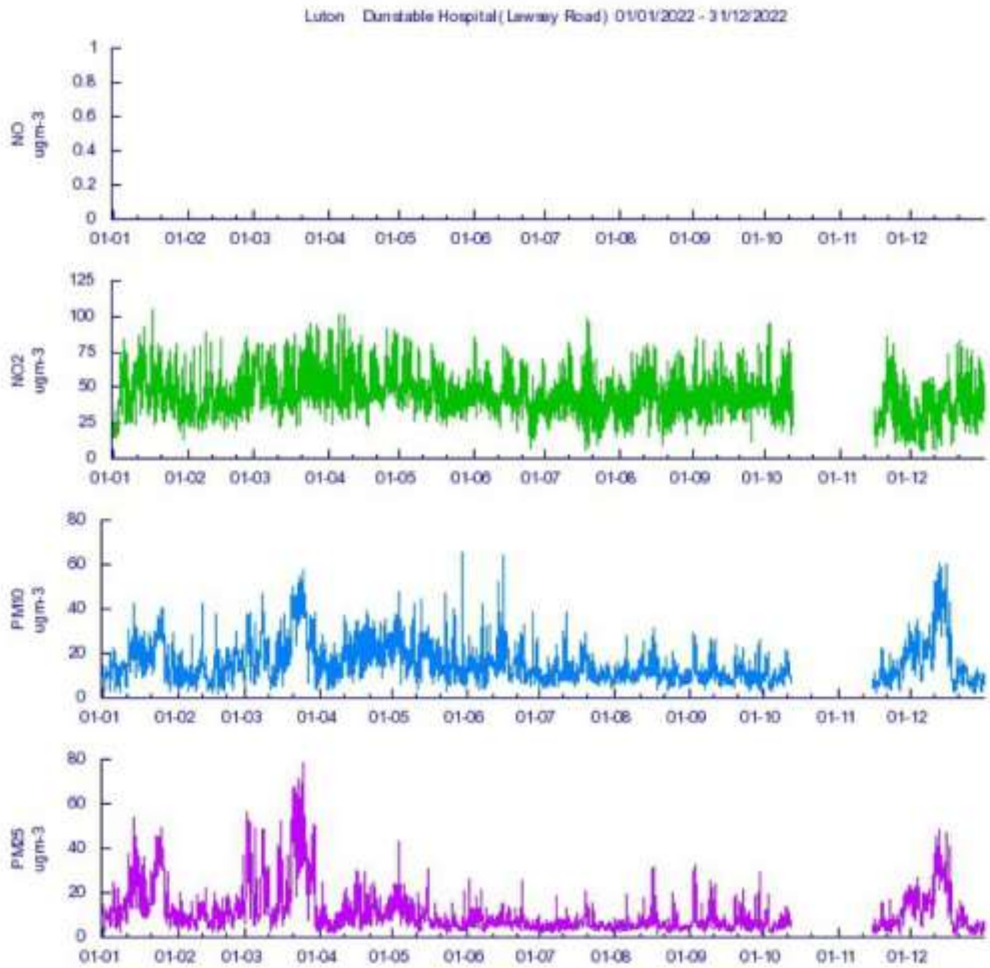

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Figure G.7 - 2022 Air Pollution Report – LN105: Peoples Park

Air Pollution Report

1st January to 31st December 2022

Air Quality England

People's Park (Site ID: scsbgx658)

These data have been fully ratified
Only relevant statistics for LAQM are presented in the table. Cells with - indicate no data available or calculated.

Pollutant	NO µg/m³	NO_2 µg/m³	PM_{10} µg/m³	PM_{25} µg/m³
Number Days Low	-	294	268	295
Number Days Moderate	-	0	0	0
Number Days High	-	0	0	0
Number Days Very High	-	0	0	0
Max Daily Mean	-	71	41	28
Annual Max	-	129	51	44
Annual Mean	-	23	12	6
98th Percentile of daily mean	-	-	31	-
90th Percentile of daily mean	-	-	17	-
99.8th Percentile of hourly mean	-	88	-	-
98th Percentile of hourly mean	-	67	33	25
95th Percentile of hourly mean	-	56	27	19
50th Percentile of hourly mean	-	18	10	4
% Annual data capture	**-**	**80.06**	**73.61**	**81.13**

Instruments:
PM_{10}: PRAXIS URBAN
PM_{25}: PRAXIS URBAN

All gaseous pollutant mass units are at 20°C and 1013mb. Particulate matter concentrations are reported at ambient temperature and pressure. NO_X mass units are NO_X as NO_2 µg m-3

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Pollutant	Air Quality Standards regulations 2010	Exceedances	Days
PM_{10} particulate matter (Hourly measured)	daily mean > 50 microgrammes per metre cubed	0	0
PM_{10} particulate matter (Hourly measured)	Annual mean > 40 microgrammes per metre cubed	0	-
$PM_{2.5}$ particulate matter (Hourly measured)	Annual mean > 25 microgrammes per metre cubed	0	-
Nitrogen dioxide	Hourly Mean > 200 microgrammes per metre cubed	0	0
Nitrogen dioxide	**Annual Mean > 40 microgrammes per metre cubed**	**0**	**-**

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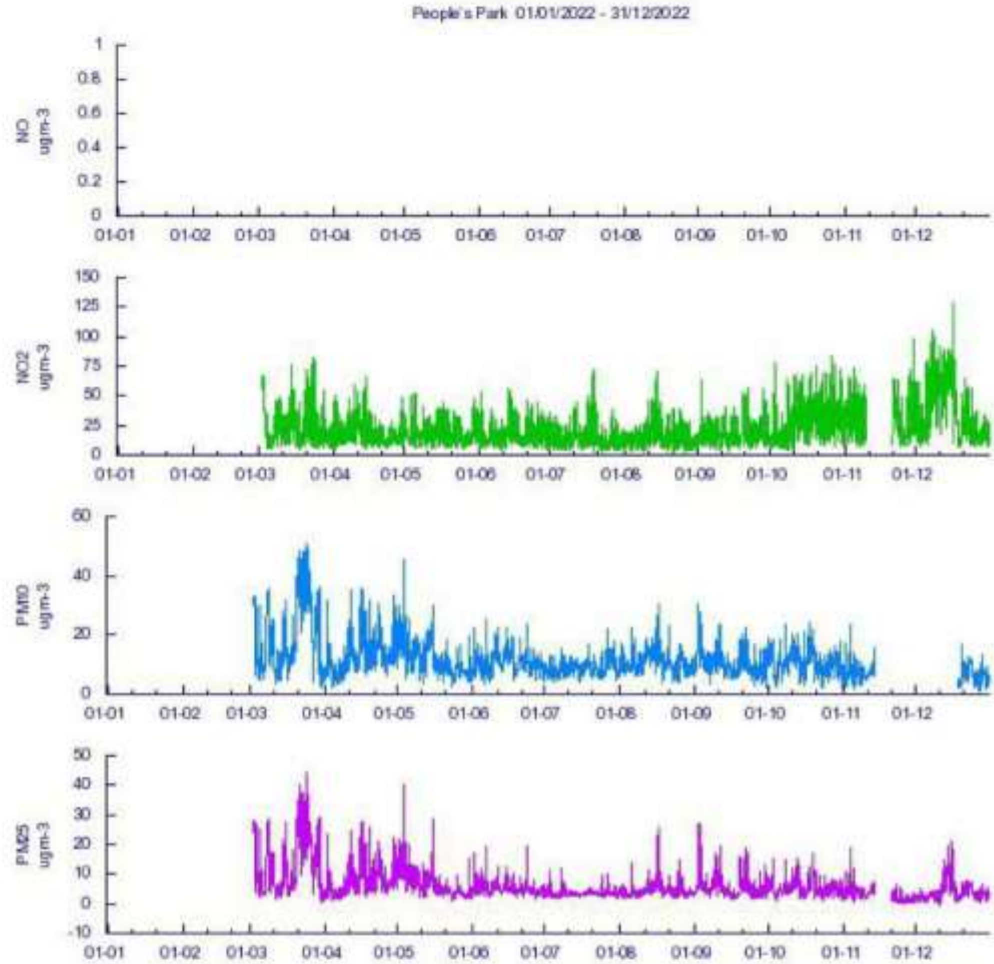
Annual Graph



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Time Variation Plots for Indicative Sensor-based Monitoring Sites

Nitrogen Dioxide (NO_2)

Figure G.8 – NO_2 data trends at LN97 – Chaul End Road during 2022

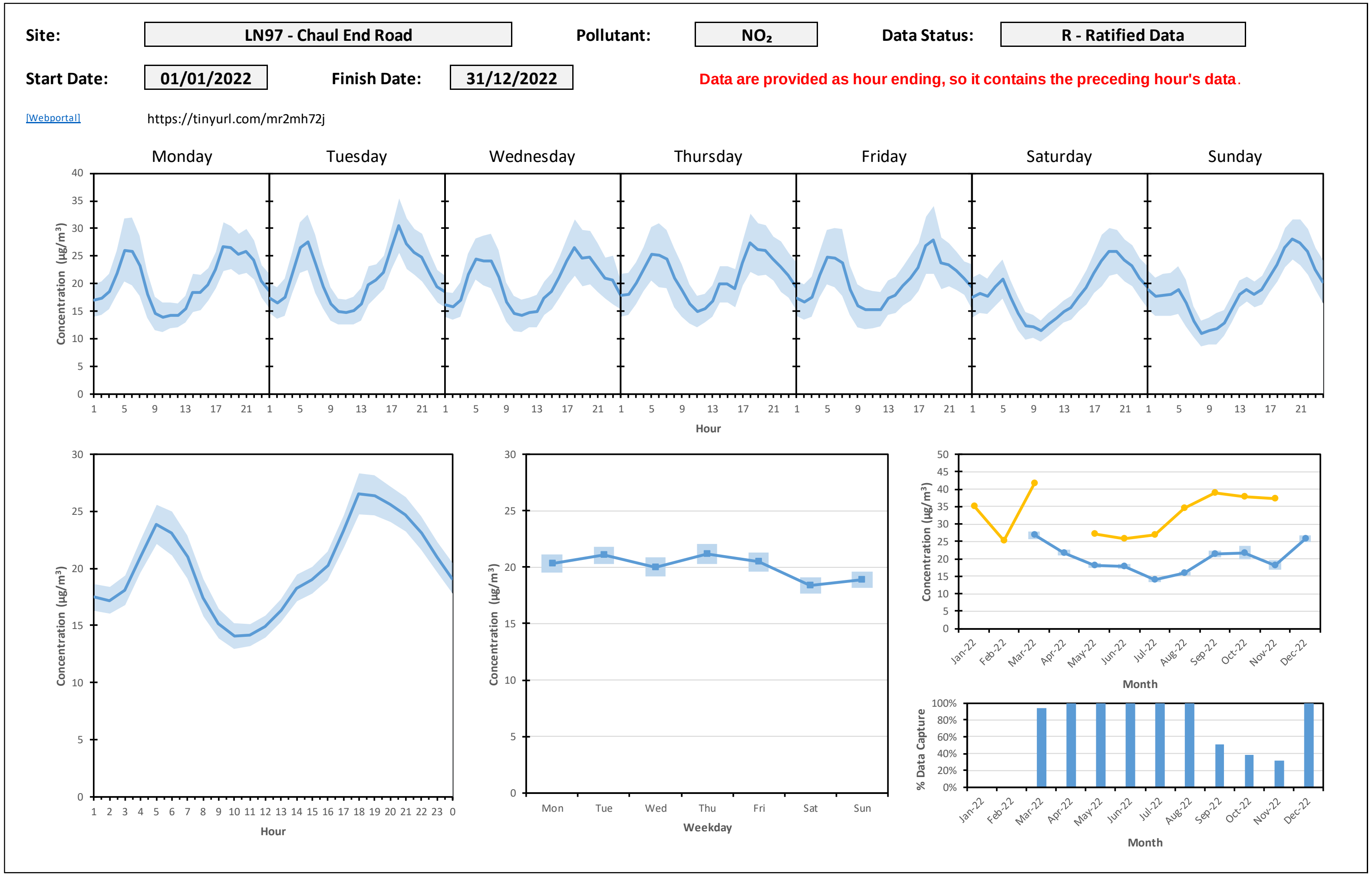


Figure G.9 – NO_2 data trends at LN99 – Dunstable Road – Bury Park 2 during 2022

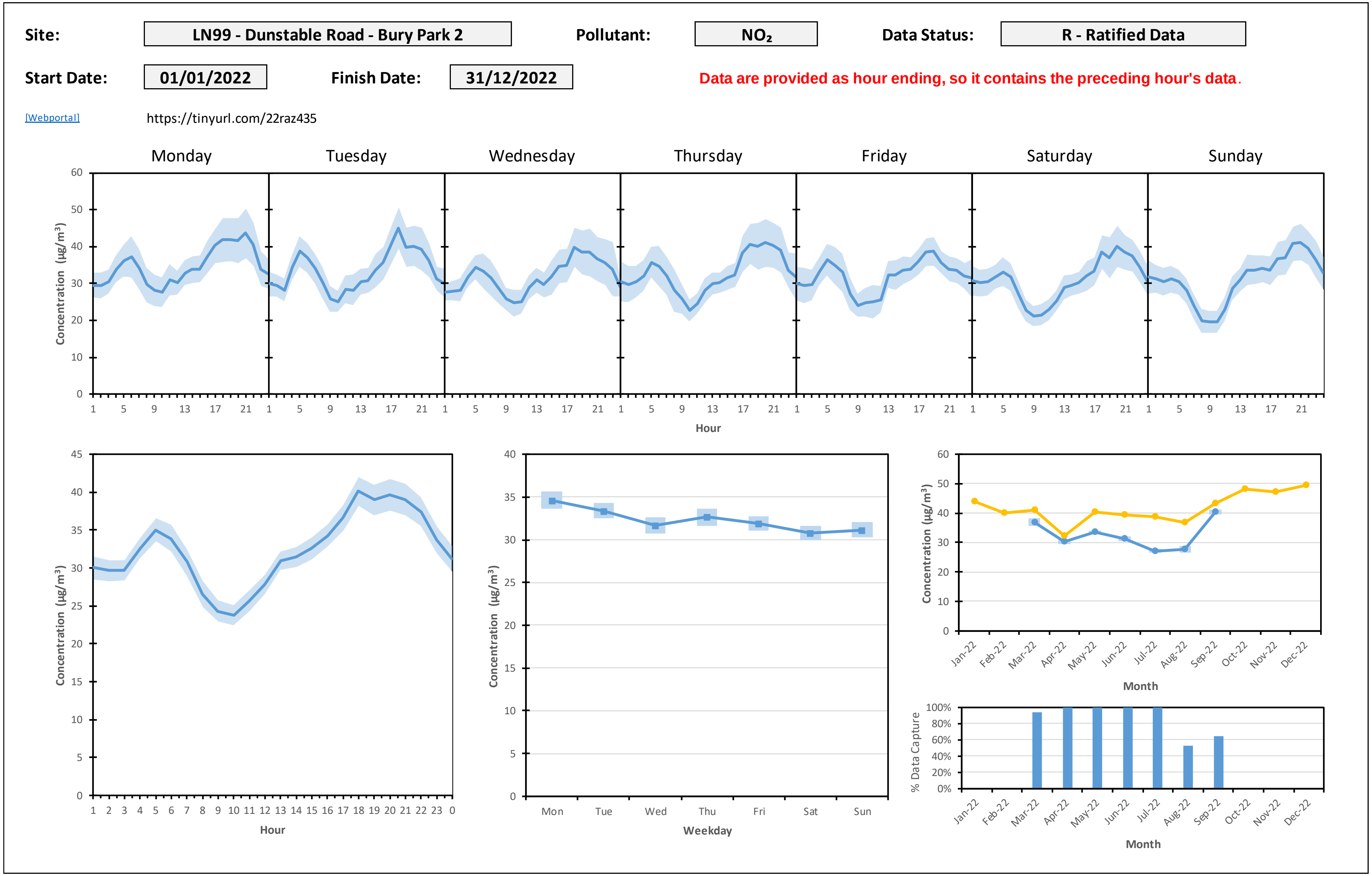


Figure G.10 – NO_2 data trends at LN101 – Beech Hill Community Primary School during 2022

Site: LN101 - Beech Hill Community Primary School **Pollutant:** NO_2 **Data Status:** R - Ratified Data

Start Date: 01/01/2022 **Finish Date:** 31/12/2022 Data are provided as hour ending, so it contains the preceding hour's data.

[Webportal] https://tinyurl.com/2p8c5jcr

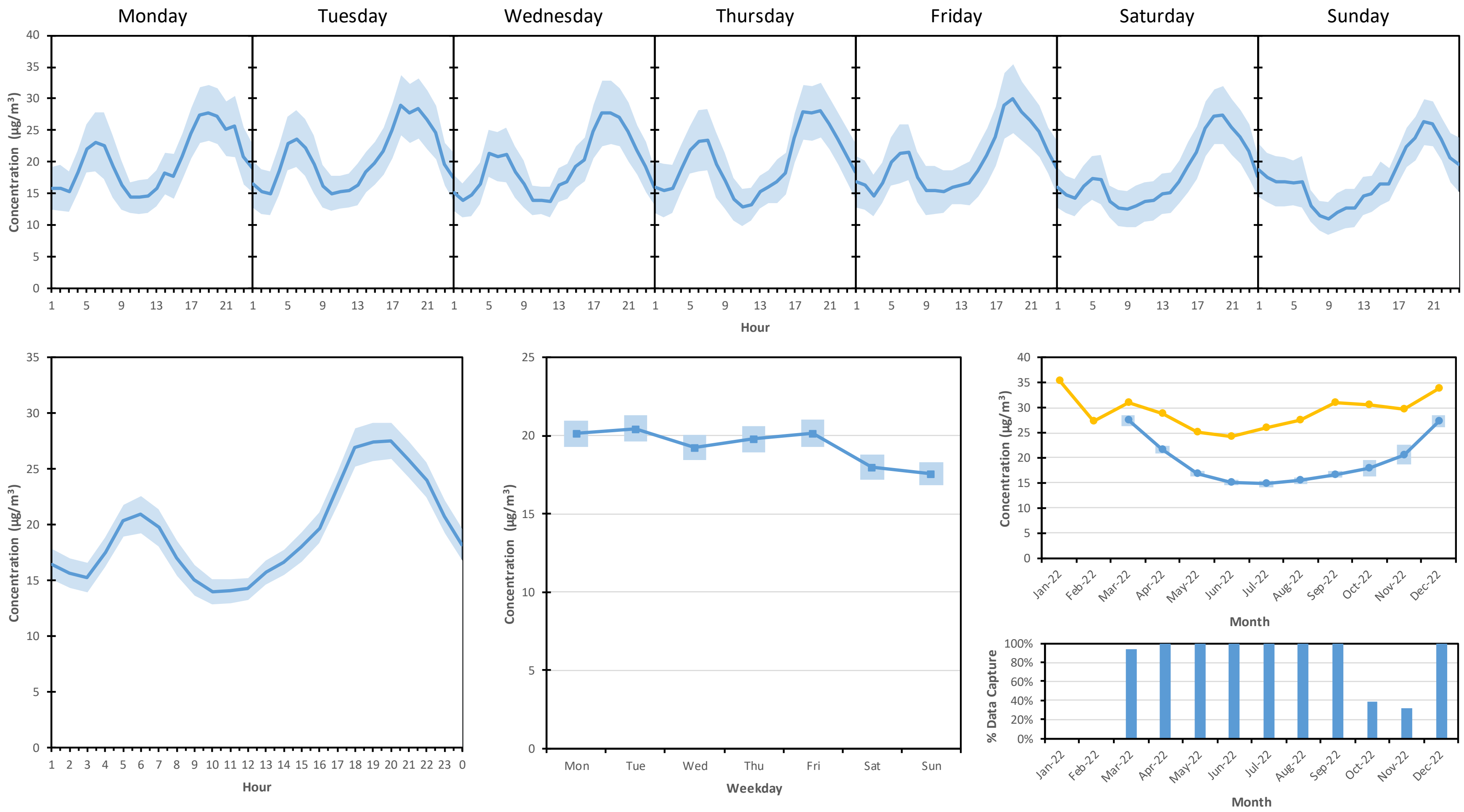


Figure G.11 – NO_2 data trends at LN103 – L&D Hospital, Lewsey Road during 2022

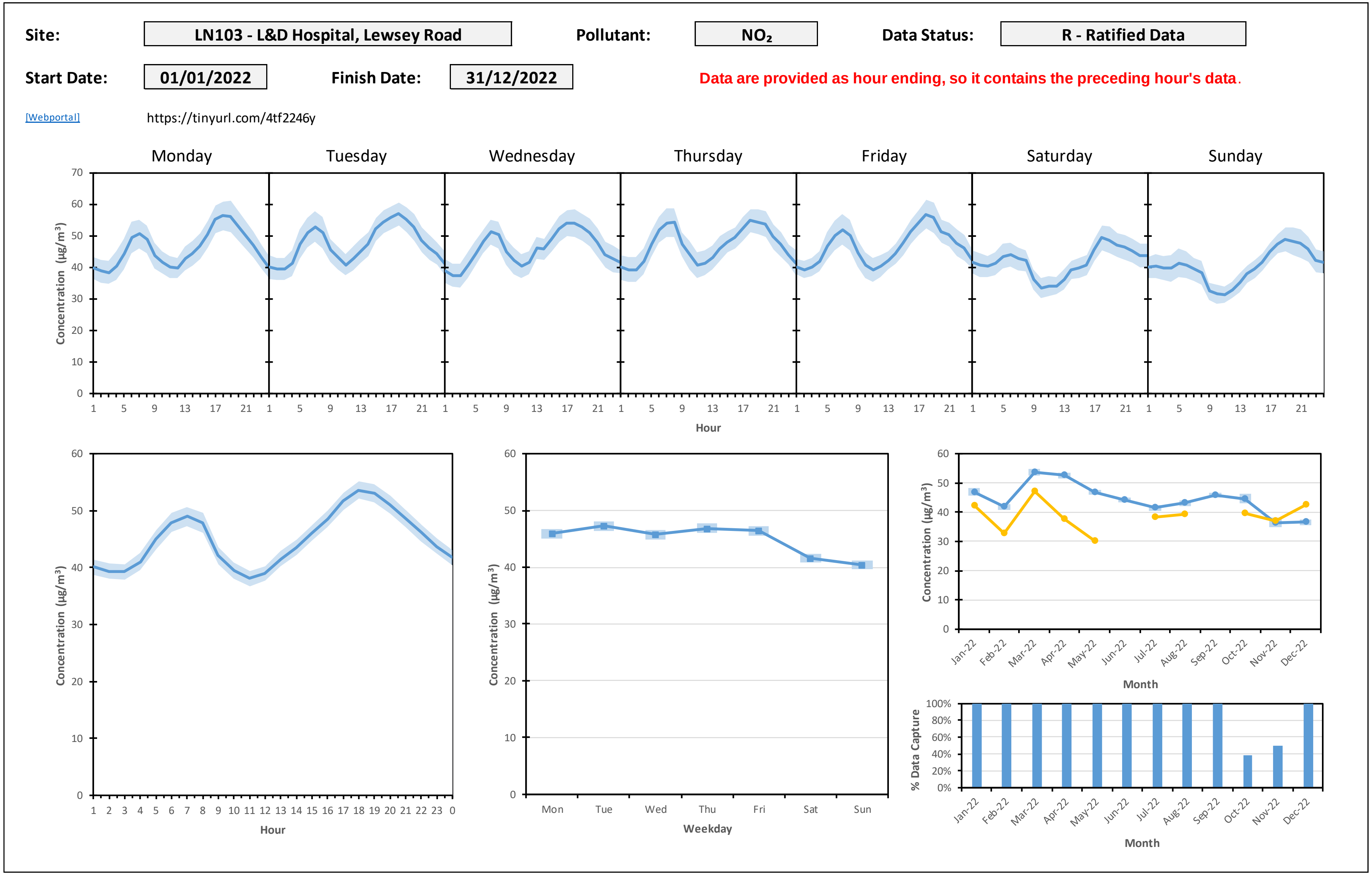
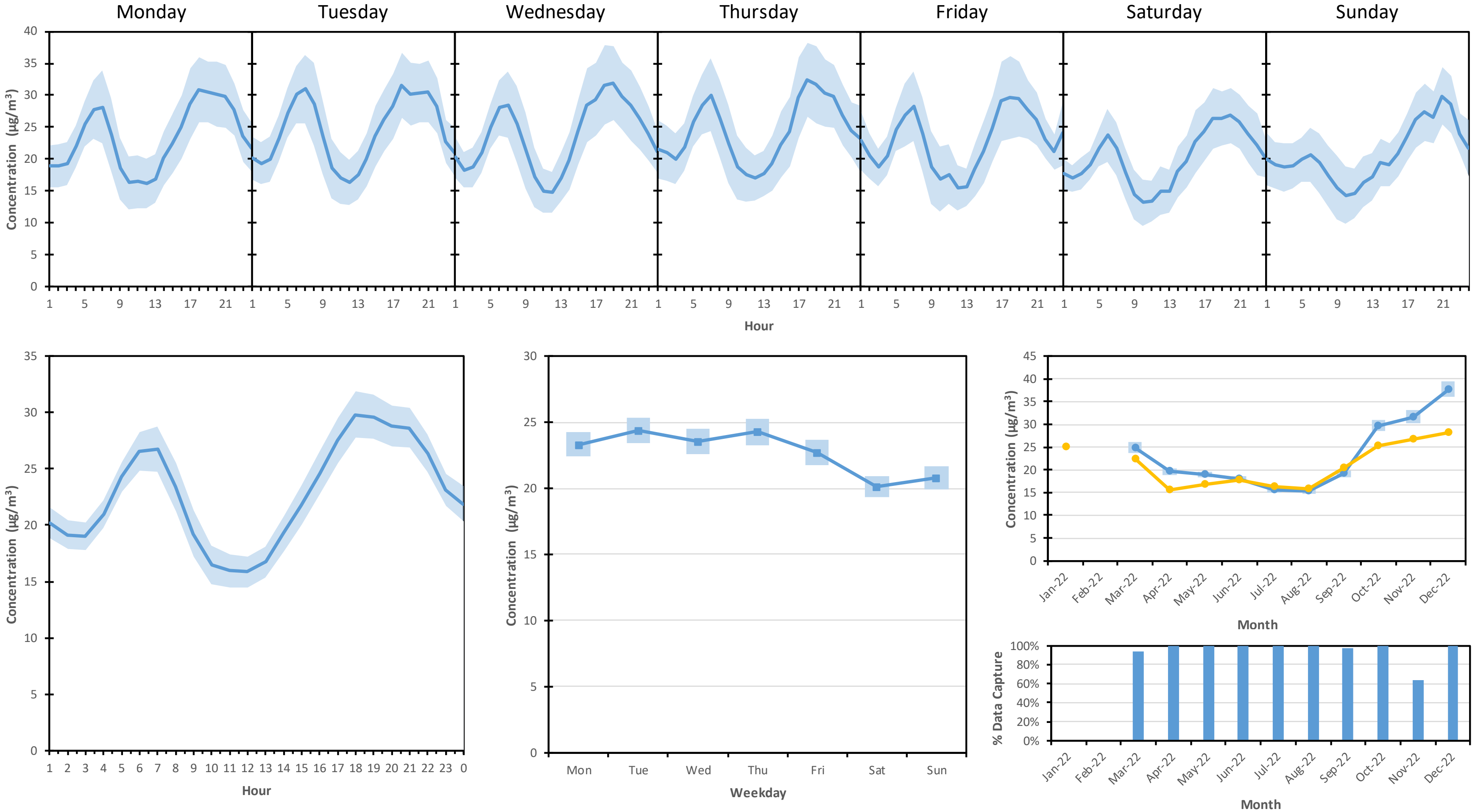


Figure G.12 – NO_2 data trends at LN105 – Peoples Park during 2022

Site:	LN105 - Peoples Park	Pollutant:	NO_2	Data Status:	R - Ratified Data
Start Date:	01/01/2022	Finish Date:	31/12/2022		

Data are provided as hour ending, so it contains the preceding hour's data.

[Webportal] https://tinyurl.com/2p869b79



Particulate Matter (PM_{10})

Figure G.13 – PM_{10} data trends at LN97 – Chaul End Road during 2022

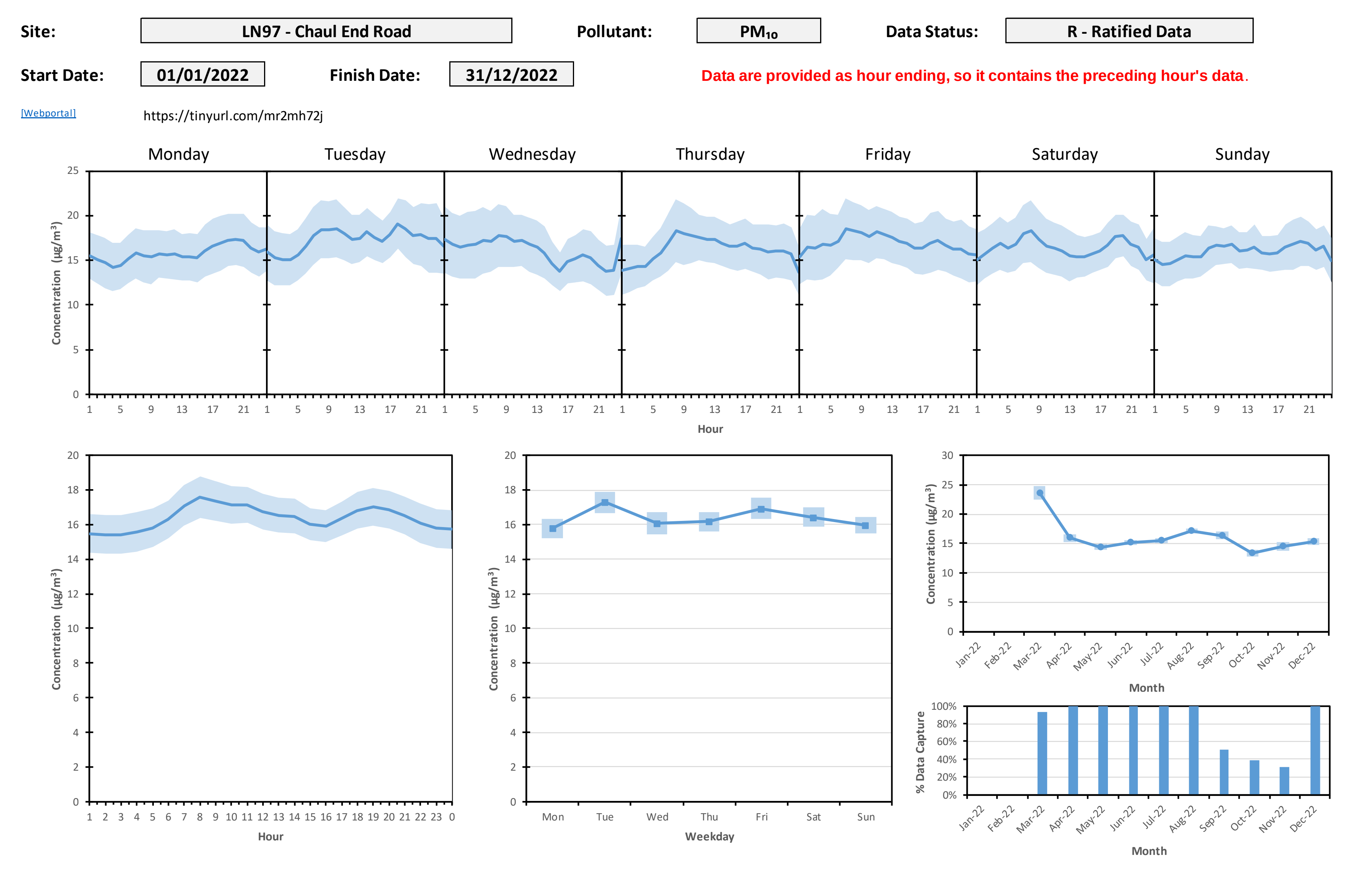


Figure G.14 – PM_{10} data trends at LN99 – Dunstable Road – Bury Park 2 during 2022

Site: LN99 - Dunstable Road - Bury Park 2 **Pollutant:** PM_{10} **Data Status:** R - Ratified Data

Start Date: 01/01/2022 **Finish Date:** 31/12/2022 **Data are provided as hour ending, so it contains the preceding hour's data.**

[Webportal] https://tinyurl.com/22raz435

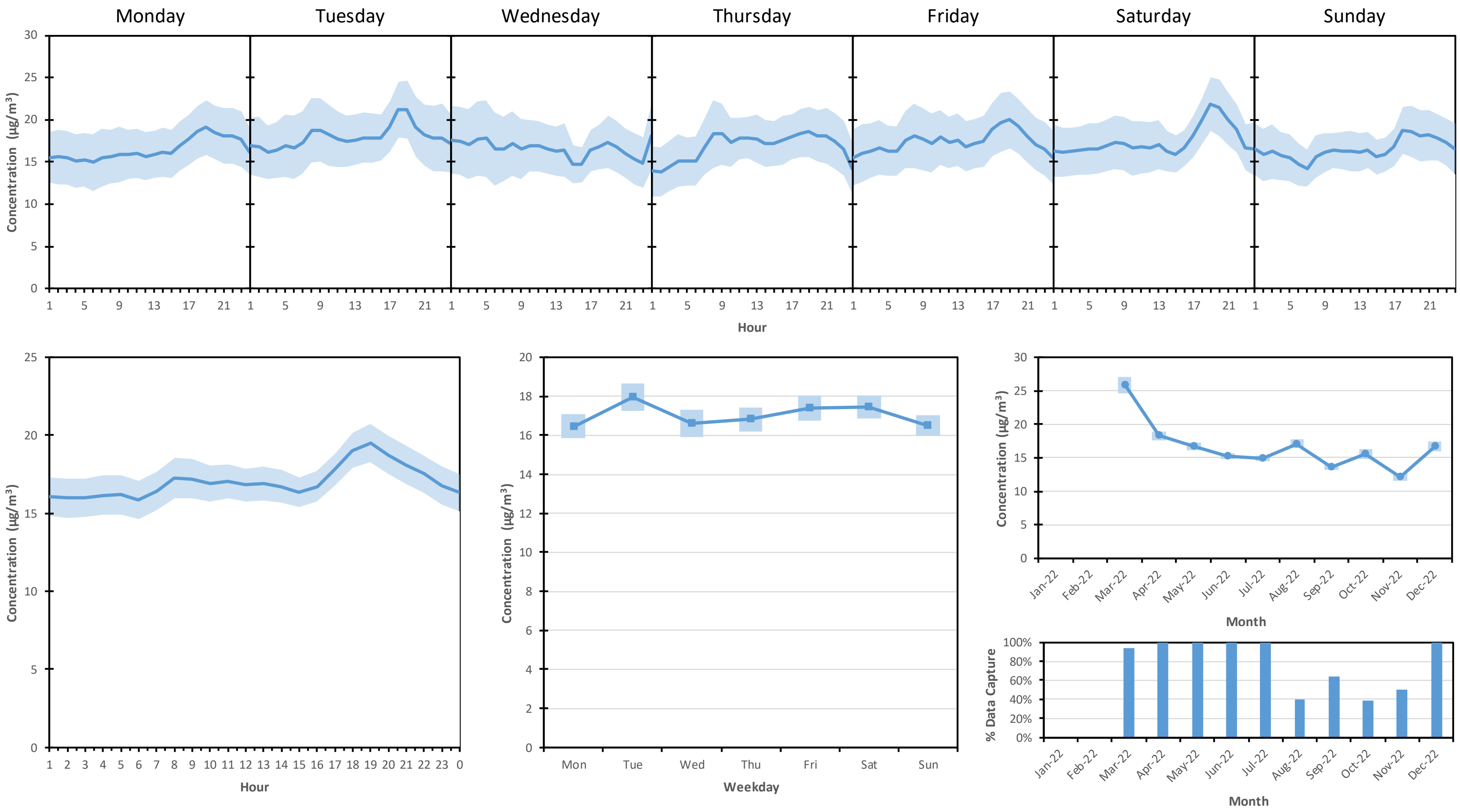


Figure G.15 – PM_{10} data trends at LN101 – Beech Hill Community Primary School during 2022

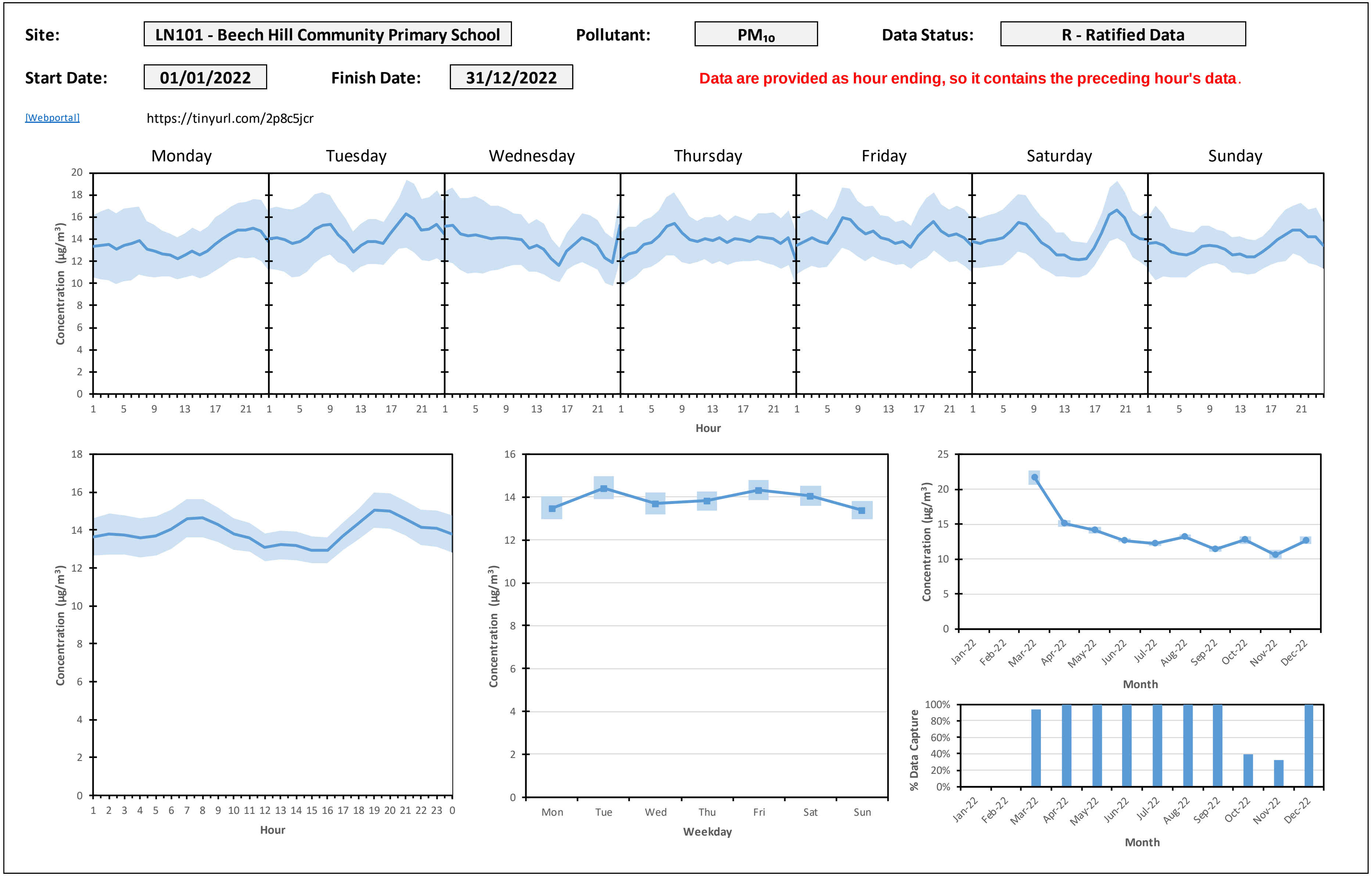
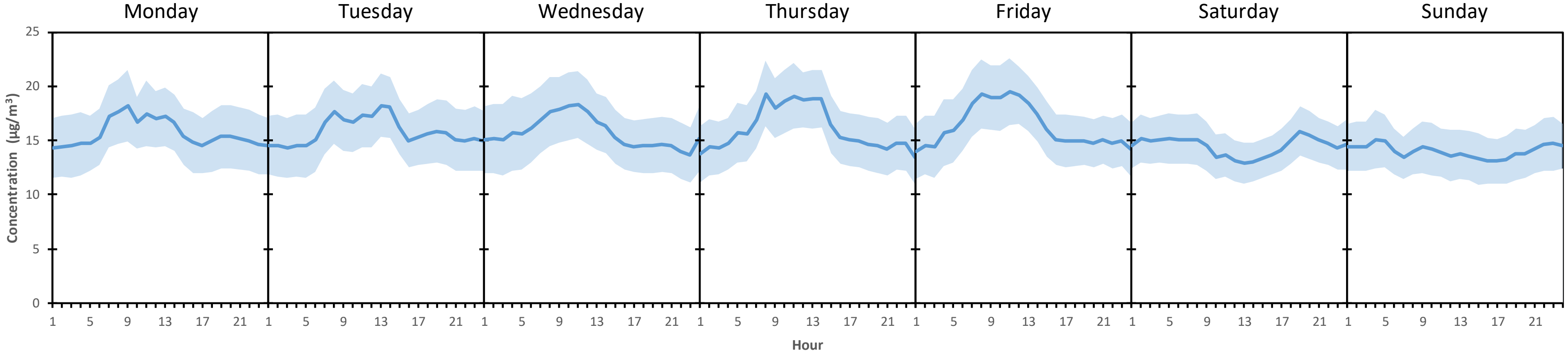


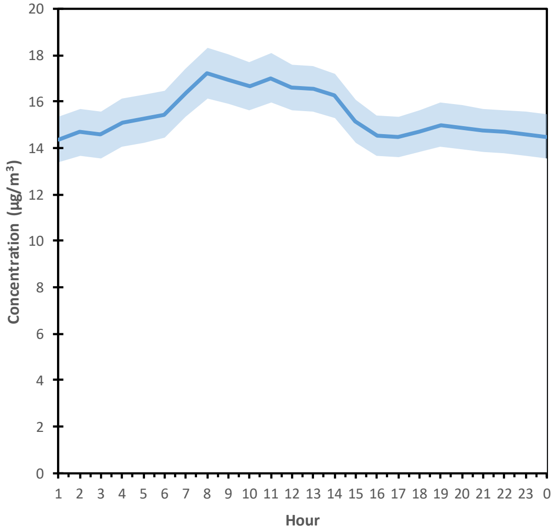
Figure G.16 – PM_{10} data trends at LN103 – L&D Hospital, Lewsey Road during 2022

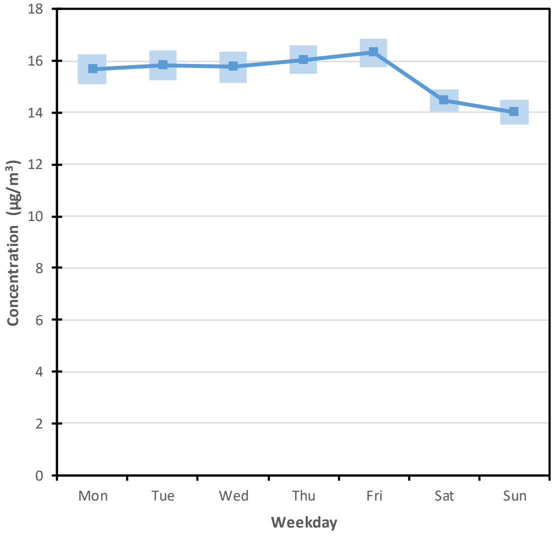
Site:	**LN103 - L&D Hospital, Lewsey Road**	**Pollutant:**	**PM_{10}**	**Data Status:**	**R - Ratified Data**
Start Date:	**01/01/2022**	**Finish Date:**	**31/12/2022**		

Data are provided as hour ending, so it contains the preceding hour's data.

[Webportal] https://tinyurl.com/4tf2246y







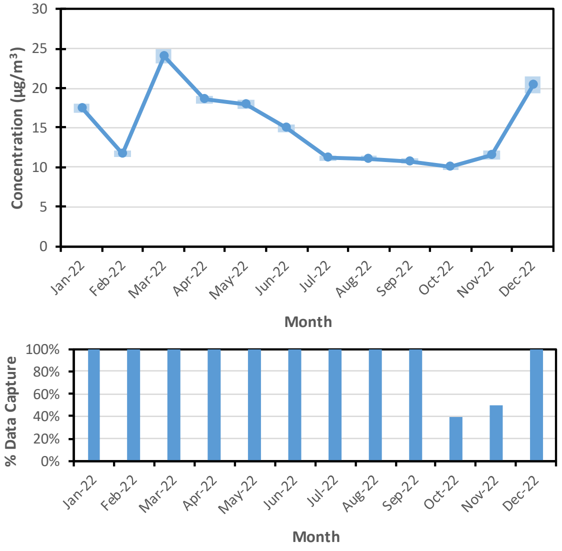
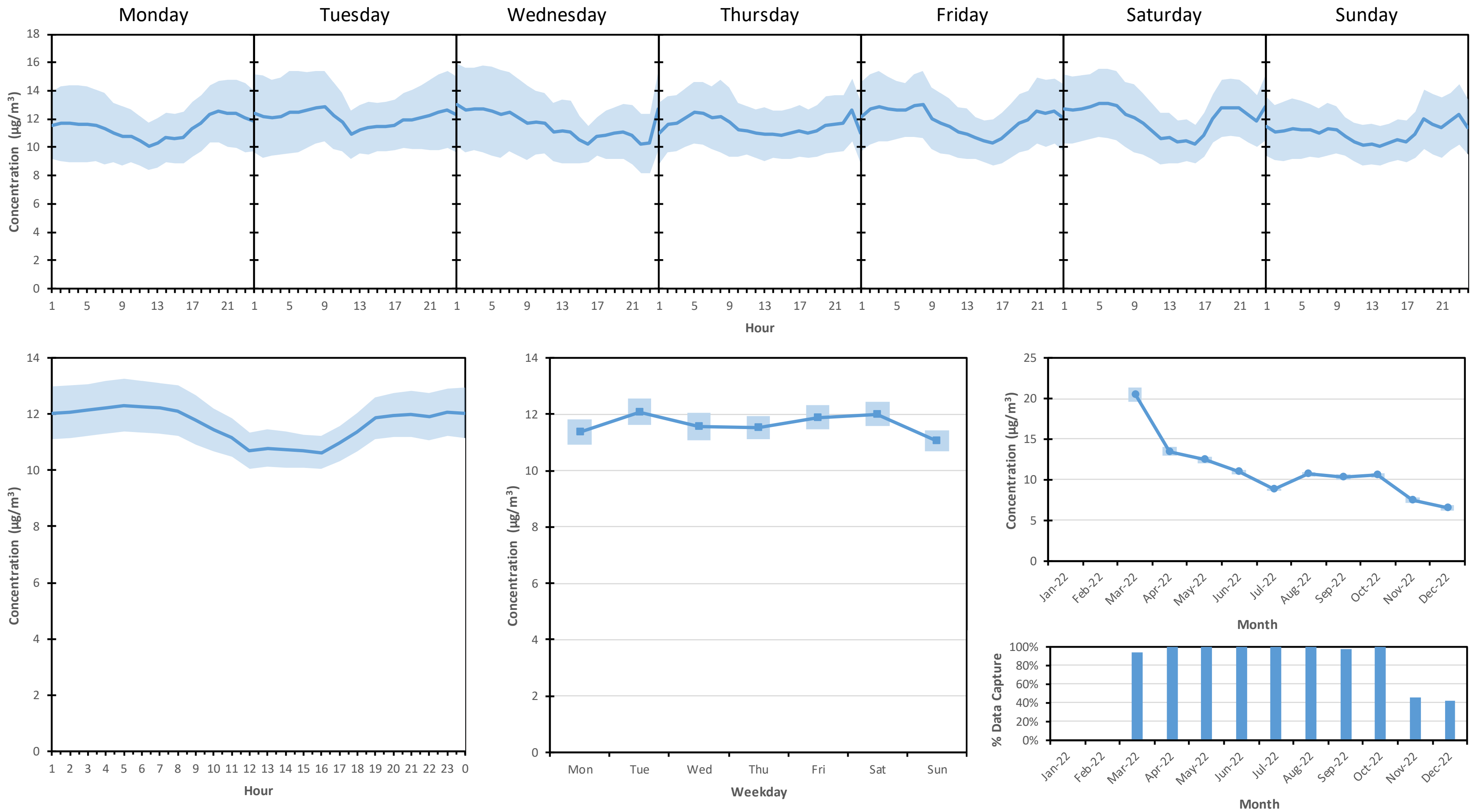


Figure G.17 – PM_{10} data trends at LN105 – Peoples Park during 2022

Site: LN105 - Peoples Park **Pollutant:** PM_{10} **Data Status:** R - Ratified Data

Start Date: 01/01/2022 **Finish Date:** 31/12/2022 **Data are provided as hour ending, so it contains the preceding hour's data.**

[Webportal] https://tinyurl.com/2p869b79



Particulate Matter ($PM_{2.5}$)

Figure G.18 – $PM_{2.5}$ data trends at LN97 – Chaul End Road during 2022

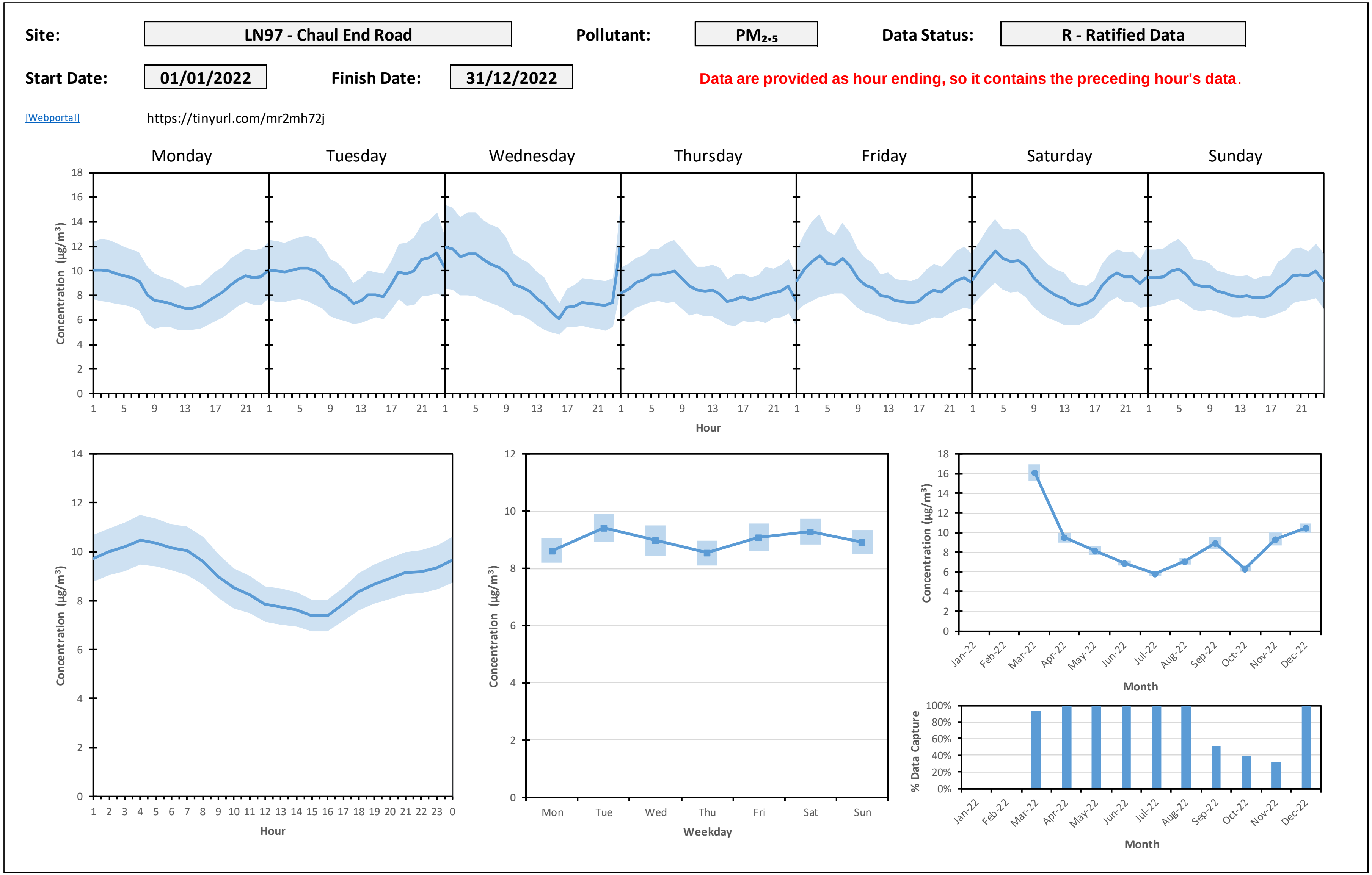


Figure G.19 – $PM_{2.5}$ data trends at LN99 – Dunstable Road – Bury Park 2 during 2022

Site: LN99 - Dunstable Road - Bury Park 2 **Pollutant:** $PM_{2.5}$ **Data Status:** R - Ratified Data

Start Date: 01/01/2022 **Finish Date:** 31/12/2022 **Data are provided as hour ending, so it contains the preceding hour's data.**

[Webportal] https://tinyurl.com/22raz435

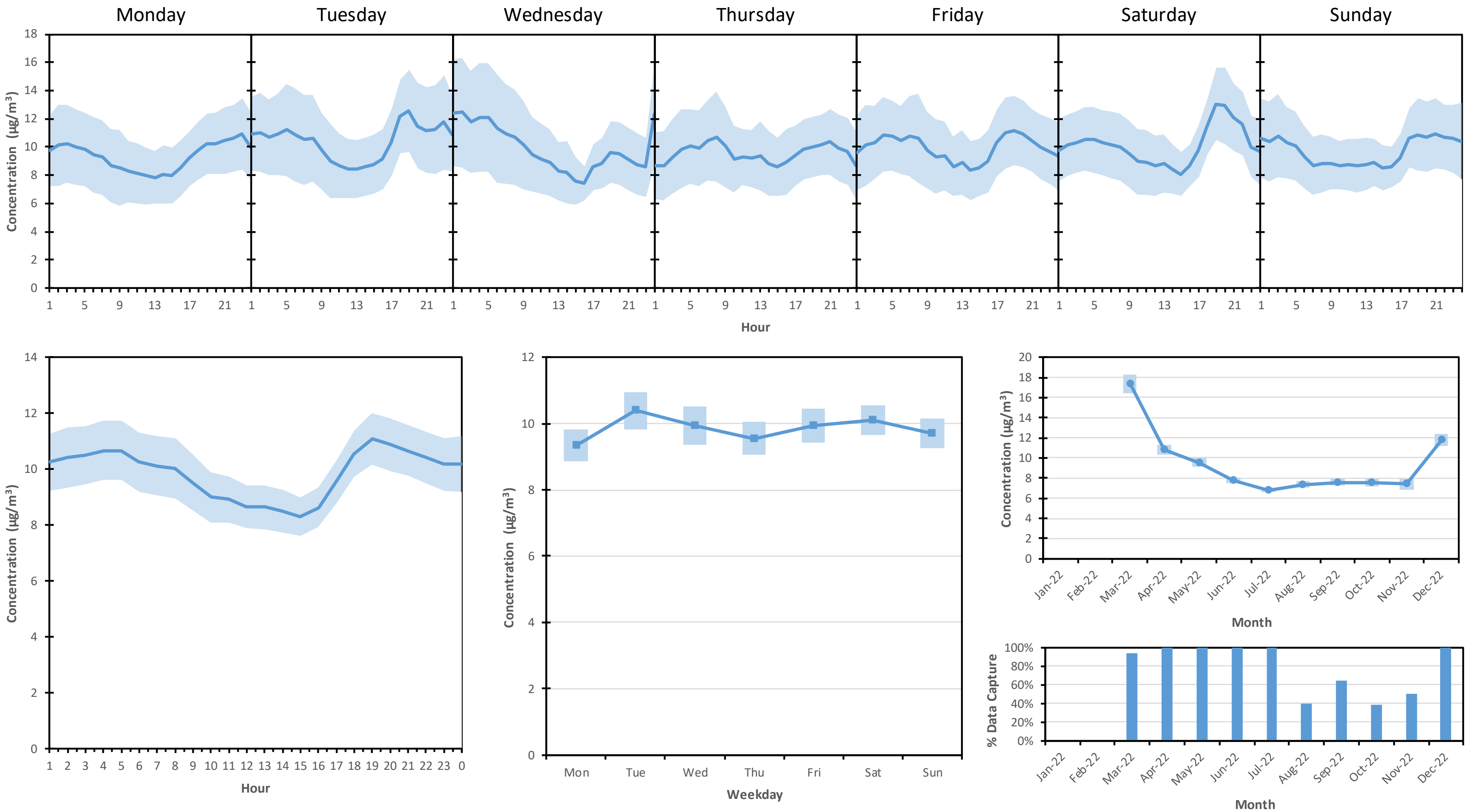


Figure G.20 – $PM_{2.5}$ data trends at LN101 – Beech Hill Community Primary School during 2022

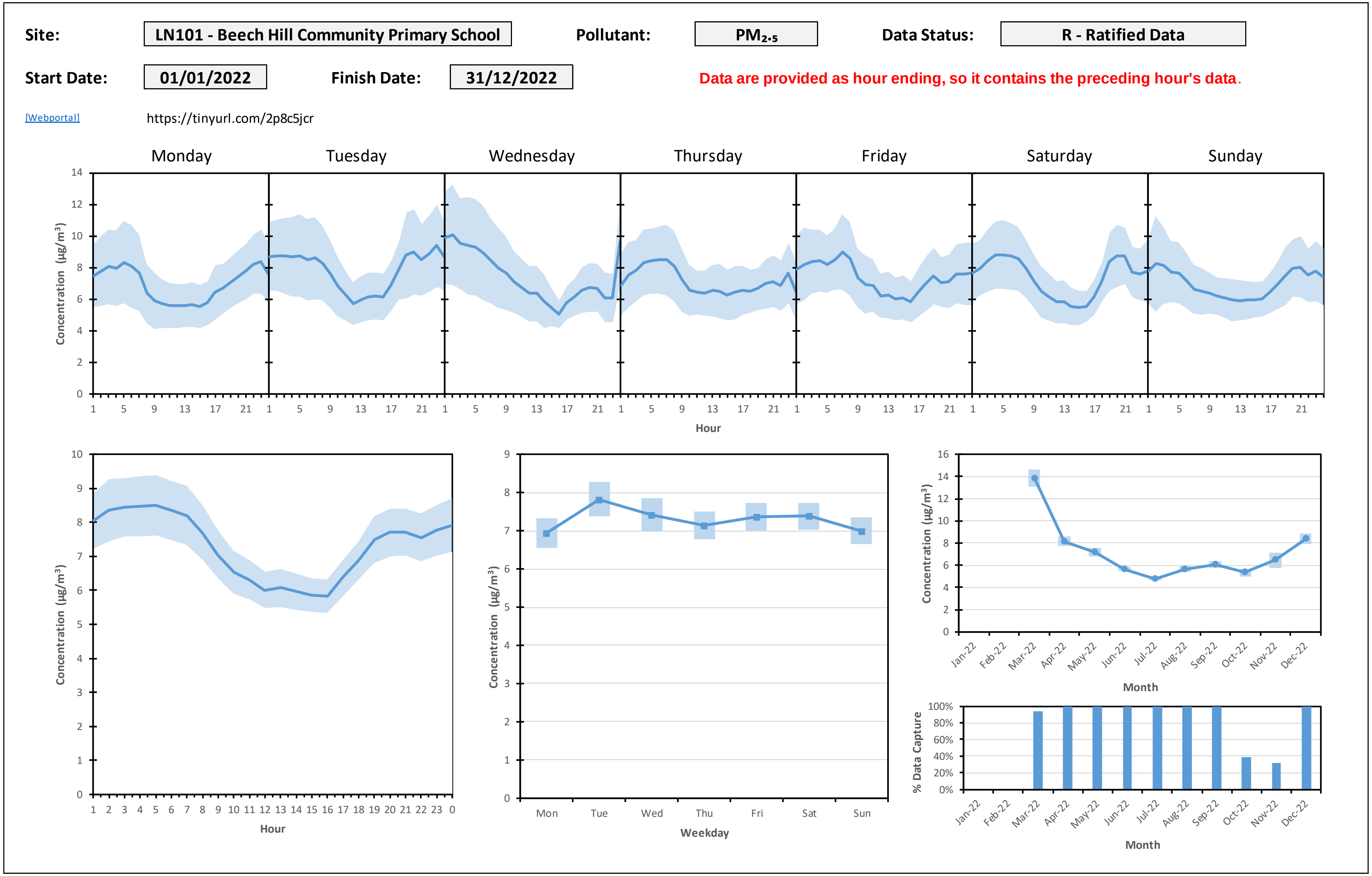


Figure G.21 – $PM_{2.5}$ data trends at LN103 – L&D Hospital, Lewsey Road during 2022

Site:	LN103 - L&D Hospital, Lewsey Road	Pollutant:	$PM_{2.5}$	Data Status:	R - Ratified Data
Start Date:	01/01/2022	Finish Date:	31/12/2022		

Data are provided as hour ending, so it contains the preceding hour's data.

[Webportal] https://tinyurl.com/4tf2246y

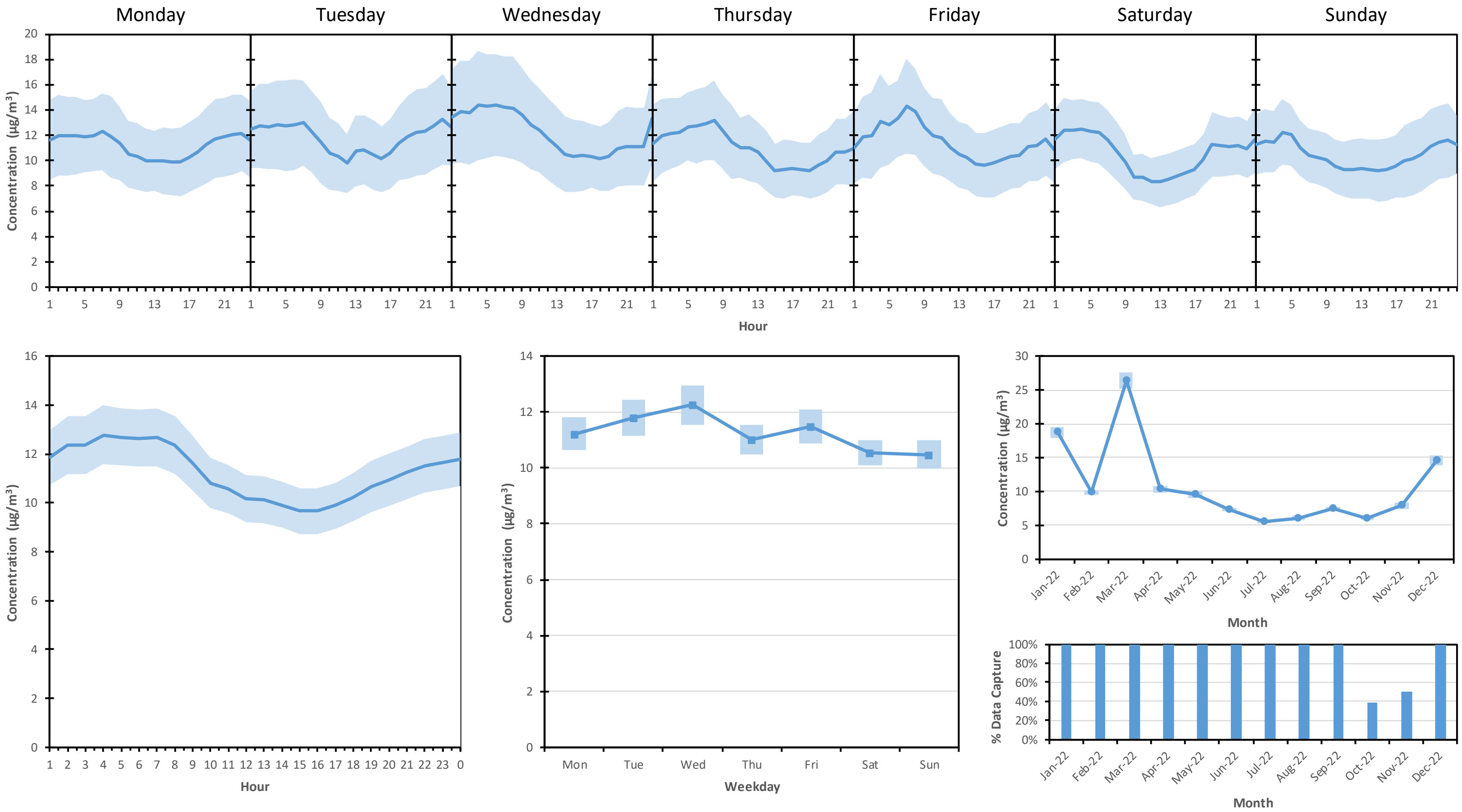
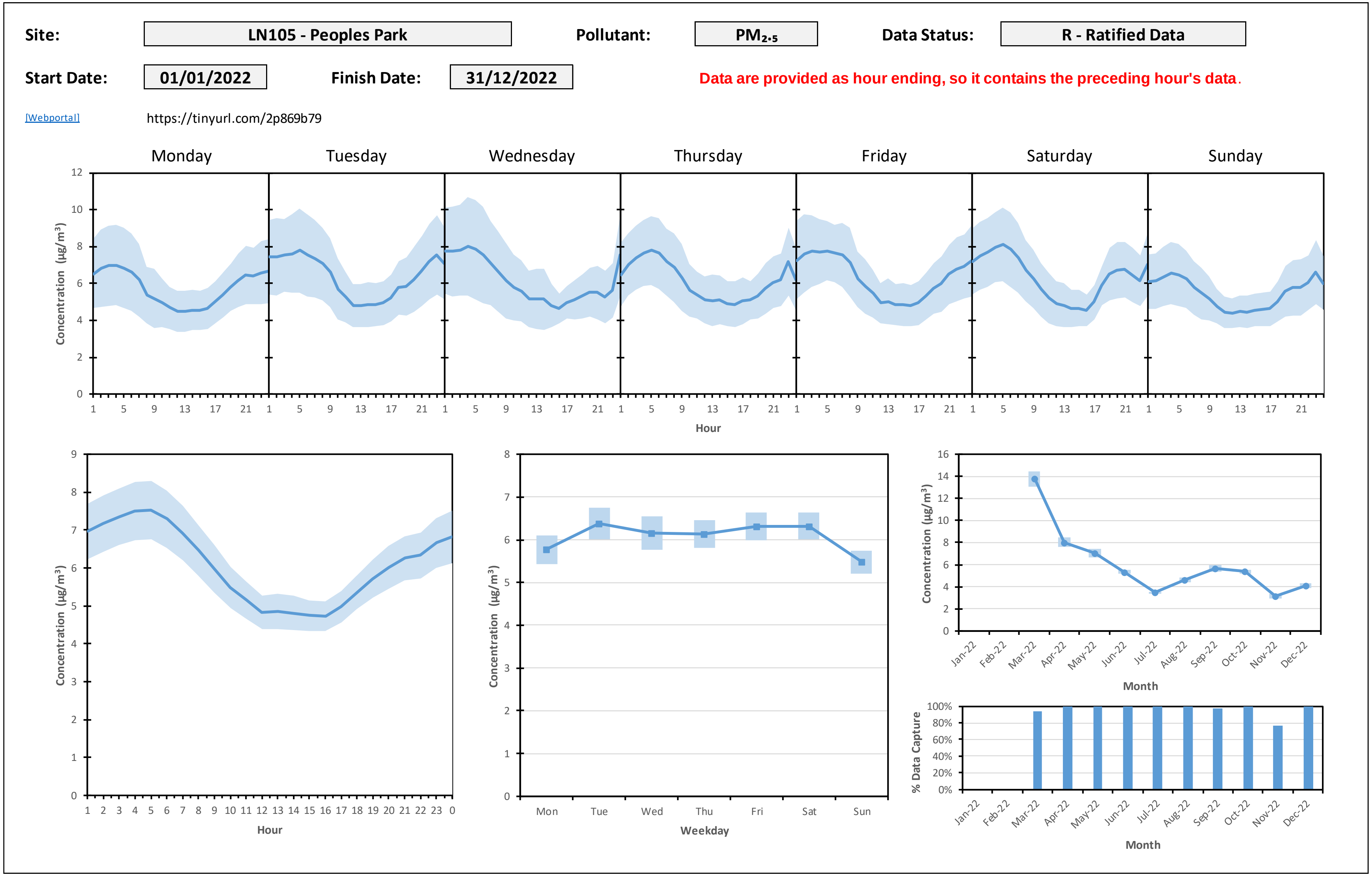


Figure G.22 – $PM_{2.5}$ data trends at LN105 – Peoples Park during 2022



Appendix H: Luton Air Quality Study – Traffic Data Technical Note (AECOM, May 2022)

AECOM

Luton Air Quality Study – Traffic Data Technical Note

May 2022

Delivering a better world

Quality information

Prepared by	Checked by	Verified by	Approved by
Emily Bulleid	Chris Wood	Siamak Khorgami	Siamak Khorgami
Senior Consultant	Principal Consultant	Lead Verifier	Regional Director

Revision History

Revision	Revision date	Details	Authorized	Name	Position
v.1	23 May 2022	Draft for comment	Siamak Khorgami	Siamak Khorgami	Regional Director

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Table of Contents

Figures

Tables

1 Introduction

1.1 Technical Note Purpose

1.1.1 Luton Borough Council (LBC) have commissioned AECOM to undertake air quality analysis around their Air Quality Management Area (AQMA) located in central Luton, shown in Figure 1. To understand the air quality situation traffic flow information was required from a transport model. Following liaison between LBC and AECOM's Transport Planning and Air Quality teams, the strategic Central Bedfordshire and Luton Transport Model (CBLTM) was chosen to provide the traffic flow information.

1.1.2 This technical note outlines the caveats, limitations and methodology used for producing daily traffic flows to support the AECOM Air Quality team in their air quality modelling work for LBC.

1.1.3 CBLTM is a strategic model which has been developed to adhere with national guidance, notably Department for Transport's (DfT) Transport Analysis Guidance (TAG), which outlines best practice and reports up to date economic parameters for use in modelling. It is important to note CBLTM is a strategic model, however it is the most appropriate tool to use for the use of the air quality study given its recent updates across the Central Bedfordshire and Luton area (detailed below). LBC decided to utilise this model without any updates or revisions, due to the work which has been carried out to update the model between 2019 and 2021. The resulting 2018 Base Year model was thoroughly reviewed and approved by the DfT for its use to assess the impacts of the M1-A6 link across northern Luton. The model provided the evidence base to support the Full Business Case and subsequent ministerial approval for the M1-A6 scheme.

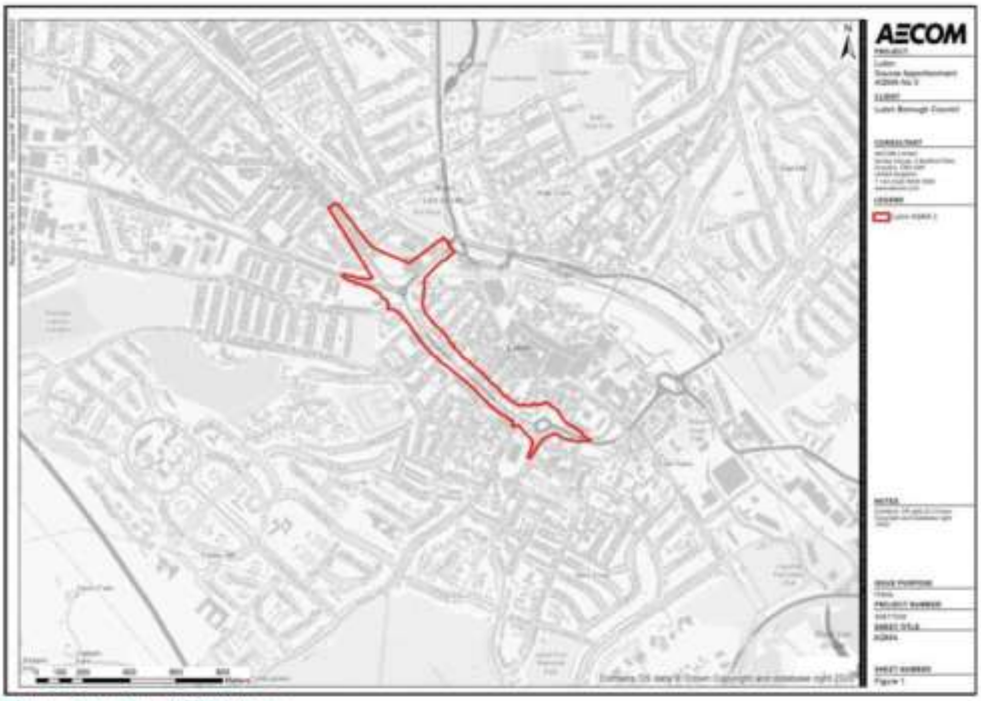

Figure 1: Luton AQMA Area

1.2 CBLTM Background

1.2.1 The original CBLTM model was commissioned in 2009 and included a SATURN highway assignment model, Voyager public transport model, and Emme demand model and was used for transport strategies, business cases, and development assessment applications. The 2009 model was updated to a Base Year of 2016 which also included the development of an enhanced public transport model (developed in Emme) in 2016/2017 and has been used to support the Central Bedfordshire Local Plan, for development assessment applications and to support the M1-A6 Link Strategic Outline Business Case.

1.2.2 As part of the evidence base to assess the M1-A6 (Full Business Case) scheme across the north of Luton, AECOM updated and enhanced the CBLTM model from the 2016 base year of the original model to a base year of 2018, on behalf of CBC. This latest update was undertaken between 2019 – 2021 in close liaison with DfT. CBLTM has been updated to represent a neutral weekday in November 2018 following analysis of available data[4]. The updated CBLTM suite includes:

- A SATURN-based Highway model;
- An EMME-based Public Transport model; and
- An EMME-based Variable Demand Model (VDM).

1.2.3 Version history of the CBLTM is shown in Table 1.

Table 1: CBLTM Version History

Version	Summary	Dates & Reports
CBLTM v3	Base Year updated from 2009 to 2016	Spring 2017; LMVR Summer 2017; Forecasting report
CBLTM v3.3	Update to correct bugs and revise Variable Demand Model Updates to RTF forecasts used for freight demand Model used for M1-A6 SOBC (Strategic Outline Business Case) & CBC Local Plan	Summer 2017; updated LMVR Autumn 2018; M1-A6 SOBC Forecasting & Economic Assessment Report Spring 2018; CBC Local Plan report
CBLTM v3.4	Updated CBLTIM model: • Update of Base Year model from 2016 to 2018 • Refinements to the highway matrix build process • New screenlines • Additional highway data collection • Network enhancement, centred around the area of the scheme and Luton, along with consistency checks across the fully modelled area • Economic parameters used: July 2020 (TAG Databook v1.13.1)	Autumn 2020

Version	Summary	Dates & Reports
CBLTM v4	Updated CBLTM Model: • New zoning system defined; zones split and merged based on number of trips and MSOA boundaries; revision of zone loading points • Refinements to the highway matrix build process • Network Enhancement across the simulation area, as well as global updates to saturation flows • Updates to speeds along the M1 to match observed data as closely as possible • Economic parameters used: July 2020 (sensitivity test) (TAG Databook v1.14)	March 2021; the updates for this model are contained within the updated LMVR

1.3 CBLTM Study Area

1.3.1 The CBLTM comprises of two model areas in line with (DfT' s Transport Analysis Guidance) TAG recommendations in Units M3.1 and M3.2 with a 'Fully Modelled Area' and an 'External Area'. The fully modelled area is further subdivided as set out below:

- **Area of Detailed Modelling** – Modelling detail in this area is characterised by: representation of all trip movements; finer zone system and network detailed networks.
- **Rest of the Fully Modelled Area** – which is characterised by: representation of all trip movements; coarser zone system and less network detail than for the Area of Detailed Modelling; and speed/flow modelling (primarily link-based but possibly also including a representation of strategically important junctions).
- The rest of the model area is defined as the '**External Area'**, which is characterised by: a network representing a large proportion of the rest of Great Britain, a partial representation of demand (trips to and from and across the Fully Modelled Area); large zones; skeletal networks and simple speed/flow relationships or fixed speed modelling.

1.3.2 These three areas are shown in Figure 2. The 'Fully Modelled Area' comprises of Central Bedfordshire and Luton but notably excludes the large neighbouring settlements of Milton Keynes and Bedford which are both outside the area of detailed modelling. The area of the Luton Air Quality study is contained within the Area of Detailed Modelling.

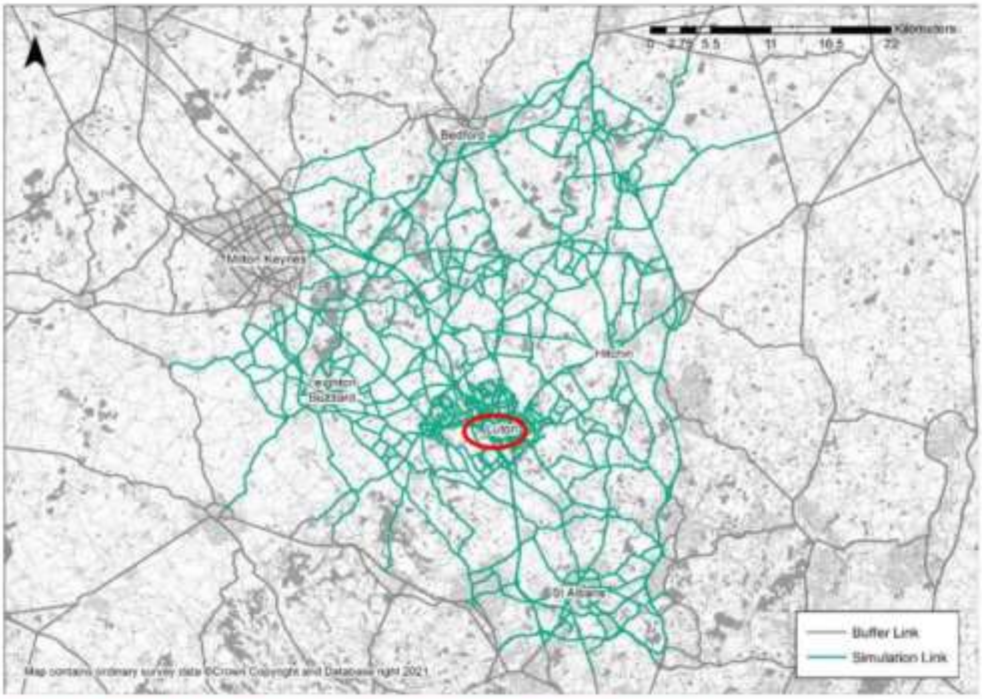

Figure 2: CBLTM coverage (Luton Air Quality area highlighted in red)

1.4 Luton Air Quality Management Area

1.4.1 To support the Luton Air Quality team, traffic data is required for links in the central Luton area. An AQMA is in place in central Luton, which is shown in Figure 3. This figure also shows the CBLTM road network (in blue), which shows good coverage of this urban area. Given the strategic nature of CBLTM model coverage ensures all the major routes around/through Luton Town Centre are contained but some of the local rat runs may be excluded. The model coverage as well as network details are deemed to be appropriate for a strategic model like CBLTM.

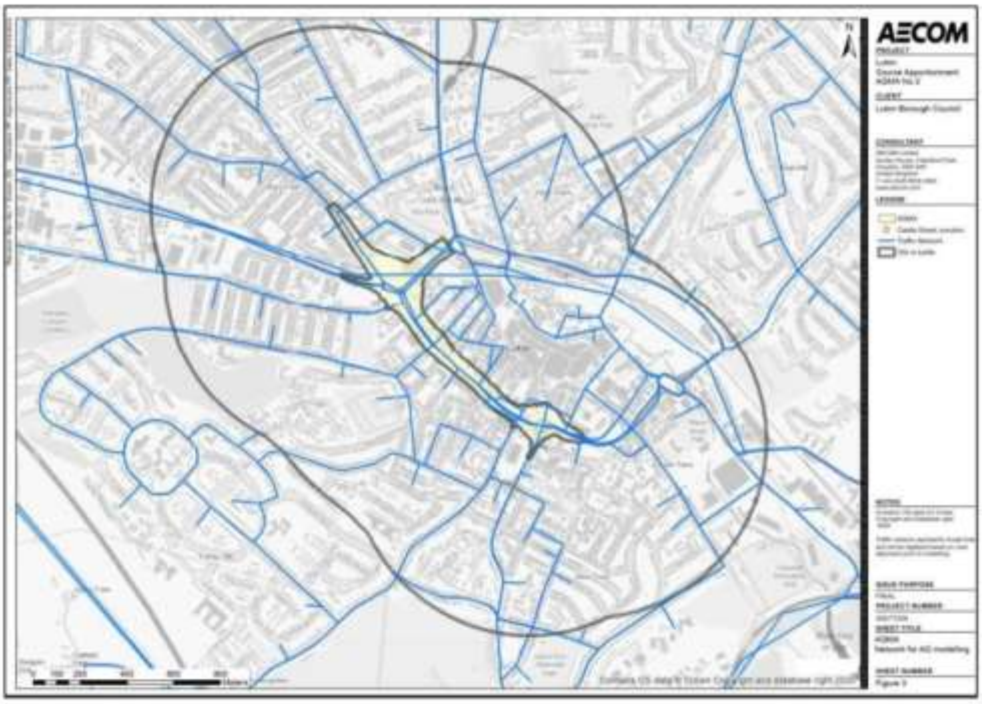

Figure 3: Luton AQMA study area and CBLTM coverage

1.5 This Technical Note

1.5.1 This technical note details CBLTM's dimensions, data and model performance relating to the data supplied for the Luton Air Quality study. This note should be viewed alongside the data supplied so decision makers are aware of the processes and caveats which underpin the data supplied.

1.5.2 Following this introduction, this technical note is split into the following sections:

- The CBLTM Model Dimensions
- Data collection;
- Data performance;
- Base Year Performance;
- Summary.

2 Model Dimensions

2.1.1 This section outlines CBLTM's model dimensions and characteristics. For a full model development approach, readers should refer to the CBLTM Local Model Validation Report for the M1-A6 Full Business Case, issued in June 2021[1] (herein referred to as the LMVR for CBLTM v4 – refer to Table 1 for version history).

2.1.2 The model uses several standard definitions and terminology regarding dimensions and the most common of these are listed below with clear reference to their meaning.

2.1.3 The CBLTM suite includes:

- A SATURN-based highway assignment model;
- An Emme-based public transport assignment model; and
- An Emme-based Variable Demand Model (VDM).

2.1.4 The model Base Year is representative of a neutral day in November 2018. All data collected to inform the Base Year model was factored as required to represent November 2018 traffic conditions.

2.1.5 For public transport services, these have been coded based on the spring 2016 timetable, inherited from the 2016 Base Year CBLTM, and all demand data has been uplifted to November 2018 level using counts and uplifted trip ends – please see the CBLTMv4 LMVR, section 6.4[2].

2.1.6 Note that the peak hours for the highway assignment model provided below have been informed by analysis of traffic count data. This has been further documented in the Data Collect Report[3] for CBLTM v4.

2.1.7 It should be noted that no validated off-peak highway assignment model was produced. The off-peak model was approximated using the existing inter-peak networks. Off-peak demand, however, was developed as part of the base matrix development. For the public transport assignment model, the reader should refer to the 2016 CBLTM LMVR for calibration/validation of the public transport assignment model. This approach was deemed proportionate as the M1-A6 Link was a highways scheme only with no direct impacts on surrounding public transport networks.

Table 2: Time Period Definition

Time Period	Variable Demand Model	Highway Assignment Model	Public Transport Model
AM	07:00 – 10:00	08:00 – 09:00	07:00 – 10:00 (average hour)
IP	10:00 – 16:00 (average hour)	10:00 – 16:00 (average hour)	10:00 – 18:00 (average hour)
PM	16:00 – 19:00	17:00 – 18:00	16:00 – 19:00 (average hour)
OP	19:00 – 07:00		

2.1.8

2.1.9 The highway model considers five separate user classes as follows:

- User Class 1 (UC1) – Car (Commuting trips);

[1] CBLTM Local Model Validation Report, M1-A6 Full Business Case, Issued 09 June 2021.
[2] CBLTM Local Model Validation Report, M1-A6 Full Business Case, Issued 09 June 2021.
[3] CBLTM Data Collection Report, M1-A6 Full Busines Case, Issued 20 May 2020

- User Class 2 (UC2) – Car (Business trips);
- User Class 3 (UC3) – Car (Other trips);
- User Class 4 (UC4) – LGV (Light Goods Vehicles); and
- User Class 5 (UC5) – HGV (Heavy Goods Vehicles).

2.1.10 The CBLTM modelling suite uses a combination of:

- Emme 4 for the demand model and public transport assignment model; and
- SATURN version 11.4.07H for highway assignment model.

3 Count Data & Annualisation Factors

3.1.1 This section provides a summary of the methodology used to process count data used in the CBLTM model, and the location of those used to calculate factors. Factors are used to convert hourly modelled flows to daily flows. These are calculated to produce Annual Average Daily Traffic (AADT) and Annual Average Weekday Traffic (AAWT). Further information on all count collection and additional analysis can be found in the Local Model Validation Report (LMVR) and Data Collection Report (DCR) for CBLTM v4[4].

3.1.2 The following process was applied to the count data collected:

- **Formatting and cleaning of data:** all count data, was put into a consistent format, then imported into a Python script which apply data exclusion to include neutral days only and identify/remove outliers. Outliers are count results which appear greatly different to the average flow pattern. The script also calculates average flows for each modelled peak hour;
- **Sample size and Relative Standard Deviation (RSD):** Sample size and RSD was checked for each count site;
- **Daily profile check:** count data was summarised and checks on the peak hour definition were undertaken;
- **Calculation of seasonal and yearly factors:** to convert all data to November 2018 (i.e. Base Year of the model): seasonal and yearly factors were calculated and applied to all count data to derive 2018 traffic flows for the development of the Base Year model; and
- **Calculation of vehicle split factors:** vehicle split factors were applied, calculated in the model update for CBLTM v4 to differentiate the traffic flows by vehicle type.

3.1.3 The location of the counts used to derive factors to calculate daily flows can be found in Figure 4. As shown, these counts spread across the Luton urban area as there are limited data collection points in central Luton. Using all available counts in the Luton area is deemed the most appropriate due to the similar daily traffic patterns across Luton.

3.1.4 There were limited count sites in the centre of Luton as it is a heavily congested area. In this area, standard tubes across the road which rely on vehicles passing over them are unreliable as stop/start/queuing traffic distorts results.

[4] CBLTM Local Model Validation Report, M1-A6 Full Business Case, Issued 09 June 2021 & CBLTM Data Collection Report, M1-A6 Full Busines Case, Issued 20 May 2020

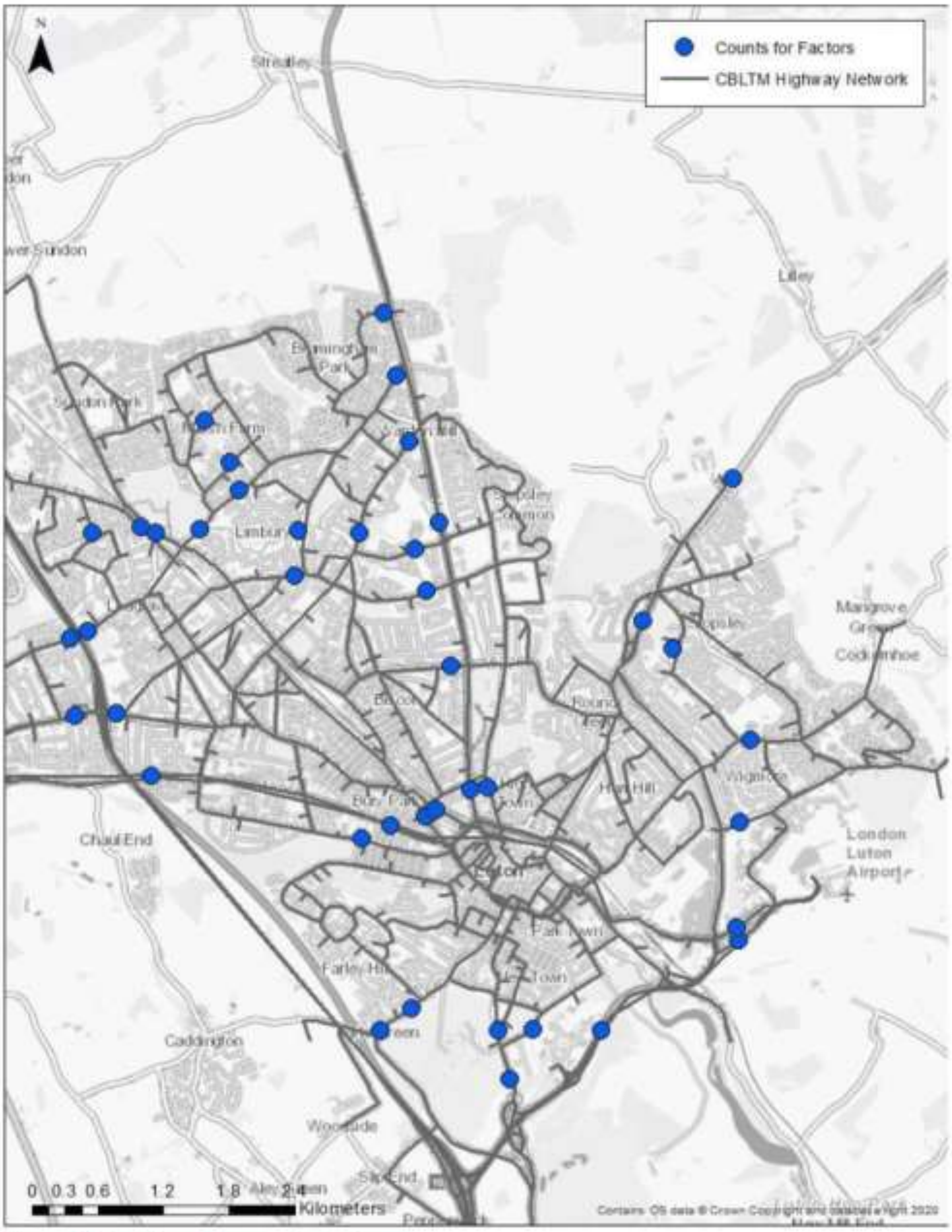

Figure 4: Location of counts for factors

Vehicle Split

3.1.5 The same vehicle splits were used for these counts as those calculated for the CBLTM v4 model. In summary, vehicle splits were calculated using a manual classified counts (MCCs). A total of 22 MCCs were used to calculate these vehicle splits, and the data was collected in November of 2019 These splits were calculated by road type:

- Rural Dual;

- Rural Single;
- Urban Dual;
- Urban Single; and
- Trunk.

3.1.6 Please refer to the LMVR[5], section 4.2.7 for full details.

[5] CBLTM Local Model Validation Report, M1-A6 Full Business Case, Issued 09 June 2021

4 Base Year Performance

4.1 Matrix Estimation Methodology

4.1.1 Matrix estimation (ME) is a powerful tool within the SATURN suite which alters the travel demand matrix in order to match count data on the links within the network. Matrix estimation effectively attempts to account for the errors inherent in modelling by assuming that the largest errors are associated with the matrix development as opposed to traffic count data or network definition, and reverse engineers the travel demand matrix to match the observed traffic counts.

4.1.2 In line with recommendations made within both TAG and the SATURN manual, matrix estimation is only applied once the prior matrices and network have reached the best level of calibration achievable without matrix estimation, thus reaching a stage where the process is considered necessary.

4.1.3 Matrix estimation has been undertaken using a set of combined constraints (i.e. short or mini screenlines). As TAG M3.1 §8.3.5 mentions 'count constraints should generally be grouped and applied at the short screenline level'. Applying constraints at an individual count level would increase the risk of ME producing trip matrices which compensate for wider deficiencies.

4.1.4 A balance has been achieved between the changes brought about matrix estimation and the resulting calibration/validation statistics of link flows. This has been accomplished by limiting the changes Matrix Estimation has been able to make using the count data.

4.1.5 For the full methodology on this process please refer to the LMVR, section 8[6].

4.2 Calibrated Results

Convergence

4.2.1 The model converged well in all time periods through all iterations of ME. The final convergence results are shown in Table 3, where all time periods are shown to converge in 56 iterations or less. This is expected in a strategic transport model like CBLTM

Table 3: Convergence

Time Period	Iteration*	%Flows	%Gap
AM Peak	53	98.3	0.0012
	54	98.5	0.00079
	55	98.8	0.0012
	56	98.1	0.00063
Inter-Peak	26	99.0	0.0011
	27	98.2	0.00070
	28	99.0	0.0012
	29	98.4	0.00062
PM Peak	21	98.1	0.0018
	22	98.6	0.0014
	23	98.7	0.0014
	24	99.0	0.0014

[6] Central Bedfordshire & Luton Transport Model: M1-A6 Local Model Validation Report, §8

Screenline and Count Performance

4.2.2 Screenline and count performance is measured in TAG criteria on how well the model reflects observed flows. Screenline and count performance for the full CBLTM model is presented in Figure 5 and Figure 6 below. This shows that across the full model there is a very good screenline performance, meaning the model tracks movements well at a total level. Count performance is slightly lower, at 82% for the AM and PM peak. This is acceptable in matching observed flows, as it should be considered that CBLTM is a strategic model. By nature, it is not designed to model individual junctions but strategic movements, and this can result in some inaccuracies in built up environments where there is a much larger route choice. This is especially the case in Luton, where there are often high delays in peak periods and traffic will reroute to avoid these delays.

Screenline Summary		
Period	Lights	Heavies
AM	87%	96%
IP	91%	93%
PM	91%	100%

Figure 5: CBLTM Screenline Performance

Count Summary (353 counts)		
Period	Lights	Heavies
AM	82%	100%
IP	93%	99%
PM	82%	100%

Figure 6: CBLTM Count Performance

4.2.3 To better understand the model in the area of interest around Luton, a subset of screenline performance is presented in Table 5 to Table 7 for the AM, Interpeak and PM peak. The locations of these screenlines are shown in Figure 7. Screenlines which are completely within the Luton Cordon (and the Luton cordon itself) are highlighted in **bold.** These results show that in all time periods, there is only one direction which fails to meet the TAG criteria in the AM peak. This is a marginal failure at 7%, and is around the east of Luton, close to the airport. It is important to note that in all cases, movements tracking in and out of the urban area (Luton) are accurate. Full tables of screenline and count performance can be found in the LMVR.

4.2.4 The count performance for counts within the Luton cordon, and all screenlines fully within this cordon, can be found in Table 8, Table 9 and Table 10 for the AM, Interpeak and PM respectively. The count performance for this subset is summarised with pass rates against TAG criteria in Table 4 below.

Table 4: Count Subset Performance

Count Summary (73 counts)		
Period	Lights	Heavies
AM	71%	100%
IP	86%	100%
PM	81%	100%

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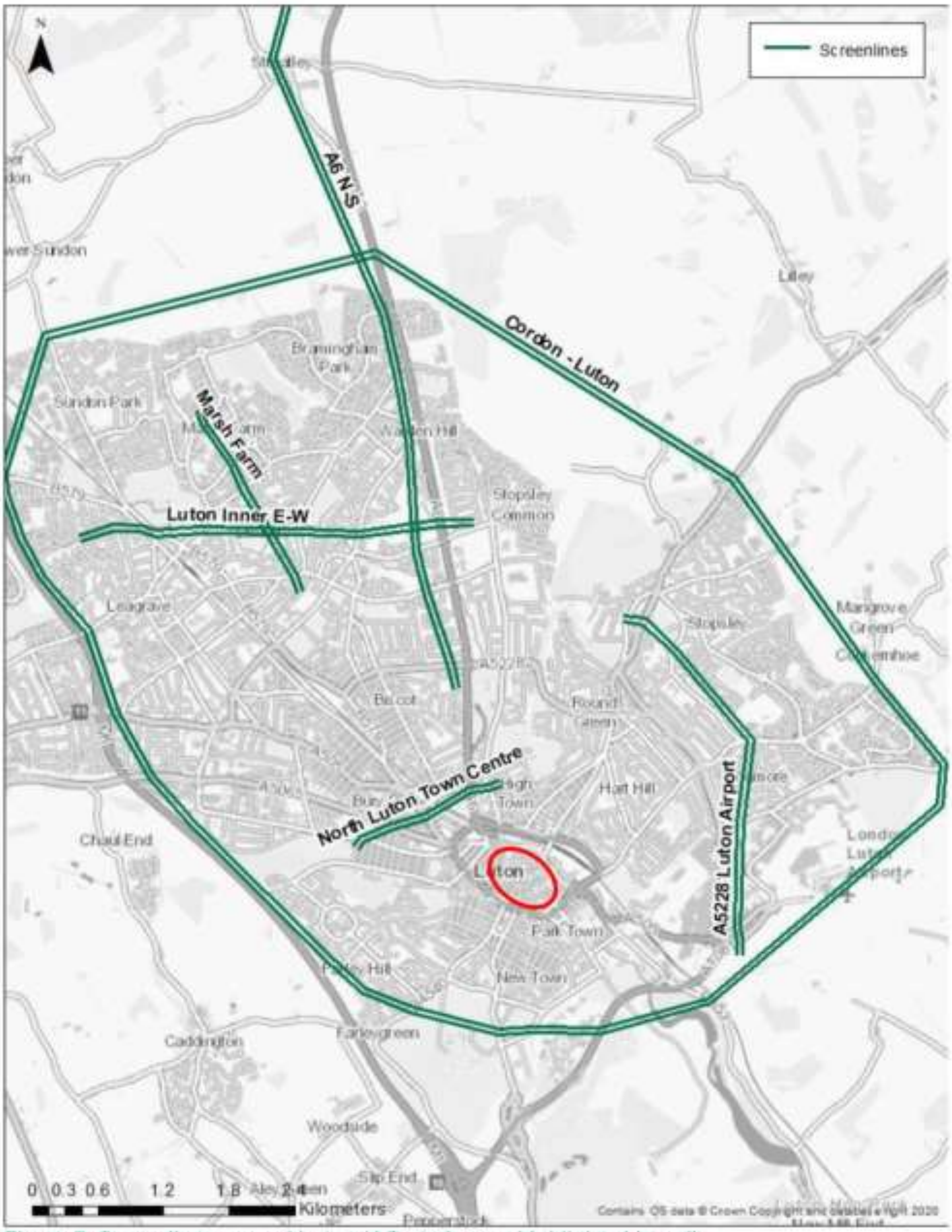

Figure 7: Screenlines around Luton (AQ study area highlighted in red)

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Table 5: AM Peak Luton Screenline Performance

Screenline	Direction	Difference Lights	Difference Heavies	% Difference Lights	% Difference Heavies	Compliant? Lights	Compliant? Heavies
A6 N-S	E	-14	-2	0%	-1%	YES	YES
A6 N-S	W	-9	2	0%	1%	YES	YES
Cordon - Luton	I	-60	-74	-1%	-14%	YES	YES
Cordon - Luton	O	75	-17	1%	-3%	YES	YES
Marsh Farm	E	13	3	1%	6%	YES	YES
Marsh Farm	W	-3	-1	0%	-3%	YES	YES
North Luton Town Centre	N	112	-1	5%	-1%	YES	YES
North Luton Town Centre	S	-49	0	-2%	0%	YES	YES
A5228 Luton Airport	E	-15	-16	0%	-12%	YES	YES
A5228 Luton Airport	W	-249	-13	-7%	-11%	NO	YES
Luton Inner E-W	N	-17	19	-1%	22%	YES	YES
Luton Inner E-W	S	-124	6	-3%	6%	YES	YES

Table 6: Interpeak Luton Screenline Performance

Screenline	Direction	Difference Lights	Difference Heavies	% Difference Lights	% Difference Heavies	Compliant? Lights	Compliant? Heavies
A6 N-S	E	13	-2	0%	-1%	YES	YES
A6 N-S	W	24	-1	1%	-1%	YES	YES
Cordon - Luton	I	-10	-39	0%	-8%	YES	YES
Cordon - Luton	O	13	-22	0%	-4%	YES	YES
Marsh Farm	E	5	0	0%	-2%	YES	YES
Marsh Farm	W	4	0	0%	-1%	YES	YES
North Luton Town Centre	N	-7	1	0%	1%	YES	YES
North Luton Town Centre	S	0	0	0%	0%	YES	YES
A5228 Luton Airport	E	-57	-5	-2%	-4%	YES	YES
A5228 Luton Airport	W	-27	-15	-1%	-11%	YES	YES
Luton Inner E-W	N	10	20	0%	32%	YES	YES
Luton Inner E-W	S	-1	26	0%	41%	YES	YES

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Table 7: PM Peak Luton Screenline Performance

		Difference		% Difference		Compliant?	
Screenline	**Direction**	**Lights**	**Heavies**	**Lights**	**Heavies**	**Lights**	**Heavies**
A6 N-S	E	-77	0	-2%	0%	YES	YES
A6 N-S	W	34	1	1%	1%	YES	YES
Cordon - Luton	**I**	**129**	**-34**	**1%**	**-14%**	**YES**	**YES**
Cordon - Luton	**O**	**-145**	**-24**	**-2%**	**-12%**	**YES**	**YES**
Marsh Farm	**E**	**-16**	**-1**	**-1%**	**-8%**	**YES**	**YES**
Marsh Farm	**W**	**-10**	**0**	**-1%**	**0%**	**YES**	**YES**
North Luton Town Centre	**N**	**35**	**0**	**1%**	**1%**	**YES**	**YES**
North Luton Town Centre	**S**	**3**	**-1**	**0%**	**-7%**	**YES**	**YES**
A5228 Luton Airport	**E**	**-118**	**0**	**-3%**	**-1%**	**YES**	**YES**
A5228 Luton Airport	**W**	**-57**	**-9**	**-2%**	**-19%**	**YES**	**YES**
Luton Inner E-W	**N**	**-6**	**6**	**0%**	**25%**	**YES**	**YES**
Luton Inner E-W	**S**	**-145**	**7**	**-5%**	**33%**	**YES**	**YES**

Table 8: Count Subset Performance - AM Peak

	Difference		% Difference		Compliant?	
Road Name	**Lights**	**Heavies**	**Lights**	**Heavies**	**Lights**	**Heavies**
A6 Barton Road	-70	-68	-8%	-56%	YES	YES
A505 Beech Hill	-1	3	0%	8%	YES	YES
Luton Road	26	2	22%	60%	YES	YES
Eaton Green Road	-35	1	-22%	15%	YES	YES
A1081	66	-2	3%	-2%	YES	YES
Cutenhoe Road	110	4	152%	171%	NO	YES
Hatters Way	162	-3	18%	-12%	NO	YES
A505 Dunstable Road	24	21	3%	58%	YES	YES
Leagrave High Street	-161	-18	-23%	-86%	NO	YES
B579 Luton Road, 60m north of Vauxhall Plant Entrance	-55	-2	-10%	-10%	YES	YES
Sundon Park Road	-28	-9	-5%	-12%	YES	YES

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Road Name	Difference		% Difference		Compliant?	
	Lights	Heavies	Lights	Heavies	Lights	Heavies
B653	15	0	3%	-1%	YES	YES
London Road	-36	8	-6%	48%	YES	YES
Farley Hill	-76	-11	-16%	-74%	YES	YES
A6 Barton Road	-23	-26	-3%	-23%	YES	YES
A505 Beech Hill	6	14	1%	52%	YES	YES
Luton Road	73	1	82%	54%	YES	YES
Eaton Green Road	-76	-1	-30%	-16%	YES	YES
A1081	-25	0	-1%	0%	YES	YES
Cutenhoe Road	-40	3	-27%	58%	YES	YES
Hatters Way	141	-12	16%	-48%	YES	YES
A505 Dunstable Road	-39	32	-4%	72%	YES	YES
Leagrave High Street	51	-21	5%	-74%	YES	YES
B579 Luton Road, 60m north of Vauxhall Plant Entrance	82	-7	21%	-60%	YES	YES
Sundon Park Road	-80	5	-23%	10%	YES	YES
B653	-8	0	-1%	0%	YES	YES
London Road	-21	4	-3%	21%	YES	YES
Farley Hill	33	-8	7%	-62%	YES	YES
The Moakes, 10m east of Vadis Close	-4	6	-2%	91%	YES	YES
Lygetun Drive, 20m north of Flint Close	1	-6	1%	-100%	YES	YES
Bramingham Road, 90m west of Watermead Road	-3	0	0%	-1%	YES	YES
Limbury Road, 130m east of Icknield Road	18	3	4%	22%	YES	YES
The Moakes, 10m east of Vadis Close	99	5	44%	72%	YES	YES
Lygetun Drive, 20m north of Flint Close	-102	-7	-46%	-100%	NO	YES
Bramingham Road, 90m west of Watermead Road	11	0	2%	-1%	YES	YES
Limbury Road, 130m east of Icknield Road	-9	1	-2%	7%	YES	YES
Dallow Road, 20m west of St. Peters Road	72	-4	25%	-48%	YES	YES
Hatters Way	-46	4	-5%	16%	YES	YES
A505 Dunstable Road, 60m north of Moor Street	4	0	1%	-1%	YES	YES
New Bedford Road	103	2	20%	13%	YES	YES
Old Bedford Road, 15m south of Reginald Street	-21	-3	-9%	-42%	YES	YES
Dallow Road, 20m west of St. Peters Road	-211	-10	-49%	-80%	NO	YES
Hatters Way	203	11	23%	41%	NO	YES

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Road Name	Difference		% Difference		Compliant?	
	Lights	Heavies	Lights	Heavies	Lights	Heavies
A505 Dunstable Road, 60m north of Moor Street	167	2	64%	19%	NO	YES
Bury Park Road, 100m south of Waldeck Road	-160	-1	-47%	-14%	NO	YES
New Bedford Road	-190	8	-24%	35%	NO	YES
Old Bedford Road, 15m south of Reginald Street	142	-9	29%	-63%	NO	YES
Stopsley Way	0	0	0%	-1%	YES	YES
Ashcroft Road	-99	-4	-42%	-62%	YES	YES
Crawley Green Road	94	4	17%	25%	YES	YES
Eaton Green Road	104	3	19%	20%	YES	YES
Airport Way	-104	-4	-43%	-59%	NO	YES
A1081, Luton Airport	-11	-15	-1%	-39%	YES	YES
Stopsley Way	19	0	2%	0%	YES	YES
Ashcroft Road	-101	-7	-32%	-73%	NO	YES
Crawley Green Road	101	7	31%	71%	NO	YES
Eaton Green Road	278	8	76%	72%	NO	YES
Airport Way	-305	-8	-67%	-58%	NO	YES
A1081, Luton Airport	-240	-14	-30%	-41%	NO	YES
Montague Avenue	-75	-3	-65%	-100%	YES	YES
Sundon Park Road	76	5	15%	31%	YES	YES
Toddington Road	0	0	0%	4%	YES	YES
Bramingham Road, 90m west of Watermead Road	-1	0	0%	-1%	YES	YES
Neville Road	-133	-10	-31%	-77%	NO	YES
Birdsfoot Lane	115	10	45%	128%	NO	YES
A6 New Bedford Road	2	18	0%	110%	YES	YES
Montague Avenue	-27	-2	-15%	-40%	YES	YES
Sundon Park Road	47	11	9%	66%	YES	YES
Toddington Road	-121	-7	-24%	-43%	NO	YES
Bramingham Road, 90m west of Watermead Road	23	0	3%	-1%	YES	YES
Neville Road	-268	-12	-43%	-62%	NO	YES
Birdsfoot Lane	255	12	68%	105%	NO	YES
A6 New Bedford Road	-32	5	-4%	20%	YES	YES

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Table 9: Count Subset Performance - Interpeak

Road Name	Difference		% Difference		Compliant?	
	Lights	Heavies	Lights	Heavies	Lights	Heavies
A6 Barton Road	4	-46	1%	-44%	YES	YES
A505 Beech Hill	15	13	3%	33%	YES	YES
Luton Road	14	0	32%	-18%	YES	YES
Eaton Green Road	-10	0	-15%	10%	YES	YES
A1081	-104	-1	-8%	-1%	YES	YES
Cutenhoe Road	39	2	71%	132%	YES	YES
Hatters Way	188	1	32%	8%	NO	YES
A505 Dunstable Road	-127	6	-15%	9%	YES	YES
Leagrave High Street	-6	-13	-1%	-85%	YES	YES
B579 Luton Road, 60m north of Vauxhall Plant Entrance	-2	-1	-1%	-16%	YES	YES
Sundon Park Road	5	1	2%	2%	YES	YES
B653	6	2	2%	4%	YES	YES
London Road	-100	1	-22%	12%	YES	YES
Farley Hill	68	-4	25%	-58%	YES	YES
A6 Barton Road	-5	-48	-1%	-44%	YES	YES
A505 Beech Hill	55	19	11%	50%	YES	YES
Luton Road	13	2	29%	200%	YES	YES
Eaton Green Road	-7	3	-10%	130%	YES	YES
A1081	-58	1	-4%	1%	YES	YES
Cutenhoe Road	68	2	94%	100%	YES	YES
Hatters Way	295	1	46%	8%	NO	YES
A505 Dunstable Road	-351	7	-36%	9%	NO	YES
Leagrave High Street	67	-9	11%	-57%	YES	YES
B579 Luton Road, 60m north of Vauxhall Plant Entrance	14	1	6%	23%	YES	YES
Sundon Park Road	-14	-2	-6%	-3%	YES	YES
B653	6	2	3%	3%	YES	YES
London Road	-112	2	-29%	25%	NO	YES
Farley Hill	43	-4	16%	-57%	YES	YES
The Moakes, 10m east of Vadis Close	35	2	30%	64%	YES	YES
Lygetun Drive, 20m north of Flint Close	-36	-2	-38%	-100%	YES	YES

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Road Name	Difference Lights	Difference Heavies	% Difference Lights	% Difference Heavies	Compliant? Lights	Compliant? Heavies
Bramingham Road, 90m west of Watermead Road	1	-1	0%	-4%	YES	YES
Limbury Road, 130m east of Icknield Road	5	0	1%	2%	YES	YES
The Moakes, 10m east of Vadis Close	17	2	14%	63%	YES	YES
Lygetun Drive, 20m north of Flint Close	-17	-2	-22%	-100%	YES	YES
Bramingham Road, 90m west of Watermead Road	11	0	2%	-1%	YES	YES
Limbury Road, 130m east of Icknield Road	-7	0	-2%	0%	YES	YES
Dallow Road, 20m west of St. Peters Road	22	-5	8%	-71%	YES	YES
Hatters Way	-24	5	-3%	21%	YES	YES
A505 Dunstable Road, 60m north of Moor Street	16	0	3%	1%	YES	YES
New Bedford Road	11	5	2%	32%	YES	YES
Old Bedford Road, 15m south of Reginald Street	-32	-4	-12%	-58%	YES	YES
Dallow Road, 20m west of St. Peters Road	-128	-7	-39%	-83%	NO	YES
Hatters Way	123	7	17%	36%	YES	YES
A505 Dunstable Road, 60m north of Moor Street	-75	-2	-28%	-31%	YES	YES
Bury Park Road, 100m south of Waldeck Road	81	3	146%	178%	YES	YES
New Bedford Road	62	4	12%	26%	YES	YES
Old Bedford Road, 15m south of Reginald Street	-64	-4	-24%	-52%	YES	YES
Stopsley Way	16	0	2%	0%	YES	YES
Ashcroft Road	-23	-2	-17%	-52%	YES	YES
Crawley Green Road	13	2	3%	21%	YES	YES
Eaton Green Road	91	4	21%	36%	YES	YES
Airport Way	-115	-4	-51%	-67%	NO	YES
A1081, Luton Airport	-40	-6	-9%	-17%	YES	YES
Stopsley Way	10	-1	1%	-1%	YES	YES
Ashcroft Road	-23	-1	-17%	-39%	YES	YES
Crawley Green Road	21	1	5%	15%	YES	YES
Eaton Green Road	117	5	31%	46%	NO	YES
Airport Way	-122	-5	-43%	-68%	NO	YES
A1081, Luton Airport	-30	-14	-6%	-37%	YES	YES
Montague Avenue	-32	-2	-41%	-100%	YES	YES
Sundon Park Road	32	8	9%	83%	YES	YES
Toddington Road	4	0	1%	2%	YES	YES
Bramingham Road, 90m west of Watermead Road	4	0	1%	0%	YES	YES

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Road Name	Difference Lights	Difference Heavies	% Difference Lights	% Difference Heavies	Compliant? Lights	Compliant? Heavies
Neville Road	-56	-5	-20%	-74%	YES	YES
Birdsfoot Lane	59	5	25%	87%	YES	YES
A6 New Bedford Road	0	14	0%	100%	YES	YES
Montague Avenue	-57	-2	-69%	-100%	YES	YES
Sundon Park Road	61	6	17%	64%	YES	YES
Toddington Road	-7	0	-2%	5%	YES	YES
Bramingham Road, 90m west of Watermead Road	10	0	2%	0%	YES	YES
Neville Road	-175	-8	-55%	-97%	NO	YES
Birdsfoot Lane	169	8	80%	149%	NO	YES
A6 New Bedford Road	-3	21	0%	148%	YES	YES

Table 10: Count Subset Performance – PM peak

Road Name	Difference Lights	Difference Heavies	% Difference Lights	% Difference Heavies	Compliant? Lights	Compliant? Heavies
A6 Barton Road	-40	-39	-4%	-64%	YES	YES
A505 Beech Hill	6	3	1%	16%	YES	YES
Luton Road	60	1	80%	194%	YES	YES
Eaton Green Road	-57	2	-29%	138%	YES	YES
A1081	-33	-1	-2%	-2%	YES	YES
Cutenhoe Road	28	1	22%	94%	YES	YES
Hatters Way	372	0	67%	10%	NO	YES
A505 Dunstable Road	-160	5	-13%	21%	YES	YES
Leagrave High Street	-102	-5	-13%	-88%	YES	YES
B579 Luton Road, 60m north of Vauxhall Plant Entrance	12	0	2%	13%	YES	YES
Sundon Park Road	40	0	8%	-1%	YES	YES
B653	15	-1	2%	-2%	YES	YES
London Road	-37	1	-4%	23%	YES	YES
Farley Hill	27	-3	5%	-70%	YES	YES
A6 Barton Road	-62	-27	-7%	-53%	YES	YES

Road Name	Difference		% Difference		Compliant?	
	Lights	Heavies	Lights	Heavies	Lights	Heavies
A505 Beech Hill	-42	0	-5%	3%	YES	YES
Luton Road	-11	2	-10%	251%	YES	YES
Eaton Green Road	-22	1	-10%	44%	YES	YES
A1081	-27	0	-1%	0%	YES	YES
Cutenhoe Road	112	1	74%	67%	NO	YES
Hatters Way	511	3	82%	60%	NO	YES
A505 Dunstable Road	-399	0	-31%	-1%	NO	YES
Leagrave High Street	-81	-2	-12%	-52%	YES	YES
B579 Luton Road, 60m north of Vauxhall Plant Entrance	11	-1	2%	-29%	YES	YES
Sundon Park Road	-16	1	-4%	5%	YES	YES
B653	-12	0	-3%	-2%	YES	YES
London Road	-156	1	-30%	16%	NO	YES
Farley Hill	49	-2	11%	-50%	YES	YES
The Moakes, 10m east of Vadis Close	79	1	42%	68%	YES	YES
Lygetun Drive, 20m north of Flint Close	-80	-1	-45%	-100%	YES	YES
Bramingham Road, 90m west of Watermead Road	-7	-1	-1%	-13%	YES	YES
Limbury Road, 130m east of Icknield Road	-7	0	-1%	-3%	YES	YES
The Moakes, 10m east of Vadis Close	32	1	20%	66%	YES	YES
Lygetun Drive, 20m north of Flint Close	-33	-1	-34%	-100%	YES	YES
Bramingham Road, 90m west of Watermead Road	-5	0	-1%	2%	YES	YES
Limbury Road, 130m east of Icknield Road	-2	0	-1%	5%	YES	YES
Dallow Road, 20m west of St. Peters Road	14	-1	4%	-39%	YES	YES
Hatters Way	-4	1	0%	14%	YES	YES
A505 Dunstable Road, 60m north of Moor Street	48	0	10%	6%	YES	YES
New Bedford Road	-38	2	-5%	38%	YES	YES
Old Bedford Road, 15m south of Reginald Street	15	-2	3%	-61%	YES	YES
Dallow Road, 20m west of St. Peters Road	-192	-2	-49%	-83%	NO	YES
Hatters Way	176	2	26%	50%	NO	YES
A505 Dunstable Road, 60m north of Moor Street	-40	-1	-15%	-49%	YES	YES
Bury Park Road, 100m south of Waldeck Road	42	0	48%	-2%	YES	YES
New Bedford Road	97	0	17%	7%	YES	YES
Old Bedford Road, 15m south of Reginald Street	-81	-1	-30%	-40%	YES	YES

Luton Air Quality - Traffic Data Technical Note

Road Name	Difference Lights	Difference Heavies	% Difference Lights	% Difference Heavies	Compliant? Lights	Compliant? Heavies
Stopsley Way	-54	-1	-5%	-4%	YES	YES
Ashcroft Road	-11	0	-6%	-5%	YES	YES
Crawley Green Road	-12	0	-2%	3%	YES	YES
Eaton Green Road	57	1	8%	25%	YES	YES
Airport Way	-78	-1	-41%	-64%	YES	YES
A1081, Luton Airport	-21	0	-3%	0%	YES	YES
Stopsley Way	-3	0	0%	-1%	YES	YES
Ashcroft Road	-13	0	-8%	-23%	YES	YES
Crawley Green Road	-6	0	-1%	9%	YES	YES
Eaton Green Road	187	2	45%	57%	NO	YES
Airport Way	-191	-2	-49%	-56%	NO	YES
A1081, Luton Airport	-31	-9	-4%	-66%	YES	YES
Montague Avenue	-25	-1	-21%	-90%	YES	YES
Sundon Park Road	32	3	8%	97%	YES	YES
Toddington Road	-14	-2	-4%	-57%	YES	YES
Bramingham Road, 90m west of Watermead Road	5	0	1%	-7%	YES	YES
Neville Road	-9	-2	-2%	-63%	YES	YES
Birdsfoot Lane	-25	2	-6%	57%	YES	YES
A6 New Bedford Road	30	6	4%	125%	YES	YES
Montague Avenue	-132	-1	-85%	-95%	NO	YES
Sundon Park Road	151	3	27%	70%	NO	YES
Toddington Road	-136	0	-30%	2%	NO	YES
Bramingham Road, 90m west of Watermead Road	-4	0	-1%	-1%	YES	YES
Neville Road	-241	-3	-57%	-96%	NO	YES
Birdsfoot Lane	251	3	94%	160%	NO	YES
A6 New Bedford Road	-34	5	-5%	114%	YES	YES

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4.2.5 The tables indicate that whilst there are some failures against TAG flow criteria, these mainly occur in the AM peak. We would not expect a strategic model to pass all flow criteria in a condensed urban area like Luton where multiple route choices exist. Some of the larger variations will be due to traffic rat running around delays and congestion, plus the network coverage in CBLTM. This is not unexpected and whilst there are limited counts in the area of the AQMA in central Luton, traffic movements across and through the Luton urban area are generally well represented.

4.2.6 For greater clarity around the AQMA, new traffic data could be collected and absorbed into CBLTM by re-running matrix estimation and enhancing performance in the study area. LBC confirmed this was out of scope for this study due to the timeframes and expense required.

Journey Time Performance

4.2.7 Journey time performance has improved from the prior matrix as for all time slices more than 80% of the journey times are within the desired 15% interval, as shown in Table 11. There is limited journey time coverage in Luton town centre, as shown in Figure 8. Full tables of journey time performance can be found in the LMVR.

Table 11: Journey Time Performance (summary)

	AM	IP	PM
Total routes	50	50	50
Total pass	40	47	40
%pass	80%	94%	80%
Total observed (s)	33,469	26,646	32,898
Total modelled (s)	32,072	27,681	31,566
% difference	-4%	4%	-4%

Luton Air Quality - Traffic Data Technical Note

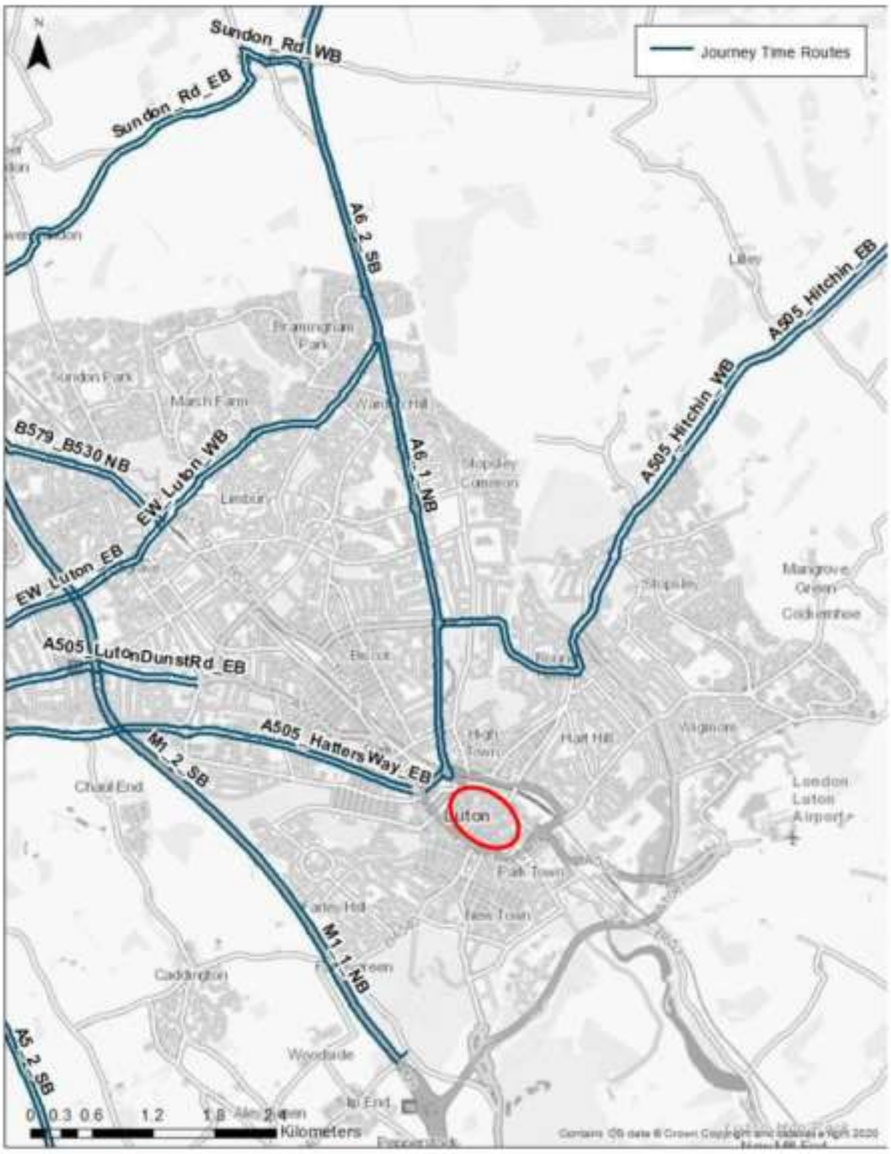

Figure 8: CBLTM Journey Time Routes (AQ study area highlighted in red)

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4.2.8 The journey time routes closest to the air quality study area are the A505_Hitchin, A505_Hatters_Way, and the southern section of the A6 (A6_1_NB and A6_2_SB). The graphs detailing the performance of these routes can be found in Figure 9 to Figure 26 below. Results are shown for the routes for each time period, along the full length of the route. All routes are directional. The section of the route closest to the Town Centre (and AQMA area) are indicated in red in each graph.

4.2.9 Figure 9 to Figure 11 show the performance of the eastbound direction of the A505 Hatters Way journey time route. Although the observed and modelled times differentiate, the end of the route (approaching the town centre) follows the correct profile in terms of delay. Figure 12 and Figure 14 show the same pattern in the opposite direction – the route may not track well across the whole length, but closest to the town centre (at the beginning of the route) reflects observed data.

4.2.10 Figure 15 to Figure 17 show that, although routes do not match across the whole route, the part of the route closest to the town centre (and the air quality study area) at the beginning of the route matches very well. Likewise, in the opposite direction, Figure 18 to Figure 20 show that on approaching the town centre (at the end of the route), the observed and modelled times, follow a similar trend.

4.2.11 Finally, the A6 journey time routes show that there is too much delay at the beginning of the northbound route (Figure 21 to Figure 23), and at the end of the southbound route (Figure 24 to Figure 26). The model is therefore overestimating delay on this southern section of the A6. This has been investigated, and the delay are due to higher than observed wait times at signals. This is a limitation of the modelling approach, as no observed signal timings have been used here. Being a strategic model, the singular junction producing too much delay is unsurprising and not deemed critical to the data supplied for this air quality study.

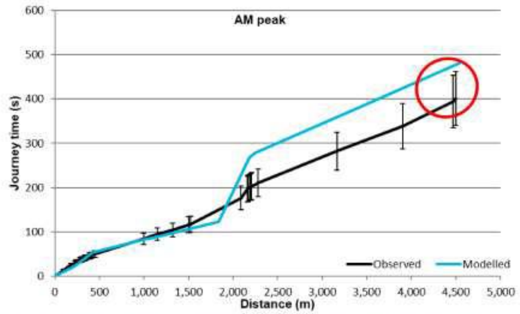

Figure 9: Modelled and Observed Journey Time, A505 Hatters Way Eastbound AM peak

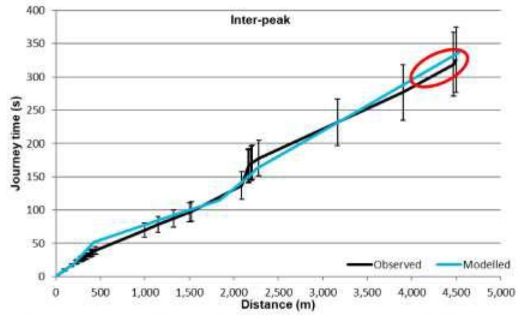

Figure 10: Modelled and Observed Journey Time, A505 Hatters Way Eastbound Interpeak

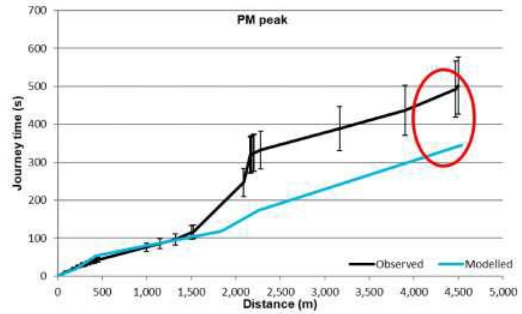

Figure 11: Modelled and Observed Journey Time, A505 Hatters Way Eastbound PM peak

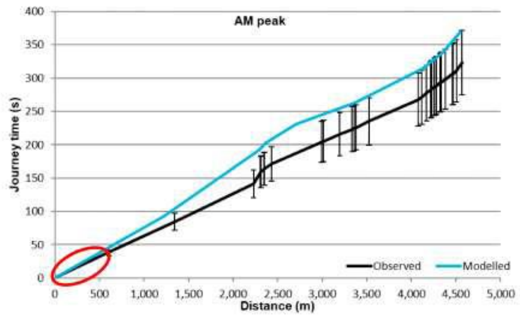

Figure 12: Modelled and Observed Journey Time, A505 Hatters Way Westbound AM peak

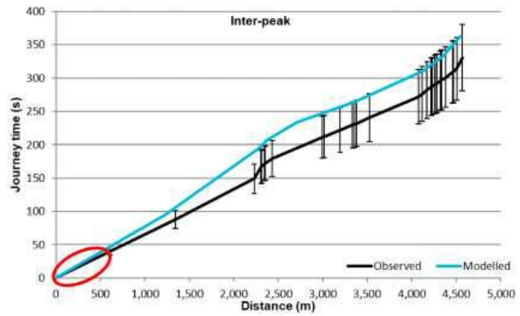

Figure 13: Modelled and Observed Journey Time, A505 Hatters Way Westbound Interpeak

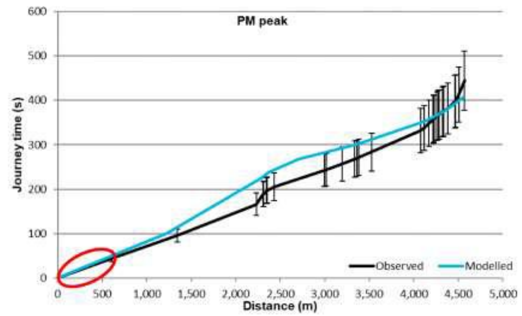

Figure 14: Modelled and Observed Journey Time, A505 Hatters Way Westbound PM peak

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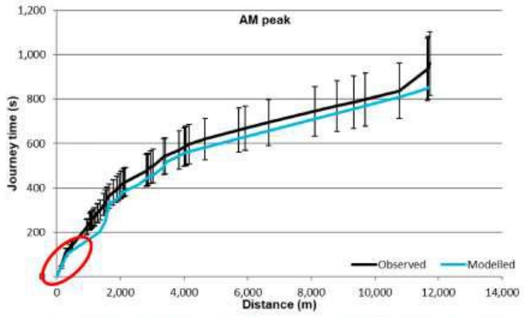

Figure 15: Modelled and Observed Journey Time, A505 Hitchin Eastbound AM peak

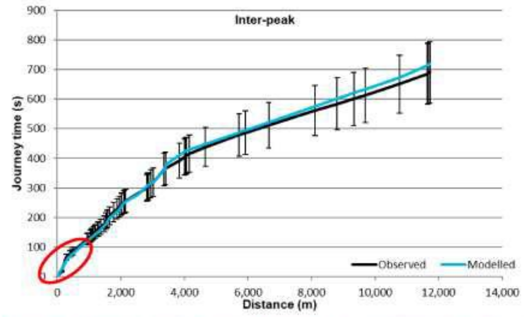

Figure 16: Modelled and Observed Journey Time, A505 Hitchin Eastbound Interpeak

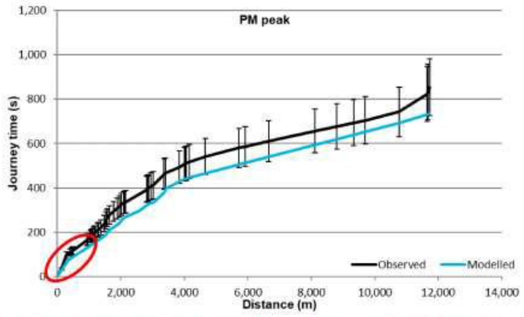

Figure 17: Modelled and Observed Journey Time, A505 Hitchin Eastbound PM peak

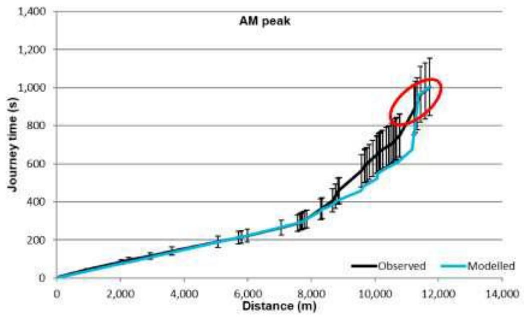

Figure 18: Modelled and Observed Journey Time, A505 Hitchin Westbound AM peak

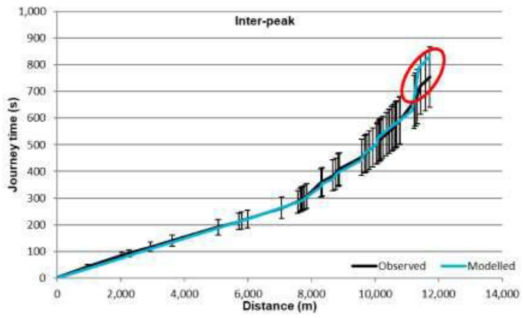

Figure 19: Modelled and Observed Journey Time, A505 Hitchin Westbound Interpeak

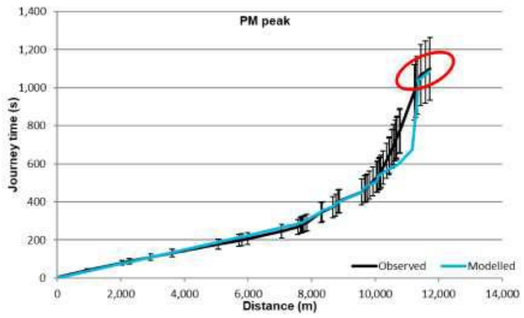

Figure 20: Modelled and Observed Journey Time, A505 Hitchin Westbound PM peak

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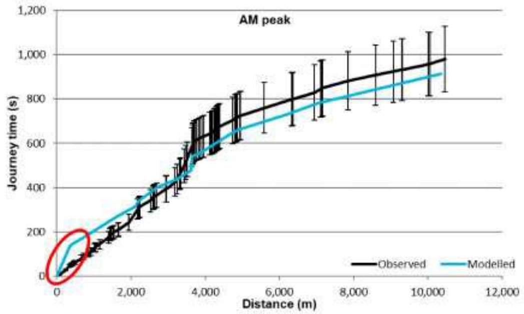

Figure 21: Modelled and Observed Journey Time, A6 (Southern Section) Northbound AM Peak

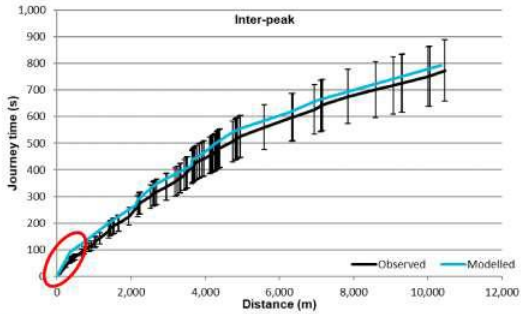

Figure 22: Modelled and Observed Journey Time, A6 (Southern Section) Northbound Interpeak

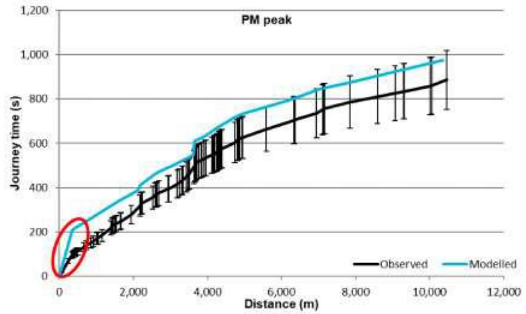

Figure 23: Modelled and Observed Journey Time, A6 (Southern Section) Northbound PM Peak

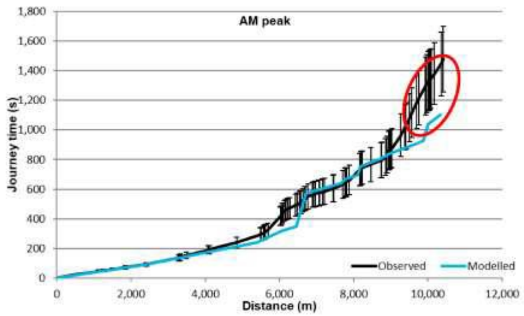

Figure 24: Modelled and Observed Journey Time, A6 (Southern Section) Southbound AM Peak

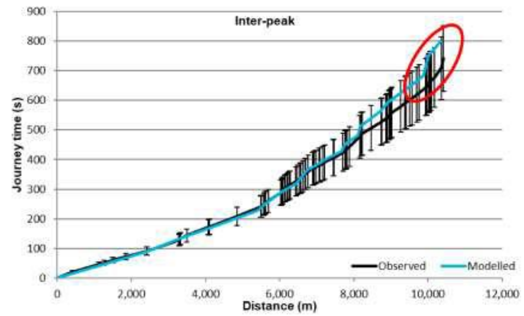

Figure 25: Modelled and Observed Journey Time, A6 (Southern Section) Southbound Interpeak

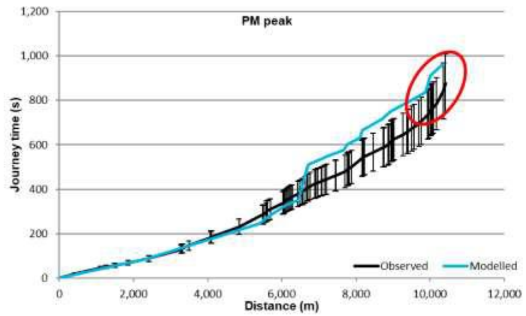

Figure 26: Modelled and Observed Journey Time, A6 (Southern Section) Southbound PM Peak

5 Summary

5.1.1 The CBLTM suite includes the Highway Assignment Model (built in SATURN), Public Transport Model (built in EMME), and Variable Demand Model (built in EMME). These models were developed with reference to national guidance, particularly from the DfT TAG and aims to accord with this guidance where possible in all modelling principles.

5.1.2 The model validates well compared to observed traffic count and journey time data. We see that traffic to and from Luton is modelled appropriately, and journey times validate overall. This Technical Note highlights that the number of counts and journey time routes in close proximity to the Air Quality study area is minimal. This means that traffic movements around the Luton AQMA and central area are not fully tracked. Network coverage around central Luton will also determine route options compared to reality. These points should be considered when utilising the data produced for the Luton Air Quality study.

5.1.3 In summary, the flow data produced from the model should be used with a certain degree of confidence, however the important caveats outlined in this technical note should be considered based on the strategic nature and resolution of the model. The model has not been developed for any specific scheme or policy assessment in Luton. Should any further more detailed analysis of the AQMA in central Luton be required, AECOM recommends that LBC consider collecting more localised data around the town centre and enhancing performance in this area.

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Appendix I: Luton Town Centre Air Quality Management Area Review (AECOM, January 2023)

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Luton Town Centre Air Quality Management Area Review

(Luton AQMA No. 3)

Luton Borough Council

Project number: 60677206

26 January 2023

Delivering a better world

Luton Town Centre Air Quality Management Area Review

Project number: 60677206

Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
0	07/07/2022	Draft	PF	Patrick Froggatt	Associate Director
1	26/01/2023	Draft	PF	Patrick Froggatt	Associate Director
2	02/03/2023	Final	PF	Patrick Froggatt	Associate Director

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Figures

Tables

1. Introduction

1.1 The requirements of Local Air Quality Management (LAQM) as set out in Part IV of the Environment Act 1995 (H.M Government, 1995) (and as amended 2021 (H.M, The Stationery Office, 2021)) places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether the Air Quality Strategy (AQS) objectives (Defra, 2007) are likely to be achieved. Where an exceedance is considered likely through monitoring or modelling, the local authority must declare an Air Quality Management Area (AQMA) and prepare an Air Quality Action Plan (AQAP) setting out the measures it intends to put in place in pursuit of the AQS objectives.

1.2 AECOM Limited (AECOM) worked alongside Luton Borough Council (LBC) to achieve two key objectives denoted as Task 1 and Task 2. These are:

- Task 1 - Address the deficiencies of the Town Centre AQAP identified within the LAQM Appraisal Report; specifically:
  - Use of old data (from 2016) in the road oxides of nitrogen (NO_x) calculations;
  - A limited source apportionment breakdown, by vehicle type only (no information on fuel type or age/emission class was provided);
  - Uncertainty regarding the necessary level of improvement, the calculation was not included; and
  - No quantification of expected improvements secured by recommended measures (the Council are additionally looking to evaluate selected existing interventions, as well as any additional measures that may be appropriate based on newly obtained fleet data).
- Task 2 - Addressing the persistent nitrogen dioxide (NO_2) exceedance at the Castle Street/Windsor Street/Hibbert Street junction (approximately 130 m outside AQMA No. 3) through an extension to AQMA No. 3.

1.3 The road NO_x calculations and source apportionment in Task 1 have been carried out in a separate technical note which is provided alongside this report. All other parts of Task 1 and Task 2 are detailed within this report.

2. Air Quality Strategy Objectives

2.1 The air quality strategy (AQS) objectives set out in the Air Quality (England) Regulations 2016 (H.M Government, 2016) provide the statutory basis for the AQS objectives under LAQM in England. Luton AQMA No.3 was declared on the basis of exceedances of the annual mean NO_2 AQS objective. Therefore this pollutant is the focus of this study. The relevant AQS objectives for the purpose of this assessment are set out in Table 2-1 below.

Table 2-1 Air Quality Strategy Objectives in England

Pollutant	Air Quality Strategy Objective	
	Concentration	Measured as
Nitrogen Dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean
	40 µg/m^3	Annual mean

3. Existing Air Quality Baseline Conditions

Air Quality Management Area

3.1 LBC declared the *"Town Centre"* Luton AQMA No.3 on 1st May 2016 following exceedances of the annual mean NO_2 AQS objective along the route of Stuart Street from Dunstable Road (by Kenilworth Road) to Chapel Viaduct (by Latimer Road).

3.2 Measured NO_2 annual mean concentrations at LBC monitoring sites within the AQMA are outlined in Table 3-1. The current extent of the AQMA is shown in Figure 1, Appendix A.

Table 3-1 Measured Annual Mean NO_2 Concentrations at Monitoring Sites within AQMA No. 3

Site Id	Site Name	Site Type	Annual mean NO_2 concentration (µg/m^3)				
			2016	2017	2018	2019	2020
LN60	Dunstable Road East (CRAQM2)	Automatic continuous monitor	**46.9**	39	37.2	**40.4**	28.3
LN52	Dunstable Road / Cardigan St Residential	Diffusion tube	**49.4**	**43**	39.5	**42.8**	33.0
LN61, LN62, LN63	Dunstable Road East (CRAQM 2A)	Diffusion tube	**45.4**	**41.9**	39.4	**40.7**	30.8
LN66	Park Viaduct	Diffusion tube	38.8	38.9	32.9	36.7	27.6

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

Background Concentrations

3.3 Defra publishes maps of background pollutant concentrations (Defra, 2020a) for each 1 km x 1 km grid square covering the whole of the United Kingdom. The most recent release of the background maps uses 2018 data as the reference year, and provides projections of background concentrations of NO_2 and NO_x from 2018 to 2030. The maps generally predict a decrease in concentrations in future years, based on national projections.

3.4 Using these background maps, the baseline year background concentrations of NO_2 and NO_x across AQMA No.3 are outlined in Table 3-2. The year 2018 is shown for consistency with the traffic data as discussed in section 4. Background NO_2 concentrations are below the annual mean AQS objective value.

Table 3-2 Defra Mapped 2018 Background Pollutant Concentrations within AQMA No. 3

Defra X, Y Grid Ref	Defra Mapped 2018 Concentrations (µg/m^3)	
	NO_2	NO_x
508500, 221500	21.8	32.0
509500, 221500	20.4	29.7
508500, 220500	17.0	23.7
509500, 220500	18.6	26.6

4. Assessment Methodology

4.1 This section presents the methodology used to model air quality in the study area. The following sources of information and data have been used to form the basis of the air quality assessment:

- Defra's Air Quality Background Concentration Maps based on a 2018 base year (Defra, 2020a);
- Defra's Vehicle Emission Factor Toolkit (EFT) version 11 (Defra, 2020b);
- Air quality monitoring data for 2018 (Luton Borough Council, 2021); and
- Traffic flows and speeds provided by AECOM's Transportation team for 2018.

4.2 The modelling assessment was conducted following the methodology within Defra's LAQM.TG(16) Technical Guidance (Defra, 2021).

Study Area

4.3 The study area encompasses the entire AQMA No. 3. Emissions from roads within 750 m of the AQMA were modelled, with some major roads extending out to approximately 1 km away from the AQMA boundary. The modelled gridded receptors covered the extent of the modelled road network. The extent of the study area can be seen in Figure 2, Appendix A.

Assessment Scenarios

4.4 A base year of 2018 was selected based on the availability of traffic data. The AECOM Transportation team are responsible for producing the Central Bedfordshire and Luton Transport Model (CBLTM) under framework agreement with Central Bedfordshire. This model extent covers the Air Quality study area surrounding AQMA No.3 and this data was utilised for the purposes of this Air Quality Assessment. The original traffic model was commissioned in 2009 and was subsequently updated to a base year of 2016 which also included the development of an enhanced public transport model in 2016/2017.

4.5 AECOM updated and enhanced the model from the 2016 base year of the original model to a base year of 2018, on behalf of Central Bedfordshire Council. This latest update was undertaken between 2019 – 2021 in close liaison with Department for Transport (DfT). Further details can be found in the Traffic Data Technical Note.

4.6 The following two scenarios have been considered:

- 2018 Base (2018 BY) – latest year with traffic and monitoring data available, to verify dispersion model and assess potential AQMA extension;
- 2018 Do Something (2018 DS) – latest year with traffic and monitoring data available as for the 2018 BY with the following measure implemented; the suspension of right turns at the Castle Street / Windsor Street / Hibbert Street junction.

Traffic Flow and Speed Data

4.7 Traffic flow data for the study area were provided by the AECOM Transportation Team as described in paragraph 4.4 above.

4.8 Data was provided in the form of annual average daily traffic (AADT) flows suitable for dispersion modelling. In a majority of cases, average speed data was also provided, and where this was not supplied, the speed limit was assumed to apply (with the exception of junctions, where the speed was lowered to assimilate traffic queuing effects).

4.9 The proportion of buses was not taken into account initially in the provided traffic flows, due to the CBLTM model being unable to accurately split out buses from heavy goods vehicles (HGVs) at the AQMA scale. Therefore, using three DfT count points within the model network, an average number of buses within the model road network was estimated and applied to those roads identified as having bus routes.

4.10 In the Do Something 2018 scenario, turning counts were provided from Castle Street onto Windsor Street in the form of AADT flows. Traffic prevented from turning right as a result of the no right turn measure was assumed to have continued southward on Castle Street instead of turning onto Windsor Street. The speed on the approach to the junction was also increased to represent improved flow as a result of the measure. Note that this scenario is based on manual amendments to the traffic data and does not represent a full transport assessment. The results are indicative only and do not take into account any redistribution of traffic further from the junction. The modelled road network domain is shown in Figure 2, Appendix A.

Emissions Modelling

4.11 The latest version of Defra's EFT (version 11) (Defra, 2020b) was used to calculate NO_x emissions by vehicle type for each road link for the assessment year of 2018. The 'Urban (not London)' road type was applied to all modelled road links.

Prediction of Air Quality Concentrations

4.12 The dispersion model ADMS Roads version 5.0.1.3 was used to quantify concentrations of NO_2 at selected receptors (see Appendix A) due to road traffic emissions (CERC, 2013). ADMS-Roads is a dispersion model that has an extensive published track record of use in the UK for the assessment of local air quality impacts, including model validation and verification studies.

Dispersion Model Input Data and Model Conditions

4.13 Details of general model conditions set up in ADMS-Roads are provided in Table 4-1.

Table 4-1 General ADMS-Roads model conditions

Variables	ADMS-Roads Model Inputs
Surface roughness at source (m)	1.5
Min Monin-Obukhov length (m)	100
Latitude(°)	52
Receptor locations	x, y coordinates determined by GIS, z = various. (See Appendix B)
Emission factors	EFT Version 11
Meteorological data	Luton Airport, 2018
Receptor types	Facades of selected receptors; Intelligent Gridding, 50 m x 50 m resolution on wider grid
Model output	Long-term (annual) mean NO_x concentrations.

Detailed Model Parameters

Meteorological Data

4.14 2018 meteorological data from Luton Airport's weather station, approximately 2.5 km to the east, has been used in this assessment. A wind rose for this data is shown in Figure 3, Appendix A.

4.15 Meteorological data should contain greater than 75% 'useable' data (i.e. less than 25% missing or calm hours in a year). Luton Airport 2018 had 8,478 useable lines of data out of 8,760, so 96.8% useable data, so was considered suitable for use in the dispersion modelling.

Predicting Short Term Objectives

4.16 Research projects completed on behalf of Defra and the Devolved Administrations have concluded that the hourly mean NO_2 AQS objective is unlikely to be exceeded if annual mean NO_2 concentrations are predicted to be less the 60 µg/m^3.

4.17 In 2003, Laxen and Marner (Laxen & Marner, 2003) concluded:

"…local authorities could reliably base decisions on likely exceedances of the 1-hour objective for nitrogen dioxide alongside busy streets using an annual mean of 60 µg/m³ and above."

4.18 The findings presented by Laxen and Marner (Laxen & Marner, 2003) are further supported by AEA (2008) (AEA Energy & Environment, 2008) who revisited the investigation to complete an updated analysis including new monitoring results and additional monitoring sites. The recommendations of this report are:

"Local authorities should continue to use the threshold of 60 µg/m³ NO_2 as the trigger for considering a likely exceedance of the hourly mean nitrogen dioxide objective."

4.19 This means that where predicted concentrations are below 60 µg/m³, it can be concluded that the hourly mean NO_2 AQS objective (200 µg/m³ NO_2 not more than 18 times per year) is likely to be achieved, which is the basis on which the conclusions of this assessment have been made.

Model Verification

4.20 Model verification is the process by which the performance of the model is assessed to identify any discrepancies between modelled and measured concentrations at air quality monitoring sites within the study area.

4.21 Model verification has been undertaken following the methodology described in LAQM.TG(16) (Defra, 2021). For NO_2, this verification process is supported by Defra's NO_x- NO_2 conversion tool (version 8.1, August 2020) to convert modelled NO_x from the road to NO_2 by taking into account the background concentrations (Defra, 2020c).

4.22 Modelled predictions were made for annual mean NO_2 concentrations at local authority monitoring sites to compare monitored and modelled NO_2 concentrations. The comparison of model outputs was made against selected 2018 monitoring data to correspond with the baseline year of assessment.

4.23 The model was found to perform differently in two distinct zones. Two adjustment factors, 3.71 and 1.52, have therefore been applied to the dispersion modelling outputs for 2018 to arrive at the final assessment results. A full description of model verification and the zones used is given in Appendix B.1.

Assessment Background Pollutant Concentrations

4.24 In the absence of appropriate monitored background concentrations representative of all the proposed receptor locations, the Defra mapped background concentrations have been added to the modelled road contributions to give total predicted concentrations of each pollutant. These are considered the most appropriate background concentrations to apply as they take account of spatial variation across the study area, rather than reliance on a few discrete monitoring locations.

4.25 Emissions from trunk roads and primary A roads within the study area were directly inputted to ADMS-Roads from the traffic model. To avoid double counting of emissions from these sources, sector removal of trunk roads and primary A roads was undertaken from the Defra mapped background concentrations. The background concentrations applied within the assessment are as outlined in Table 4-2. These represent background concentrations after sector removal of trunk roads and primary A roads within the grid square. Note that background concentrations across the AQMA prior to sector removal can be found in Table 3-2.

Table 4-2 Sector Removed Background NO_x and NO_2 Concentrations used within this Assessment

X,Y Grid Reference	2018 NO_x (µg/m³)	2018 NO_2 (µg/m³)
507500, 220500	19.6	14.4
508500, 220500	23.7	17.0
509500, 220500	25.7	18.1
510500, 220500	26.1	18.2
507500, 221500	22.9	16.5
508500, 221500	29.4	20.2
509500, 221500	29.0	20.0
510500, 221500	24.3	17.2
507500, 222500	25.8	18.2
508500, 222500	23.7	16.9

X,Y Grid Reference	2018 NO_x (µg/m^3)	2018 NO_2 (µg/m^3)
509500, 222500	23.2	16.6
510500, 222500	23.0	16.5
507500, 223500	22.8	16.4
508500, 223500	20.6	15.0
509500, 223500	20.0	14.6
510500, 223500	20.8	15.1

Receptors

Discrete Receptors

4.26 The concentration of road traffic emitted pollutants at the roadside and at sensitive receptors is influenced by a number of factors. These include background pollutant concentrations and the amount of traffic emissions, which is dictated by traffic flow rates, composition and speed.

4.27 The AQS objective values for pollutants have been set at concentrations that provide protection to all members of society, including more vulnerable groups such as the very young, elderly or unwell. As such the sensitivity of receptors was accounted for in the definition of the air quality objective values and therefore all receptors that represent exposure of the public are considered to be of equal sensitivity as any member of the public could be present at those locations.

4.28 Receptors to be considered against the annual mean AQS objective include public present in areas affected by regular exposure. This includes building facades of residential properties, schools, hospitals, care homes, etc. Receptors to be considered against the short-term hourly mean objective include members of the public present in areas where the annual mean AQS objective applies, but also areas with less regular exposure, such as any outdoor locations where the public might reasonably be expected to spend one hour or longer (e.g. gardens).

4.29 Commercial properties are not considered sensitive to changes in ambient pollutant concentrations and are legislated separately as part of health and safety regulations. These are therefore not included in the assessment.

4.30 The pollutant concentrations have been calculated at sixteen receptors selected around the Castle Street / Windsor Street / Hibbert Street junction. Each of the discrete receptors chosen are intended to represent the maximum level of exposure that could be experienced by other receptors in their vicinity, i.e. are 'worst case' locations. Additionally, there are five LBC monitoring locations either close to (<0.5 m) or at relevant exposure which were also modelled in the respective scenarios. The locations of these discrete receptors are shown in Figure 4 and Figure 5, Appendix A.

4.31 The selected discrete receptors are presented in Appendix A. Receptors have been modelled at 1.5 m representing the lowest floor of exposure.

Gridded outputs

4.32 Annual mean pollutant concentrations were also produced on a grid with a spatial resolution of 50 m x 50 m, in addition to employing the intelligent gridding option in ADMS-Roads, which added receptors with a finer spatial resolution closer to the road sources. This enabled the generation of concentration isopleths, which identified the extent of areas of elevated concentrations, for the determination of AQMA extent. The locations of these gridded points and road points are shown in Figure 6, Appendix A.

5. Results

AQMA Isopleth Plot

5.1 The contour plot of annual mean NO_2 concentrations in 2018 across Luton Town Centre AQMA No. 3 is shown in Figure 7, Appendix A.

5.2 Areas with modelled NO_2 concentrations above 40 µg/m^3 are highlighted in the plot (as recommended per para 7.78 of LAQM.TG(16) (Defra, 2021), and were used to determine changes in the extent of the AQMA. Modelling agrees with the current AQMA extent to a large degree with considerable parts of the AQMA still showing exceedances of NO_2 concentrations at sensitive receptors. There are also exceedances noted outside the current AQMA boundary, such as on Castle Street.

5.3 Modelled annual mean NO_2 concentrations along Mill Street and Hucklesby Way to the northeast of the AQMA are shown to be above the annual mean AQS objective levels for NO_2 (40 µg/m^3) in 2018. These roads are in close proximity to both Luton bus station and railway station. Due to limited information on bus movements, queuing and congestion in these areas, the model uncertainty is high.

5.4 Comparison to the monitoring data at these locations, shows that whilst exceedances have been recorded in the past at site LN73 (Mill Street), there were no exceedances recorded in 2018 (see Table 5-1). The model is, therefore, likely to be overestimating concentrations in this area. It is recommended that monitoring continues in this area and further detailed modelling carried out with higher resolution data should exceedances be recorded at monitoring sites in future years.

Table 5-1 LBC Annual Mean NO_2 Monitoring Results at Selected Sites

Site	X	Y	Site Type	NO_2 Annual Mean Conc. (µg/m^3)				
				2015	2016	2017	2018	2019
LN70	509813	221161	R	31	34	34	31	33
LN71	509549	221623	UB	28	32	31	31	31
LN72	508937	221745	UB	27	31	30	31	30
LN73	508959	221633	R	37	**44**	**42**	37	38

Note: Exceedances of the annual mean NO_2 AQS objective are shown in **bold**.

5.5 Within the isopleth plot shown in Figure 7, Appendix A, there are a number of roads/junctions (which include Hitchin Road/ Hucklesby Way, John Street/ Church Street and Crawley Green Road/Windmill Road) that appear to have high annual mean NO_2 concentrations in the area (as shown by the 40 µg/m^3 contour line), however, these are localised to the roads themselves. At sensitive receptor locations, the concentrations reduce to levels below the annual mean AQS objective for NO_2 and, therefore, do not present an exceedance. Monitoring sites in these locations (e.g. sites LN70 and LN71) do not note any exceedances in recent years (see Table 5-1).

5.6 Where sensitive receptors are located within the 40 µg/m^3 contour, these locations can be considered to be hotspots. On this basis, all other areas around the AQMA were observed to be below the annual mean AQS objective for NO_2. Exceedances around Castle Street are discussed in further detail in the following sections.

Castle Street Junction Results

5.7 As shown by the 2018 baseline modelling results, exceedances are noted along Castle Street, including at the junction of Castle Street / Windsor Street / Hibbert Street.

5.8 Table 5-2 presents the effects of implementing a suspension of right turns at the junction of Castle Street / Windsor Street / Hibbert Street on annual mean NO_2 concentrations at modelled discrete receptors. These locations are also displayed within Figure 4 and Figure 5, Appendix A, with the concentrations of the respective receptors provided at each location.

Table 5-2 Predicted Impacts on Annual Mean NO_2 concentrations, 2018

Site ID	X,Y OS Grid Ref	Description	2018 BY	2018 DS	Change in Annual Mean NO_2 ($\mu g/m^3$)
LN67*	509084, 220709	76 Castle Street	**46.9**	**40.3**	-6.6
LN68*	508969, 220487	2 London Road	29.2	29.5	0.3
LN78*	509109, 220676	2 Hibbert Street	26.6	26.1	-0.5
LN79*	509050, 220634	Portcullis Place	34.6	35.0	0.4
LN80*	509038, 220719	2 Windsor Street	36.0	34.5	-1.5
R1	509042, 220676	Medici Medical Centre	33.9	33.7	-0.3
R2	508912, 220703	Chapel Street Nursery School	24.9	24.8	-0.1
R3	509129, 220992	Wesley House	46.6	46.5	0.0
R4	509022, 220710	Medici Medical Centre	29.3	28.2	-1.1
R5	509056, 220654	119 Castle Street	**40.5**	**41.1**	0.6
R6	509078, 220727	76 Castle Street	47.3	42.6	-4.8
R7	509143, 220677	Hibbert Cottages	24.4	24.1	-0.3
R8	509086, 220687	6 Hibbert Street	32.5	31.4	-1.2
R9	509189, 220647	35 Hibbert Street	23.7	23.6	-0.1
R10	509118, 220744	Kelvin Close	32.1	30.1	-2.1
R11	509129, 220780	56 Castle Street	32.7	31.9	-0.8
R12	509159, 220837	49 Castle Street	32.9	32.7	-0.2
R13	509230, 220940	Hatbox	**41.8**	**41.8**	0.0
R14	509007, 220543	Castle Street/1 Cowper Street	37.4	38.2	0.8
R15	509011, 220379	35 London Road	31.8	32.4	0.6
R16	508996, 220595	Ceira Court	27.8	27.9	0.1

Notes: 2018 BY = 2018 Base Year. 2018 DS = 2018 Do Something.

* Denotes monitoring locations that are close to (<0.5 m) or already at relevant exposure (i.e. located at sensitive receptors). Exceedances of the NO_2 annual mean objective of 40 $\mu g/m^3$ are shown in **bold**.

5.9 There are five existing receptors predicted to exceed the AQS annual mean NO_2 objective in the 'BY 2018 scenario, with two additional receptors predicted to be within 10% of the AQS objective. In the 'Do Something' scenario, the same five existing receptors are predicted to exceed the AQS annual mean NO_2 objective, with one receptor predicted to be within 10% of the AQS objective. The highest predicted annual mean NO_2 concentration is 47.3 $\mu g/m^3$ at Receptor R6 in the 'Base Year' scenario. However, concentrations at Receptor R6 are substantially reduced in the 'Do Something' scenario, where the highest predicted annual mean NO_2 concentration is instead at Receptor R3 (46.5 $\mu g/m^3$).

5.10 The predicted annual mean concentration is below 60 $\mu g/m^3$ at all receptors, which suggests that the short-term NO_2 AQS objective is unlikely to be exceeded.

5.11 There is a predicted increase in annual mean NO_2 concentrations at six receptor locations. The largest increase in annual mean NO_2 concentrations is predicted at Receptor R14, with an increase of 0.8 $\mu g/m^3$. Receptors which show an increase in annual mean NO_2 concentrations (LN68, LN79, R5, R14, R15 and R16) are all located south of the Castle Street / Windsor Street / Hibbert Street junction, where the suspension of right turns will likely lead to an increase in traffic.

5.12 There is a predicted decrease in annual mean NO_2 concentrations at fifteen receptor locations. The largest decrease in annual mean NO_2 concentrations is predicted at Receptor LN67, with a decrease of 6.6 $\mu g/m^3$. Receptors LN67 and R6 are located along the approach to the Castle Street / Windsor Street / Hibbert Street junction and show the largest decrease in annual mean NO_2 concentration, due to reduced queuing as a result of the measure. There are also improvements at receptors on Windsor Street (Receptors LN80 and R4) due to reduced traffic flows here.

5.13 Contour plots around Castle Street / Windsor Street / Hibbert Street junction for the 2018 BY and 2018 DS scenarios have been produced in Figure 4 and Figure 5, Appendix A. The contour plots display the current extent of the AQMA which covers the northern portion of Castle Street down to Holly Street. The NO_2 concentrations discussed above show exceedances remain around the Castle Street / Windsor Street / Hibbert Street junction and this extends down towards Receptor R14 located close to the corner of Stockwood Crescent and Castle Street. Receptor R14 was modelled to have an annual mean NO_2 concentration of 37.4 $\mu g/m^3$ in the 2018 BY scenario and this increased slightly (38.2 $\mu g/m^3$) in the 2018 DS scenario as a result of the intervention measure applied to the junction.

5.14 Receptors further south on Castle Street past Receptor R14 do not display concentrations close to or above the NO_2 annual mean AQS objective (Receptor R15 had a modelled annual mean NO_2 concentration of 27.8 $\mu g/m^3$ in 2018). As such, it is recommended that the AQMA be extended along Castle Street further south to Stockwood Crescent to ensure that all relevant hotspots are captured within the amended AQMA. The extended portion of the AQMA is shown in Figure 8, Appendix A.

Other Intervention Measures

5.15 Whilst the measure of a no right turn implementation at Castle Street / Windsor Street / Hibbert Street was modelled in detail, quantification of expected impacts can also be calculated for a number of other measures in the Luton AQAP.

5.16 In Defra's appraisal of the Luton AQAP, there was a concern that no quantification of expected improvements secured by recommended measures was made. To address this, emissions reduction calculations have been made for a number of measures. This includes 8 measures that lend themselves to such quantification (namely measures 8-12, 16, 22 and 24).

5.17 In Table 5-3, the NO_x emissions reduction for respective measures 8 - 12, 16, 22 and 24 are outlined. Measures 8,10 and 11 were grouped together with similar changes required to calculate the NO_x emission reductions. The change made to the EFTs to account for each measure and limitation/assumption are also provided in the table. An average NO_x emissions reduction is given in the table (and where possible a potential maximum is given for road links) across the area impacted by the measure.

Table 5-3 NO_x reduction calculations of other intervention measures

Measure No.	Description of Measure	Implementation of measures in EFT calculations	Assumptions and Limitations	NO_x emission reductions on average (potential maximum of different road links considered)
8	Promote / encourage more take-up of the electric vehicle Town Centre car club with residents and businesses in the town centre	The vehicle fleet portion for 2018 was amended to use the 2030 vehicle fleet split for Electric Vehicles to account for a shift from use of traditional vehicles (such as Petrol and Diesel vehicles).	The update to the 2030 electric vehicle fleet split may not represent a realistic uptake of EVs by public.	4% (5%)
10	Encourage greater uptake of clean energies. Provide charging points at town centre taxi ranks, car parks and on-street for electric vehicles, with free/ reduced parking during charging period. Encourage new developments to incorporate electric car charging points. (Prioritise AQMA 3)			
11	Hold electric vehicle (EV) pop-up events in Luton town centre to showcase the variety of EVs that are available to help inform people. In coordination with Luton BID and local EV dealers.			

Luton Town Centre Air Quality Management Area Review

Measure No.	Description of Measure	Implementation of measures in EFT calculations	Assumptions and Limitations	NO_x emission reductions on average (potential maximum of different road links considered)
9	Investigate implementing a Clean Air/Low Emissions Zone in the town centre	Application of base level Clean Air Zone (Zone A). The euro split compositions for Bus & Coaches are equal to and above Euro VI. Taxis have also been improved to Euro IV.	Assume 100% compliance with Clean Air Zone A.	14% (30%)
12	Work with operators to introduce hybrid/low emission buses on routes within the AQMA 3 area.	The euro split compositions for Bus have been amended to be equal to or above Euro VI.	Assume that all buses running through AQMA are operated by LBC. Further improvements (including the shift towards EVs buses) could not be determined through calculation and modelling.	9% (18%)
16	Review 20mph zones in and around the AQMA3 to encourage traffic calming and lower speeds.	Within the current boundaries of the AQMA, speeds for all links were amended to 20 mph (32 kph).	Achieving speeds of 20 mph across the AQMA may be unrealistic in practice.	4% (Junction reduce by up to 20% and Free Flow roads reduce by up to 0.8%)
22	Emissions reduction – investigate the expansion of the pedestrianised area around the town centre, either permanently or at peak times.	Roads to the north of Shopping Centre within 200m (Guilford Street, John Street, Cheapside and Bute Street).	Removal of NOx emissions from this area, however traffic may be rerouted through other roads with these impacts not investigated.	1%
24	Improvement of Chapel viaduct / Castle Street roundabout	Applied a 5% increase in speeds on roundabout and associated connecting roads to simulate improvement in vehicle flow.	The change in speeds was applied as an approximate figure, with the actual levels of impact on traffic flow currently unknown.	4.6% (3%)

Prepared for: Luton Borough Council

6. Conclusions and Recommendations

6.1 Modelling of Luton's AQMA No.3 demonstrates that exceedances of the annual mean NO_2 AQS objective occur outside the current AQMA boundaries in the 2018 base year. These exceedances extend southwards from the AQMA on Castle Street down to the Stockwood Crescent / Castle Street / Cowper Street / London Road junction at relevant receptors. Whilst the contour plots show concentrations over 40 µg/m^3 extending down to the junction with Ashton Road, these exceedances are in the road not at properties.

6.2 As such, it is recommended that AQMA No. 3 is extended along Castle Street southward to the Stockwood Crescent / Castle Street / Cowper Street / London Road junction to ensure that all relevant hotspots are captured within the amended AQMA.

6.3 Calculations of NO_x reductions associated with proposed measures in the Luton AQAP have been carried out for 8 measures. The NO_x emission reductions were found to be on the order of 1-14% on average. There are a number of soft policy measures and measures that do not lend themselves to quantification of impacts included within Luton's AQAP (namely measures 1-7,13,15, 17-20). Therefore it is suggested that KPI's are used to help monitor the success of such measures. These KPI's could be developed from those already included in the Luton AQAP, for example tracking the number of car club users, assessing the update of clean energy vehicles by local businesses, reporting the number of EV charge points and monitoring the number of workplace travel plans in place.

6.4 Defra provides examples of adopted AQAPs, which show a range of approaches taken by local authorities in the development of Plans. These examples of best practice are made on the basis of the overall approach taken by the authority, or the endorsement of specific elements of the plan, which may prove useful to other authorities. AQAPs that are highlighted as examples of good practice can be found online at https://laqm.defra.gov.uk/air-quality/action-planning/examples-of-good-practice/.

6.5 An air quality hub has been developed by the Low Emission Partnership and funded by Defra to share resources and knowledge online between local authorities[1]. The hub contains case studies and advice notes, as well as acting as a location to share best practice. LBC may wish to use this resource when further developing their AQAP.

[1] https://www.airqualityhub.co.uk/

7. References

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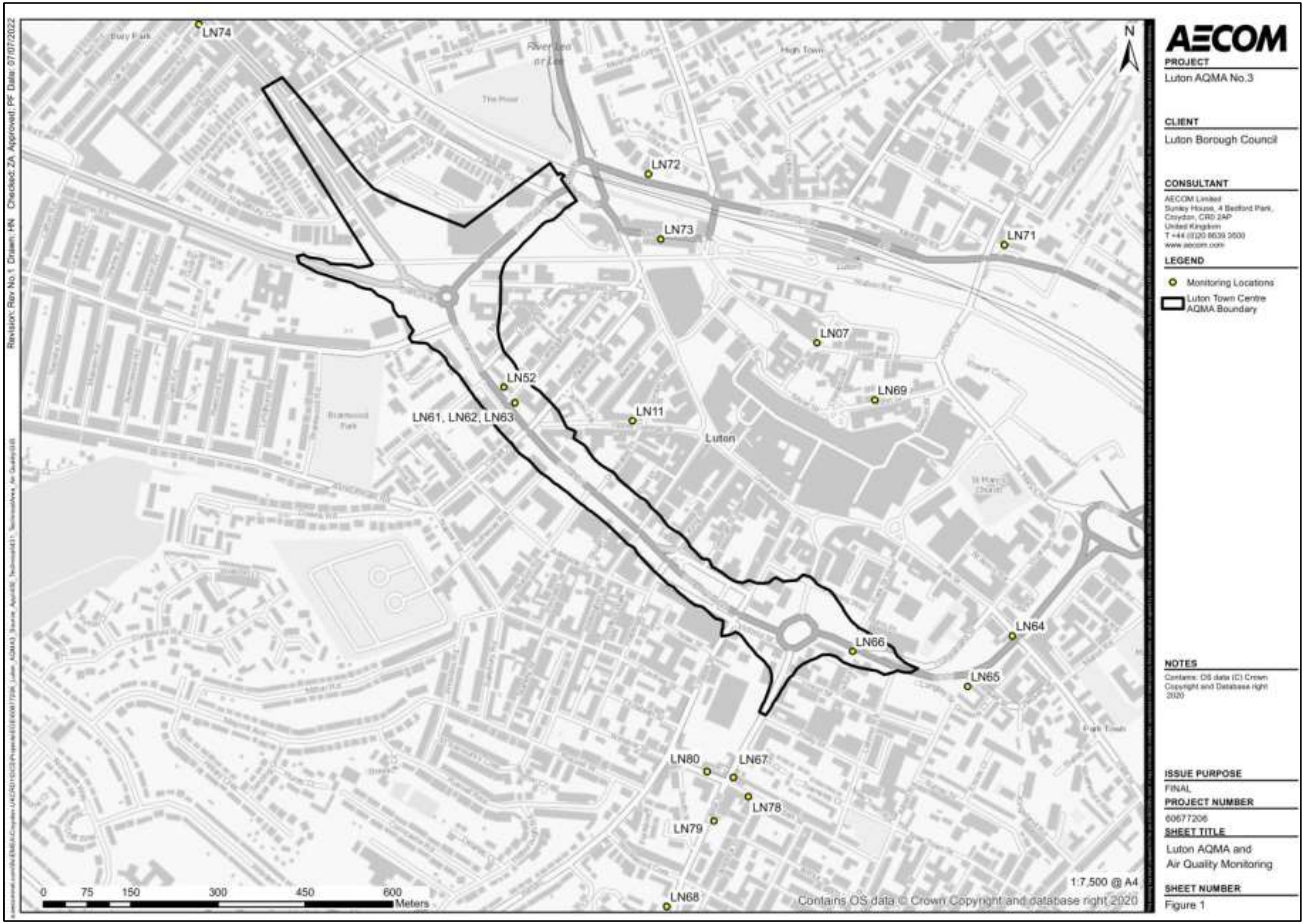
Luton Town Centre Air Quality Management Area Review

Appendix A Figures

Prepared for: Luton Borough Council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LN67
LN78
LN79
LN68
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CLIENT
Luton Borough Council
CONSULTANT
LEGEND
Monitoring Locations
Luton Town Centre AQMA Boundary
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60677206
SHEET TITLE
Luton AQMA and Air Quality Monitoring
SHEET NUMBER
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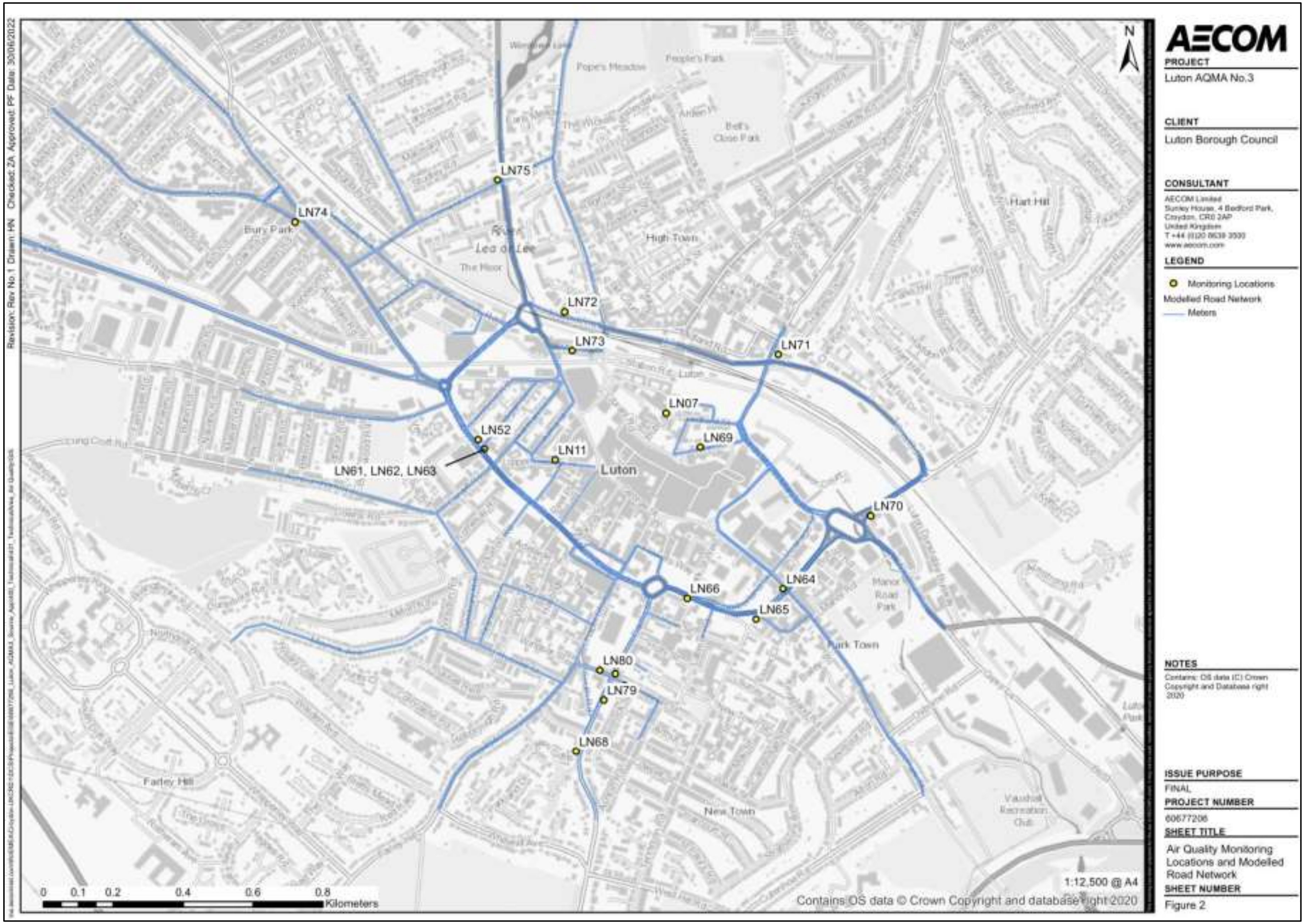
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LN68
Bury Park
High Town
Hart Hill
Park Town
New Town
Farley Hill
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Luton Borough Council
CONSULTANT
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Monitoring Locations
Modelled Road Network
Meters
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Air Quality Monitoring Locations and Modelled Road Network
SHEET NUMBER
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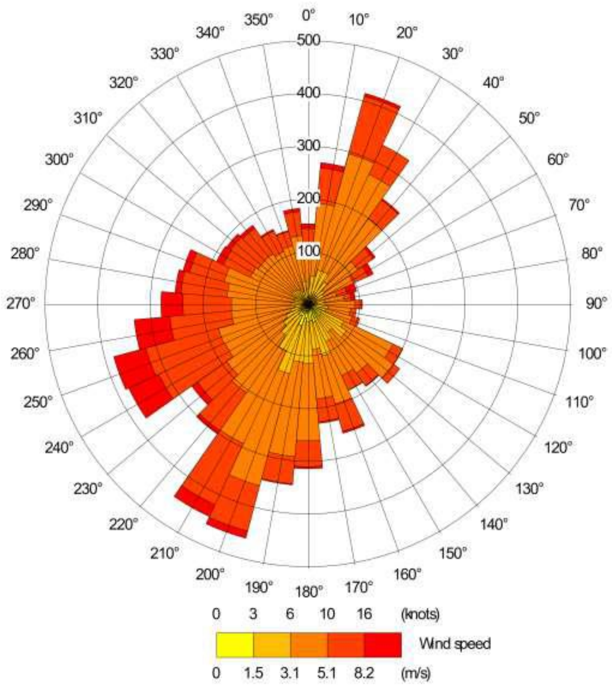
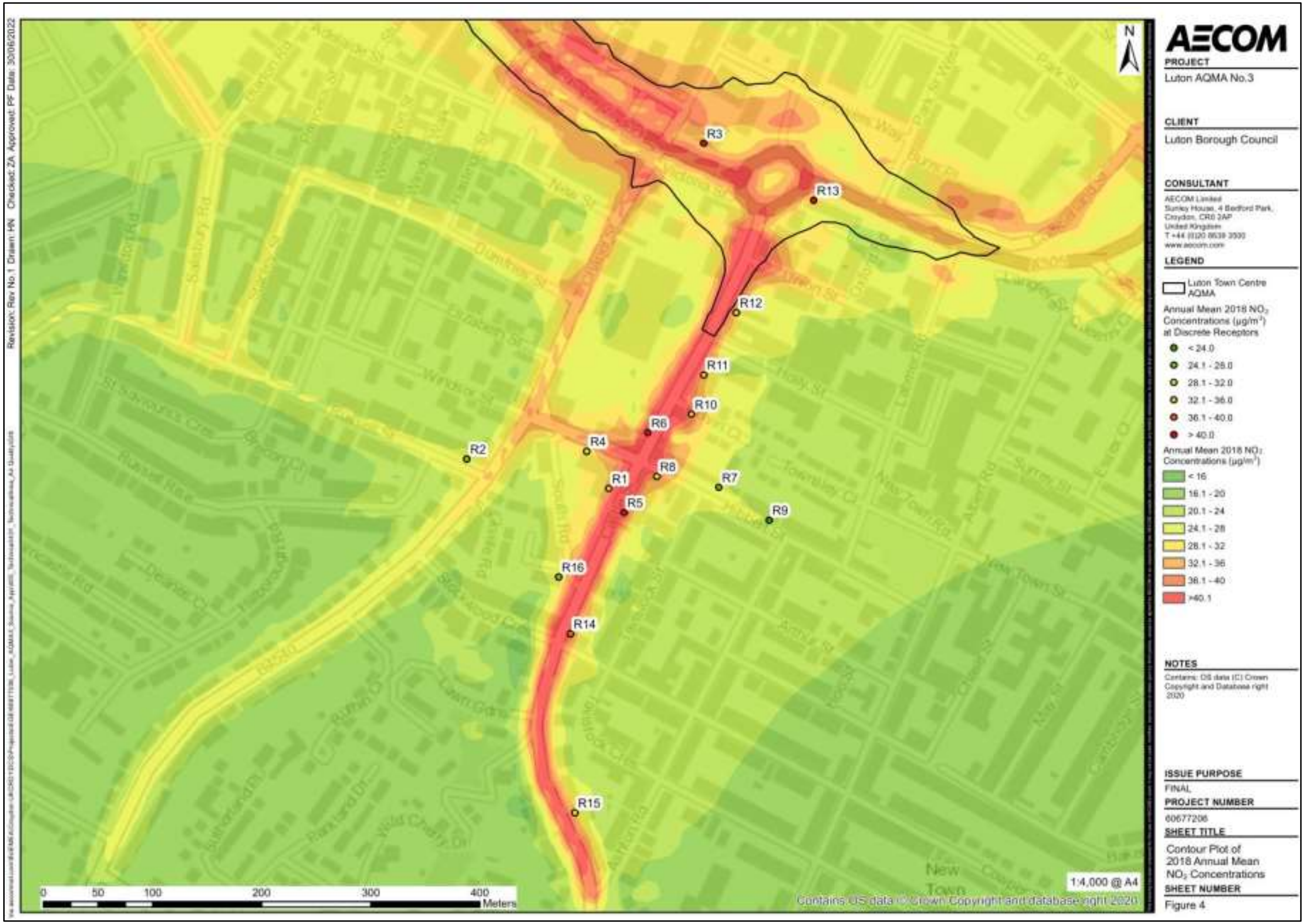
Figure 3 Windrose of 2018 Luton Airport Meteorological Data





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Luton Borough Council
CONSULTANT
LEGEND
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Annual Mean 2018 NO2 Concentrations (µg/m³) at Discrete Receptors
< 24.0
24.1 - 28.0
28.1 - 32.0
32.1 - 36.0
36.1 - 40.0
> 40.0
Annual Mean 2018 NO2 Concentrations (µg/m³)
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16.1 - 20
20.1 - 24
24.1 - 28
28.1 - 32
32.1 - 36
36.1 - 40
>40.1
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FINAL
PROJECT NUMBER
60677206
SHEET TITLE
Contour Plot of 2018 Annual Mean NO2 Concentrations
SHEET NUMBER
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R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
1:4,000 @ A4
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PROJECT
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CLIENT
Luton Borough Council
CONSULTANT
LEGEND
Luton Town Centre AQMA
Annual Mean 2018 DS Scenario NO_2 Concentrations (µg/m³) at Discrete Receptors
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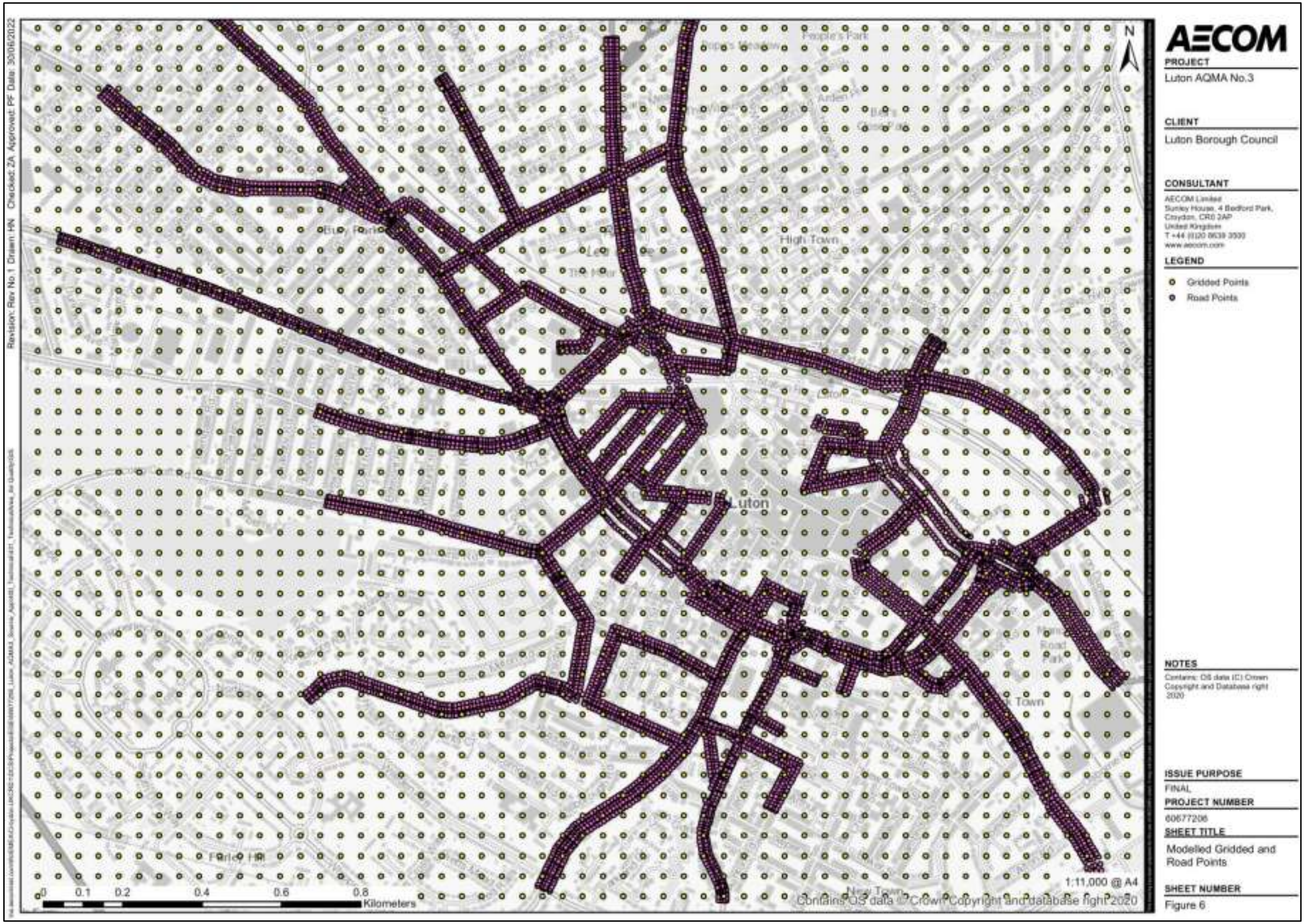
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AECOM Limited
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LEGEND
Gridded Points
Road Points
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ISSUE PURPOSE
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SHEET TITLE
Modelled Gridded and Road Points
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Figure 6
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High Town
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Bury Park
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Kilometers
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LEGEND
Luton Town Centre AQMA
Contour Line for Annual Mean 2018 NO2 Concentrations (µg/m³)
Annual Mean 2018 NO2 Concentrations (µg/m³)
< 16
16.1 - 20
20.1 - 24
24.1 - 28
28.1 - 32
32.1 - 36
36.1 - 40
>40.1
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Contains: OS data (C) Crown Copyright and Database right 2020
ISSUE PURPOSE
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Contour Plot of 2018 Annual Mean NO2 Concentrations
SHEET NUMBER
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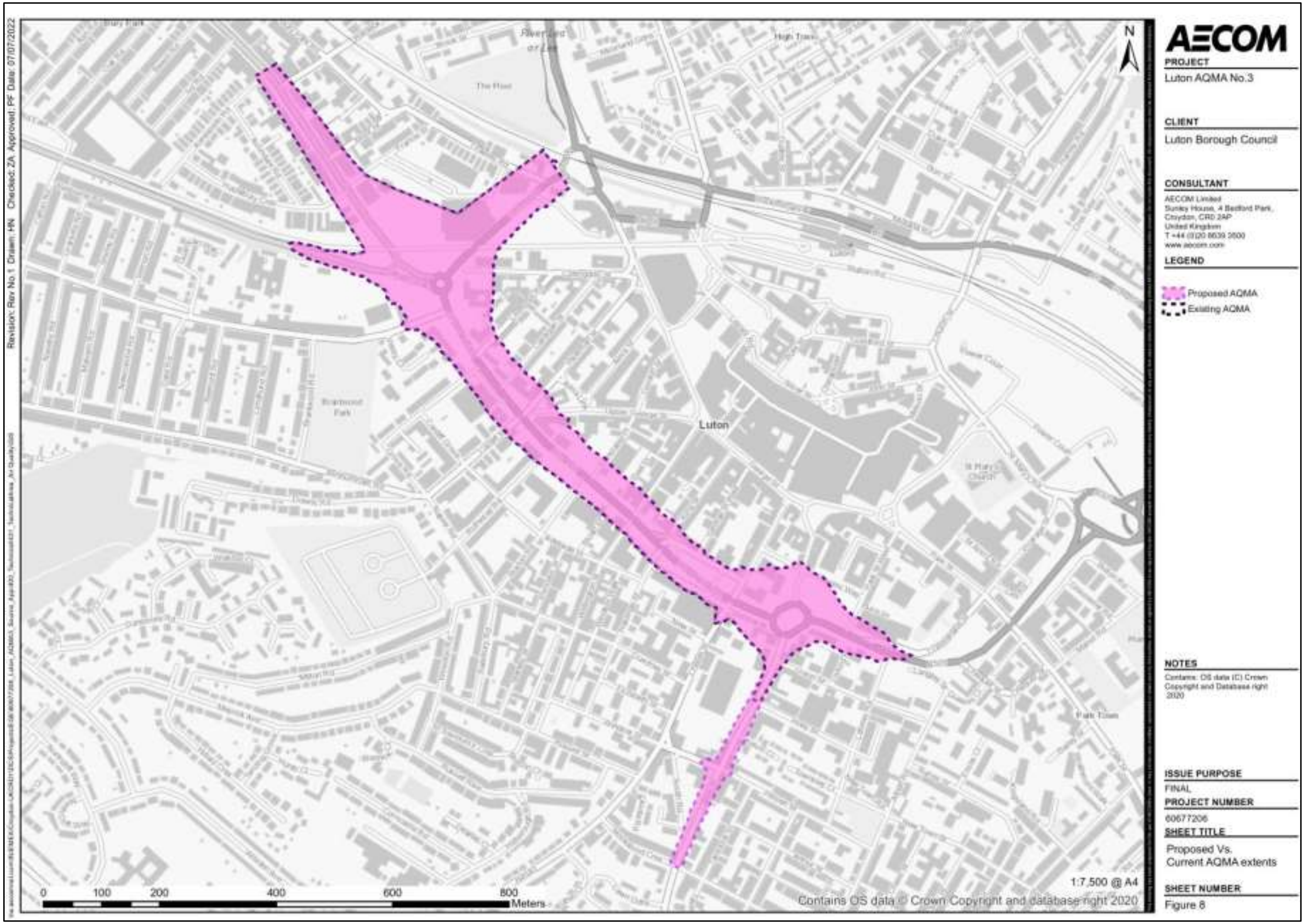
High Town
Park Town
Farley Hill
New Town
Revision: Rev No 1 Drawn: HN Checked: ZA Approved: PF Date: 30/06/2022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SHEET TITLE
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SHEET NUMBER
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Contains OS data © Crown Copyright and database right 2020
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Meters

Appendix B Technical Appendices

B.1 ADMS Model Verification

A number of the sites that could potentially have been used for verification had to be excluded from consideration in the final verification factors, the reasons for which are summarised in Table A.1.

Table A.1 Monitoring Site Exclusions

Site ID	Type	Reason for Exclusion
LN07	Roadside	This site is located on a road which was not modelled.
LN61, LN62, LN63	Roadside	This is a triplicate site co-located with Automatic Monitor, LN60, which has higher accuracy than the diffusion tube.
LN71	Urban Background	An urban background site which is not representative of road traffic emissions.
LN72	Urban Background	An urban background site which is not representative of road traffic emissions.

Table A.2 presents a summary of the model performance prior to bias adjustment.

Table A.2: Comparison of Unadjusted Results Against Monitoring Results Across All Domains

Domain Name	Site ID	Background NO_2 ($\mu g/m^3$)	Monitored total NO_2 ($\mu g/m^3$)	Modelled total NO_2 ($\mu g/m^3$)	% Diff. unadjusted modelled NO_2 vs. monitored NO_2
Zone A – Main Zone	LN11	20.2	33.6	24.6	-26.8
	LN67	18.1	41.1	26.65	-35.2
	LN68	17.0	30.8	20.41	-33.7
	LN69	20.0	29.1	21.75	-25.3
	LN73	20.2	37.1	23.79	-35.9
	LN74	16.9	34.8	19.19	-44.9
	LN75	16.9	35.8	22.51	-37.1
	LN78	18.1	28.7	20.45	-28.7
	LN79	18.1	37.3	22.8	-38.9
	LN80	18.1	36.8	23.23	-36.9
Zone B – Dunstable Road	LN52	20.2	39.5	31.75	-19.6
	LN64	18.1	28.1	25.39	-9.6
	LN65	18.1	23.3	21.28	-8.7
	LN70	20.0	30.8	26.4	-14.3
	LN60	20.2	37.2	34.27	-7.9
	LN66	18.1	32.9	25.35	-22.9

These comparisons show that the model had a tendency to under predict annual mean concentrations of NO_2 with 10 sites under predicting by more than 25%.

An adjustment factor was applied to the modelled road NO_x concentrations to adjust for model bias. The comparison of modelled with measured values was then repeated. The results are shown in Table A.3.

Table A.3: Adjustment Factor and Comparison of Verified Results Against Monitoring Results Across All Domains

Domain	Site ID	Ratio of modelled road NO_x vs. monitored road NO_x	Adjustment factor for modelled road NO_x	Adjusted modelled road NO_x ($\mu g/m^3$)	Modelled total NO_2 ($\mu g/m^3$)	Monitored total NO_2 ($\mu g/m^3$)	% Diff. adjusted modelled NO_2 vs. monitored NO_2
Zone A – Main Zone	LN11	-69%	3.71	31.17	35.7	33.6	6.1
	LN67	-65%		61.40	46.9	41.1	14.0
	LN68	-76%		24.02	29.2	30.8	-5.1
	LN69	-82%		12.23	26.3	29.1	-9.5
	LN73	-80%		25.31	32.9	37.1	-11.3
	LN74	-88%		15.92	25.2	34.8	-27.7
	LN75	-72%		39.59	36.4	35.8	1.7
	LN78	-79%		16.36	26.6	28.7	-7.5
	LN79	-77%		33.11	34.6	37.3	-7.3
	LN80	-74%		36.20	36.0	36.8	-2.2
Zone B – Dunstable Road	LN52	-42%	1.52	34.80	37.3	39.5	-5.5
	LN64	-28%		21.34	29.0	28.1	3.2
	LN65	-40%		9.11	22.9	23.3	-1.7
	LN70	-42%		18.85	29.6	30.8	-3.9
	LN60	-18%		42.93	40.9	37.2	10.0
	LN66	-53%		21.22	29.0	32.9	-12.0

The model underpredicts NO_2 concentrations at 11 of the 16 sites, 10 within the ±25% margin acceptable within model verification, and 8 are within the desirable ±10% margin. The model overpredicts NO_2 concentrations at 5 of the 16 sites, all of which are within the ±25% margin acceptable within model verification, and 4 are within the desirable ±10% margin.

The model performs differently in the two areas, and as such, a distinct adjustment factor is determined for each of the respective zones to improve model performance as per LAQM.TG.16 (Defra, 2021). The adjustment factors in each domain were subsequently derived. Each factor was applied to the road NO_x concentrations predicted by the model in the appropriate domain, then added to the background concentration, to arrive at the final NO_2 concentrations. The root mean squared error (RMSE) and fractional bias values are summarised before and after adjustment for each domain in Table A.4. The RMSE provides an indication of the uncertainty of the model and the fractional bias indicates if the model is under or overpredicting concentrations.

Table A.4: Performance of Adjusted Model Output

Domain	RMSE ($\mu g/m^3$)		Fractional Bias	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Zone A – Main Zone	10.2	4.1	0.3	0.0
Zone B -Dunstable Road	10.2	2.5	0.3	0.0

With the unadjusted model results, the RMSE was 10.2 $\mu g/m^3$, while with the adjusted model results this was reduced to 4.1 $\mu g/m^3$ and 2.5 $\mu g/m^3$ in Zones A and B respectively. The adjustment has reduced the average error or uncertainty in the model results. The fractional bias was 0.3 with the unadjusted model which shows a slight tendency to under predict. The adjusted model shows a fraction bias of zero in both zones which shows that the under prediction has been removed.

B.2 Modelled Discrete Receptors

Existing receptors were identified near roads that are likely to be affected by the suspension of right turns at the Castle Street / Windsor Street / Hibbert Street. The same receptors were assessed for each of the scenarios assessed. Concentrations have been predicted at the ground floor. These receptors are outlined in Table 7-1.

Table 7-1 Modelled Discrete Receptors

Receptor ID	X, Y OS Grid Ref	Description	Type	Receptor Height (m)
LN67	509084, 220709	76 Castle Street	Residential	2.7
LN68	508969, 220487	2 London Road	Residential	2.57
LN78	509109, 220676	2 Hibbert Street	Residential	2.4
LN79	509050, 220634	Portcullis Place	Residential	3
LN80	509038, 220719	2 Windsor Street	Residential	2.33
R1	509042, 220676	Medici Medical Centre	Hospital	1.5
R2	508912, 220703	Chapel Street Nursery School	School	1.5
R3	509129, 220992	Wesley House	Residential	1.5
R4	509022, 220710	Medici Medical Centre	Hospital	1.5
R5	509056, 220654	119 Castle Street	Residential	1.5
R6	509078, 220727	76 Castle Street	Residential	1.5
R7	509143, 220677	Hibbert Cottages	Residential	1.5
R8	509086, 220687	6 Hibbert Street	Residential	1.5
R9	509189, 220647	35 Hibbert Street	Residential	1.5
R10	509118, 220744	Kelvin Close	Residential	1.5
R11	509129, 220780	56 Castle Street	Residential	1.5
R12	509159, 220837	49 Castle Street	Residential	1.5
R13	509230, 220940	Hatbox	Residential	1.5
R14	509007, 220543	Castle Street/1 Cowper Street	Residential	1.5
R15	509011, 220379	35 London Road	Residential	1.5
R16	508996, 220595	Ceira Court	Residential	1.5

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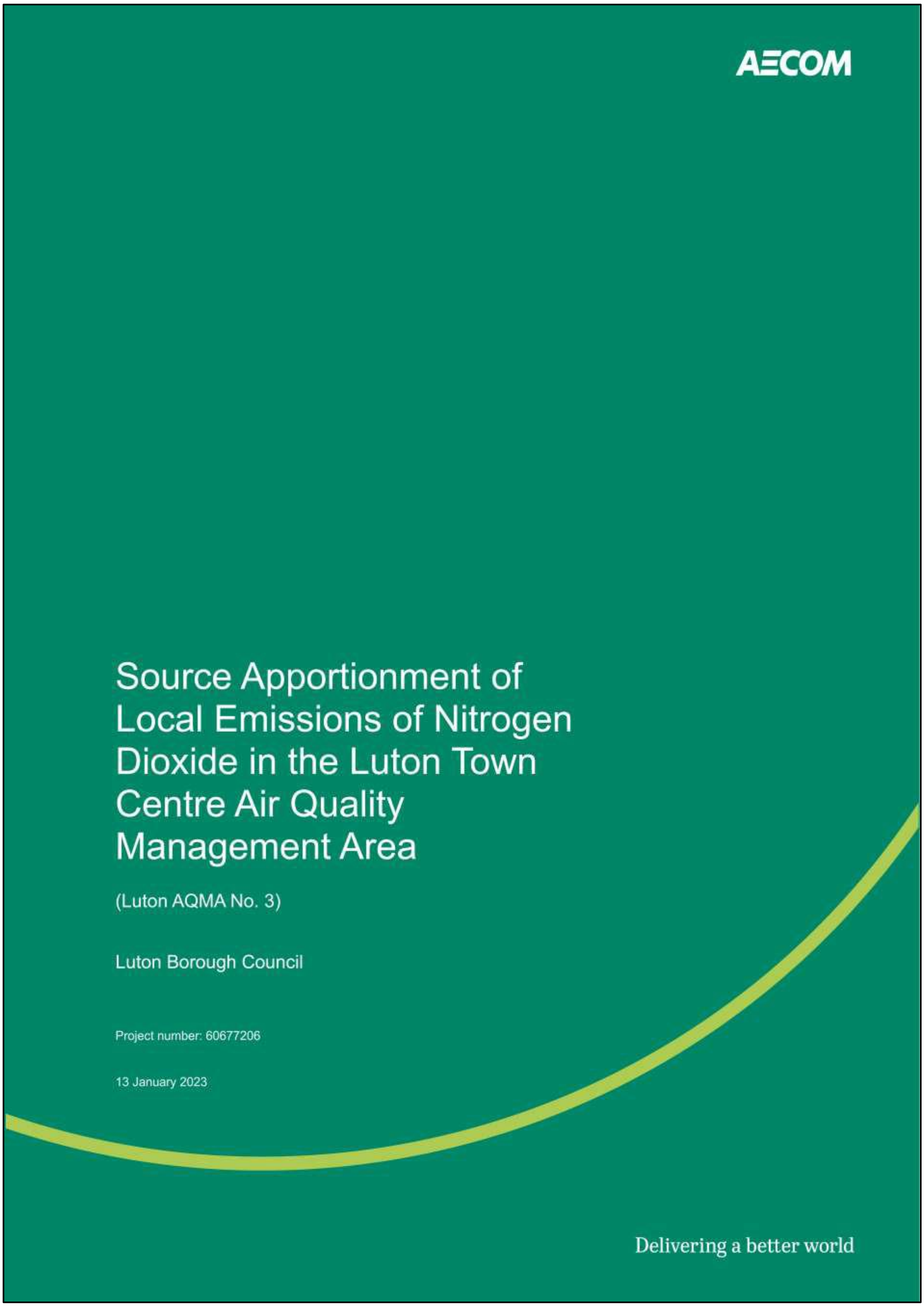
Appendix J: Source Apportionment of Local Emissions of Nitrogen Dioxide in the Luton Town Centre Air Quality Management Area (AECOM, January 2023)



AECOM

Source Apportionment of Local Emissions of Nitrogen Dioxide in the Luton Town Centre Air Quality Management Area

(Luton AQMA No. 3)

Luton Borough Council

Project number: 60677206

13 January 2023

Delivering a better world

Source Apportionment of Local Emissions of Nitrogen Dioxide in the Luton Town Centre Air Quality Management Area

Project number: 60677206

Quality information

Prepared by	Checked by	Verified by	Approved by
Hiren Nakum	Zadie Astill	Anna Savage	Patrick Froggatt
Air Quality Consultant	Principal Air Quality Consultant	Associate Air Quality Director	Associate Air Quality Director

Revision History

Revision	Revision date	Details	Authorized	Name	Position
0	07/07/22	Draft	PF	Patrick Froggatt	Associate Director
1	13/01/23	Final	PF	Patrick Froggatt	Associate Director

Distribution List

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Hiren Nakum
Air Quality Consultant
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Table of Contents

Figures

Tables

1. Introduction

1.1 The requirements of Local Air Quality Management (LAQM) as set out in Part IV of the Environment Act 1995 (H.M Government, 1995) (and as amended 2021 (H.M, The Stationery Office, 2021)) places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether the Air Quality Strategy (AQS) objectives (Defra, 2007) are likely to be achieved. Where an exceedance is considered likely through monitoring or modelling, the local authority must declare an Air Quality Management Area (AQMA).

1.2 Policy Guidance (LAQM.PG16) (Defra, 2016) requires a Local Authority to produce an Air Quality Action Plan (AQAP) following declaration of an AQMA setting out the measures it intends to put in place in order to improve air quality so that the AQS objective is achieved. In order to develop an appropriate plan it is necessary to identify the pollution sources that are contributing to the exceedances of the AQS objective within the AQMA.

1.3 This source apportionment report fulfils the requirements of the Local Air Quality Management (LAQM) process as set out in Part IV of the Environment Act (1995) (H.M Government, 1995) (and as amended 2021 (H.M, The Stationery Office, 2021)) and the relevant Policy and Technical Guidance documents.

1.4 AECOM Limited (AECOM) worked alongside Luton Borough Council (LBC) to achieve two key objectives denoted as Task 1 and Task 2. These are:

- Task 1 - Address the deficiencies of the Town Centre AQAP identified within the LAQM Appraisal Report; specifically:
  - Use of old data (from 2016) in the road oxides of nitrogen (NO_x) calculations;
  - A limited source apportionment breakdown, by vehicle type only (no information on fuel type or age/emission class was provided);
  - Uncertainty regarding the necessary level of improvement, the calculation was not included; and
  - No quantification of expected improvements secured by recommended measures (the Council are additionally looking to evaluate selected exiting interventions, as well as any additional measures that may be appropriate based on newly obtained fleet data).
- Task 2 - Addressing the persistent nitrogen dioxide (NO_2) exceedance at the Castle Street/Windsor Street/Hibbert Street junction (approximately 130m outside AQMA No. 3) through an extension to AQMA No. 3.

1.5 The road NO_x calculations and source apportionment in Task 1 are covered in this report. All other parts of Task 1 and Task 2 are detailed in the main report that is provided alongside this report.

2. Air Quality Strategy Objectives

2.1 The air quality strategy (AQS) objectives set out in the Air Quality (England) Regulations 2016 (H.M Government, 2016) provide the statutory basis for the AQS objectives under LAQM in England. The relevant AQS objectives for the purpose of this assessment are set out in Table 2-1 below:

Table 2-1 Air Quality Strategy Objectives in England

Pollutant	Air Quality Strategy Objective	
	Concentration	Measured as
Nitrogen Dioxide (NO_2)	200 μg/m^3 not to be exceeded more than 18 times a year	1-hour mean
	40 μg/m^3	Annual mean

3. Existing Air Quality Baseline Conditions

Air Quality Management Area

3.1 LBC declared the *"Town Centre"* Luton AQMA No.3 on 1 May 2016 following exceedances of the AQS objective annual average concentration for NO_2 along the route of Stuart Street from Dunstable Road (by Kenilworth Road) to Chapel Viaduct (by Latimer Road).

NO_2 Monitoring Data

3.2 LBC monitors annual mean NO_2 concentrations using a continuous automatic analyser located on Dunstable Road East (Stuart Street) and passive diffusion tubes at 51 locations across the town. In addition to the automatic monitor, three of the Council's diffusion tube sites are situated within the boundary of Luton AQMA No. 3 (one being a triplicate site co-located with the continuous chemiluminescence analyser on Stuart Street).

3.3 Results of monitoring in and close to the Luton Town Centre AQMA are provided in Table 3-1 and are displayed in Figure 1, Appendix A.

Table 3-1 Annual Mean NO_2 Monitoring Results in the Town Centre AQMA and on Castle Street

Site ID	Site Name	Monitoring Type	Distance to Relevant Exposure (m)	NO_2 Annual Mean Concentration ($\mu g/m^3$)				
				2016	2017	2018	2019	2020
LN52	Dunstable Rd/Cardigan St Residential (Roadside)	Diffusion Tube	0	**49.4**	**43.0**	39.5	**42.8**	33.0
LN60	Dunstable Road East (CRAQM2, Roadside)	Automatic continuous monitor	6	**46.9**	39.0	37.2	**40.4**	28.3
LN61/ 62/ 63*	Dunstable Road East (CRAQM2, Roadside)	Diffusion Tube	6	**45.4**	**41.9**	39.4	**40.7**	30.8
LN66	Park Viaduct	Diffusion Tube	5	38.8	38.9	32.9	36.7	27.6
LN67	Castle Street (Roadside)	Diffusion Tube	0	**47.9**	**42.0**	**41.1**	**43.0**	32.7
LN79	Castle Street 2 (Roadside)	Diffusion Tube	0	36.7	32.9	37.3	33.9	24.0

Note: Exceedances of the NO_2 annual mean objective of 40 $\mu g/m^3$ are shown in **bold**.

4. NO_x Reduction Calculations

4.1 The reduction in NO_2 concentrations required to attain the annual mean AQS objective within an AQMA is equal to the margin by which the highest measured or predicted concentration exceeds the AQS objective level of 40 µg/m³. During 2018, the highest NO_2 concentration at a representative location within the Town Centre AQMA was 41.1 µg/m³ at LN67. Consequently, a minimum NO_2 reduction of 1.1 µg/m³ will be required to achieve compliance. 2018 was chosen as the year to carry out NO_x reduction calculations for consistency with modelling undertaken for the development of the AQAP. When considering the necessary percentage reduction LAQM.TG16 (Defra, 2021) paragraph 7.105 states that:

> *"…any required percentage reductions of local emissions should be expressed in terms of NO_x due to the local road traffic. This is because the primary emission is of NO_x and there is a non-linear relationship between NO_x concentrations and NO_2 concentrations."*

4.2 Consequently, the reduction in road NO_x emissions required to meet the 40 µg/m³ annual mean AQS objective for NO_2 has been calculated using Defra's NO_x to NO_2 calculator v8.1 (Defra, 2020c) in accordance with the procedure laid out in LAQM.TG16 (Defra, 2021) Box 7.6 (see Appendix B). In addition to the 40 µg/m³ AQS objective, the reduction in road NO_x emissions necessary to achieve NO_2 concentrations of 36 µg/m³ (*i.e.* 10% below the AQS objective level) have also been calculated at other monitoring locations to evaluate the level of improvement necessary to achieve a sufficient margin of safety to ensure continued compliance.

4.3 A summary of the reductions in NO_2 and NO_x needed to achieve annual mean NO_2 concentrations of 36 µg/m³ and 40 µg/m³ at LN67 (the worst affected monitoring site that represents a receptor location) and at the other selected locations is provided in Table 4-1.

Table 4-1 Required reductions in annual mean NO_x and NO_2 concentrations at monitoring locations in the AQMA

Site ID	NO_2 Background Concentration in 2018	Monitored Road NO_2	Total Monitored Road NO_x	Total Monitored NO_x required for 40 µg/m³	Required NO_x Reduction (40 µg/m³)	Required NO_x Reduction % (40 µg/m³)	Total Monitored NO_x required for 36 µg/m³	Required NO_x Reduction (36 µg/m³)	Required NO_x Reduction (36 µg/m³)
LN67	18.1	23.0	47.7	45.2	2.5	6%	36.2	11.5	32%
LN52	20.2	19.3	39.7	-	-	-	31.9	12.1	38%
LN61-63	20.2	19.2	39.5	-	-	-	31.9	7.5	24%
LN79	18.1	19.2	39.1	-	-	-	36.2	2.9	8%
LN60	20.2	17.0	34.6	-	-	-	31.9	2.6	8%

4.4 Table 4-1 shows that annually a minimum reduction of 6% NO_x emissions or 2.5 µg/m³ NO_x would be required to reduce concentrations to the AQS objective at LN67 based on 2018 data (which is in line with year of modelling for the revised AQAP).

5. Source Apportionment Approach

Emission Factor Toolkit

5.1 This source apportionment assessment has been undertaken using the simplified methodology outlined in LAQM.TG16 (Defra, 2021), paragraph 7.100 of which advises:

"…source apportionment may be undertaken using a simple spreadsheet approach. For example, where road traffic emissions are the principal concern, the percentage contribution to total NO_x emissions may be calculated using the appropriate emission factors."

5.2 Applying this approach to the Town Centre AQMA, source apportionment has been completed utilising Defra's Emissions Factor Toolkit (EFT) v11 (Defra, 2020a).

Source Apportionment

5.3 LAQM.TG16 (Defra, 2021), paragraph 7.102 advises that:

"Apportionment for NO_2 is not straightforward due to the non-linear relationship between the emissions of NO_2 and nitrous oxides (NO_x). This is additionally complicated by the different proportions of NO_2 in the NO_x emission for different sources, for example, petrol cars or diesel cars. The following advice therefore applies to NO_2 source apportionment:

- **Background contributions:** the national maps will give the total background NO_2 concentration. This should be apportioned to regional and local background using the ratio of the background NO_x concentrations attributable to these two sources, which are also available in the national maps; and
- **Local contributions:** the local contribution to NO_2 is the difference between the total (measured or modelled) NO_2 and the total background NO_2. This is then apportioned to the local sources, for example, buses, heavy goods vehicles (HGVs), taxis, cars, using the relative contributions of these sources to the local NO_x concentration."

5.4 2018 background estimates for NO_2 and NO_x have been obtained from the relevant Defra 2018-based background maps (Defra, 2020b). Following the procedure laid out in LAQM.TG16 (Defra, 2021) Box 7.5, these values have been used to calculate the local NO_2 contribution at each relevant receptor in AQMA No. 3 (*i.e.* at each of the monitoring locations within the AQMA boundary). In the case of the CRAQM2 monitoring site on Dunstable Road East, data from the reference chemiluminescence analyser (LN60) has been used in preference to the average NO_2 concentration obtained from the less accurate triplicate collocated diffusion tubes (LN61/62/63).

5.5 Once determined, the local contribution has then been apportioned to each vehicle class according to results obtained using the EFT. The 2018 annual mean NO_2 source apportionment for the three sites are summarised in Appendix D. Local background contributes between 31-39% to the total NO_2 concentrations monitored at locations with the highest levels in the AQMA.

NO_2 concentrations

5.6 At the monitoring location that represents relevant exposure with the maximum NO_2 concentration (LN67 located along Castle Street between Kelvin Close and Windsor Street), the total NO_2 concentration is made up of 23.0 $\mu g/m^3$ from road NO_2 contributions, followed by a further 13.0 $\mu g/m^3$ from local background NO_2 and 5.1 $\mu g/m^3$ from regional background NO_2. NO_2 from road NO_x emissions accounts for 55.9% of the total NO_2 concentrations, with local and regional background accounting for 31.7% and 12.4% respectively.

NOx Emissions

5.7 The NO_x road emissions breakdown are displayed in Figure 2 to Figure 4, Appendix A. The figures show that a large proportion (greater than 90%) of road NO_x emissions come from diesel cars, diesel light goods vehicles (LGVs), articulated HGVs, rigid HGVs and Bus & Coaches. Of these, diesel cars, then diesel LGVs and Bus & Coaches make up the largest vehicles classes contributing the road NO_x emissions. In particular, the diesel cars on Dunstable Road make up over 35% of road NO_x emissions, with a similar figure (34.2%) noted for the stretch of Castle Street between Stockwood Crescent and Windsor Street.

6. Comparison with Previous Source Apportionment

6.1 In 2016, following the declaration of the Town Centre AQMA, LBC commissioned a source apportionment study to inform the development of an AQAP. The previous study uses old data from 2014 for the NO_x reduction. Following an appraisal by Defra, the previous study was considered to require further details and in need of updating, therefore, this study has used 2018 data to update the conclusions and has provided further details. This study also provides a breakdown of NO_x and NO_2 emissions by vehicle type which was not previously done. These address the deficiencies identified in the appraisal of the Town Centre AQAP.

6.2 Table 6-1 displays the comparison of results from both studies undertaken in 2016 and 2022. The most notable difference between the two sets of figures is the marked reduction in the contribution attributed to buses, which drops from 51.2% of total road NO_2 contributions in 2014 to 25.2% in 2018. It should be noted that the Bus category for this 2022 study also includes coaches. Part of this may be due to a reduced number of buses on certain routes following the opening of the Luton – Dunstable Busway.

6.3 In addition to this, the percentage increase in contributions from LGVs and HGVs from 2014 (0.90% and 5.10% respectively) to 2018 (18.69% and 27.15% respectively) is also notable. This could be as a result of changes to the fleet, or of updates to the EFT used to calculate contributions.

Table 6-1: Comparison of source apportionment study outputs for the location representative of exposure with maximum NO_2 concentration

Year	NO_2 Source Apportionment Results	All Vehicles	Car	LGV	HGV	Bus*	Other	Background
2014	NO_2 Concentration ($\mu g/m^3$)	32.4	13.8	0.3	1.6	16.6	0.0	24.8
	Percentage of Total NO_2	56.6%	24.2%	0.5%	2.9%	29.0%	0.1%	43.4%
	Percentage Road Contribution to NO_2	100.0%	42.7%	0.9%	5.1%	51.2%	0.1%	-
2018	NO_2 Concentration ($\mu g/m^3$)	23.0	6.5	4.3	6.24	5.8	0.1	18.1
	Percentage of Total NO_2	55.9%	15.9%	10.5%	15.2%	14.1%	0.3%	44.1%
	Percentage Road Contribution to NO_2	100.0%	28.5%	18.7%	27.2%	25.2%	0.5%	-

Notes: *2022 study using 2018 data includes bus and coaches as part of the bus category

7. Limitations and Assumptions

- The average annual daily flow (AADT) figures used for the apportionment are based on traffic provided by AECOM's Transportation team for 2018 and the data provides no information on fleet composition in terms of Euro emissions class. In the absence of a breakdown based on local ANPR survey data, it has been assumed that the EFT *"England (not London)"* default Euro proportions are representative of the fleet made up in Luton.
- The monitoring data used for monitored NO_2 concentrations and year assumed for calculation in EFT was chosen as 2018 to correlate to the modelling undertaken for the AQAP.
- The vehicle emissions split between moving and stationary traffic (potentially significant in the vicinity of the junction with Cardiff Road), has not been considered.
- The vehicle emissions split between local and through traffic has not been considered.

8. References

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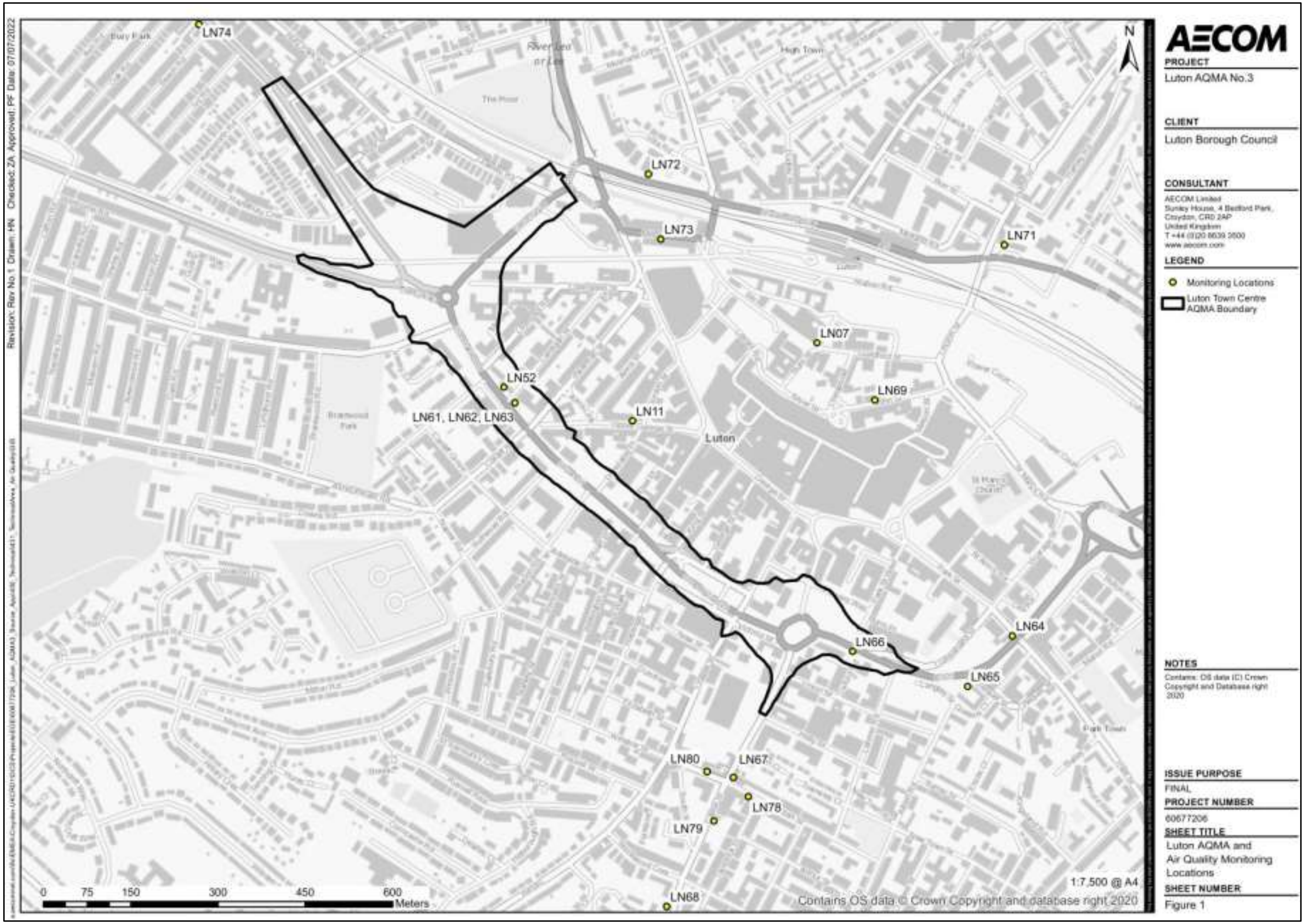
Appendix A : Figures



LN74
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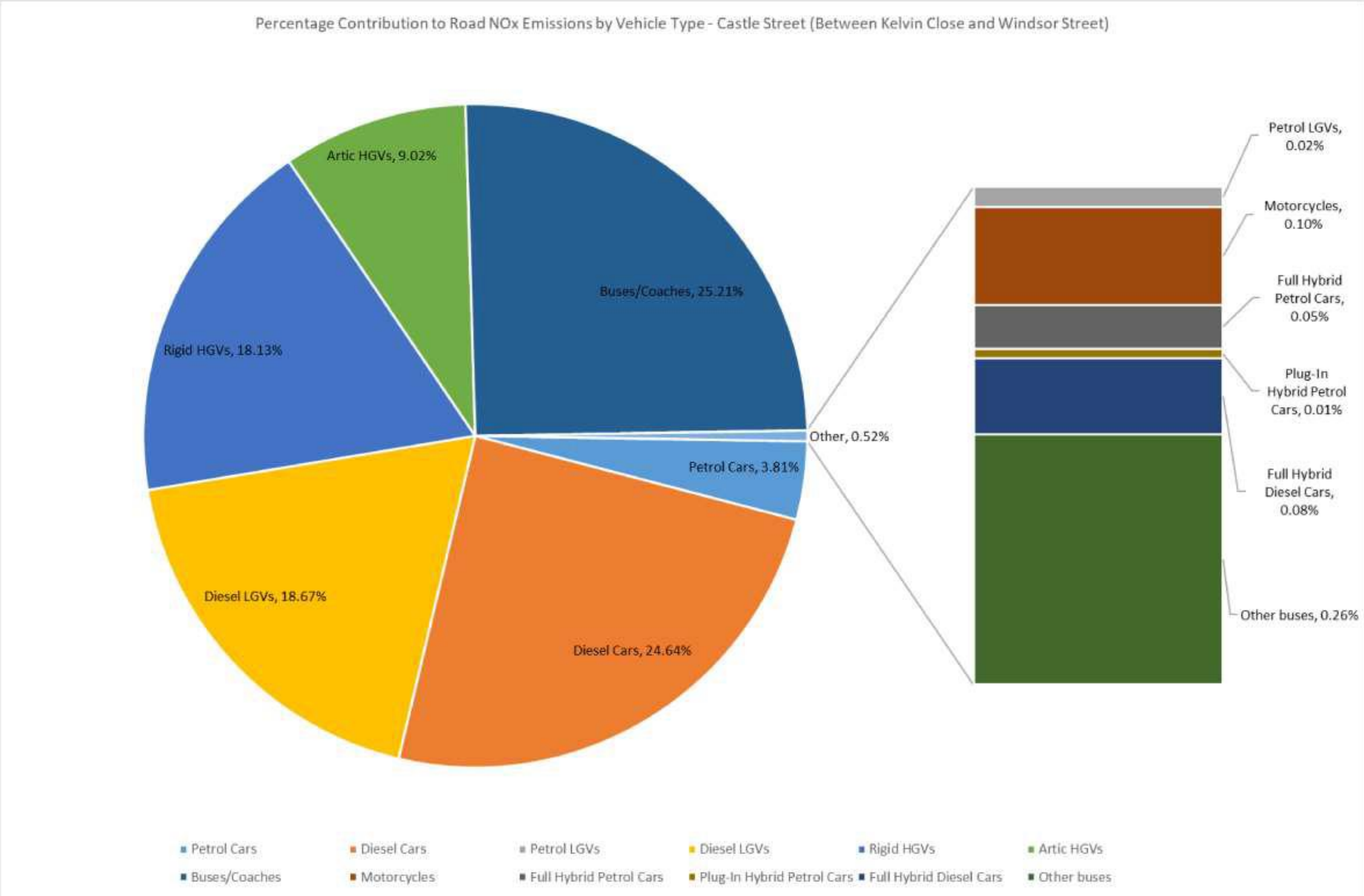
CONSULTANT
LEGEND
Monitoring Locations
Luton Town Centre AQMA Boundary
NOTES
ISSUE PURPOSE
FINAL
PROJECT NUMBER
60677206
SHEET TITLE
Luton AQMA and Air Quality Monitoring Locations
SHEET NUMBER
Figure 1

Source Apportionment of Local Emissions of Nitrogen Dioxide in the Luton Town Centre Air Quality Management Area

Project number: 60677206

Figure 2 Percentage Contribution to Road NO_x Emissions by Vehicle Type - Castle Street (Between Kelvin Close and Windsor Street)



Prepared for: Luton Borough Council

AECOM
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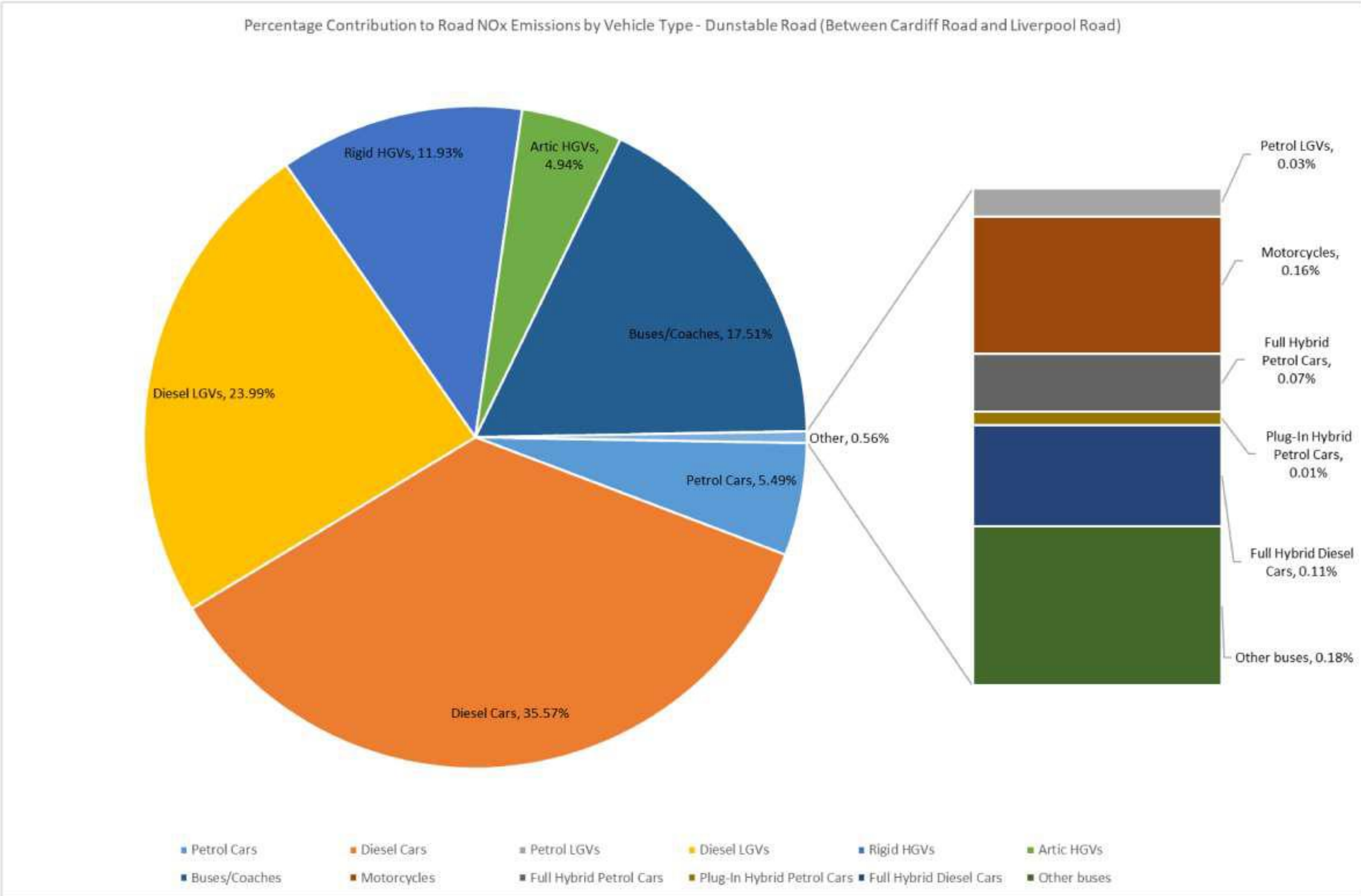
Source Apportionment of Local Emissions of Nitrogen Dioxide in the Luton Town Centre Air Quality Management Area

Project number: 60677206

Figure 3 Percentage Contribution to Road NO_x Emissions by Vehicle Type - Dunstable Road (Between Cardiff Road and Liverpool Road)



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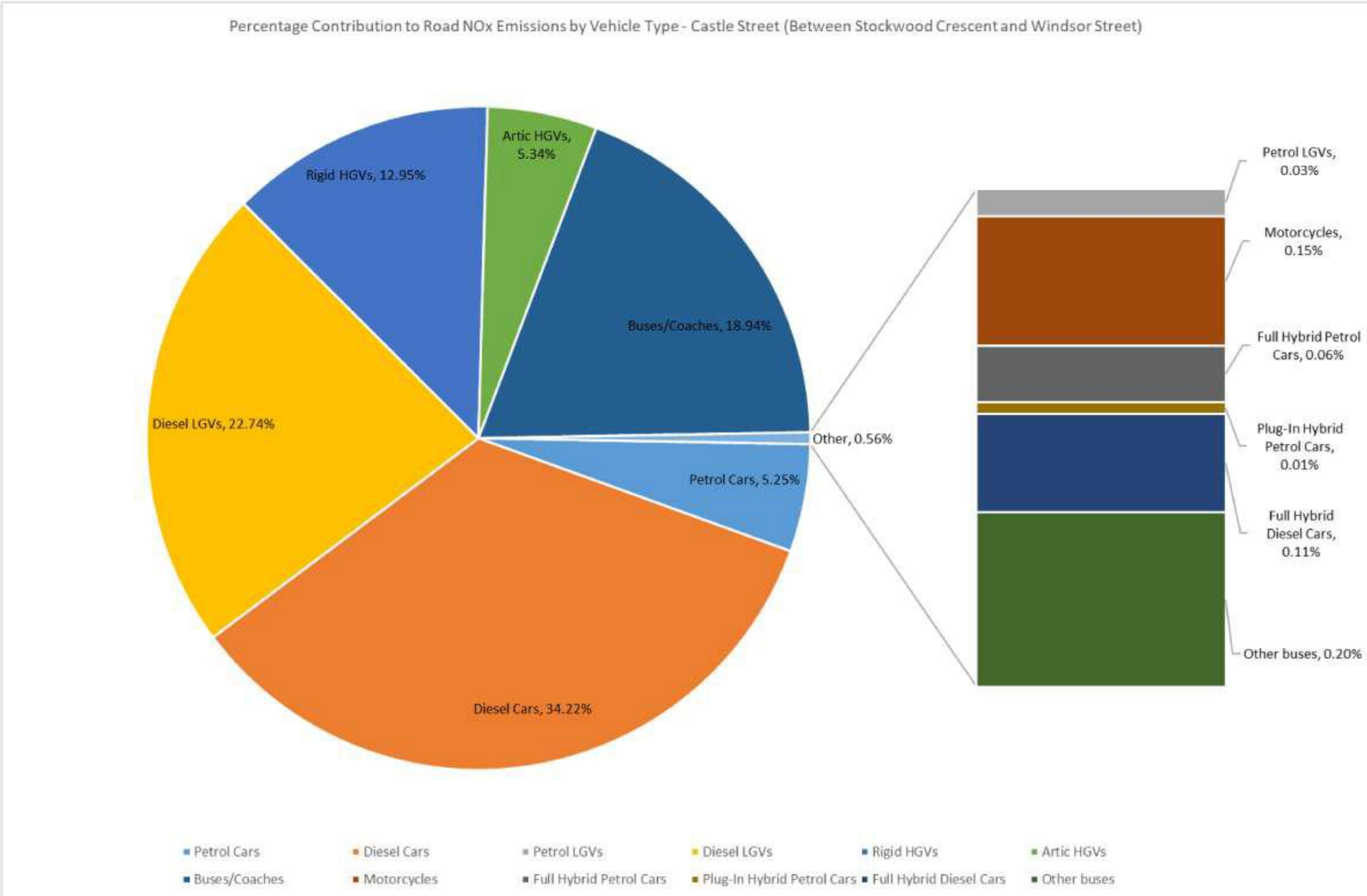
Source Apportionment of Local Emissions of Nitrogen Dioxide in the Luton Town Centre Air Quality Management Area

Project number: 60677206

Figure 4 Percentage Contribution to Road NOx Emissions by Vehicle Type - Castle Street (Between Stockwood Crescent and Windsor Street)



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Appendix B NO_x Emission Reduction Methodology

The following is provided as an example of how the reduction in road NOx emission required to meet the 40 μg/m^3 annual mean AQS objective for NO_2 has been calculated. Using diffusion tube LN67 as an example, the measured or modelled NO_2 is 41.1 μg/m^3. It is based on the required reduction in the road NO_x concentration at the worst-case relevant exposure location.

Step 1: Use the NO_x to NO_2 calculator (see para 7.86 of Technical Guidance LAQM.TG(16)) to obtain the NO_x concentration that equates to the 41.1 μg/m^3 NO_2, which is 47.7 μg/m^3.

Step 2: Obtain the local background concentrations of NO_2 for the year of interest. This is 18.1 μg/m^3, from the background maps (see para 7.68 Technical Guidance LAQM.TG(16)).

Step 3: Calculate the road NO_x concentration required to give a total NO_2 concentration of 40 μg/m^3 i.e. the annual mean AQS objective (road NO_x-required). This can be done using the NO_2 from NO_x calculator by entering a total NO_2 concentration of 40 μg/m^3 along with the local background NO_2 concentrations. The calculator gives the road NO_x-required concentration which is 45.2 μg/m^3.

Step 4: Calculate the road NO_x reduction to go from the road NO_x-current to the road NO_x-required. In this example the road NO_x reduction is 2.5 μg/m^3 (47.7 μg/m^3 minus 45.2 μg/m^3), which represents a 6% reduction in road NO_x (2.53/48.72 as a percentage).

Appendix C Source Apportionment for NO_2

LAQM Technical guidance (TG.16) (Defra, 2021) provides an example of a source apportionment for NO_2 in a hot-spot near to a busy road. The highest annual mean NO_2 concentration [T-NO_2] at a relevant receptor, obtained from a verified model or monitoring is 46 μg/m^3.

Step 1: From the national maps of background annual mean concentrations obtain the total background NO_2 for the grid square within which the hot-spot is located [TB-NO_2] = 28 μg/m^3 also the total background NO_x [TB-NO_x] = 45 μg/m^3 and regional background NO_x [RB-NO_x] = 25 μg/m^3. From the total and regional background NO_x derive a local background NO_x:

[LB-NO_x] = [TB-NO_x] – [RB-NO_x] = 20 μg/m^3

Step 2: Apportion the total background NO_2 into regional and local using the regional and local NO_x proportions:

- [RB-NO_2] = [TB-NO_2] × ([RB-NO_x] / [TB-NO_x]) = 15.6 μg/m^3
- [LB-NO_2] = [TB-NO_2] × ([LB-NO_x] / [TB-NO_x]) = 12.4 μg/m^3

Step 3: Calculate the local NO_2 contribution at the worst-case location [L-NO_2] from the total measured minus background:

[L-NO_2] = [T-NO_2] – [TB-NO_2] = 18 μg/m^3

Step 4: Apportion the local contributions to total NO_2 concentration using the model concentrations or emission results for NO_x. In this example, it is shown that 44% of the NO_x at the worst-case relevant is from vans and lorries, 22% from buses and 34% from cars.

- NO_2 vans and lorries = 44% × [L-NO_2] = 7.9 μg/m^3
- NO_2 buses = 22% × [L-NO_2] = 4.0 μg/m^3
- NO_2 cars = 34% × [L-NO_2] = 6.1 μg/m^3

The final source apportionment of the worst-case NO_2 46 μg/m^3 is thus:

- Regional background = 15.6 μg/m^3 (34%)
- Local background = 12.4 μg/m^3 (27%)
- Local traffic:
  - Vans and lorries = 7.9 μg/m^3 (17%)
  - Buses = 4.0 μg/m^3 (9%)
  - Cars = 6.1 μg/m^3 (13%)

Appendix D Source Apportionment Tables

Table 8-1 Traffic data used for Source Apportionment Study

Road Link	Description of Roads covered by link	DTs on Road Link	Traffic Flow (AADT)	% HDV	Speed(kph)	Comments
13269_34003	Castle Street (between Kelvin Close and Windsor Street)	LN67	11195	5.8	29.5	
34003_13269	Castle Street (between Kelvin Close and Windsor Street)	LN67	8307.6	7.6	5	Reverse link of 13269_34003
14233_98259	Dunstable Road (between Cardiff Road and Liverpool Road)	LN52, LN60 & LN61-63	28625.4	5.4	38.1	
99512_14233	Dunstable Road (between Cardiff Road and Liverpool Road)	LN52, LN60 & LN61-63	24932.6	5.8	13.3	Reverse link of 99512_14233
13269_34591	Castle Street (between Stockwood Crescent and Windsor Street)	LN79	7786.1	7.8	38.6	
34591_13269	Castle Street (between Stockwood Crescent and Windsor Street)	LN79	11955.6	5.8	15	Reverse link of 13269_34591

Table 8-2 Breakdown of NO_2 concentrations

Classification	NO_2 Source Apportionment µg/m^3 (in brackets, % of total)		
	LN67	LN52, LN60 & LN61-63	LN79
Regional Background NO_2	5.1 (12.4)	4.73 (12)	4.24 (11.4)
Local Background NO_2	13.02 (31.7)	15.5 (39.2)	13.88 (37.2)
Road NO_2	22.98 (55.9)	19.27 (48.8)	19.18 (51.4)
Petrol Cars	0.88 (2.1)	1.06 (2.7)	1.01 (2.7)
Diesel Cars	5.66 (13.8)	6.85 (17.4)	6.56 (17.6)
LGVs	4.3 (10.5)	4.63 (11.7)	4.37 (11.7)
HGVs	6.24 (15.2)	3.25 (8.2)	3.51 (9.4)
Buses/Coaches	5.79 (14.1)	3.37 (8.5)	3.63 (9.7)
Other	0.11 (0.3)	0.06 (0.1)	0.1 (0.3)

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Glossary of Terms

Abbreviation	Description
AQAP	Air Quality Action Plan - A detailed description of measures, outcomes, achievement dates and implementation methods, showing how the local authority intends to achieve air quality limit values’
AQMA	Air Quality Management Area – An area where air pollutant concentrations exceed / are likely to exceed the relevant air quality objectives. AQMAs are declared for specific pollutants and objectives
ASR	Annual Status Report
AURN	Automatic Urban & Rural Network – the UK’s largest automatic monitoring network and is the main network used for compliance reporting against the Ambient Air Quality Directives.
BAM	Beta Attenuation Mass Monitor – air quality monitoring instrument that uses the absorption of beta radiation by solid particles extracted from an air flow to measure PM_{10} and $PM_{2.5}$
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges – Air quality screening tool produced by National Highways
EU	European Union
EV	Electric Vehicle
FDMS	Filter Dynamics Measurement System
LAQM	Local Air Quality Management
LCWIP	Local Cycling and Walking Infrastructure Plan
LSO	Local Site Operator
MCERTS	The Environment Agency’s Monitoring Certification Scheme for equipment
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
PM_{10}	Airborne particulate matter with an aerodynamic diameter of 10µm or less
$PM_{2.5}$	Airborne particulate matter with an aerodynamic diameter of 2.5µm or less
QA/QC	Quality Assurance and Quality Control
SO_2	Sulphur Dioxide
WHO	World Health Organisation

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