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OXFORD CITY COUNCIL

2017 Air Quality Annual Status Report (ASR)

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

June 2018

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Executive Summary

Health Impacts of Air Pollution

Air pollution is currently one of the biggest environmental risks to human health. Polluted air is estimated to have been directly responsible for 6.4 million deaths worldwide[1] in 2015, a figure only superseded by the amount of early deaths caused by tobacco (7 million in the same year)[1]. The Organisation for Economic Co-operation and Development (OECD)[2] estimates that without active control measures, by 2060 these figures can reach values between 6-9 million deaths per year.

Within the UK, poor outdoor air quality is linked to 50,000 early deaths each year[1]. The most vulnerable are children, the elderly, or those with pre-existing medical conditions. Exposure to poor air quality is directly related to diseases such as cancer, asthma, stroke, heart disease, diabetes, obesity and dementia. Frequently, there is also a strong correlation with equality issues, because areas with poor air quality often coincide with less affluent areas[3, 4].

Air Quality in Oxford

The city of Oxford, in common with many urban areas throughout the United Kingdom, is subject to poor air quality, particularly in areas with high levels of road traffic. In the city, nitrogen dioxide (NO_2) is the pollutant of most concern, and transport is the most significant source of emissions of oxides of nitrogen ($NO+NO_2$), commonly called NO_x.

The process of review and assessment of air quality in Oxford has been taking place since 1999. In 2010, the whole of the city of Oxford was declared as an Air Quality Management Area (AQMA), and an Air Quality Action Plan (AQAP) was adopted by the Council in 2013. More details on the AQMA and AQAP are available here:

https://www.oxford.gov.uk/info/20216/air_quality_management/206/air_quality_management_in_oxford/2

Air quality has reduced significantly over the last 10 years (2007-2017). Over this time period, we have seen a 43% decline in NO_2 levels, 17% of which result from the contribution of 2017 alone. Significant decreases of NO_2 levels were observed in the city centre in 2017, the largest drops being observed along Beaumont Street, George

Street, St Clements, Speedwell Street and Castle Street. In 2017, NO_2 pollution levels saw an overall reduction of 23% in the city centre when compared with the figures obtained in 2016.

This means that we are now, for the first time since monitoring began, compliant with the annual mean limit values for NO_2 at all three automatic monitoring stations, including the two which are part of the Automatic Urban and Rural Network (AURN). We have generally seen significant reductions in NO_2 across the city; with only 4 locations now showing exceedances down from 17 in 2016, which represents a reduction of 76%.

From 2016 to 2017 we have seen significant reductions in NO2 across city centre sites. Analysis, comparing result with the St Ebbe's urban background site AURN, suggest that weather and wind direction cannot explain the reduction seen from 2016 -2017, hence suggesting that the reduction is due to a change in traffic emissions. The majority of streets impacted have not seen significant changes to flow or road layout which can explain this reduction. Therefore, we believe the main reason for a reduction in these streets is due to a change in fleet composition, with a significant amount of Euro VI buses coming on board in addition to the normal fleet turnover. Euro VI buses achieve an estimated 99.5% reduction in NOx compared to EuroV, which is likely to explain part of the reduction we have seen from 2016-2017.

This is very good news for everyone living in or visiting Oxford as the air they breathe is now cleaner than any time in the last 10 years. However, despite these improvements there is still much that needs to be done to ensure that Oxford's air is not just cleaner, but safe to breathe. We need to ensure that the reductions are sustained; we have seen improvements in the past, followed by subsequent increases in NOx levels.

The 2008 Ambient Air Quality Directive[5] (ED/2008/50/EC) sets legally binding limits for concentrations in outdoor air for major air pollutants that impact public health such as particulate matter (PM_{10} and $PM_{2.5}$) and nitrogen dioxide (NO_2), to be met before 2010. The limit values were established in 2008 and are now over 10 years old. The majority of UK cities failed to meet the objective by 2010 as required by the Directive. Significant amounts of research have been completed in the time since the air quality

directive was established which has provided further evidence of the health impacts of air pollution.

The World Health Organisation (WHO) has set guideline[6] values for key air pollutants based on evidence of their health impacts. The recommended WHO guideline values are significantly lower for PM_{10} and $PM_{2.5}$ than the UK limit values. The WHO guideline value for NO_2 currently corresponds to the UK limit value of 40µgm^{-3}, however both short- and long-term studies have found adverse associations at concentrations that were at or below the current UK limit values. A WHO Expert Consultation[7] has therefore recommended that a new revised limit for NO_2 is set as soon as possible. Several studies [8,9] suggest that there are in fact no 'safe' levels of air pollution and that governments should therefore be aiming for the lowest possible air pollution levels.

Actions to Improve Air Quality

Oxford's AQAP focusses on measures the City Council has the ability to address, but includes measures that we can influence, or work in partnership with others to deliver. Effective measures require co-operation from all sectors including transport policy and management, the Council's priorities for new developments, freight management for business and commerce, and daily choices made by every single transport user. Oxford's AQAP recognises that the City Council cannot act in isolation in order to deliver a comprehensive package of measures without engagement and delivery from a wide range of stakeholders.

The following are actions that Oxford City Council has already taken to improve air quality in the city:

- Launched an educational toolkit for primary and secondary schools in Oxford, which provides science teachers with a range of interactive activities, based both in the classroom and outdoors, to raise awareness about the causes and impacts of air pollution (link to press release);
- Launched, a city wide anti-idling campaign in partnership with Friends of the Earth called 'Oxford Air Needs Your Care', particularly focused on for tackling vehicles idling around schools during drop off and pick up times (link to Anti-Idling campaign);

- Completed a feasibility study and public consultation to investigate options for the introduction of a Zero Emission Zone (ZEZ) in Oxford city centre staring in 2020, which would then be expanded so that the entire city is covered by 2035. The study was supported by Oxfordshire County Council and Oxford City Council (link to press release);
- Launched the Go Ultra Low Oxford project (GULO), with the aim of increasing uptake of ultra-low emission vehicles through support for individuals and provision of enabling infrastructure (link to press release);
- Launched a project for the provision of 19 electric vehicle charging points for the use of hackney carriages and private hire taxis in the city. The scheme also includes a review of licensing requirements for hackney carriage vehicles, in order to drive improvements in emissions standards; an investigation of the business case for investment in ultra-low emissions taxis based on local Oxford duty-cycles; and bringing vehicle manufacturers to Oxford to showcase their vehicles and offer test drives (link to press release);
- Secured £1.7million from the Clean Bus Technology fund (CBTF) for the retrofit of 5 buses to fully electric and 78 to euro VI standard, with expected NO_2 savings of 5.5 tonnes/year and a total of 27.6 tonnes over the lifetime of the project (link to press release);
- Secured nearly £200,000 from the Department for Environment, Food and Rural Affairs (DEFRA) Air Quality Fund for the purchase of electric delivery vehicles and installation of charging points to address the specific issue of Covered Market deliveries, to help retailers get ready for the introduction of the world's first Zero Emission Zone, to be introduced progressively across the city centre from 2020 (link to press release);
- Participated in several DEFRA webinars, including one as main speaker, where we shared our experience of introducing and implementing a Low Emission Zone for the city with DEFRA and other local authorities, to inform consideration of the most appropriate mechanism for establishing newly proposed Clean Air Zones (CAZ);
- Ran the "*Test Drive the Future"* annual event to introduce the public to a range of electric vehicles (EVs) and the financial and environmental benefits of going

electric. The event provides every year an opportunity to test drive vehicles, and outlines the options for driving an electric car *'pay as you go'* through one of Oxford's car clubs (link to press release);

- Created an Air Quality steering group with members from Oxford City Council, Oxfordshire County Council and relevant Councillors with the objective of specifically address the problem of poor air quality around St Clements in Oxford (link to press release);
- Developed a set of air quality stickers, to be placed in all our monitoring locations, with relevant AQ information and direct link to Oxfordshire's air quality website, in order to improve communication around air quality with members of the public;
- Launched the School's Tackling Air Pollution (STOP) Project, which provides real-time NO_2 and PM_{10} air quality monitors for installation in 6 schools;
- Declared the whole of the city an Air Quality Management Area for NO_2;
- Developed an Air Quality Action Plan and Low Emission Strategy for the city;
- Introduced the first extensive Low Emission Zone (LEZ) outside of London. This won the prize for Local Authority Air Quality Initiative of the Year at the National Air Quality Awards 2015;
- Launched the Oxfordshire Air Quality website to make historic and real time air quality data more readily accessible to members of the public;
- Increased the number of diffusion tube monitoring locations in the city by nearly 50% from January 2015 – we now monitor air quality in 71 locations around the city;
- Launched Oxford Park and Pedal which has seen over 100 cycle parking spaces introduced at two of our park and ride sites;
- Engaged with the Oxfordshire Health Improvement Board to ensure that air quality is considered in the context of the Joint Strategic Needs Assessment (JSNA);
- Commissioned a study into options for a Delivery and Servicing Plan for the Council's city centre premises;

- Continued to seek opportunities to work in partnership with neighbouring District Councils through participation in the Oxfordshire Air Quality Group.

Conclusions and Priorities

The results of the monitoring work carried out by Oxford City Council for 2017 show the following:

- The annual mean Air Quality Strategy (AQS) objective for NO_2 is 40 μgm^{-3}. In 2017, this objective was met for the first time since monitoring began at Oxford Centre Roadside and Oxford High Street automatic monitoring stations. Oxford Centre roadside registered an annual mean for NO_2 of 40 ugm^{-3}, High Street annual mean was 39 ugm^{-3}. The results obtained represent an average reduction of NO_2 of 18% on those sites, when compared with the results from 2016;

- The diffusion tube results show that the annual mean AQS objective of 40 μgm^{-3} for NO_2 was exceeded at only 4 of the 71 monitoring locations in 2017 - a reduction of 76% of the amount of sites registering exceedances, when compared with the results obtained in 2016;

- The AQS hourly mean objective for NO_2 is 200 μgm^{-3}, with no more than 18 exceedances allowed each year. None of Oxford's automatic monitoring sites registered any exceedances of this value during 2017, matching the results that were obtained for the first time in 2016;

- 13 diffusion tube locations which have previously showed exceedances are now below the NO_2 annual mean limit value of 40 μgm^{-3}. However, NO_2 levels at 5 of those locations proved to be marginally below the threshold for compliance - given the degree of uncertainty associated with the diffusion tube methodology, it is highly recommended that those results are to be treated with due care;

- None of the locations where NO_2 was measured for the first time in 2017, reported exceedances of the annual mean limit value for NO_2.

- The annual mean AQS limit value for PM_{10} is 40 μgm^{-3}. WHO guidelines for PM_{10} however recommend that the annual mean limit for this pollutant should be much lower at only 20 μgm^{-3}. The PM_{10} annual mean results obtained from the two automatic monitoring stations (Oxford High Street and St Ebbe's) were of 18 μgm^{-3} and 13 μgm^{-3} respectively. Those figures show that both AQS and WHO limit values were achieved in 2017 for this pollutant;

- PM_{10} may exceed the 24-hour mean limit of 50 μgm^{-3} no more than 35 times per year to meet the AQS objective. During 2017, there were only 2 exceedances to this value, both picked up at the automatic monitoring stations of High Street and St Ebbe's. Those were attributed to a trans-boundary pollution episode, and not directly to pollution emitted from the city. The AQS objective for hourly PM_{10} was therefore met in 2017;

- $PM_{2.5}$ has a non-mandatory AQS annual mean compliance target of 25 μgm^{-3}. As for PM_{10}, WHO guidelines are much stricter for this pollutant. Those recommend an annual mean limit value of 10 μgm^{-3} for this pollutant. St Ebbe's recorded $PM_{2.5}$ annual mean of 11 μgm^{-3} in 2017, which shows compliance with the AQS non mandatory target and it is 1 μgm^{-3} above what is considered to be a safe level by current WHO Guidelines;

- Oxford St. Ebbe's met the AQS objective for ozone in 2017.

Oxford City Council's priorities for the coming year are to:

- Continue to work in partnership with the Oxford Mobile Air Quality Measurement Group and support their OxAir project to test new monitoring technology to measure, map and analyse air pollution at a city scale, and expand the monitoring regime, where appropriate;

- Progress plans for the introduction of a ZEZ in Oxford in 2020, working in partnership with the Local Transport Authority – Oxfordshire County Council;

- Investigate specific solutions to tackling air pollution in St Clements which currently registers the highest readings of NO_2 in Oxford;

- Run anti-idling campaigns across the city in partnership with Friends of the Earth (FoE) Oxford;
- Complete 12 month trial collecting data on performance and user experience from recently installed on-street charging equipment, from volunteer EV drivers and car club members, as part of the on street charging trial;
- Report annually to the Health Improvement Board on the state of air quality across the county and what measures are being taken to improve it;
- Launch the first phase of the £1.7million CBTF project for the retrofitting of five of the city's open-top sightseeing buses to become fully electric, and the retrofitting of 78 local buses to euro VI standards, using Selective Catalytic Reduction (SCR) technology;
- Begin delivery of a £200,000 DEFRA Air Quality Grant funded project aimed at facilitating Oxford's historic Covered Market to go electric through the provision of electric charging points and electric delivery vehicles;
- Actively engage with and support schools to raise awareness of air pollution, through the schools STOP project, organisation of schools assemblies and running of anti-idling campaigns;
- Continue to improve communication with the public on air quality, review our website and ensure we provide easy access to material about air pollution;
- Continue the expansion of the City Council's fleet of electric vehicles which currently counts 17 full electric vehicles and 22 electric/diesel light commercial hybrid vehicles;
- Continue developing work for the provision of electric vehicle charging infrastructure for the use of hackney carriages and private hire taxis in the city, using £370,000 of funding awarded by the Government's Office for Low Emissions Vehicles;

How to get involved

Everyday decisions can have an impact on the air we breathe. Do you take the car when you could have cycled? Do you drive your children to school when you could have walked? We all have a huge role to play and we can all be part of the solution. Encouraging walking and cycling in the city not only has a positive impact on air quality levels, but it also has multiple other benefits, including increasing the health of wellbeing of all those who live, work and visit Oxford.

Full details of Oxford's air quality monitoring results, including real time data on pollutant levels and reference to the city's daily Air Quality Index (AQI), a metric on the daily levels of air pollution, together with recommended actions and health advice is available on the Oxfordshire Air Quality Group (OAQG) website https://oxfordshire.air-quality.info/

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1 Local Air Quality Management

This report provides an overview of air quality in Oxford during 2017. It fulfils the requirements of Local Air Quality Management (LAQM) as set out in Part IV of the Environment Act (1995) and the relevant Policy and Technical Guidance documents.

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

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

2 Actions to Improve Air Quality

2.1 Air Quality Management Areas

AQMAs are declared when there is an exceedance or likely exceedance of an air quality objective. After declaration, the authority must prepare an AQAP within 12-18 months setting out measures it intends to put in place in pursuit of compliance with the objectives.

A summary of AQMAs declared by Oxford City Council can be found in Table 2.1 below. Further information related to declared or revoked AQMAs, including maps of AQMA boundaries are available online on the website of the Department for Environment, Food & Rural Affairs (DEFRA): https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=193. The boundaries of the current AQMA are also available in Oxfordshire's air quality website: https://oxfordshire.air-quality.info/.

A map showing the locations where air quality monitoring was carried out during 2017 can be found in Appendix C. All monitoring locations are inside the city's current AQMA.

Table 2-1– Declared Air Quality Management Areas

AQMA Name	Date of Declaration	Pollutants and Air Quality Objectives	City / Town	One Line Description	Is air quality in the AQMA influenced by roads controlled by Highways England?	Level of Exceedance (maximum monitored/modelled concentration at a location of relevant exposure)		Action Plan (inc. date of publication)
						At Declaration	Now	
The City of Oxford AQMA	Declared in 2010	NO_2 annual mean	Oxford	The whole of the administrative area of Oxford City Council	YES	78 ugm^{-3} annual mean NO_2 at High Street (Diffusion tube)	47 ugm^{-3} annual mean NO_2 at St. Clements (Diffusion tube)	Air quality Action Plan 2013-2020 http://www.oxford.gov.uk/info/20216/air_quality_management/206/air_quality_management_in_oxford/2

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

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

Oxford City Council has taken forward a number of direct measures during the current reporting year of 2017 in pursuit of improving local air quality. Details of all measures completed, in progress or planned are set out in Table 2.2 below.

More detail on these measures can be found in the AQAP. Key completed measures in 2017 include:

- Engaging and briefing Oxfordshire Health Improvement Board on air quality;
- Completed a feasibility study and public consultation to investigate options for the introduction of a Zero Emission Zone (ZEZ) in Oxford city centre starting in 2020, which would then be expanded so that the entire city is covered by 2035. The study was supported by Oxfordshire County Council and Oxford City Council;
- Improved air quality information with members of the public through the use of relevant information and a direct link to Oxfordshire's air quality website at all monitoring locations;
- Promoted a range of electric vehicles (EV's) at "*Test Drive the Future"* annual event to introduce the public to the financial and environmental benefits of going electric. The event provides an opportunity to test drive vehicles, and outlines the options for driving an electric car *'pay as you go'* through one of Oxford's car clubs;
- Engaged positively with DEFRA, providing Oxford City Council's views and ideas in all consultation phases of the national air quality national plans for nitrogen dioxide;
- Participated in several DEFRA's webinars, including one as main speaker, where Oxford City Council shared with DEFRA and other local authorities its own experience of introducing and implementing a Low Emission Zone for the city, to inform consideration of the most appropriate mechanism for establishing newly proposed Clean Air Zones (CAZ);
- Launched a project for the provision of 19 electric vehicle charging points for the use of hackney carriages and private hire taxis in the city. The scheme

also includes a review of licensing requirements for hackney carriage vehicles, in order to drive improvements in emissions standards; an investigation of the business case for investment in ultra-low emissions taxis based on local Oxford duty-cycles; and bringing vehicle manufacturers to Oxford to showcase their vehicles and offer test drives.

- Submitted successful bid to Clean Bus Technology fund worth £1.7million for the retrofit of 5 buses to electric and retrofit of 78 city bus with euro VI SCR technology. The measure is expected to result in NO_2 savings of 5.5 tonnes/year and a total of 27.6 tonnes over the lifetime of the project;

- Finalised procurement exercise and subsequent installation of six different EV charging infrastructure models, under the Go Ultra Low Oxford project . A 12 month trial will be undertaken during 2018 and will allow the identification of the most suitable type of EV charging technologies to be utilised and installed in Oxford. The aim is to help people who want to buy electric vehicles but are unable to as they have no means of charging it.

- Created an Air Quality steering group with officers from Oxford City Council, Oxfordshire County Council and relevant Councillors with the objective of specifically addressing the problem of poor air quality around St Clements in Oxford;

- Submitted a successful bid worth nearly £200,000 to DEFRA for the purchase of electric delivery vehicles and installation of charging points to address the specific issue of Covered Market deliveries, to help retailers get ready for the introduction of the world's first Zero Emission Zone, to be introduced progressively across the city centre from 2020;

- Development of preliminary work with Friends of the Earth with the objective of launching a city wide anti-Idling campaign, particularly focused on tackling vehicles idling around schools during drop off and pick up times;

- Development of an educational toolkit for primary and secondary schools, which provides science teachers with a range of interactive activities, based

both in the classroom and outdoors, to raise awareness about the causes and impacts of air pollution.

Progress on the following measures has been slower than expected:

- Full rollout of Schools Tackling Oxford Air Pollution (STOP) project to schools has been delayed due to supplier's personal circumstances and technical difficulties that have prevented the installation and activation of some of the air quality sensors around schools;
- Completion of Air Quality Technical Guidance for developers and planners to ensure that air quality is adequately considered in development planning and management in Oxford has been delayed due to need to take account of development of revised Local Plan.

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

- Retrofitting up to 78 local buses to Euro VI standard using SCR technology and 5 to fully electric as part of the recently awarded Clean Bus Technology Fund;
- Delivery of the Initiation Phase of DEFRA's Air Quality Grant funded project aimed at facilitating Oxford's historic Covered Market to go electric through the provision of electric charging points and electric delivery vehicles in order to prepare retailers for the introduction of a ZEZ;
- Progress plans to introduce a Zero Emission Zone in Oxford
- Publication of Air Quality Technical Guidance for developers and planners to ensure that air quality is adequately considered in development planning and management in Oxford;
- Ensure that Air Quality is considered fully in the upcoming Oxford Local Plan, by creating air quality policies that are able to effectively respond to the city's air quality problems in the future;
- Continue to work together with the Oxford Mobile Air Quality Measurement Group project OxAir on the characterisation of new innovative NO_2 sensors for use across a range of projects and in citizen science;

- Finish the 12 month trial testing different on-street charging equipment, as part of Go Ultra Low Oxford, and start planning for the roll out phase of the 100 EV on street chargers. The project will allow the identification of the most suitable type of EV charging technology to be used and installed in Oxford;
- Continue engagement with teachers and students/pupils through the delivery of school assemblies on air quality. Continue provision of support to schools to allow implementation of air quality activities included in the recently launched air quality toolkit;
- Installation of the first two electric vehicle charging points for taxis during the course of 2018, as part of the £500,000 fund awarded from OLEV.

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

- Progress plans for the introduction of a Zero Emission Zone in oxford in 2020, working in partnership with the Local Transport Authority – Oxfordshire County Council;
- Complete 12 month trial collecting data on performance and user experience from recently installed on-street charging equipment from volunteer EV drivers and car club members as part of the Go Ultra Low Project;
- Installation of the first two electric vehicle charging points for taxis during the course of 2018, as part of the £500,000 fund awarded from OLEV;
- Completion of Air Quality Technical Guidance for developers and planners to ensure that air quality is adequately considered in development planning and management in Oxford;
- Finalise and deliver the £1.7million Clean Bus Technology Fund project aimed at retrofitting 78 buses, from euro V to euro VI using SCR technology, and retrofitting of 5 buses to fully electric.
- Finalise and deliver the project funded by DEFRA for the purchase of electric delivery vehicles and installation of charging points to address the specific issue of Covered Market deliveries, to help retailers get ready for the introduction of the world's first zero emission zone, to be introduced progressively across the city centre from 2020;

- Continue to provide full support to the primary and secondary school community in Oxford, delivering anti-idling campaigns, and providing assistance to teachers in the implementation of citizen science AQ activities developed in the recently released AQ toolkit.

Whilst the measures stated above and in Table 2.2 will help to contribute towards compliance, Oxford City Council considers that much more still needs to be done, and therefore anticipates that further additional measures not yet prescribed will be required in subsequent years to achieve compliance and enable the full revocation of the City of Oxford's AQMA.

Table 2-2– Progress on Measures to Improve Air Quality

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
1	Manage bus emissions through the implementation of the Low Emission Zone	Promoting Low Emission Transport	Low Emission Zone (LEZ)	OCC	Complete	On-going	All local bus services within the streets affected must be operated exclusively by buses whose engines meet the Euro V emission standard	N/A	The Low Emission zone has been implemented	Completed	Zone successfully introduced in 2014
2	Work to ensure sustainable transport measures developed in the Oxford Area Strategy of the LTP support the targets of the AQAP	Promoting Low Emission Transport	Other	OCC/ Oxfordshire County Council	Complete	Complete	Oxford Transport Strategy includes measures that support delivery of the AQAP	N/A	The Oxford Transport Strategy has been published and includes measures which support the targets of the AQAP <u>Oxfordshire County measures in 2017:</u> - Design and feasibility studies for corridor improvements to create segregated cycling, bus priority and new pavements for 7 major corridors coming into the city - Demand management (assess the possibility of introducing a congestion charge and work place parking levy) - Project Cities-4-People: Seeking to transform mobility design – aims to provide new ways to create innovative, sustainable and targeted mobility solutions by placing citizens at the centre of the development process.	On-going	

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
3	Support walking and cycling strategies within the LTP to ensure they assist delivery of the AQAP objectives	Promoting Travel Alternatives	Promotion of Cycling	OCC/Oxfordshire County Council	Complete	Complete	Walking and Cycling strategies include measures that support delivery of the AQAP	N/A	The Active Healthy Travel Strategy has been published and includes measures to support the targets of the AQAP, various schemes around the city, new cycle assess to Headington, riverside routes, etc. Publication in 2017 of the code of conduct for dock less bike sharing operators, which lays down the process for introducing and operating dock less bike sharing schemes in Oxford as well as the core responsibilities of the operators.	On-going	
4	Assist in development of bus and park and ride strategies within the LTP which support the AQAP. In particular we will work with the County to promote traffic management and routing measures to reduce bus emissions	Alternatives to private vehicle use	Bus based Park & Ride	OCC/Oxfordshire County Council	Complete	On-going	Bus and Park & Ride strategies include measures that support delivery of the AQAP	N/A	The Bus Strategy has been published and includes measures to support the targets of the AQAP. There have also been city centre bus improvements – including Queen Street (walking, cycling, bus), improvements on the A40 -A44 strategic link road (traffic management and priority to busses at Hinksey Hill	On-going	Zero Emission Zone plans currently being progressed. On-going studies include: work place parking and access restrictions.
5	Work with the County and our partners in Low Carbon Oxford to promote travel plans with organisations across the city	Promoting travel Alternatives	Workplace Travel Planning	OCC	On-going	Started	Travel Plans adopted by organisations in the city	N/A	OCC currently requires the submission of a travel plan for all the major developments in the city The county is also working on several projects related with integrated mobility: Zipp.to – multimodal journey planner: a journey planner that integrated private car, bike (including dock less), trains, buses and even flight information, with live updates, weather information and personalised mobility options	On-going	

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
6	Continue to work with the County and bus operators to reduce bus emissions further, supporting the tightening of emission standards in contracted services and enforcement of the anti-idling policy following implementation of the LEZ	Vehicle Fleet Efficiency	Promoting Low Emission Transport	OCC	Complete	On-going	Amount of city fleet buses retrofitted with SCR – Euro 6 technology	The estimated NO_2 savings are 5.5 tonnes/year and a total of 27.6 tonnes over the lifetime of the project	Continue to work with bus companies to reduce their emissions and explore ways of compliance with ZEZ. Oxford City Council was recently awarded with £1.7milliion from the Clean Bus Technology Fund, for the retrofitting of 78 city buses to EURO 6 and other 5 to become fully electric. The retrofitting will be carried out on a rolling basis until April 2019.	On-going	The successful bid was only possible due to a joint working between Oxford City Council, Oxford Bus Company, Stagecoach and City Sightseeing Oxford

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
91	Promote the uptake of electric vehicles by working with our partners to install electric vehicle recharging infrastructure	Promoting Low Emission Transport	Procuring alternative refuelling infrastructure to promote Low Emission Vehicles, EV recharging, Gas fuel recharging	OCC/Oxfordshire County Council	On-going	On-going	Charging infrastructure installed	N/A	Go Ultra Low project: Infrastructure trial phase will continue during 2018 to assess the best technology to provide electric car charging for people who have to park their car on the street. Work being developed between OCC and COLTA (City of Oxford Licensed Taxicab Association) for the introduction of EV infrastructure for Hackneys and private hire. First 7 charging points expected to be installed during 2018 Recent successful bid of £200.000 from DEFRA air quality Grant for the provision of EV infrastructure and EV fleet to the city's covered market Oxfordshire county council also launched in 2017: V2go project – that will look at the role that electric delivery fleet vehicles could play in strengthening Oxford's power grid HelloEV project – funded by the European investment bank, will do a comprehensive planning, market analysis and in-depth business case development that will enable a large scale deployment of EV's in Oxfordshire – Oxford City council has been providing fleet data and support to the project that will help drive costs for vehicles and chargers down	On-going	The remaining 12 taxi charging points are expected to be installed in 2019. The scheme also includes a review of licensing requirements for hackney carriage vehicles, in order to drive improvements in emissions standards; an investigation of the business case for investment in ultra-low emissions taxis based on local Oxford duty-cycles; and bringing vehicle manufacturers to Oxford to showcase their vehicles and offer test drives.

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
8	Investigate the feasibility of developing infrastructure to support emerging low or zero emission vehicle technologies, such as hydrogen cells	Promoting Low Emission Transport	Procuring alternative Refuelling infrastructure to promote Low Emission Vehicles, EV recharging, Gas fuel recharging	Oxfordshire County Council, OCC	On-going	Not commenced	TBC	N/A	Feasibility study conducted by Oxfordshire County Council looking at the cost and practicality of installing a Hydrogen refuelling station at Oxford Parkway - Park and Ride. Using £800,000 worth of grant funding won through the Go Ultra Low City Scheme to roll out EV charging solutions for properties without dedicated parking spaces; Using £500,000 worth of grant funding from the Office for Low Emission Vehicles Taxi Scheme to facilitate the installation of electric charging infrastructure to encourage the uptake of electric taxis.	On-going	Feasibility study Provided a good idea about the complexity and costs of deployment. of hydrogen. Not many consumers available as the costs are still too high. EV charging project on-going **Achieved in 2017:** Recent successful bid of £200.000 from DEFRA air quality Grant to enable the provision of EV infrastructure and EV fleet to the city's covered market Launching of Oxfordshire Hydrogen Hub, in preparation for ZEZ
9	Continue to develop low emission and zero emission vehicles in our own fleet, and seek opportunities to increase the council's electric vehicle car-pool	Promoting Low Emission Transport	Company Vehicle Procurement – Prioritising uptake of low emission vehicles	OCC	Complete	On-going	Number of electric vehicles in Council's fleet	N/A	The number of electric pool vehicles in Oxford City Council's fleet continues to increase. Opportunities to replace conventionally fuelled vehicles with electric vehicles are assessed on a case by case basis. Oxfordshire county council is also starting to look at converting some of its fleet to electric through procurement	On-going	

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
10	Promote the development of low and zero emission car clubs schemes in the city	Alternatives to private vehicle use	Car Clubs	OCC	Complete	On-going	Number of low/zero emission car club vehicles available in the city	N/A	We have been working with car club providers to promote the provision of zero emission vehicles in the city as part of the GULO project	On-going	
11	Work with our Low Carbon Oxford Pathfinders to support the introduction of low emission vehicle into their fleets	Promoting Low Emission Transport	Company Vehicle Procurement – Prioritising uptake of low emission vehicles	OCC	Complete	On-going	Number of low/zero emission vehicles in LCO Pathfinder fleets	N/A	A number of Low Carbon Oxford Pathfinder events were held to bring together key organisations, to increase awareness of the impacts of business related travel and transport on the environment and human health	On-going	ZEZ effect is expected to accelerate this measure
12	Support eco-driving through inclusion of eco-driving information in the Low Carbon Hub and other travel information services, and where possible look to support eco-driving schemes with for example taxi companies	Public information	Via the internet	OCC	On-going	On-going	TBC	N/A	Oxfordshire County Council is currently working on the following projects: CATCH! – integrates software into a journey planner, which provides crowd-sourced information on travel (e.g. congestion, train delays etc.), increasing the tool's potential to influence travel behaviour CASPAR – aims to improve end to end journey for drivers in Oxfordshire by providing real-time information regarding the availability of blue badge parking spaces	On-going	
13	Explore the impact of alternative and low emission transport on air quality in Oxford	Promoting Low Emission Transport	Company Vehicle Procurement – Prioritising uptake on low emission vehicles	OCC	On-going	On-going	Feasibility study report	N/A	A feasibility study for a possible zero emission zone has been undertaken by Oxford City Council and Oxfordshire County Council	On-going	ZEZ feasibility study provided good level of information with regards to expected NOx / PM emissions savings, and impacts on people's health with the implementation of a ZEZ

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
14	Exploring the options available for freight consolidation and management and other schemes to reduce the amount of freight vehicles operating in the city. We also need to consider low and zero emission vehicles in relation to the final delivery leg of any such consolidation schemes	Freight and Delivery Management	Other	OCC	Complete	On-going	TBC	N/A	Report has been completed and published https://www.oxford.gov.uk/info/20216/air_quality:management/977/reducing_freight_emissions We continue to consider how we can carry out mini consolidation across our own organisation. Achieved in 2017: Recent successful bid of £200.000 from DEFRA air quality Grant for the provision of EV infrastructure and EV fleet to the city's covered market	On-going	Freight and consolidation study identified issues with viability for major consolidation. However, the ZEZ feasibility study recommended the introduction of local parcel consolidation centres as a supported measure for ZEZ implementation
15	Seek to establish a freight quality partnership to promote Eco-driving and anti-idling policies with operators in the city	Freight and Delivery Management	Freight Partnerships for city centre deliveries	OCC	On-going	Not commenced	TBC	N/A	This measure has not been progressed to date	N/A	Delivery of ZEZ has superseded this measure.

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
16	Support the development of Delivery and Servicing Plans (DSPs) with business across the city to further reduce unnecessary freight movements. The development of such DSP's will need to consider integration with work emerging on freight consolidation	Freight and Delivery Management	Delivery and Service Plans	OCC	Not commenced	Not commenced	TBC	N/A	Development of service and delivery plan for own sites being investigated	On-going	At the moment this is being managed through the planning process
17	Ensure that transport and environmental impact assessments for new developments are adequate to determine what levels of mitigation may be required to offset potential increases in transport activity and emissions	Policy Guidance and Development Control	Low Emissions Strategy	OCC	Complete	On-going	Air Quality Assessments undertaken for all major development in the city	N/A	Air Quality Assessments are required for all new development classified as 'major'. OCC is also developing a Technical Advisory Note for developers and planners, setting out our approach to consideration of air quality in the planning process. We are also ensuring that air quality is considered fully during the development of the Oxford Local Plan.	On-going	

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
18	Explore opportunities to develop policy measures that require developers to provide investments in and contributions to the delivery of low emission transport projects and plans, including strategic monitoring and assessment activities.	Policy Guidance and Development Control	Low emissions strategy	OCC	On-going	On-going	TBC	N/A	The Oxford Local Plan is currently under review. This measure will be progressed through that process	Dec 2019	
19	Seek to ensure that stretching targets are set within travel plans for new developments, and that all new developments are encouraged to adopt Delivery and Servicing Plans to reduce freight movements.	Policy Guidance and Development Control	Low Emissions Strategy	OCC	On-going	Not Commenced	TBC	N/A	The Oxford Local Plan is currently under review. This measure will be progressed through that process	Dec 2019	

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
20	Seek to ensure that new developments make appropriate provision for walking, cycling, public transport and low emission vehicle infrastructure e.g. EV charging points	Policy Guidance and Development Control	Low Emissions Strategy	OCC	Complete	On-going	EV charging points installed at all new major developments	N/A	Currently happening through DM process. The Oxford Local Plan is currently under review and further stretching targets are being sought as part of this process. This measure will be further progressed through that process	On-going	A condition is already being imposed through the planning process requiring the installation of EV charging points for commercial and residential spaces
21	We will encourage the development of voluntary area-wide travel plans for existing developments through the Community Action Groups	Promoting Travel Alternatives	Other	OCC	On-going	Not commenced	TBC	N/A		TBC	
22	Promote the development of car clubs within new developments	Alternatives to private vehicle use	Car Clubs	OCC	On-going	On-going	Number of car clubs in new developments	N/A	Where appropriate, car clubs are considered as part of mitigation measures for air quality impacts in major developments	On-going	10 Electric Car Clubs will be launched as part of GULO project
23	Development of low emission vehicle hierarchy to guide the procurement of vehicles within our fleet	Promoting Low emission Transport	Company Vehicle Procurement – Prioritising uptake of low emission vehicles	OCC	On-going	Not commenced	Number of low emission vehicles within Council fleet	N/A	Formal hierarchy not adopted but opportunities for EV is considered when vehicles are replaced.	TBC	

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
24	Continue to assess our fleet operations in terms of mileage management and efficient routing of vehicle movements	Vehicle Fleet Efficiency	Driver training and ECO driving aids	OCC	Complete	On-going	N/A	N/A	Route and mileage management are integrated into business as usual for the fleet	On-going	Recent Installation of a box on every fleet vehicle that lists an assessment for alternative fuel which covers eco improvements
25	Maintain and develop our staff travel plan and complement this with Delivery and Servicing Plans (DSP) for key Council sites such as Town Hall	Freight and Delivery Management	Delivery and Service Plans	OCC	Complete	On-going	An adopted DSP is in place for the Council's city centre locations	N/A	A report outlining options for a DSP for city centre Council sites has been prepared and consideration of the options and implementation is on-going	On-going	
26	Roll out Eco-driving training for our staff	Vehicle Fleet Efficiency	Driver training and ECO driving aids	OCC	Complete	On-going	Eco-driving training in place for staff	N/A	Eco-driving training is now in place for staff	On-going	
27	Seek to develop a sub-regional approach to air quality monitoring and action planning, working closely with our County and District Colleagues, through engagement with the Oxfordshire Air Quality Partnership	Policy Guidance and Development Control	Regional Groups Co-ordinating programmes to develop Area wide Strategies to reduce emissions and improve air quality	OCC	Complete	On-going	Attendance at the Oxfordshire Air Quality Group	N/A	Engagement with neighbouring District Councils has been developed through the participation in the Oxfordshire Air Quality Group	On-going	

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
28	Consider the benefit of including wider stakeholders such as transport providers, public health organisations and research and consulting expertise	Policy Guidance and Development Control	Regional Groups Co-ordinating programmes to develop Area wide Strategies to reduce emissions and improve air quality	OCC	Complete	On-going	Regular updates on air quality provided to the Health improvement Board	N/A	Engagement with the Health Improvement Board	On-going	We are also working together with the Mobile Air Quality Measurement group and members of the university on the characterisation of new innovative NO_2 sensors for use across a range of projects and citizen science
29	Improve communication to increase the public's understanding of the main sources and health effects of air pollution emissions	Public information	Via the internet	OCC	Complete	On-going	County wide Oxfordshire Air Quality Group website launched	N/A	The Oxfordshire Air Quality Group website (http://oxfordshire.air-quality.info/) was launched in October 2015. As well as providing real time and historic monitoring data, the website provides information on the health impacts of air quality and a 'Children's Area'	On-going	Oxford City Council has recently launched, in partnership with friends of the earth a city wide anti-idling campaign to reduce unnecessary emissions from stationary vehicles

	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
30	Work with the district and County Councils in Oxfordshire to provide a co-ordinated approach to public awareness and education	Public Information	Other	OCC	On-going	On-going	Total amount of available sensors installed at schools, air quality stickers installed at all the monitoring sites linking with the AQ website, anti-idling campaign idling surveys	N/A	STOP Project (air quality sensors installed at 6 schools in Oxford) Oxford City Council has developed an air quality sticker with an R code with direct link with Oxfordshire's AQ website. The sticker has been installed at every AQ monitoring location in the city, in order to provide more information to the public about air pollution. Oxford City Council has also recently launched air quality toolkit to be used by students and pupils with AQ science citizen activities to raise awareness and educate on air quality. Development of an Anti-Idling campaign for Oxford in March 2018 together with local Friends of the Earth.	On-going	AQ toolkit is part of a wider engagement project (STOP project) with Oxford's schools

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

As detailed in Policy Guidance LAQM.PG16[10] (Chapter 7), local authorities (LAs) are expected to work towards reducing emissions and/or concentrations of $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5 µm 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.

Oxford City Council measures $PM_{2.5}$ at St Ebbe's urban background site. In 2017 the annual mean concentration was 11 μgm^{-3}. Oxford City Council considers that many of the measures designed to reduce levels of nitrogen dioxide set out in the AQAP will also contribute to reducing levels of $PM_{2.5}$. Oxford City Council considers that the following existing measures contained in the AQAP will contribute to reducing levels of $PM_{2.5}$:

1. Manage bus emissions through the implementation of the Low Emission Zone;
2. Work to ensure sustainable transport measures developed in the Oxford Area Strategy of the LTP support the targets of the AQAP;
3. Support walking and cycling strategies within the Local Transport Plan (LTP) to ensure they assist delivery of the AQAP objectives;
4. Assist in development of bus and park and ride strategies within the LTP which support the AQAP. In particular we will work with the County to promote traffic management and routing measures to reduce bus emissions;
5. Work with the County and our partners in Low Carbon Oxford to promote travel plans with organisations across the city;
6. Continue to work with the County and bus operators to reduce bus emissions further, supporting the tightening of emission standards in contracted services and enforcement of the anti-idling policy following implementation of the LEZ;
7. Promote the uptake of electric vehicles by working with our partners to install electric vehicle recharging infrastructure;
8. Continue to develop low emission and zero emission vehicles in our own fleet, and seek opportunities to increase the Council's electric vehicle car-pools;

9. Promote the development of low and zero emission car clubs schemes in the city;
10. Work with our Low Carbon Oxford Pathfinders to support the introduction of low emission vehicle into their fleets;
11. Support eco-driving through inclusion of eco-driving information in the Low Carbon Hub and other travel information services, and where possible look to support eco-driving schemes with for example taxi companies;
12. Exploring the options available for freight consolidation and management and other schemes to reduce the amount of freight vehicles operating in the city. We will also consider low and zero emission vehicles in relation to the final delivery leg of any such consolidation schemes;
13. Seek to establish a freight quality partnership to promote Eco-driving and anti-idling policies with operators in the city;
14. Support the development of Delivery and Servicing Plans (DSPs) with business across the city to further reduce unnecessary freight movements. The development of such DSP's will need to consider integration with work emerging on freight consolidation;
15. Ensure that transport and environmental impact assessments for new developments are adequate to determine what levels of mitigation may be required to offset potential increases in transport activity and emissions;
16. Explore opportunities to develop policy measures that require developers to provide investments in and contributions to the delivery of low emission transport projects and plans, including strategic monitoring and assessment activities;
17. Seek to ensure that stretching targets are set within travel plans for new developments, and that all new developments are encouraged to adopt Delivery and Servicing Plans to reduce freight movements;
18. Seek to ensure that new developments make appropriate provision for walking, cycling, public transport and low emission vehicle infrastructure e.g. EV charging points;

19. Develop a low emission vehicle hierarchy to guide the procurement of vehicles within our fleet;
20. Maintain and develop our staff travel plan and complement this with Delivery and Servicing Plans (DSPs) for key Council sites such as Town Hall.
21. Roll out eco-driving training for our staff;
22. Redevelopment of the entire delivery system of the city's heritage site covered market for it to be emission free, through the introduction of EV infrastructure and an EV fleet to be used by market retailers for their deliveries within the city.

In addition we have continued to seek opportunities to engage with Public Health colleagues on air quality, presenting annual updates on air quality to the Oxfordshire Health Improvement Board, which links in to the Public Health Outcome Framework $PM_{2.5}$ indicator. We are working in partnership with Oxfordshire County Council on the introduction of a Zero Emission Zone in the city centre. The introduction of a Zero Emission Zone is expected to contribute to the reduction of $PM_{2.5}$ emissions.

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

3.1 Summary of Monitoring Undertaken

Oxford City Council undertook automatic (continuous) monitoring of Nitrogen Oxides (NOx) at 3 sites, Particulate Matter (PM_{10} and $PM_{2.5}$) at 2 sites and Ozone (O_3) at one site in 2017. Non-automatic (passive) monitoring of Nitrogen Dioxide (NO_2) was carried out at 71 sites in 2017.

A map showing the location of the air quality monitoring (continuous and passive) that has been conducted in 2017 can be found in appendix C. Maps covering the historic locations of air quality monitoring locations are provided on the Oxfordshire Air Quality Group website (https://oxfordshire.air-quality.info/). Further details on Quality Assurance/Quality Control (QA/QC), how the monitors are calibrated, how the data has been adjusted and the bias adjustment factor used for the diffusion tubes are included in Appendix B.

3.1.1 Automatic Monitoring Sites

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

Oxford City Council undertook automatic (continuous) monitoring at 3 sites during 2017. Table A.1 in Appendix A shows the details of the sites. National monitoring results of those sites are available at https://uk-air.defra.gov.uk/ and http://www.airqualityengland.co.uk/.

3.1.2 Non-Automatic Monitoring Sites

We undertook non-automatic (passive) monitoring of NO_2 at 71 sites in 2017. Table A.2 in Appendix A shows the details of those sites.

For the purposes of deciding which locations to monitor, the City Council considers in the first instance locations where there is relevant public exposure. It is important that assessments focus on locations where members of the public are likely to be regularly present for a period of time appropriate to the averaging period of the

objective. Monitoring is carried out in line with DEFRA's Technical Guidance LAQM.TG (16)[11].

Approximately half of the monitoring locations are within central Oxford at locations where we believe relevant exposure is most likely to be significant. The remaining locations are outside of the central area, again prioritised by locations where relevant exposure is most likely.

Monitoring of NO_2 cannot be undertaken at every location on a continuous basis. The City Council therefore makes the most efficient use of available resources by implementing a rotational system on a percentage of monitoring sites every year, ensuring such sites are covered on average every 2 to 3 years.

One important aspect of monitoring is to be able to demonstrate trends in air quality over long time periods. In order to do so, the City Council continues monitoring at a number of the same sites year on year, so that the results reported can provide a strong basis for showing trends that are independent of location.

3.2 Individual Pollutants

The air quality monitoring results presented in this section are ratified, and, where relevant, adjusted for *"annualisation"* and bias. Further details on adjustments are provided in Appendix B. Details of the UK air quality objectives for protection of human health for comparison with the 2017 monitoring results can be found in Appendix E.

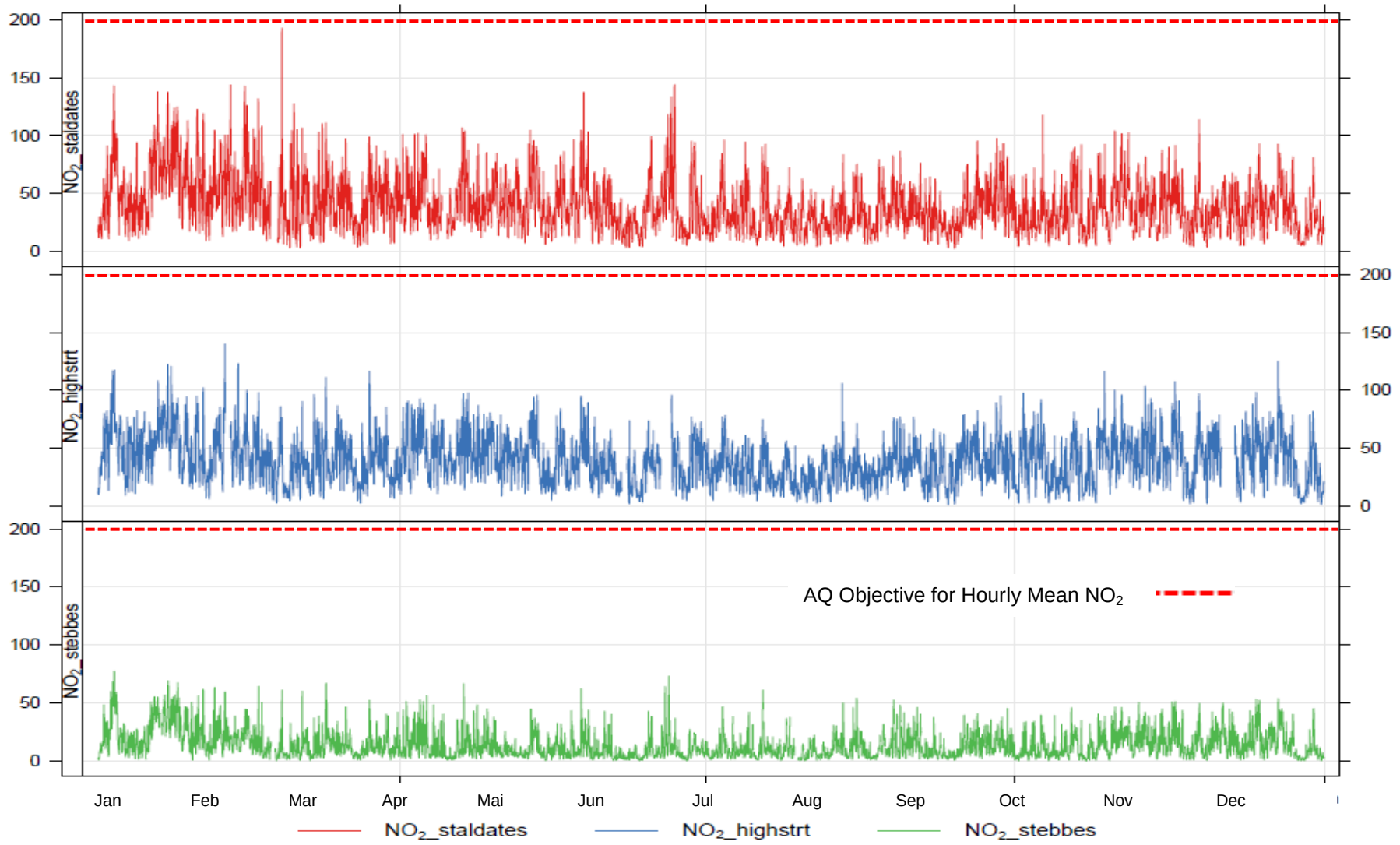
3.2.1 Nitrogen Dioxide (NO_2)

Combustion processes emit a mixture of nitrogen oxides – NO and NO_2 - collectively termed NOx.

- NO is described as a primary pollutant (meaning it is directly emitted from source). NO is not known to have any harmful effects on human health at ambient concentrations. However, it undergoes oxidation in the atmosphere to form the secondary pollutant NO_2.
- NO_2 has a primary (directly emitted) component and a secondary component, formed by oxidation of NO. NO_2 is a respiratory irritant and is toxic at high concentrations. It is also involved in the formation of photochemical smog and acid rain and may cause damage to crops and vegetation.

NO_2 data has been monitored by the use of automatic continuous monitors and passive monitoring (diffusion tubes) in 2017. The time series of hourly averaged concentrations of NO_2 for the 3 automatic monitoring sites is shown in Figure 3.1. The results are expressed in μgm^{-3}.

Figure 3-1 - Time series of hourly averaged concentrations of NO_2 (μgm^{-3}) at automatic monitoring sites, 2017.



The AQS objective for hourly mean NO_2 concentration is 200 μgm^{-3}, and may be exceeded up to 18 times per calendar year. Figure 3.1 shows that during 2017 there were no recorded hourly mean NO_2 measurements exceeding 200 μgm^{-3}. The highest hourly mean NO_2 measured in 2017 was of 193 μgm^{-3} and was registered on the 24th February at 19:00 at Oxford Centre Roadside (St Aldates). Table A.4 in Appendix A summarises the NO_2 hourly mean exceedances of the 200 μgm^{-3} hourly air quality objective reported in Oxford over the past 5 years.

The threshold of the *"Moderate"* air quality band as set out by DEFRA for the NO_2 hourly mean ranges from 201 to 400 μgm^{-3}. NO_2 levels at all 3 sites were recorded within the DEFRA *"Low"* band for the whole year. The AQS hourly objective for NO_2 was therefore met in 2017.

The annual mean AQS objective for NO_2 is 40 μgm^{-3}. In 2017, Oxford High Street's annual mean for NO_2 was 39 μgm^{-3} and Oxford Centre Roadside 40 μgm^{-3}. At St Ebbe's, the NO_2 annual mean was 14 μgm^{-3}. This objective was met for the first time at all the automatic monitoring stations in Oxford in 2017.

From 2016 to 2017 we have seen significant reductions in NO2 across city centre sites. Analysis, comparing result with the St Ebbe's Urban Background site AURN, suggest that weather and wind direction cannot explain the reduction seen from 2016 -2017, hence suggesting that the reduction in due to a change in traffic emissions. The streets have not seen significant changes to flow or road layout which can explain this reduction.

The major change in these streets has been the upgrade of buses to Euro VI. This upgrade has taken place from late 2014, majority coming on board in mid-late 2016 and is on-going, with the fleet euro standard split now Euro V 61% and Euro VI 39%. Euro VI buses achieve an estimated 99.5% reduction in NOx compared to Euro V, which is likely to explain the reduction we have seen from 2016-2017.

Table A.3 in Appendix A compares the ratified monitored NO_2 annual mean concentrations for the past 5 years with the air quality objective of 40 μgm^{-3}.

Figure 3.2 (below) shows the 14 year long term trend for levels of measured NO_2 at continuous monitoring stations. The results are expressed in μgm^{-3}.

Figure 3-2 – Long term trends of Annual Mean NO_2 (μgm^{-3}) at Oxford's Continuous Monitoring Stations, 2003-2017.

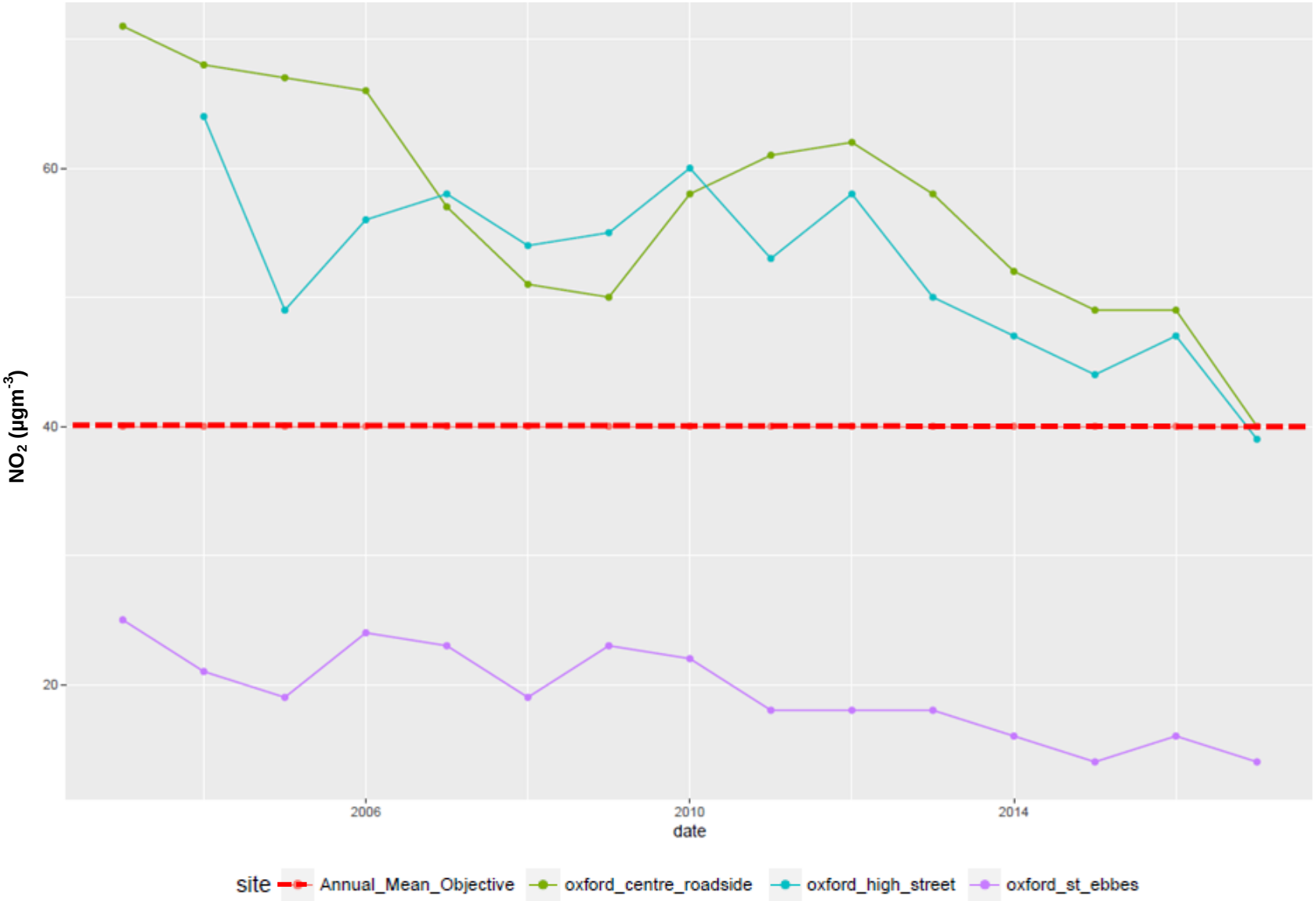


Figure 3.2 shows that NO_2 levels have reduced significantly at all Oxford's automatic monitoring stations in 2017, when compared with the results obtained in 2016. The highest level of reduction (18%) was seen at the roadside monitoring stations of Oxford High Street and Oxford Centre roadside.

Appendix D shows the daily average levels of NO_2 along the entire calendar year 2017 for the automatic monitoring stations of Oxford Centre Roadside, Oxford High Street and Oxford St Ebbe's.

Non-Automatic Monitoring

Non-automatic monitoring using diffusion tubes took place at 71 locations in 2017. Approximately half of this number was exposed within central Oxford, rotated between the locations where we believe relevant exposure is most likely. The remaining tubes were used outside of the central area, again prioritised by locations where relevant exposure is most likely.

The Diffusion tube results show that the annual mean AQS objective of 40 μgm^{-3} for NO_2 specified by DEFRA was exceeded at only 4 of the 71 monitoring locations where NO_2 levels were measured in 2017. All the diffusion tube monitoring locations are within the existing AQMA and were considered representative of public exposure; therefore there was no need to correct the results for distance. The main observations of the monitoring carried out in 2017 using non-automatic monitoring are as follow:

- In 2017, significant decreases of NO_2 levels were observed in the city centre, the largest drops being observed along Beaumont Street, George Street, St Clements, Speedwell Street and Castle Street. NO_2 pollution levels saw an overal reduction of 23% in the city centre when compared with the figures obtained in 2016;
- From the 71 locations where NO_2 levels were monitored using diffusion tubes in 2017, only 4 proved to be exceeding the annual mean limit value for nitrogen dioxide. Two of those sites are located at the North West boundary of the City (Cutteslowe and Wolvercote). The other two are located in the city centre (St Clements and High Street);

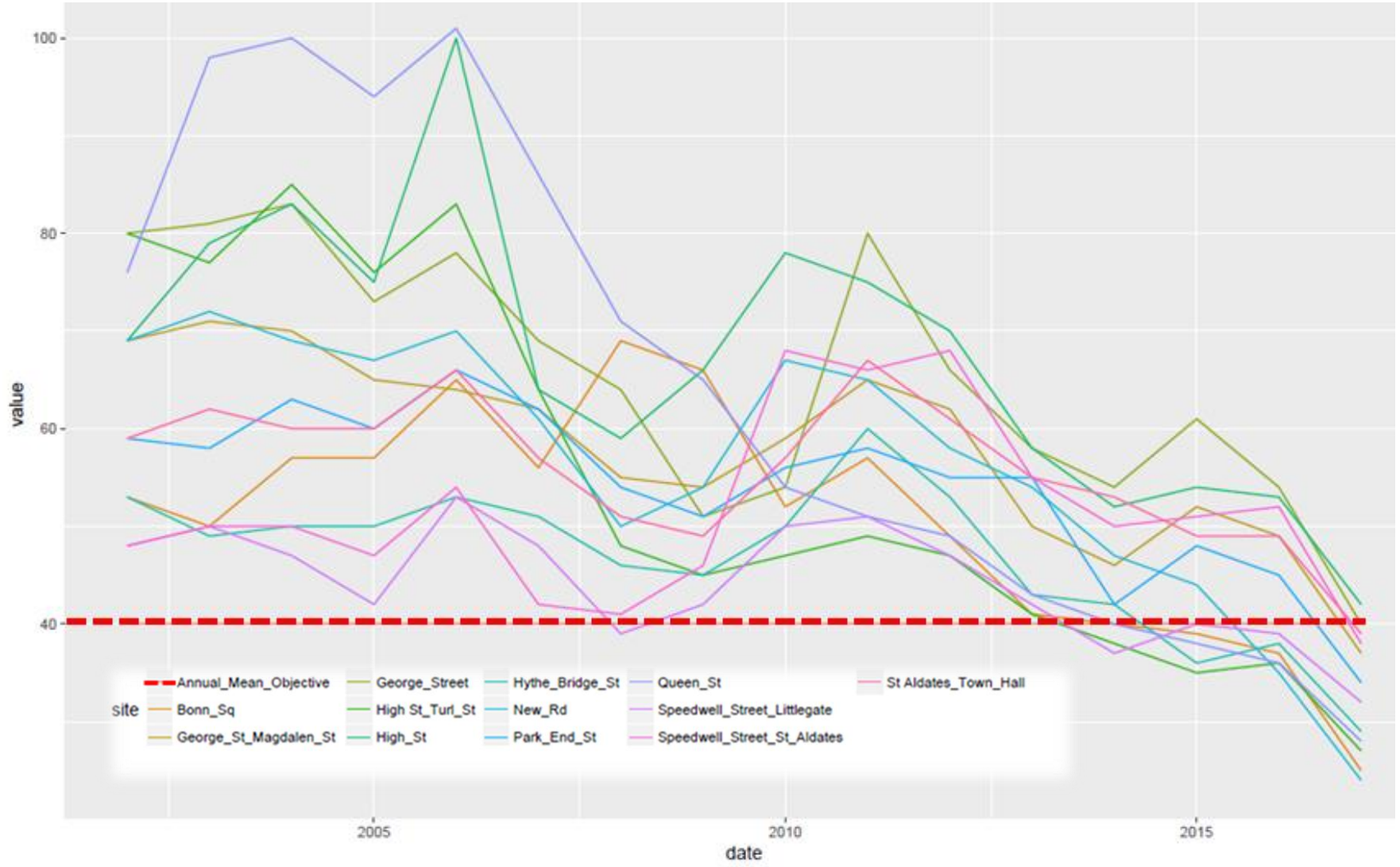
- The monitoring location with the highest annual mean for NO_2 in 2017 was DT55 - St Clements - with a value of 47 μgm^{-3}. In 2016 this site measured 61 μgm^{-3}. The annual mean measured in 2017 represents therefore a reduction of 23%. The results need to be treated carefully however, as from June to August St Clements street had limited traffic due to disruptive sewer works being conducted on-site. The works resulted in pollution levels being halfed during that period, which is reflected in the NO_2 annual mean. A methodology was applied, to calculate what the NO_2 annual mean would have been, if the roadworks had not been conducted. The results show a predicted annual mean of 51 μgm^{-3} , which indicates that there was a clear reduction of pollution levels in St Clements, which is not directly related with the roadworks but related instead with the overall reduction in levels observed across the city in 2017;
- None of the City's NO_2 monitoring sites presented an annual mean equal or above 60 ugm^{-3} which is the first time since monitoring began. According to LAQM (TG16)[11], this is a indication that exceedances of the 1-hour mean objective for NO_2 are also not likely to have occurred in the city in 2017;
- In 2017, NO_2 was measured at 3 monitoring locations that had not been measured in 2016. At one of those location, measured concentrations of NO_2 were above the annual mean limit value: DT71: BP Service Station Woodstock Road;
- Air Quality has improved at 57 of the 59 historic diffusion tube locations in 2017, with 15 of those improvements occurring in places were the NO_2 annual mean was historically above the NO_2 annual limit value of 40 ugm^{-3} (Windmill road – DT14, Cutteslowe – DT25, St Aldates, Park end St, Worcester St, Beaumont St, George St (DT47 and DT48), High St (DT51 and DT56), Long Wall St, St Clements. Speedwel St, Folly Bridge and Castle Street);
- 10 locations in the city (Windmill road, St. Aldates, Park End St., Worcester St., Beaumont St., George St., Folly Bridge, Castle St., Long Wall St. and Speedwell St.) are now below the NO_2 annual mean limit value of 40 μgm^{-3}, however, NO_2 levels at 5 of those locations proved to be marginally below the threshold for compliance - given the degree of uncertainty associated with the

diffusion tube methodology, it is recommended that those results are to be treated with due care;

Figure 3.3 below shows the long term trend for levels of measured NO_2 at a number of historic diffusion tube monitoring stations. The results are expressed in μgm^{-3}.

It is quite clear that there has been a significant downward trend in measured levels of NO_2 at all of these locations in 2017. Overall, the annual mean objective for NO_2 was only exceeded at 4 of the 71 locations monitored in 2017.

Figure 3-3 – Long Term Trends in Annual Mean NO_2 (ugm^{-3}) at Oxford's diffusion tube monitoring locations, 2003-2017.



The reduction of NO_2 levels observed in several locations across the city centre is likely to be explained by the following:

- During 2017, new Euro VI buses were purchased and introduced in the city by both Stagecoach and Oxford Bus Company, while Euro V buses were at the same time discontinued. Differences in primary NO_2 emissions between Euro VI and Euro V engines are proven to be quite substantial. The city centre fleet that was originally consisting of 100% Euro V buses in 2014 – in order to meet compliance with the city's recently implemented LEZ - can now in 2017 be split into 61% of buses Euro V and 39% buses Euro VI, and that seems to have been the main driver of the significant reductions seen in air quality levels across the city.
- Some of the biggest reductions can also be explained by several road works, prolonged road closures or traffic diversions, which relived the traffic levels in certain areas of the city for considerable periods of time in 2017. The table below provides some information on the type of construction/road works that have been conducted in very specific locations of the city, where the reductions of NO_2 levels were highest.

Table 3-1 - List of sites were some of the highest levels of NO_2 reductions were observed and likely associated causes.

Location	List of Affected sites (per site ID)	Max observed reduction (µgm-^{3})	Likely Causes
St Clements	DT54, DT 55	14	*Sewer works conducted by Thames water during 3 months in the summer, which were responsible for the use of a unique single track lane in the street, reducing the traffic levels to half during that period*
West Gate area	DT70, DT68, DT42, DT43, DT60, DT66, DT67, DT40, DT59, DT61, DT62, DT63, DT64, DT65, DT41	14	*Several road closures related with the work conducted around the Westgate shopping centre, which changed bus routes and general traffic levels in the area (castle street was even closed for a significant amount of time to traffic in 2017)*

Queen St	DT40, DT41	12	*Works around the experimental pedestrianisation of queen street, which ultimately lead to a significant reduction of traffic/buses in queen street, in particular immediately after Westgate shopping centre opening day in October*
Latimer Road/London Road	DT17	13	*Road was closed for several periods of time during 2017 linked to OUHT's heat pipeline and then development of the student accommodation on the corner of Latimer Rd/London Rd*
George St and Speedwell street	DT48, DT47, DT57	14	*Major bus routes (emission reductions most likely caused by purchase of Euro VI buses)*

A list of diffusion tube locations, details and results can be found in Tables A.2 and A.3 in Appendix A. A map with the locations of the air quality monitoring that was conducted during 2017 and levels of NO_2 is shown in Appendix C.

3.2.2 Particulate Matter (PM_{10} and $PM_{2.5}$)

Airborne particulate matter varies widely in its physical and chemical composition, source and particle size. The terms PM_{10} and $PM_{2.5}$ are used to describe particles with an effective size less than 10 and 2.5 µm respectively. These are of concern with regard to human health, as they are small enough to penetrate deep into the lungs. They can cause inflammation and a worsening of the condition of people with heart and lung diseases. In addition, they may carry surface absorbed carcinogenic compounds into the lungs. Larger particles, meanwhile, are not readily inhaled, and are removed relatively efficiently from the air by sedimentation.

In 2017 PM_{10} data has been monitored by automatic continuous monitors at Oxford St. Ebbe's and Oxford High Street. $PM_{2.5}$ has been monitored at Oxford St Ebbes in 2017.

The AQS objective for PM_{10} is a maximum of 50 μgm^{-3} for any 24h mean period, not to be exceeded more than 35 times a year.

The results of PM_{10} measurements during the course of 2017 show only 2 exceedances of the 50 μgm^{-3} 24h mean, which were registered on the 22nd and 23rd January and recorded at both Oxford High Street and Oxford St Ebbe's monitoring

sites. According to Kings College[12], those are not directly related with pollution generated in the city but instead with a trans-boundary pollution episode that resulted from a regional mix of traffic pollution and wood burning that were exponentiated by "*(…) cold, calm and settled weather conditions resulting from a high pressure system have contributed to a widespread particulate pollution episode with levels reaching 'very high'* ".

The analysis from King's continues: *"On Sunday 22nd, an import of pollution from the continent during the afternoon was followed in the evening by cold foggy conditions with almost no dispersion. The rapid rise in pollution at this time was caused by a combination of traffic pollution and also air pollution from wood burning. This was the largest contribution from wood burning measured during the winter. (…) On Monday 23rd, the 'very high' threshold was exceeded again at an even greater number of sites as weekday emissions added to the already elevated pollution levels. Continuing very light winds causing poor pollution dispersion resulted in 'very high' particulate pollution (…)".*

The AQS objective for 24-hour mean PM_{10} was fully met at Oxford High Street and Oxford St Ebbe's in 2017.

Table A.6 in Appendix A shows the number of exceedances to the PM_{10} 24-hour mean objective in the past 5 years.

The annual mean AQS objective for PM_{10} is 40 μgm^{-3}. Table A.5 in Appendix A compares the ratified and adjusted monitored PM_{10} annual mean concentrations for the past 5 years with the air quality objective of 40μgm^{-3}.

Oxford High Street registered an annual mean of 18 μgm^{-3}. Oxford St. Ebbe's 13 μgm^{-3}. This objective was therefore met in 2017.

No AQS objective exists for $PM_{2.5}$; however a non-mandatory compliance target of 25 μgm^{-3} to be met by 2020 exists. The annual mean for this pollutant was 11 μgm^{-3} at Oxford St. Ebbe's. Table A.7 in Appendix A presents the ratified and adjusted monitored $PM_{2.5}$ annual mean concentrations for the past 5 years.

3.2.3 Ozone (O_3)

Ozone (O_3) is not emitted directly into the atmosphere in significant quantities, but is a secondary pollutant produced by reaction between nitrogen dioxide (NO_2) and hydrocarbons, in the presence of sunlight. Whereas nitrogen dioxide (NO_2)

contributes to ozone formation, nitrogen oxide (NO) destroys ozone and therefore acts as a local sink. For this reason, ozone levels are not as high in urban areas (where NO is emitted from vehicles) as in rural areas. Ozone levels are usually highest in rural areas, particularly in hot, still, sunny weather conditions giving rise to *"summer smog".*

O_3 is measured at Oxford St. Ebbe's. The AQS objective for daily maximum on an 8 hour running mean is 100 μgm^{-3} not to be exceeded more than 10 days a year. Oxford St. Ebbe's met the AQS objectives for this pollutant in 2017.

Oxford St. Ebbe's data capture of O_3 was of 96% in 2017. The site exceeded the AQS daily objective for ozone on 5 days during the year. The maximum concentrations of ozone were recorded between 18th and the 21st June 2017, with a maximum of 150.5 μgm^{-3} on the 21st June 16h00. According to Kings College[12], the period 18th-21st June corresponds to a period where moderate and high levels of Ozone where seen across England. The 21st of June was even considered the hottest day of the year, and June 2017 was the hottest since 1976. Ground-level ozone production requires both ozone precursor chemicals such as oxides of nitrogen, Volatile Organic Compounds (VOCs) and carbon monoxide, and time in strong sunshine to power conversion of these chemicals into ozone. *"(…) On 21st June polluted air drifted over the southern UK from the near continent. Widespread high ozone was measured on King's networks across Kent, Surrey and Sussex and at several sites on the UK AURN. This polluted air moved northwards and affected London during the late afternoon and early evening. In the capital there was widespread moderate ozone and high ozone was measured in Harlington and North Kensington*[12]."

"The greatest ozone concentration was measured in Sevenoaks, Kent and at Lullington Heath on the Sussex coast. Across London and the south east, this is the greatest June ozone for 11 years and the first time that ozone has reached index level 8 since the UK daily air quality index was launched in 2012. The high ozone on the 21st June was the fourth day of this air pollution episode that has brought widespread moderate ozone to London and the south east, building as the heat wave progressed[12]."

Appendix A: Monitoring Results

Table A.1 – Details of Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA?	Monitoring Technique	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Inlet Height (m)
CM1	St. Aldate's (Oxford Centre AURN)	Roadside	451359	206157	NO_2	YES	Chemiluminescent	1	3	2.5
CM2	High Street	Roadside	451677	206272	NO_2 PM_{10}	YES	Chemiluminescent Conventional TEOM Gravimetric Equivalent	1	2	1.5
CM3	St Ebbe's	Urban Background	451118	205353	NO_2; PM_{10}; $PM_{2.5}$; O_3	YES	Chemiluminescent; FDMS; FDMS; UV absorption	10	2	2.5

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.

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

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?	Height (m)
DT1	St Ebbe's	Urban Background	451118	205353	NO_2	YES	10	2	YES	2.5
DT2	Weirs Lane/Abingdon Road Lamp Post 1	Roadside	451904	204215	NO_2	YES	2	2	NO	3
DT3	Lamp Post 52 Abingdon Road	Roadside	451914	204154	NO_2	YES	3	2	NO	3
DT4	Boundary Brook Road/ Iffley Road	Roadside	452961	204662	NO_2	YES	0	2	NO	3
DT5	Lenthall Road Allotments	Urban background	452818	203448	NO_2	YES	5	N/A	NO	1.5
DT6	Templar Square	Roadside	454336	203952	NO_2	YES	2	2	NO	3
DT7	Oxford Road/ Between Towns Road	Roadside	454472	204246	NO_2	YES	3	2	NO	3
DT8	Oxford Road (Cowley) Lampost 13	Roadside	454355	204296	NO_2	YES	0	1	NO	3
DT9	Cowley Road/ Divinity Road	Roadside	453151	205536	NO_2	YES	3	1	NO	3
DT72	Cowley Road/James Street	Roadside	452761	205745	NO_2	YES	1	1	NO	3
DT10	Divinity Road/ Warneford Lane	Roadside	453617	206072	NO_2	YES	2	1	NO	3

DT11	Gypsy Lane/ Old Road	Roadside	453910	206334	NO_2	YES	3	5	NO	3
DT12	Churchill Drive/ Old Road	Roadside	454493	206367	NO_2	YES	1	1	NO	3
DT13	Windmill Road/ Old Road	Roadside	454876	206447	NO_2	YES	3	0.5	NO	3
DT14	Windmill Road W	Roadside	454554	207102	NO_2	YES	0	2.5	NO	3
DT15	London Road / BHF	Roadside	454433	207058	NO_2	YES	0	2.5	NO	3
DT16	Headley Way/ London Road lamp post 2	Roadside	453982	206817	NO_2	YES	1	2	NO	3
DT17	Latimer Road/London Road	Roadside	454138	206903	NO_2	YES	2	2	NO	3
DT18	4 The Round way	Roadside	455596	207367	NO_2	YES	0	5	NO	3
DT19	North Way (Lamp Post 9)	Roadside	455457	207513	NO_2	YES	0	1	NO	3
DT20	Barton Lane (Lamp post 2)	Roadside	454999	207759	NO_2	YES	3	1	NO	3
DT21	North Way/ Barton Village Road (Lamp post 20)	Roadside	455116	207796	NO_2	YES	0	0.5	NO	3
DT22	Foxwell Drive (Lamp post 4)	Roadside	453885	208334	NO_2	YES	2	1	NO	3
DT23	Marsh lane/ Dents Close Lamp Post 1	Roadside	453228	208285	NO_2	YES	3	2	NO	3
DT25	3 Elsfield Road Cutteslowe Roundabout	Roadside	450419	210256	NO_2	YES	5	2	NO	3
DT26	3 Summers Place Cutteslowe	Roadside	450389	210189	NO_2	YES	1	2	NO	3

	Roundabout									
DT27	Wolvercote roundabout - 78 sunderland avenue	Roadside	449824	210198	NO_2	YES	1	1	NO	3
DT28	Wolvercote Roundabout - 51 Sunderland Avenue	Roadside	449856	210162	NO_2	YES	1	1	NO	3
DT71	BP Service Station Woodstock Road	Roadside	449617	210216	NO_2	YES	5	5	NO	3
DT29	Pear Tree Park & Ride	Roadside	449530	210734	NO_2	YES	10	4	NO	3
DT30	Osney Lane/ Hollybush Row	Kerbside	450668	206053	NO_2	YES	2	2	NO	3
DT31	Beckett Street	Roadside	450566	206227	NO_2	YES	5	2	NO	3
DT32	Royal Oxford Hotel	Roadside	450674	206273	NO_2	YES	0	2.5	NO	3
DT33	Botley Road/ Mill Street	Roadside	450409	206224	NO_2	YES	1	1	NO	3
DT34	Abbey Road corner	Roadside	450356	206255	NO_2	YES	0	1	NO	3
DT35	Botley Road/ Hillview Road	Roadside	450029	206207	NO_2	YES	1	2	NO	3
DT36	Botley Road N (Corner of Prestwich Place)	Roadside	449657	206245	NO_2	YES	0	2	NO	3
DT37	Botley Road South (Corner of Duke Street)	Roadside	449655	206227	NO_2	YES	0	2	NO	3
DT39	St Aldate's	Roadside	451359	206157	NO_2	YES	0	2	YES	2.5
DT40	Queen Street	Roadside	451270	206144	NO_2	YES	0	2	NO	3

DT41	Bonn Square	Roadside	451216	206133	NO_2	YES	0	2	NO	3
DT42	New Road	Roadside	451073	206191	NO_2	YES	2	3.5	NO	3
DT43	Park End Street	Kerbside	450885	206275	NO_2	YES	2	1	NO	3
DT44	Hythe Bridge Street	Roadside	450795	206343	NO_2	YES	0	2	NO	3
DT45	Worcester Street	Roadside	450942	206424	NO_2	YES	2	2	NO	3
DT46	Beaumont Street	Kerbside	451167	206519	NO_2	YES	2	1	NO	3
DT47	George Street/ Magdalen Street	Kerbside	451222	206387	NO_2	YES	2	0.5	NO	3
DT73	Walton Street (lamp post 18)	Roadside	450960	206590	NO_2	YES	1	1	NO	2.5
DT48	George Street	Kerbside	450981	206344	NO_2	YES	0	0.5	NO	3
DT49	Cornmarket street	Urban Centre	451322	206242	NO_2	YES	0	2	NO	3
DT50	High Street/ Turl Street	Roadside	451467	206222	NO_2	YES	1	2.5	NO	3
DT51	50 High Street	Roadside	451900	206250	NO_2	YES	0	2.5	NO	3
DT52	Longwall Street	Kerbside	451972	206283	NO_2	YES	1	1	NO	3
DT53	Magdalen Bridge	Roadside	452099	206117	NO_2	YES	0	2	NO	3
DT54	York Place	Kerbside	452325	206015	NO_2	YES	0	2	NO	3
DT55	St Clements	Kerbside	452326	205992	NO_2	YES	1	1	NO	3
DT56	High Street	Kerbside	451576	206232	NO_2	YES	2	1	NO	3
DT57	Speedwell Street/ St Aldate's	Roadside	451407	205807	NO_2	YES	1	3	NO	3
DT58	Folly Bridge	Roadside	451437	205529	NO_2	YES	0	1	NO	3

DT59	Thames Street	Roadside	451353	205643	NO_2	YES	1	3	NO	3
DT60	New Butterwyke Place/ Thames Street	Roadside	451248	205710	NO_2	YES	5	2	NO	3
DT61	Friars Wharf	Roadside	451219	205707	NO_2	YES	0	3	NO	3
DT62	1 Blackfriars Road	Roadside	451072	205750	NO_2	YES	0	3	NO	3
DT63	Thames Street/ Trinity Street	Roadside	450926	205797	NO_2	YES	0	10	NO	3
DT64	Thames Street/ Oxpens Road	Roadside	450887	205825	NO_2	YES	0	1	NO	3
DT65	Speedwell Street/ Littlegate	Roadside	451206	205780	NO_2	YES	1	2	NO	3
DT66	36 Faulkner Street	Urban Background	451149	205859	NO_2	YES	1	20	NO	3
DT67	Old Greyfriars Street	Roadside	451149	205947	NO_2	YES	5	5	NO	3
DT68	Norfolk Street	Roadside	451030	205962	NO_2	YES	0	1.5	NO	3
DT69	Paradise Square	Roadside	450982	205973	NO_2	YES	0	1	NO	3
DT70	Castle Street	Roadside	451062	206067	NO_2	YES	0	1.5	NO	3

Notes:

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

(2) N/A if not applicable.

Table A.3 – Annual Mean NO_2 Monitoring Results

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) [1]	Valid Data Capture 2017 (%) [2]	NO_2 Annual Mean Concentration ($\mu g/m^3$) [3]				
					2013	2014	2015	2016	2017
CM1	St Aldate's (Oxford Centre AURN)	Automatic	96	96	**56**	**52**	**49**	**49**	40
CM2	High Street	Automatic	97	97	**50**	**47**	**44**	**47**	39
CM3	St Ebbe's	Automatic	97	97	18	17	14	16	14
DT1	St Ebbe's	Passive	100	100	20	17	16	18	14
DT2	Weirs Lane/Abingdon Road Lamp Post 1	Passive	92	92	35	35	39	34	28
DT3	Lamp Post 52 Abingdon Road	Passive	100	100	**40**	37	**42**	38	31
DT4	Boundary Brook Road/ Iffley Road	Passive	67	67	NM	NM	NM	34	28
DT5	Lenthall Road Allotments	Passive	92	92	20	13	15	14	10
DT6	Templar Square	Passive	92	92	NM	NM	NM	25	21
DT7	Oxford Road/ Between Towns Road	Passive	100	100	NM	NM	NM	36	31
DT8	Oxford Road (Cowley) Lampost 13	Passive	100	100	NM	NM	NM	34	29
DT9	Cowley Road/ Divinity Road	Passive	100	100	NM	NM	NM	28	25
DT72	Cowley	Passive	92	92	NM	NM	NM	NM	29

	Road/James Street								
DT10	Divinity Road/ Warneford Lane	Passive	50	50	NM	NM	NM	25	19
DT11	Gypsy Lane/ Old Road	Passive	92	92	NM	NM	NM	24	20
DT12	Churchill Drive/ Old Road	Passive	50	50	NM	NM	NM	NM	22
DT13	Windmill Road/ Old Road	Passive	100	100	NM	NM	NM	29	23
DT14	Windmill Road W	Passive	100	100	NM	**40**	**44**	**43**	33
DT15	London Road / BHF	Passive	100	100	NM	36	34	34	26
DT16	Headley Way/ London Road lamp post 2	Passive	100	100	NM	NM	NM	35	27
DT17	Latimer Road/London Road	Passive	100	100	NM	NM	NM	37	24
DT18	4 The Round way	Passive	92	92	37	32	32	33	23
DT19	North Way (Lamp Post 9)	Passive	100	100	NM	NM	30	30	27
DT20	Barton Lane (Lamp post 2)	Passive	100	100	NM	NM	31	29	25
DT21	North Way/ Barton Village Road (Lamp post 20)	Passive	100	100	NM	NM	30	30	26
DT22	Foxwell Drive (Lamp post 4)	Passive	92	92	NM	NM	22	21	17
DT23	Marsh lane/ Dents Close Lamp Post 1	Passive	100	100	NM	NM	20	20	15

DT25	3 Elsfield Road Cutteslowe Roundabout	Passive	100	100	NM	NM	**40**	**48**	35
DT26	3 Summers Place Cutteslowe Roundabout	Passive	100	100	NM	NM	**42**	**40**	**41**
DT27	Wolvercote roundabout - 78 sunderland avenue	Passive	92	92	NM	NM	39	34	29
DT28	Wolvercote Roundabout - 51 Sunderland Avenue	Passive	92	92	NM	NM	34	32	26
DT 71	BP Service Station Woodstock Road	Passive	100	100	NM	NM	44	NM	**41**
DT29	Pear Tree Park & Ride	Passive	100	100	NM	NM	38	36	28
DT30	Osney Lane/ Hollybush Row	Passive	100	100	33	28	32	33	27
DT31	Beckett Street	Passive	100	100	36	33	30	39	29
DT32	Royal Oxford Hotel	Passive	100	100	**47**	**41**	**40**	38	32
DT33	Botley Road/ Mill Street	Passive	92	92	NM	NM	28	29	23
DT34	Abbey Road corner	Passive	92	92	NM	NM	28	30	23
DT35	Botley Road/ Hillview Road	Passive	100	100	NM	NM	**40**	**40**	34
DT36	Botley Road N (Corner of Prestwich Place)	Passive	92	92	NM	NM	29	35	27

DT37	Botley Road South (Corner of Duke Street)	Passive	100	100	NM	NM	34	22	25
DT39	St Aldate's	Passive	100	100	**55**	**53**	**49**	**49**	39
DT40	Queen Street	Passive	100	100	**43**	**40**	38	36	28
DT41	Bonn Square	Passive	100	100	**41**	**40**	39	37	25
DT42	New Road	Passive	58	58	**54**	**47**	**44**	35	24
DT43	Park End Street	Passive	100	100	**55**	**42**	**48**	**45**	34
DT44	Hythe Bridge Street	Passive	100	100	**43**	**42**	36	38	29
DT45	Worcester Street	Passive	92	92	**54**	**52**	**50**	**51**	38
DT46	Beaumont Street	Passive	92	92	**42**	**43**	**44**	**45**	31
DT47	George Street/ Magdalen Street	Passive	100	100	**50**	**46**	**52**	**49**	37
DT 73	Walton Street (lamp post 18)	Passive	100	100	NM	NM	NM	NM	27
DT48	George Street	Passive	83	83	**58**	**54**	**61**	**54**	40
DT49	Cornmarket street	Passive	92	92	29	29	31	30	23
DT50	High Street/ Turl Street	Passive	100	100	**41**	38	35	36	27
DT51	50 High Street	Passive	100	100	**56**	**47**	**45**	**43**	34
DT52	Longwall Street	Passive	100	100	**53**	**50**	**50**	**49**	38
DT53	Magdalen Bridge	Passive	100	100	NM	NM	27	28	22
DT54	York Place	Passive	100	100	31	32	30	28	23
DT55	St Clements	Passive	100	100	**70**	**65**	**67**	**61**	**47**
DT56	High Street	Passive	100	100	**58**	**52**	**54**	**53**	**42**

DT57	Speedwell Street/ St Aldate's	Passive	100	100	**55**	**50**	**51**	**52**	38
DT58	Folly Bridge	Passive	100	100	NM	NM	**40**	**41**	31
DT59	Thames Street	Passive	100	100	**44**	28	30	32	25
DT60	New Butterwyke Place/ Thames Street	Passive	100	100	35	**44**	38	39	29
DT61	Friars Wharf	Passive	100	100	NM	25	25	27	20
DT62	1 Blackfriars Road	Passive	100	100	NM	NM	26	27	20
DT63	Thames Street/ Trinity Street	Passive	100	100	22	19	20	23	16
DT64	Thames Street/ Oxpens Road	Passive	92	92	31	27	27	32	25
DT65	Speedwell Street/ Littlegate	Passive	100	100	**42**	37	**40**	39	32
DT66	36 Faulkner Street	Passive	100	100	32	34	30	31	22
DT67	Old Greyfriars Street	Passive	100	100	NM	NM	26	30	21
DT68	Norfolk Street	Passive	50	50	NM	23	30	35	23
DT69	Paradise Square	Passive	92	92	NM	29	24	27	26
DT70	Castle Street	Passive	92	92	NM	**42**	**47**	**42**	28

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

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

☒ **If applicable, all data has been distance corrected for relevant exposure**

Notes:

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

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

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

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

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

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

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2016 (%) (2)	NO_2 1-Hour Means > 200µg/m^3 (3)				
					2013	2014	2015	2016	2017
CM1	Roadside	Automatic	96	96	11	0	2	0	0
CM2	Roadside	Automatic	97	97	1	0	0	0	0
CM3	Urban Background	Automatic	97	97	0	0	0	0(76)	0

Notes:

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

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

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

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

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

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2016 (%) (2)	PM_{10} Annual Mean Concentration ($\mu g/m^3$) (3)				
				2013	2014	2015	2016	2017
CM2	Roadside	96	96	24	22	21	20	18
CM3	Urban Background	92	92	20	15	13	15	13

☒ **Annualisation has been conducted where data capture is <75%** **(confirm by selecting in box)**

Notes:

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

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

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

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

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

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2016 (%) (2)	PM_{10} 24-Hour Means > 50µg/m^3 (3)				
				2013	2014	2015	2016	2017
CM2	Roadside	96	96	0	0	1	4	2
CM3	Urban Background	92	92	5	0	6	0 (24)	2

Notes:

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

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

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

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

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

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2017 (%) (2)	$PM_{2.5}$ Annual Mean Concentration ($\mu g/m^3$) (3)				
				2013	2014	2015	2016	2017
CM3	Urban Background	87	87	14	10	10	13	11

☒ **Annualisation has been conducted where data capture is <75%** **(confirm by selecting in box)**

Notes:

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

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

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

Appendix B: Supporting Technical Information

Automatic Monitoring Sites

Oxford City Council currently operates three continuous monitoring sites. All routine calibration and maintenance is carried out and recorded in accordance with manufacturers' and Automated Urban Monitoring Network site operators' manual. Instrument drift is routinely checked by:

- a daily internal instrument calibration which is carried out automatically using an electronic calibration check;
- every two weeks a manual external instrument calibration is carried out by Oxford City Council using gas cylinders that can be traced back to reference standards for each pollutant;
- every six months an audit of instrument response is carried out by an external organization using independent gas calibration standards.

The above checks enable data to be examined subsequently for instrument drift, which is expected, or for faulty data which is usually not expected. Instrument drift is routinely adjusted by means of the 2 weekly external gas calibrations. Scaled data is calculated using the gas calibrations for each analyser.

Data from the continuous monitoring sites is collected and independently validated by Ricardo Energy & Environment following robust QA/QC procedures.

A dedicated supporting unit is also employed for each site, responding to equipment breakdowns and scheduled maintenance and servicing.

Annualisation

There was no need to annualise the results of any of the pollutants measured by the automatic methods, as the percentage of data capture for all pollutants in 2017 was always above the 75%, which is the minimum required for annualisation not to occur.

Non-Automatic Monitoring Sites

Diffusion tubes are supplied and analysed by an accredited laboratory (South Yorkshire Air Quality Samplers), using the 50% TEA in Acetone method.

The laboratory is subject to quality assurance testing as part of their accreditation. This involves an independent comparison to other laboratories. The results of inter-comparisons are available for scrutiny.

As diffusion tubes are not the reference method due to is low accuracy when compared with automatic monitoring, it is necessary to bias correct them.

A bias correction factor is applied to diffusion tube results to account for laboratory bias and to correct to continuous monitoring results. Oxford City Council carries out a co-location study annually, and has used the results to calculate a locally derived bias adjustment factor for each separate year studied.

In 2017 the bias correction factor derived from the local co-location study was **0.83** The national bias correction factor was **0.86**. It was considered most appropriate to use the locally derived factor for a question of methodology consistency with previous AQ AS reports, but also because once more, our local co-location study has presented *"good"* precision for the diffusion tubes, together with high quality chemiluminescence results. This was considered to be more representative of the local situation.

Annualisation

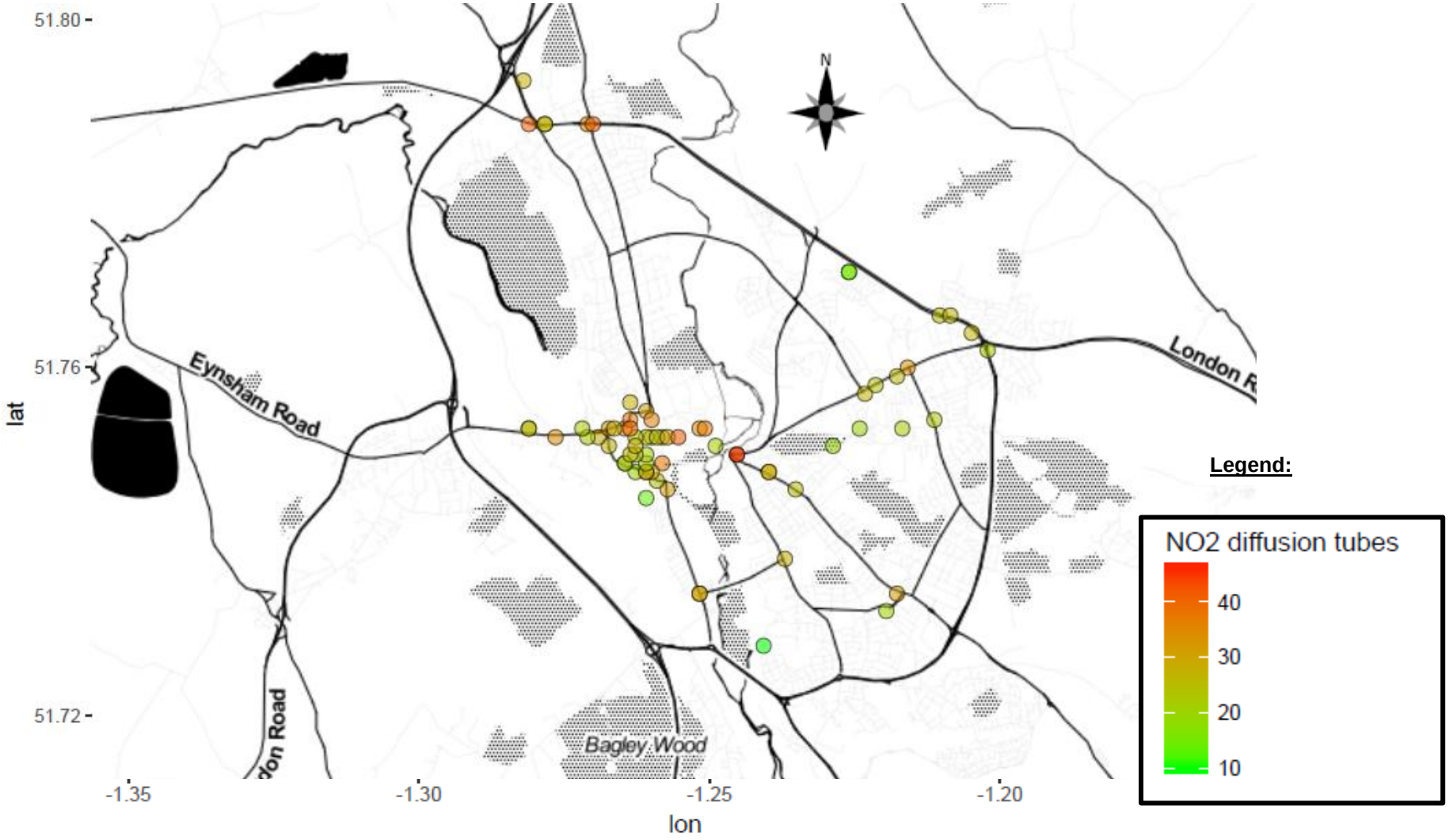
The annual mean NO_2 has been also annualised for all the cases where diffusion tube annual data capture was below 75%, following the specific annualisation procedure described on LAQM (TG16).

Appendix C: Maps of monitoring locations and NO_2 levels in Oxford

Figure C 1– Oxford's air quality monitoring locations, 2017

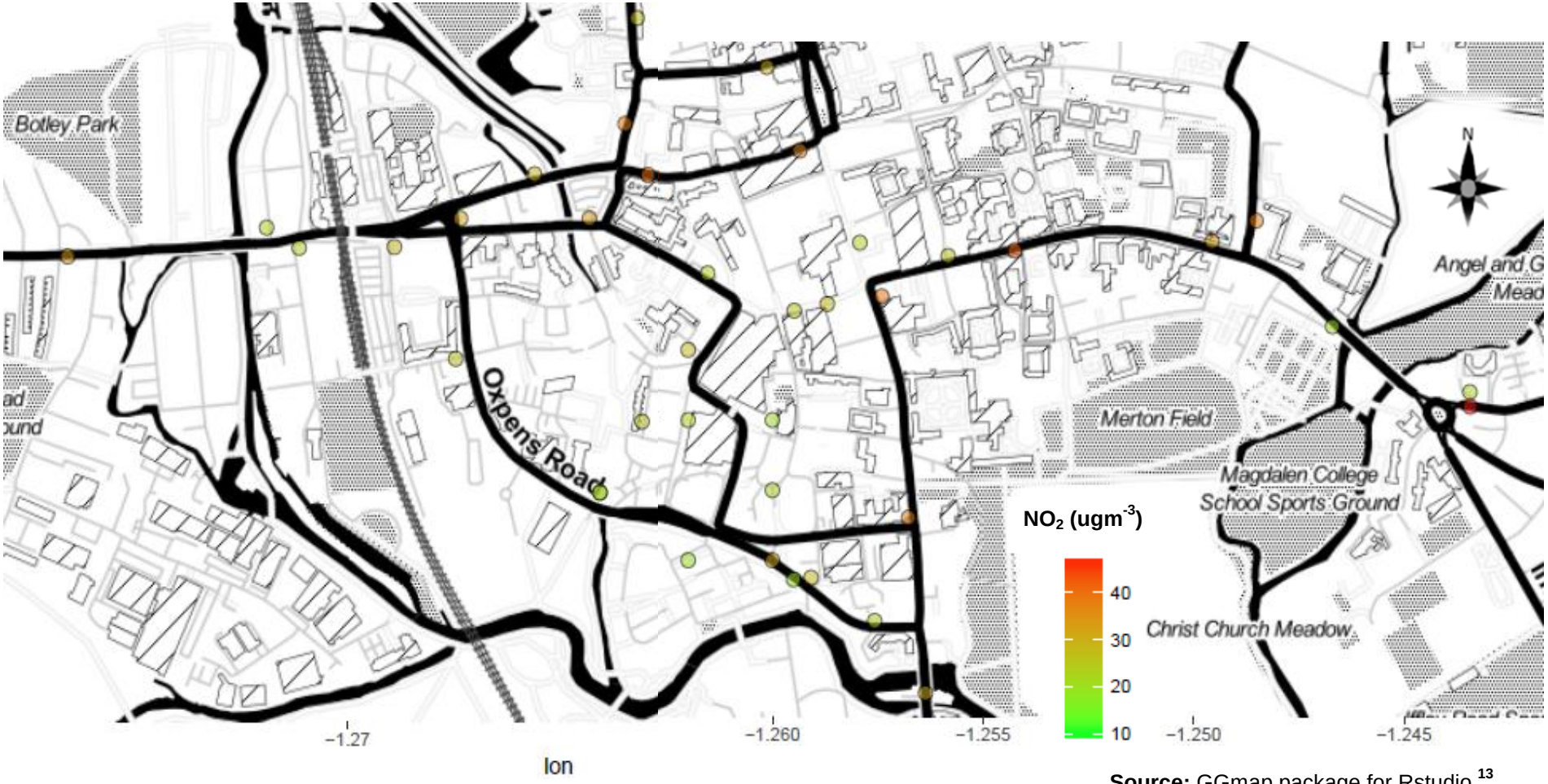
Source: GGmap package for Rstudio [13]

Figure C 2– Oxford's diffusion tube locations by level of NO2, 2017



Source: GGmap package for Rstudio [13]

Figure C 3– Oxford city centre diffusion tube locations by level of NO_2, 2017



Source: GGmap package for Rstudio [13]

Appendix D: Calendar Plots of Oxford's NO_2 automatic monitoring

Figure D 1–Daily NO_2 averages at AURN automatic monitoring station of Oxford Centre roadside along calendar year 2017

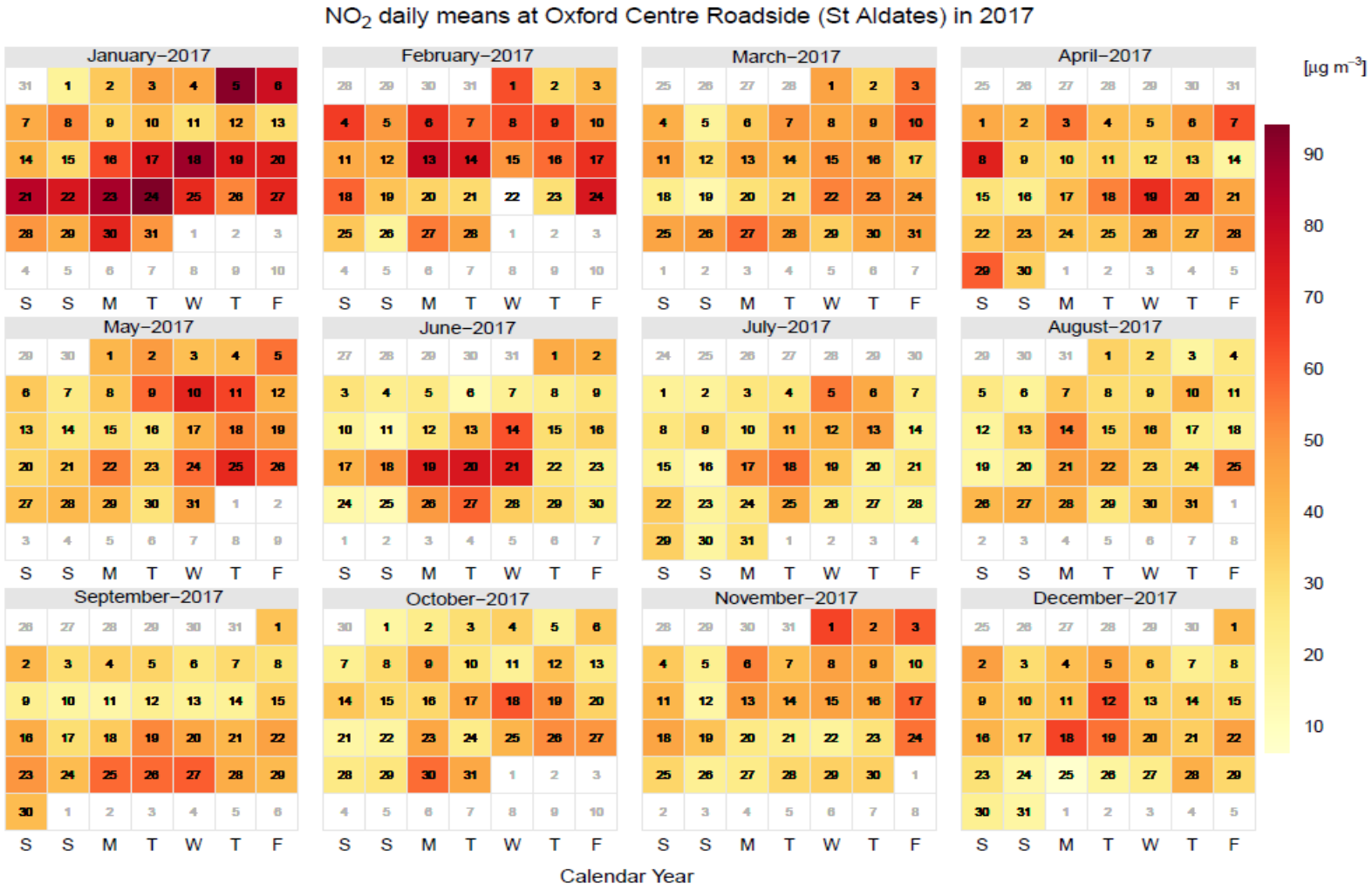


Figure D 2– Daily NO_2 averages at AURN automatic monitoring station of Oxford High Street along calendar year 2017

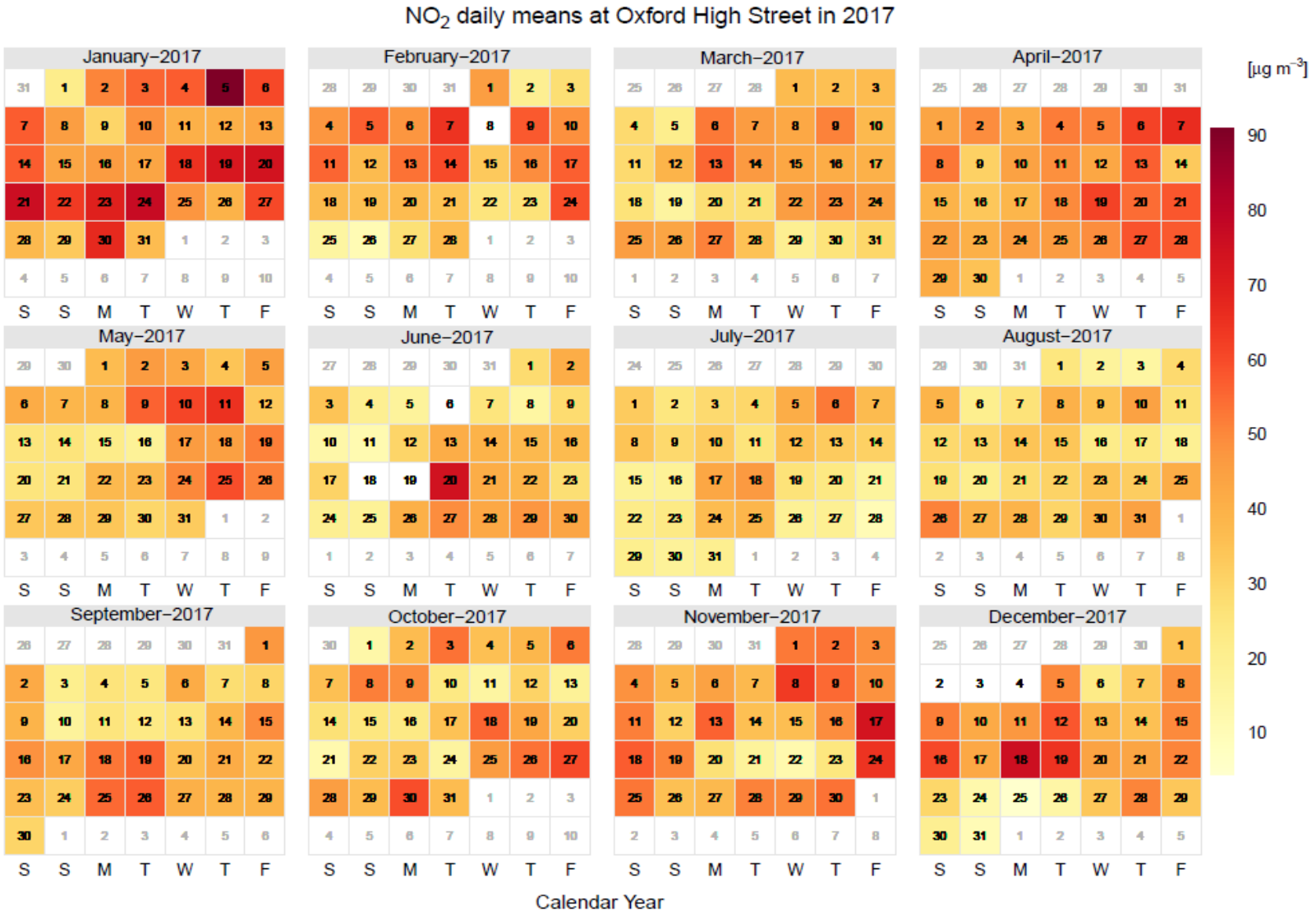
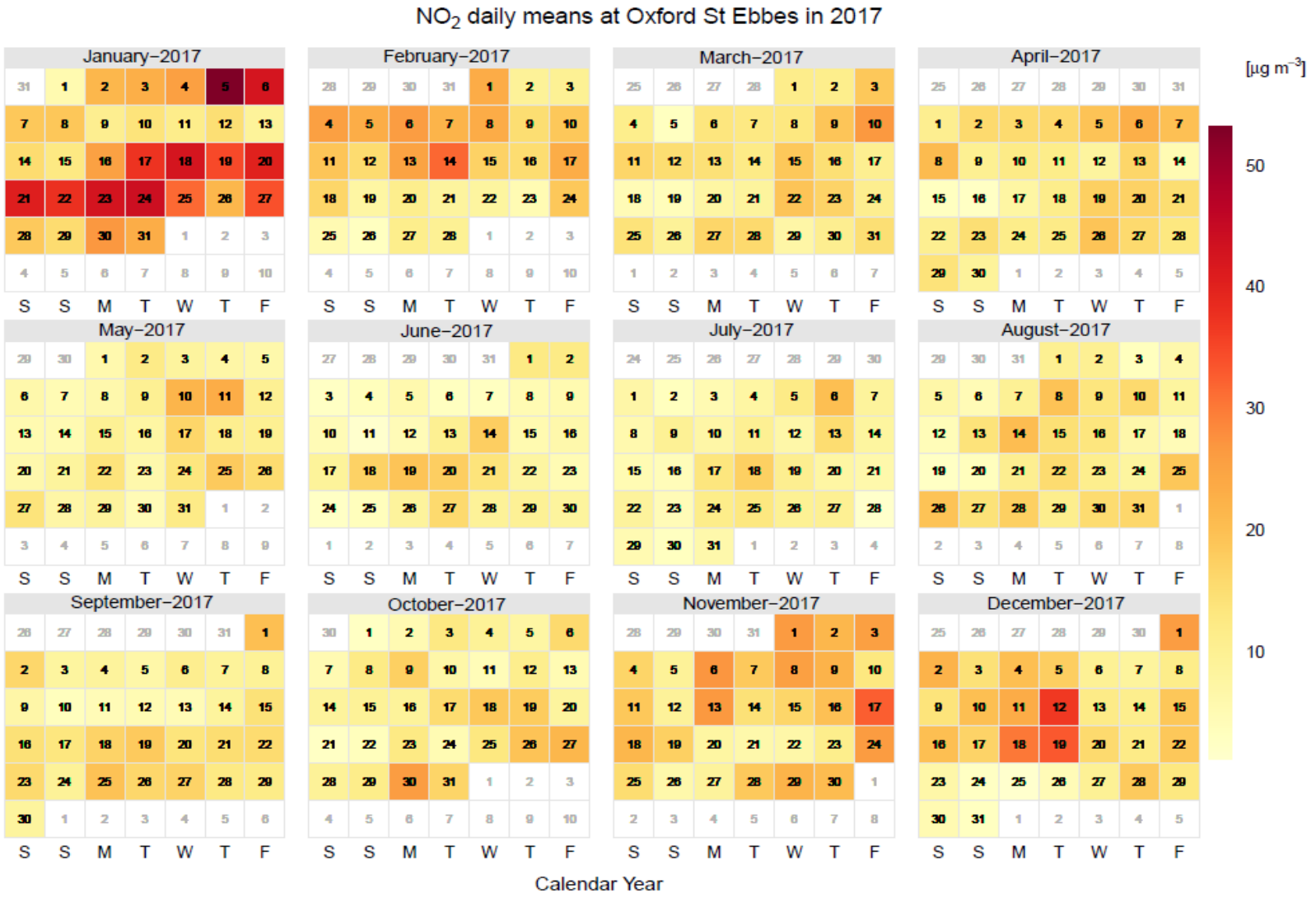


Figure D 3– Daily NO_2 averages at AURN automatic monitoring station of Oxford St Ebbe's along calendar year 2017



Appendix E: Summary of Air Quality Objectives in England

Figure E 1– Air Quality Objectives in England

Pollutant	Air Quality Objective[1]	
	Concentration	Measured as
Nitrogen Dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean
	40 µg/m^3	Annual mean
Particulate Matter (PM_{10})	50 µg/m^3, not to be exceeded more than 35 times a year	24-hour mean
	40 µg/m^3	Annual mean
Particulate Matter ($PM_{2.5}$)[5]	25 µg/m^3	Annual Mean
Sulphur Dioxide (SO_2)	350 µg/m^3, not to be exceeded more than 24 times a year	1-hour mean
	125 µg/m^3, not to be exceeded more than 3 times a year	24-hour mean
	266 µg/m^3, not to be exceeded more than 35 times a year	15-minute mean
Ozone (O_3)	100 µg/m^3 not to be exceeded over 10 days a year	8-hour mean

[1] The units are in micrograms of pollutant per cubic metre of air (µg/m^3).
[5] Non-mandatory target value, to be achieved by 2020.

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
AQ	Air Quality
AQS	Air Quality Strategy
AQI	Air Quality Index
AURN	Automatic Urban and Rural Network
ASR	Air quality Annual Status Report
CAZ	Clean Air Zone
CBTF	Clean Bus Technology Fund
DEFRA	Department for Environment, Food and Rural Affairs
DSPs	Delivery and Servicing Plans
EC	European Commission
ED	European Directive
EVs	Electric Vehicles
FDMS	Filter Dynamics Measurement System
FoE	Friends of the Earth
GULOP	Go Ultra Low Oxford Project
JSNA	Joint Strategic Needs Assessment
LAQM	Local Air Quality Management
LAQM PG 16	Local Air Quality Management Policy Guidance 2016

LAQM TG 16	Local Air Quality Management Technical Guidance 2016
LA's	Local Authorities
LEZ	Low Emission Zone
LTP	Local Transport Plan
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NO	Nitric Oxide
OAQG	Oxfordshire's Air Quality Group
O_3	Ozone
OCC	Oxford City council
OLEV	Office for Low Emission Vehicles
PM_{10}	Airborne particulate matter with an aerodynamic diameter of 10 µm or less
$PM_{2.5}$	Airborne particulate matter with an aerodynamic diameter of 2.5 µm (micrometres) or less
QA/QC	Quality Assurance and Quality Control
SCR	Selective Catalytic Reduction
STOP	School's Tackling Oxford's Air Pollution
TEOM	Tapered Element Oscillating Micro Balance
UK	United Kingdom
ULEV	Ultra Low Emission Vehicle
VOCs	Volatile Organic Compounds
WHO	World Health Organisation
ZEZ	Zero Emission Zone

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