
# 2019 Air Quality Annual Status Report (ASR)

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

June 2020

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| Local Authority Officer | Pedro Abreu |
| Department | Environmental Sustainability |
| Address | St Aldate's Chambers - 109 St Aldate's Oxford - OX1 1DS |
| Telephone | 01865 249811 |
| E-mail | airquality@oxford.gov.uk |
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# Executive Summary

## Health Impacts of Air Pollution

Air pollution can cause, complicate, or exacerbate many adverse health conditions and it is usually manifested by respiratory or cardiac symptoms that can ultimately lead to chronic health issues. Recent studies show that poor air quality can affect every organ in the body[1] and even cause damage to cognitive performance[2]. Exposure to poor air quality is directly related to diseases such as cancer, asthma, stroke, heart disease, diabetes, obesity and dementia[3, 4].

According to the World Health Organisation (WHO)[5], air pollution kills an estimated 8 million people worldwide every year, of which 4.2 million are attributed to exposure to outdoor air pollution and 3.8 million to indoor air pollution. Currently nine out of 10 people in the world breathe air containing health impacting levels of air pollutants.

The 2008 Ambient Air Quality Directive[6] (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 12 years old. The majority of UK cities failed to meet the objective by 2010 as required by the Directive. Currently air quality is a significant issue in the UK, with 37 of Britain's 43 air quality zones still exceeding EU safety limits for nitrogen dioxide[7], and London being the worst European capital for the pollutant.

In response to the UK leaving the EU, the UK Government introduced a new Environmental Bill to parliament in October 2019. Along with the commitment to set targets on air quality for the UK, the new Bill also promises the creation of a new independent Office for Environmental Protection to scrutinise environmental policy and law, investigate complaints and take enforcement action against public authorities, if necessary, to uphold current and future environmental standards.

Although air pollution affects people of all regions, ages, and social groups, it is likely to impact those who experience heavy exposure and who have greater susceptibility more[8]. The most vulnerable are children, the elderly, or those with pre-existing

medical conditions. Harmful effects of air pollution are seen at levels below air quality standards previously considered to be safe.[3, 4].

In 2005, the World Health Organisation (WHO) set guideline[9] values for key outdoor 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 values for $NO_2$ currently corresponds to the UK limit value of 40$\mu gm^{-3}$ (annual mean) and 200 $\mu gm^{-3}$ (hourly mean).

Since then, evidence of adverse health effects related to short- and long-term exposure to these pollutants has significantly increased. As a result, in 2016 WHO started the revision process of the current air quality guidance for outdoor air pollution, with a first draft of the new guidance expected to be released by the end of 2020. It is expected that the new guidelines will provide up-to-date recommendations on ambient pollutant concentrations in order to support policy makers and other decision-makers setting efficient standards and goals across the world for air quality management to protect public health.

Table E2 in Appendix E shows the current WHO recommended limit values for each pollutant.

## 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 ($NO_2$) continues to be the pollutant of most concern. Transport is the most significant source of emissions of oxides of nitrogen ($NO+NO_2$), commonly called $NO_X$. This sector accounts for 68% of these emissions in Oxford[10].

This report outlines the result of air quality monitoring undertaken across the city of Oxford in 2019. Data for a full year of monitoring is required in order to report on the annual mean and Oxford City Council annually publishes all air quality data on its website as well as on https://oxfordshire.air-quality.info/

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

Oxford City Council currently operates an air quality monitoring network that consist of a total of 71 sites using passive monitoring (diffusion tubes) and three sites using automatic (continuous) monitoring.

Historical analysis of our air quality data shows that $NO_2$ levels have significantly improved over the period 2009-2019 in the city of Oxford. Over this period, we have seen declines of 29% in $NO_2$, 21% in Particulate Matter ($PM_{10}$) and 18% in Particulate Matter ($PM_{2.5}$) in the places where air quality is being monitored.

The majority of the reductions observed over the above period have to do mainly with significant changes in traffic emissions. The introduction of a Low Emission Zone (LEZ) for buses in the city in 2014 and the retrofit of several buses to cleaner Euro VI engines (which achieve an estimated 99.5% reduction in NOx emissions compared to Euro V) have contributed to these improvements. However, air quality monitoring results from the most recent years have shown that the rate of these reductions seems to be slowing down. In many cases, air quality levels seem to have plateaued in the city, suggesting that more robust actions to tackle air quality in the city are required.

Results from the air quality monitoring conducted during 2019 indicate overall increases of $NO_2$ levels in the majority of monitoring locations in the city. Across the 64 sites where $NO_2$ was monitored in both 2018 and 2019, 70% showed increases of air quality levels; 16% measured the same levels as the previous year and only 9% showed slight decreases in $NO_2$ values.

A quarter of sites (24.4%) saw increases of only of 1 $\mu g/m^3$, which is within the margin of error of the monitoring method. This means that the $NO_2$ increase measured at those locations in 2019 cannot be considered statistically significant. However, the majority of sites (51.1%) saw increases of between 2-3 $\mu g/m^3$; which were observed at 23 locations across the city. The remaining sites (24.4%) saw increases between 4-6 $\mu g/m^3$ which is considered significant and this was observed

at most of the city's air pollution hotspots and in locations of the city where air pollution has been historically high.

In order to understand the cause of the increase in pollution level a detailed analysis of the 2019 air quality monitoring data was undertaken. This analysis indicates that the observed $NO_2$ increase was related to the effect of weather, rather than to specific increases due to traffic and/or congestion. The following reasons corroborate this conclusion:

a) Analysis of traffic data for 2019 do not show significant increases in traffic levels in Oxford city when compared with 2018 data;

b) 2019 was a year of extremes for weather, with record-breaking spells of cold in January/February, April and November[11]. Comparison of air pollution data from AURN Oxford Centre Roadside with 2019 meteorological data clearly shows significant increases of the $NO_2$ levels coinciding with those months, whilst the levels in all other months remained similar to the previous year. The effect of increased $NO_2$ seen during those cold months significantly influenced the $NO_2$ annual means. This is a clear indication of the negative effects that the record breaking cold weather episodes had on air pollution dispersion in 2019;

c) The monitoring site 'AURN Oxford Centre Roadside' belongs to the UK's national air quality network, and as such, needs to obey the specific sitting requirements of the AQ European Directive (Annex 3, section B) in terms of macro-scale representativeness[12]. These requirements are intended to ensure that sites are representative of the areas in which they are located, are not unduly affected by specific processes, and are typical of areas where the population may be exposed for a significant time. – the $2\mu g/m^3$ increase in the $NO_2$ levels measured at this site roadside site in 2019 can, therefore, be considered, representative of increases that were observed at other roadside sites in Oxford in 2019;

d) Increases in $NO_2$ observed across the city rather that in localised areas points to an overall homogeneous city-wide increase which can be explained by

weather, rather than a localised one, which is normally explained by increases in local emission sources (traffic, etc.);

e) The highest $NO_2$ increases (4-6µg/$m^3$) were measured across most of Oxford's air pollution hotspots, or places were air pollution has been historically high in the city. The impact of cold weather on (poor) air pollution dispersion is as high at any given location as the typical air pollution levels that are measured at that location. Hence locations of the city that historically measures higher $NO_2$ levels, will see a substantial increase of air pollution entrapment during those still weather episodes. This will automatically lead to increases of the $NO_2$ levels measured at those locations, which will be higher in comparison with the levels measured in other less polluted areas of the city during the same weather episode.

If the overall 2-3 µg/$m^3$ increase of the $NO_2$ annual mean values attributed to weather were not to be accounted for in 2019 air quality data, air pollution levels in Oxford would have shown the same $NO_2$ plateauing trend that was observed in 2018.

Six locations in the city showed exceedances of the annual mean legal limit value for $NO_2$ in 2019. This represents an increase of two sites when compared with the previous year, but down from a total of 17 sites just five years ago.

The 2019 monitoring results also show that there were no exceedances of the UK limit values as well as of the WHO recommended guidelines for Particulate Matter ($PM_{2.5}$ and $PM_{10}$) and Ozone ($O_3$) in all the locations where these pollutants were measured.

Despite the clear impacts of weather on air pollution in 2019, the fact is that in real terms air pollution was higher than in the year before. We therefore need continued action to reduce our emissions from transport, homes and industry. We need to ensure that air quality levels continue to reduce significantly throughout the city, and that Oxford's air is not just cleaner, but safer to breathe.

As such, in March 2020, Oxford City Council, and Oxfordshire County Council published updated proposals for a Zero Emission Zone (ZEZ) in Oxford city centre.

The ZEZ aims to tackle Oxford's air pollution and protect the health of everyone who lives in, works in and visits the city.

Under the latest proposals, Oxford's ZEZ phase 1, currently due to be introduced in the summer of 2021 would be based on:

a) A road user charging scheme, where Zero emission vehicles would be able to drive in the city centre ZEZ free of charge. Other vehicles would be permitted in the zone but would have to pay £10 per day to drive in the zone between 7am and 7pm. There would be discounts and exemptions for some road users, including, blue badge holders, residents and businesses in the zone;

b) The implementation of a city-wide Euro VI Low Emission Zone (LEZ) for buses, replacing the existing Euro V LEZ for buses from Dec 2021;

c) New City-wide taxi emissions standards, with increasingly improving standards to 2025, were Hackney carriage taxi drivers will be required to have zero-emission capable vehicles to renew their licence or receive a new licence.

In January 2020, Oxford City Council and Oxfordshire County Council published proposals for "*Connecting Oxford*": these are bold plans to tackle congestion and the poor public transport connections into and across some parts of Oxford, particularly the city's eastern arc. The proposals involve the implementation of new traffic restrictions and the introduction of a workplace parking levy, with the income generated to be used to fund new and improved bus routes, and new and improved walking and cycling routes across the city.

The ZEZ and Connecting Oxford are directly related to each other, and both form part of Oxford's Transport Strategy set out in the Local Transport Plan. Connecting Oxford aims to (amongst other things) reduce motorised traffic levels whilst the ZEZ aims to minimise emissions from the traffic that remains.

## Actions to Improve Air Quality

Oxford's Air Quality Action Plan (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 action require co-operation from all sectors including transport, construction, 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:

1) Secured £150,000 from the Department for Environment, Food, and Rural Affairs (DEFRA) Air Quality Fund for the delivery of a low-cost mobile Automated Number Plate Recognition (ANPR) enforcement system to be implemented and trialled as part of the first phase of the Oxford's Zero Emission Zone (link to press release);

2) Delivered a feasibility study, several public consultations and in March 2020 updated final proposals for the introduction of a Zero Emission Zone (ZEZ) in Oxford city centre, following 27 months of listening to businesses, residents, transport operators and health experts in Oxfordshire. Due to the COVID-19 outbreak, the proposed ZEZ (which was expected to be launched in December 2020), will now launch in summer 2021. The ZEZ will be based on a road user charging scheme where Zero emission vehicles will be able to drive in the zone free of charge. The ZEZ is delivered in partnership between Oxfordshire County Council and Oxford City Council (link to press release);

3) Announced in January 2020, and in partnership with Oxfordshire County Council - "*Connecting Oxford*": a package of traffic measures to tackle congestion and the poor public transport connections into and across Oxford which involve the implementation of new traffic restrictions and a workplace parking levy. The generated revenue will be used for investment into new and improved bus routes and new and improved walking and cycling routes across the city. Future steps involve developing a detailed business case as well as modelling, design and a comprehensive engagement programme with a wide range of stakeholders and resident groups across the city. (link to press release);

4) Secured £128,500 from the Department for Environment, Food and Rural Affairs (DEFRA) Air Quality Fund for the testing of low cost innovative Air Quality sensors to map air pollution and human exposure in Oxford. This

project is being delivered in partnership with local group Ox-Air (link to press release);

5) Secured £122,500 from DEFRA Air Quality Fund for the development of a robust, integrated communication and engagement plan, to inform and work with businesses in the city centre on how to adopt zero emission delivery and servicing solutions for their business. A dedicated Zero emission Officer has joined the team in January 2020 to specifically deliver this project (link to press release);

6) Secured £10 million from central Government as part of a £41 million project for the development of an innovative new Energy Super hub project in Oxford (ESO), to cut carbon emissions and improve air quality in the city. The project involves the installation of a giant battery, allowing spare capacity to be fed into a new high capacity electric supply. This will power thousands of electric vehicle's via rapid charging stations to enable migration of full fleets to electric vehicles. The project will also deliver 320 heat pump installation, that will be rolled out across the city and provide low cost carbon heating to homes. In 2019 Planning permission was granted for the installation of the giant battery at a local National Grid substation and it's expected to 'go live' in Winter 20/21. Planning is in progress for a new high capacity electric wire, running around the East and West part of Oxford. The City Council has also recently placed orders for a further 27 electric vehicles, including cars, vans, sweeper and a JCB. ( link to press release ; link to project's website);

7) Held a workshop in February 2020 at the town hall with 62 people, representing County, District and Parish Councils, major employers and sustainable travel advocacy groups to present and discuss Oxford Greenways Project – Oxford City Council, Oxfordshire County Council and the University of Oxford's commitment to fund a concept master plan for a new network of cycling and walking routes into Oxford, to be achieved within 18 months (link to press release);

8) In January 2019, Oxford City Council members unanimously declared a climate emergency and agreed to create a citizens assembly in Oxford to help consider new carbon targets and additional measures to reduce emissions. In

April, Members set a vision to reduce the City Council's own emissions to net-zero by 2030 at the latest (link to press release);

9) Hosted, during the weekends of 28th-29th September and 19th-20th October 2019 a Citizens Assembly on Climate Change, which involved a randomly-selected representative sample of 50 Oxford residents who learned about climate change and explored different options to cut carbon emissions through a combination of presentations from experts and facilitated workshops. Oxford was the first city in the UK to deliver a full citizens assembly on the topic of climate change (link to press release);

10) Secured £2.3million from the Clean Bus Technology fund (CBTF) for the retrofit of 5 buses to fully electric and 115 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) - The euro VI retrofitting plan is now nearly finished, and the first new EV bus is in operation in the city since March 2020 ;

11) Secured nearly £200,000 from DEFRA's 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 Zero Emission Zone to be introduced progressively across the city centre from 2020 (link to press release).

12) Created new emission standards for Hackney Carriage Vehicles, which will see Hackney taxis adopting a phased approach to zero-emission capable vehicles between 2020 and 2025, with drivers only able to get a licence in 2025 if they have a zero-emission capable cab. The new standards were developed in consultation with City of Oxford Licensed Taxi Association (COLTA) and with feedback from taxi drivers and owners (link to press release);

13) Co-organised (in association with Green TV) and delivered the second Electric Vehicle summit in Oxford. The event took place at the Saïd Business School in Oxford, on 26th and 27th June 2019 and brought together key figures in the electric vehicles and EV charging markets. The summit was focused on dual themes of business development and thought leadership (link to press release);

14) Co-organised (in association with Green TV) and delivered the first Electric Bike summit in Oxford. The event took place at Oxford University's Wolfson College on 10th April 2019, bringing together industry players and business leaders from cycling bodies, cycle manufacturers, the retail sector, investors and the public sector, with the aim to create a business forum to propel the business of e-Bike mobility (link to press release);

15) Launched in January 2020 as part of the award-winning STOP project, an Air Quality Banner competition, in partnership with local Friends of the Earth, for children in school years three to six across Oxford. The competition will include a children's winning artwork in the design of a 3m x 1m banner to be displayed at primary school entrances, with the objective to raise awareness about the links between air pollution and health and to promote sustainable modes of transport, such as walking and cycling;

16) A new charter for cleaner air was been launched by Oxford City Council, Greenpeace UK, and Friends of the Earth. The charter, which was created by Oxford City Council, is believed to be the first formal cooperation with Greenpeace UK and Friends of the Earth (EWNI) (England, Wales and Northern Ireland) to be led by a local authority. (link to charter);

17) Oxford City Council attended and supported National Clean Air Summit organised by UK100 and hosted by Mayor of London Sadiq Khan which included meetings with ministers to discuss the current clean air crisis;

18) Hosted Birmingham and Nottingham to share knowledge between UK cities and facilitate partnership work across the UK;

19) 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);

20) Launched, a city wide anti-idling campaign in partnership with Friends of the Earth called *'Oxford Air Needs Your Care'*, particularly focused on tackling vehicles idling around schools during drop off and pick up times (link to Anti-Idling campaign);

21) Published Air Quality Planning Application Guidance, in recognition that one of the ways to reduce air pollution effectively is through efficient use of the planning system. The new guidance is aimed at creating a better understanding of the air quality requirements that need to be considered by applicants prior to the submission of a valid planning proposal, and is available for download at Oxford City Council's Air Quality website;

22) Worked in collaboration with Oxfordshire County Council Public Health, and Oxford Health respiratory nurses and physios working in the Integrated Respiratory Team project of Churchill's Hospital in Oxford, to explore ways to provide better Air Quality communication and advice for Chronic Obstructive Pulmonary Disease (COPD) patients;

23) 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);

24) 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 an investigation of the business case for investment in ultra-low emissions taxis based on local Oxford duty-cycles; (link to press release);

25) 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);

26) Supported and run "*Test Drive the Future"* events to introduce the public to a range of electric vehicles (EVs) and the financial and environmental benefits of going electric. The events provide an opportunity to test drive vehicles, and outline the options for driving an electric car *'pay as you go'* through one of Oxford's car clubs (link to press release);

27) 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);

28) Developed a set of air quality stickers placed at all 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;

29) Launched the Schools Tackling Oxford's Air Pollution (STOP) Project, which provides real-time $NO_2$ and $PM_{10}$ air quality monitors in 6 schools. The project was awarded the Communications Initiative of the Year at the National Air Quality Awards 2018 (link to press release);

30) Declared the whole of the city an Air Quality Management Area for $NO_2$;

31) Developed an Air Quality Action Plan and Low Emission Strategy for the city;

32) 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 (link to press release);

33) Launched the Oxfordshire Air Quality website to make historic and real time air quality data more readily accessible to members of the public;

34) 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;

35) Launched Oxford Park and Pedal which has seen over 100 cycle parking spaces introduced at two of our park and ride sites;

36) Engaged with the Oxfordshire Health Improvement Board to ensure that air quality is considered in the context of the Joint Strategic Needs Assessment (JSNA);

37) 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 in 2019 show the following:

1. The annual mean Air Quality Strategy (AQS) objective for $NO_2$ is 40 $\mu gm^{-3}$. This objective was met at the automatic monitoring stations of Oxford High Street and AURN Oxford St. Ebbes in 2019. AURN Oxford Centre roadside

registered an annual mean for $NO_2$ of 42 $\mu gm^{-3}$ and therefore did not comply with this objective. This represents an increase of 3 $\mu gm^{-3}$ when compared with the measurement obtained at this monitoring site in 2018. Oxford High Street and AURN Oxford St Ebbes registered $NO_2$ annual means of 40 and 16 $\mu gm^{-3}$ respectively;

2. Diffusion tube results show that the annual mean AQS objective of 40 $\mu gm^{-3}$ for $NO_2$ was exceeded at six of the 71 monitoring locations in 2019. This represents an increase of two sites when compared with 2018. The locations where the annual mean $NO_2$ limit value was exceeded in 2019 are: St. Clements Street (One), St Clements Street (Two), George Street, St Aldates, High Street and Long wall street.
3. The AQS hourly mean objective for $NO_2$ is 200 $\mu gm^{-3}$, with no more than 18 exceedances allowed each year. In total, 3 exceedances were reported at Oxford Centre roadside, and 2 exceedances at Oxford High Street. The highest hourly mean $NO_2$ measured in 2019 was of 727.2 $\mu gm^{-3}$ and was registered on the 1st March 13:00 at Oxford High Street. This objective was achieved at all our automatic monitoring sites in 2019.
4. There were seven new locations where air pollution was monitored in 2019: Old Abingdon Road, Hollow Way road, Cowley Road/Union Street, Summertown Parade, Woodstock Road, Botley Road and St Clements (Three). None of these seven locations experienced exceedances of the annual mean limit value for $NO_2$.
5. Across the 64 sites where $NO_2$ was monitored in both 2018 and 2019, 70% showed increases in air pollution levels; 16% measured the same levels as the previous year and only 9% showed slight decreases in $NO_2$ values.
6. A quarter of sites (24.4%) saw increases of only of 1 $\mu g/m^3$, which is within the margin of error of the monitoring method. This means that the $NO_2$ increase measured at those locations in 2019 cannot be considered statistically significant. However, the majority of sites (51.1%) saw increases of between 2-3 $\mu g/m^3$; which were observed at 23 locations across the city. The remaining sites (24.4%) saw increases between 4-6 $\mu g/m^3$ which is considered

significant and this was observed at most of the city's air pollution hotspots and in locations of the city where air pollution has been historically high.

7. Subsequent analysis of the 2019 air quality monitoring data indicates that the vast majority of $NO_2$ increases that were measured across the city by both monitoring methods (automatic and diffusion tubes) are related to specific weather events (record-breaking spells of cold and still weather)[11] occurring in the months of January/February, April and November, which led to pollutant entrapment and air pollution build-up in several locations across the city, rather than to specific increases due to traffic and/or congestion.

8. One site is now, for the first time, in compliance with the annual mean limit value for $NO_2$: Cutteslowe Roundabout on Banbury Road. The concentration registered at this location in 2019 (40 $ugm^{-3}$) is at the threshold for compliance. However, this only represents a reduction of 1$ugm^{-3}$ when compared with the results obtained at this location in 2018, and given the degree of uncertainty associated with the diffusion tube methodology a further year of consistent results are required to verify the result.

9. The monitoring location with the highest annual mean for $NO_2$ in 2019 was DT55 - St. Clements Street/The Plain - with a value of 53 $\mu gm^{-3}$. This represents an increase of 13% in $NO_2$ levels at this location when compared with data from the previous year. Discussions held with transport planner at Oxfordshire County Council did not identify any particular reason that could help to explain this significant increase in the levels of $NO_2$ measured in 2019. However, this is one of Oxford's $NO_2$ hotspots and it is expected that locations of the city that historically experience high $NO_2$ emissions, will have a much more substantial increase of air pollution entrapment translated into a $NO_2$ annual mean increase as a result of the still weather episodes identified above, than in any other location in the city where air pollution is not as high.

10. The second site with a significant $NO_2$ increase (going from 44 $ug/m^3$ in 2018 to 50 $ug/m^3$ in 2019) was DT56 - High Street. However, in 2019 there was a substantial amount of construction and scaffolding work immediately around the area of the monitoring site. It is therefore highly likely that this increase results from a combination of the meteorology events described above, with

the effects of construction on traffic flows leading to an increase of $NO_2$ at this location.

11. In 2019 the second full year of monitoring was completed since the opening of Westgate Oxford. Air Quality was monitored at a total of 12 locations around Westgate Oxford. The vast majority of these sites showed monitoring increases of up to 2 $ugm^{-3}$, which are consistent with the observed city-wide $NO_2$ increment which is being attributed to weather. Overall, the results of the monitoring sites around the Westgate indicate little change in $NO_2$ levels when compared with the previous year.

12. The annual mean AQS limit value for $PM_{10}$ is 40 $\mu gm^{-3}$. WHO guidelines for $PM_{10}$ however recommend that the annual mean limit for this pollutant should be 20 $\mu gm^{-3}$. The $PM_{10}$ annual mean results obtained from the two automatic monitoring stations, Oxford High Street and St. Ebbes, were of 19 $\mu gm^{-3}$ and 14 $\mu gm^{-3}$ respectively. Both AQS and WHO limit values were achieved in 2019 for this pollutant.

13. $PM_{10}$ may exceed the 24-hour mean limit of 50 $\mu gm^{-3}$ no more than 35 times per year to meet the AQS objective. During 2019, we recorded 7 exceedances of the 50 $\mu gm^{-3}$ 24h mean for this pollutant on High Street, and 5 exceedances at St Ebbes. All of these exceedences occurred in the periods 25th-28th February and 17th-19th April 2019 and were not directly related with pollution generated in the city but instead it was attributed to 2 trans-boundary pollution episodes[13] involving the dispersion PM pollution from the European Continent. The AQS objective for hourly $PM_{10}$ was met in 2019.

14. $PM_{2.5}$ has a non-mandatory AQS annual mean compliance target of 25 $\mu gm^{-3}$. As for $PM_{10}$, WHO guidelines are much stricter for this pollutant with a recommended annual mean limit value of 10 $\mu gm^{-3}$. St Ebbes recorded for the first time a $PM_{2.5}$ annual mean of 9 $\mu gm^{-3}$ in 2019, which means that both the non-mandatory AQS and WHO limit values were achieved for this pollutant in 2019.

15. Ozone ($O_3$) has an AQS objective for daily maximum on an eight hour running mean of 100$\mu gm^{-3}$, not to be exceeded more than 10 days a year. In 2019,

there was a significant decrease on the number of exceedances (-109) and days (-17) where $O_3$ was registered above the legal threshold, when compared with the results from 2018. In 2019, Oxford St. Ebbes exceeded the AQS daily objective for ozone 40 times, during a total of 10 days. Ozone develops under specific meteorological conditions, characterised by large stagnant areas of high pressure. This is why it is considered an area wide pollutant, and emissions are not alone attributed to a local area. In 2019, the highest readings of $O_3$ registered at Oxford St Ebbes occurred on the 29th June, 23rd July and 25th-26th August and were all the result of regional air pollution episodes[13,14] that covered London and the entire south east of England. The AQS objective for ozone was achieved in 2019.

Oxford City Council's priorities for 2020 are to:

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

2. Continue to run anti-idling campaigns across the city in partnership with Friends of the Earth (FoE) Oxford and continue to work with local schools via STOP Project on the subjects of air quality and sustainable travel;

3. To continue the roll out a further 100 EV chargers across the city by the end of 2021, as part of the GULO project;

4. To finalise the delivery of £2.3 million CBTF project for the retrofitting of five of the city's open-top sightseeing buses to become fully electric, and the retrofitting of 115 local buses to euro VI standards, using Selective Catalytic Reduction (SCR) technology;

5. To finalise the delivery of the OxAir project, which is aimed at testing low cost innovative Air Quality sensors to map air pollution and human exposure in Oxford;

6. Initiate delivery of a £122,500 DEFRA Air Quality Grant funded project aimed at the development of a communication and engagement plan, to

inform and work with businesses in the city centre on how to adopt zero emission delivery and servicing solutions for their business;

7. Progress with the delivery of a £40 million central Government funded project for the development of an innovative new energy super hub project in Oxford;
8. Progress £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, electric delivery vehicles and the delivery of an e-cargo bike pilot study to facilitate sustainable deliveries;
9. To explore ways to Improve Oxfordshire's Air Quality Website and develop work with the District and County Councils on a co-ordinated approach to public awareness and education;
10. Continue the expansion of the City Council's fleet of electric vehicles which currently counts 34 full electric vehicles and 20 electric/diesel light commercial hybrid vehicles;
11. 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.
12. To organise and deliver new Electric Vehicle and e-bike Summits in Oxford, on an effort to bring together business leaders and key players working on electric vehicles, energy, information technology and charging infrastructure, to explore how we advance full, battery electric, e-Mobility.
13. Looking to lock in anticipated public health gains arising from reduced air pollution and environmental gains arising from reduced vehicular traffic; encouraging a modal shift to walking and cycling through the recently announced Governmental funding for this area..

## 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 2019. 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 reporting 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, and the World Health Organisation (WHO) air quality guidelines can be found in Tables E1 and E2 in Appendix E.

# 2 Actions to Improve Air Quality

## 2.1 Air Quality Management Areas

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

A summary of AQMAs declared by 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/.

Maps showing the locations where air quality monitoring was carried out during 2019 can be found in Appendix D. 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 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | At Declaration | | Now | | Name | Date of Publication | Link |
| 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 | $\mu gm^{-3}$ | 53 | $\mu gm^{-3}$ | Air Quality Action Plan 2013-2020 | 2013 | https://www.oxford.gov.uk/downloads/file/539/air_quality_action_plan_2013. |

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

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

Oxford City Council has taken forward a number of direct measures during the current reporting year of 2019 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 2019 include:

- Secured £150,000 of funding from the Department for Environment, Food, and Rural Affairs (DEFRA) Air Quality Fund for the delivery of a low-cost mobile Automated Number Plate Recognition (ANPR) enforcement system to be implemented and trialled in the first phase of the Oxford's Zero Emission Zone (ZEZ);
- Development of the ZEZ including public consultation on the proposals as well as events gaining feedback from businesses, residents, transport operators and health experts in Oxfordshire. The ZEZ will be based on a road user charging scheme where only zero emission vehicles will be allowed to drive in the zone free of charge. The ZEZ is delivered in partnership between Oxfordshire County Council and Oxford City Council;
- In partnership with Oxfordshire County Council publication of proposals for "*Connecting Oxford*": a package of traffic measures to tackle congestion and the poor public transport connections into and across Oxford which involve the implementation of new traffic restrictions and a workplace parking levy;
- Progressed delivery of OxAir a project funded by the Department for Environment, Food and Rural Affairs (DEFRA) Air Quality Fund for the testing of low cost innovative Air Quality sensors to map air pollution and human exposure in Oxford. In 2019, several low-cost Air Quality sensors were installed in city buses and delivery vehicles and worn by cyclists and pedestrians to map air pollution in Oxford. A competency group has also been created with people from across Oxford to conduct citizen science

and explore the use of these sensors by the local communities. This project is being delivered in partnership with local group OxAir;

- Progressed the delivery of £41 million Innovate UK funded project for the development of an innovative new Energy Super Hub project in Oxford (ESO). In 2019 Planning permission was granted for the installation of a giant battery at a local National Grid substation and it is expected to 'go live' in winter 20/21. Planning is in progress for a new high capacity electric wire, running around the East and West part of Oxford. As part of the project the City Council has also recently placed orders for a further 27 electric vehicles, including cars, vans, sweeper and a JCB.
- Declared a climate emergency in January 2019 and agreed to create a citizens assembly in Oxford to help consider new carbon targets and additional measures to reduce emissions. In April, Members set a vision to reduce the City Council's own emissions to net-zero by 2030 at the latest
- Hosted, during the weekends of 28th-29th September and 19th-20th October 2019 a Citizens Assembly on Climate Change, which involved a randomly-selected representative sample of 50 Oxford residents who learned about climate change and explored different options to cut carbon emissions through a combination of presentations from experts and facilitated workshops. Oxford was the first city in the UK to deliver a full citizens assembly on the topic of climate change;
- Progressed the delivery of £2.3million Clean Bus Technology funded (CBTF) project for the retrofit of 5 buses to fully electric and 115 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. The first fully electric double decker bus to operate in Oxford was launched in March 2020.
- Co-organised and delivered, in association with Green TV, the second Electric Vehicle summit in Oxford. The event took place at the Saïd Business School in Oxford, on 26th and 27th June 2019 and brought together key figures in the electric vehicles and EV charging markets. The summit was focused on dual themes of business development and thought leadership;

- Co-organised and delivered, in association with Green TV, the first Electric Bike summit in Oxford. The event took place at Oxford University's Wolfson College on 10th April 2019, bringing together industry players and business leaders from cycling bodies, cycle manufacturers, the retail sector, investors and the public sector, with the aim to create a business forum to propel the business of e-Bike mobility;
- Progressed the delivery of DEFRA's Air Quality Funded project aimed at addressing the specific challenges of Covered Market deliveries, to help retailers get ready for the introduction of the Zero Emission Zone to be introduced progressively across the city centre from 2020.

Progress on the following measures has been slower than expected:

- The full delivery of funding obtained from DEFRA's Air Quality Fund for the purchase of electric delivery vehicles and installation of charging points to support retailers to get ready for the introduction of Oxford's ZEZ has been delayed due to the need to integrate the project into plans for Market Street as a result of Jesus College redevelopment.
- The full delivery of funding obtained from DEFRA's Air Quality Fund for the development of a robust, integrated communication and engagement plan, to inform and work with businesses in the city centre on how to adopt zero emission delivery and servicing solutions for their business has been delayed. However, a dedicated Zero emission Officer has recently joined the team in January 2020 to specifically deliver this project so progress is expected in 2020;

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

- In partnership with the Local Transport Authority, Oxfordshire County Council, continue work on the introduction of a Zero Emission Zone (ZEZ) in Oxford city centre, with the expectation of delivering ZEZ phase one in summer 2021;
- To progress the delivery of a low-cost mobile Automated Number Plate Recognition (ANPR) enforcement system to be implemented and trialled in the first phase of the Oxford's Zero Emission Zone;

- Continue to deliver the anti-idling campaign '*Oxford Air Needs Your Care'*, in partnership with Friends of the Earth, particularly focused on tackling vehicles idling around schools during drop off and pick up times;

- Finalise the delivery of £2.3million CBTF project for the retrofitting of five of the city's open-top sightseeing buses to become fully electric, and the retrofitting of 115 local buses to euro VI standards, using Selective Catalytic Reduction (SCR) technology;

- To deliver £128,500 DEFRA Air Quality Grant funded project involving partnership work with local group OxAir, aimed at testing low cost innovative Air Quality sensors to map air pollution and human exposure in Oxford;

- To deliver £122,500 DEFRA Air Quality Grant funded project aimed at the development of a robust, integrated communication and engagement plan, to inform and work with businesses in the city centre on how to adopt zero emission delivery and servicing solutions for their business;

- To progress the delivery of the £41 million Innovate UK funded project for the development of an innovative new Energy Super Hub project in Oxford (ESO), to cut carbon emissions and improve air quality in the city.

- To deliver £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;

- 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;

- To progress with "Connecting Oxford": a package of traffic measures to tackle congestion and the poor public transport connections into and across Oxford which involve the implementation of new traffic restrictions and of a workplace parking levy;

- Continue to improve communication with the public on air quality, review our Air Quality 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 27 full electric vehicles and 23 electric/diesel light commercial hybrid vehicles;

- Continue the roll out of electric vehicle charging infrastructure for the use of hackney carriages and private hire taxis in the city, using £500,000 of funding awarded by the Government's Office for Low Emissions Vehicles;

- To continue the roll out a further 100 EV chargers across the city by the end of 2021, as part of the GULO project;

- To co-organise and deliver Electric Vehicle Summit and e-bike summit in Oxford, bringing together key leaders from across the electric vehicle and charging infrastructure industry, as well as industry players and business leaders from cycling bodies, cycle manufacturers, the retail sector, investors and the public sector, with the aim to create a business forum to propel the business of e-Bike mobility;

- To adopt a new Local Plan for Oxford City, which will guide the city's future development up to 2036. Oxford's new Local Plan was submitted on 22nd March 2019 for examination and is expected to be adopted in full around June 2020. The new Plan incorporates new Air Quality related policies that will start being applied to new developments in the city, such as the prioritisation of car-free developments, the establishment of certain EV infrastructure requirements for residential and commercial parking, and in general, reinforced powers to control the air quality impacts of new developments to both current and new occupants and surrounding area, considering the developments operational and construction phases.

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

| | Measure | EU Category | EU Classification | Organisations involved and Funding Source | Planning Phase | Implementation Phase | Key Performance Indicator | Reduction in Pollutant / Emission from Measure | Progress to Date | Estimated Completion Date | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Manage bus emissions through the implementation of the Low Emission Zone | Promoting Low Emission Transport | Low Emission Zone (LEZ) | Oxford City Council/Oxfordshire County Council | 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<br><br>Plans are in place to extend LEZ to Euro VI standard from 2021 |
| 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 | Oxford City Council/ 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<br><br>"Connecting Oxford" Plans were put forward. The plans will see the introduction of several traffic restrictions in the city centre as well as the introduction of a Workplace Paring Levy | On-going | Oxfordshire County Council is working on LTCP5, whilst Oxford City Council is developing a new AQAP for the city. |
| 3 | Support walking and cycling strategies within the LTP to ensure they assist delivery of the AQAP objectives | Promoting Travel Alternatives | Promotion of Cycling | Oxford City council /Oxfordshire County Council | Complete | Complete | Walking and Cycling strategies include measures that support delivery of the AQAP | N/A | <u>Oxford City Council 2019 update:</u><br><br>Hosted a workshop in February 2020 at the town hall with 62 people, representing County, District and Parish Councils, major employers and sustainable travel advocacy groups to present and discuss Oxford Greenways Project - Oxford City Council, Oxfordshire County Council and the University of Oxford's commitment to fund a concept master plan for a new network of cycling and walking routes into Oxford, to be achieved within 18 months<br><br><u>Being delivered by Oxfordshire County Council in 2019:</u><br><br>In 2019 The County Council developed an Oxford Local Cycling & Walking Infrastructure Plan (LCWIP) that was approved by cabinet on 17th March 2020. The plan sets out what the County Council needs to do for walking/cycling over the next 10 years | On-going | |

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| 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 | Oxford City council 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 | Oxford City council | On-going | Started | Travel Plans adopted by organisations in the city | N/A | Oxfordshire County Council currently requires the submission of a travel plan for all major developments in the city<br><br>The county council has also delivered a project related with integrated mobility called 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 | |
| 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 | Oxford City Council | Complete | On-going | Amount of city fleet buses retrofitted with SCR – Euro 6 technology | | Continue to work with bus companies to reduce their emissions and explore ways of compliance with ZEZ. Oxford City Council progressed the delivery of £2.3million Clean Bus Technology funded (CBTF) project for the retrofit of 5 buses to fully electric and 115 to euro VI standard, with expected NO2 savings of 5.5 tonnes/year and a total of 27.6 tonnes over the lifetime of the project. The first fully electric double decker bus to operate in Oxford was launched in March 2020.<br><br>Developed in 2019:<br><br>As part of the ZEZ implementation, there will be an upgrade of the current city centre Euro V LEZ for buses to a higher (Euro VI) standard from late 2021<br><br>Adoption of new emission standards for Hackney Carriage vehicles in 2020, will also be the beginning of a plan to see Hackney taxis adopting a phased approach to zero emission capable between 2020 and 2025, with drivers only able to get a license in 2025 if they have a | On-going | The successful bid(s) were possible due to joint working between Oxford City Council, Oxford Bus Company, Stagecoach and City Sightseeing Oxford<br><br>The new standards were developed in consultation with COLTA (City of Oxford Licensed Taxicab Association) and with feedback from taxi drivers and owners |

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| | | | | | | | | | zero emission cab | | |
| 7 | 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 | Oxford City Council /Oxfordshire County Council | On-going | On-going | Charging infrastructure installed | N/A | Oxford City Council 2019 Updates:<br><br>Oxford City Council co-organised (in association with Green TV and Electric Drivers) and delivered the second Electric Vehicle summit in Oxford. The event brought together key figures in the electric vehicles and EV charging markets to explore the opportunities and barriers for those working in electro-mobility<br><br>Oxfordshire county council 2019 updates:<br><br>Electra has now completed and the technology and developments from it are planned to be used in the Park and Charge project..(see 8)<br><br>EV Charging Strategy – Working with District Council partners Oxfordshire County Council are leading a working group developing a consistent approach to EV charging across Oxfordshire. This is planned to be complete by late 2020. | On-going | |
| 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 | Oxford City Council / Oxfordshire County Council | On-going | On-going | TBC | N/A | Oxford City Council achieved in 2019:<br><br>Using £200.000 from DEFRA air quality Grant to enable the provision of EV infrastructure and EV fleet to the city's covered market<br><br>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.<br><br>Oxfordshire county council 2019 updates:<br><br>. | On-going | Launch of Oxfordshire Hydrogen Hub, in preparation for ZEZ<br><br>Virgin Park and Charge (VPACH) - Feasibility study examining extending the use of existing Virgin Media infrastructure to supply energy and data communications to be used for electric vehicle charging for residents with no access to off road charging. Like the above project there is an application in for the demonstration phase of VPACH 1 looking to |

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| | | | | | | | | | VAPCH – Also successful in obtaining Innovate UK funds to move into a pilot stage. Unfortunately work done to date shows little opportunity to use this model in those areas available within Oxfordshire. | | install a significant number of road side charge points across the UK. Numbers for Oxfordshire are not currently known. |
| 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 | Oxford City Council | Complete | On-going | Number of electric vehicles in Council's fleet | N/A | Oxford City Council 2019:<br><br>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. Oxford City Council's current fleet is composed by:<br><br>Cars 41 (includes 17 electric) (<br>Small vans 52 (includes 9 electric)<br>Large vans 93 (includes 7 hybrids)<br>Tippers 57 (includes 13 hybrids)<br>Pick Ups 19<br>HGVs 53<br>Miscellaneous Plant, Grounds Maintenance, Municipal and Utility vehicles 40 (includes 8 electric)<br><br>Total fleet 355 (15.2% reduced emissions of which 9.5% is zero emission capable).<br><br>Oxfordshire County Council 2019:<br><br>The County Council continued the transition of its fleet to low emission vehicles that had been initiated in 2018. The County now have 17 fully electric vans and cars operating, a further 4 on order, and several trials taking place in a number of service areas within the County Council.<br><br>'One Fleet' Programme:<br>A programme 'One Fleet' has been agreed to bring all fleet into one centralised management function within the County Council. This will be a key supporting element in delivering County Council's ambition towards low emission fleet. Support has been put in place to support the transition to electric vehicles including programme to install charging infrastructure on the corporate estate, analytics devices to report on suitability of replacement with EV or Hybrid and fleet assessment advice and vehicle trials | On-going | Procurement processes have been created to ensure that :<br>•Alternatives to fully internal combustion engine vehicles are identified<br><br>•Impact on emissions and operating costs for ULEV vehicles are fully considered<br><br>•Zero emission vehicles are the preferred solution in all cases where they are operationally feasible and financially viable. |

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| | | | | | | | | | EV Charging Infrastructure for Fleet:<br>At the end of 2019, charging infrastructure had already been installed at 18 council sites. OLEV workplace charge point grant scheme was used to part fund the installation of these charge points (£500 per point for a maximum of up to 20 charge points). | | |
| 10 | Promote the development of low and zero emission car clubs schemes in the city | Alternatives to private vehicle use | Car Clubs | Oxford City council | 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 | Oxford City Council | 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 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 | Oxford City Council | On-going | On-going | TBC | N/A | Oxfordshire County Council has finalised delivery of the following projects in 2019:<br><br>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<br>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 | Oxford City Council | On-going | On-going | Feasibility study report | N/A | A feasibility study for the zero emission zone has been completed which provide projections on emission savings. | Finished | 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 |
| 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 | Freight and Delivery Management | Other | Oxford City Council | 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<br>We continue to consider how we can carry out mini consolidation across our own organisation.<br><br>In 2018:Oxford City Council secured £122.500 from DEFRA Air Quality fund for | 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 |

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| | in relation to the final delivery leg of any such consolidation schemes | | | | | | | | the development of a robust, integrated communication and engagement plan, to inform and work with businesses in the city centre on how to adopt zero emission delivery and servicing solutions for their businesses. A Zero Emission Zone Officer has recently joined the team in January 2020 and will be working full time on this particular project | | 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 | Oxford City Council | On-going | Not commenced | TBC | N/A | This measure has not been progressed to date | N/A | Delivery of ZEZ has superseded this measure. |
| 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 | Oxford City Council | Not commenced | Not commenced | TBC | N/A | This is being managed through the planning process | On-going | Part of ZEZ programme aims to support businesses in development of plans. |
| 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 | Oxford City Council | Complete | On-going | Air Quality Assessments undertaken for all major development in the city | N/A | Oxford City Council has already Published Air Quality Planning Application Guidance, aimed at creating a better understanding of the air quality requirements that need to be considered by applicants prior to the submission of a valid planning proposal<br><br>We are also ensuring that air quality is considered fully during the development of the Oxford Local Plan. | On-going | Air Quality planning guidance is currently available for download at Oxford City Council's Air Quality Website |
| 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 | Oxford City Council | On-going | On-going | TBC | N/A | The Oxford Local Plan is going to be adopted by the end of 2020. This measure will be progressed through that process | On-going | |

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| 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 | Oxford City council | On-going | Not Commenced | TBC | N/A | The Oxford Local Plan is going to be adopted by the end of 2020. This measure will be progressed through that process | On-going | |
| 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 | Oxford City Council | Complete | On-going | EV charging points installed at all new major developments | N/A | Currently happening through Development Management process. The Oxford Local Plan is going to be adopted by the end of 2020. This measure will be 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 | Oxford City council | On-going | Not commenced | TBC | N/A | | Measure on hold | ZEZ is expected to accelerate this measure |
| 22 | Promote the development of car clubs within new developments | Alternatives to private vehicle use | Car Clubs | Oxford City Council | 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. 6 Electric Car Club vehicles were launched in 2019, as part of GULO project, to add to the 4 that were launched in 2018 | On-going | |
| 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 | Oxford City council | 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. | On-going | |
| 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 | Oxford City Council | 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 | Oxford City council | 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 still on-going | On-going | |

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| 26 | Roll out Eco-driving training for our staff | Vehicle Fleet Efficiency | Driver training and ECO driving aids | Oxford City council | 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 Developme nt Control | Regional Groups Co-ordinating programmes to develop Area wide Strategies to reduce emissions and improve air quality | Oxford City council | 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. Regular meeting every 3 months | On-going | |
| 28 | Consider the benefit of including wider stakeholders such as transport providers, public health organisations and research and consulting expertise | Policy Guidance and Developme nt Control | Regional Groups Co-ordinating programmes to develop Area wide Strategies to reduce emissions and improve air quality | Oxford City council | Complete | On-going | air quality updates provided to the Health improvement Board when required | N/A | Engagement with the Health Improvement Board and Oxfordshire County Council Public Health colleagues | On-going | We are also still working together with a local group called OxAir, 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 | Oxford City council with other district councils | 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'<br><br>In 2019 a joint bid by all district councils in Oxfordshire for a new air quality website to be developed, which a much better layout and info graphs, and also with the possibility to incorporate a smart text message alert system that could be used to alert COPD patients and others of high pollution episode. Unfortunately we have not been successful, but we will try to re-submit an application in 2020<br><br>In 2019, Oxford City Council also launched an air quality banner competition to primary schools in Oxford, in an effort to promote sustainable travel and reduce air pollution around schools<br><br>Oxfordshire County Council have delivered in 2019 NEVFMA, a project that integrates data from 18 AQ sensors | On-going | In 2018 and throughout 2019, Oxford City Council launched in partnership with friends of the earth a city wide anti-idling campaign to reduce unnecessary emissions from stationary vehicles<br><br>NEVFMA is a project with the main objective of improving air quality by optimising traffic management |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | (Zephyrs) installed, MappAir model available, Aimsum next links to UTMC. | | |
| 30 | Work with the district and County Councils in Oxfordshire to provide a co-ordinated approach to public awareness and education | Public Information | Other | Oxford City Council, Local Friends of the Earth, Schools, OxAir | 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 | <u>Developed in 2019:</u><br><br>Launch of an Anti-Idling campaign for Oxford in March 2018 together with local Friends of the Earth.<br><br>Oxford City Council continues to deliver on £128,500 from DEFRA Air Quality fund for the testing of low cost innovative Air Quality sensors to map air pollution and human exposure in Oxford – the project also aims to educate on air quality via links with projects with schools and communities; and provide advice on how to reduce personal exposure to air pollution<br><br>Continued collaborative work with Oxfordshire County Council's Public Health England colleagues around raising awareness of air pollution and the benefits of active travelling around schools, and also with Oxford Health respiratory nurses and physios working on the integrated respiratory team project of Churchill's Hospital in Oxford to explore ways of provide better Air Quality communication and advice for COPD patients<br><br>Initiated collaborative work with Oxfordshire County Council on the promotion of Oxford City Council's STOP and County's WOW project | On-going | STOP Project was awarded best Air Quality communication initiative of the year at the national Air Quality Awards in October 2018 |

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

As detailed in Policy Guidance LAQM.PG16 (Chapter 7), local authorities (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 Ebbes' urban background site. In 2019 the annual mean concentration was 9 $\mu gm^{-3}$. 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 are working in partnership with Oxfordshire County Council on the delivery of:

a) A Zero Emission Zone (ZEZ) in Oxford, to be rolled out in phases over 15 years, starting in 2021. The overall aim of this 'journey to zero' is to largely eliminate transport 'tailpipe' emissions in Oxford city centre by 2035
b) Connecting Oxford, a set of proposals that will deliver a number of traffic restrictions in Oxford together with the introduction of a Workplace Parking Levy (WPL), which is an annual charge paid by employers for each parking space they provide, on or off-site, that is used for employee (commuter) car parking.

Connecting Oxford aims to (amongst other things) reduce motorised traffic levels; the ZEZ aims to minimise emissions from the traffic that remains, and therefore both are 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 ($NO_X$) at three sites, Particulate Matter ($PM_{10}$ and $PM_{2.5}$) at two sites and Ozone ($O_3$) at one site in 2019. Non-automatic (passive) monitoring of Nitrogen Dioxide ($NO_2$) was carried out at seventy one locations in 2019.

Maps showing the location of the air quality monitoring (continuous and passive) conducted in 2019 can be found in Appendix D. Maps covering current and 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 factors 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 three sites during 2019. 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

Oxford City Council undertook non-automatic (passive) monitoring of $NO_2$ at 71 sites in 2019. 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)[15].

Approximately half of the monitoring locations are within central Oxford at locations where the City Council believes 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 these sections are ratified, and, where relevant, adjusted for bias, *"annualisation"* and distance correction. Further details on adjustments are provided in Appendix B. Details of the UK air quality objectives for protection of human health, as well as of WHO's recommended limit values for comparison with the 2019 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 $NO_X$.

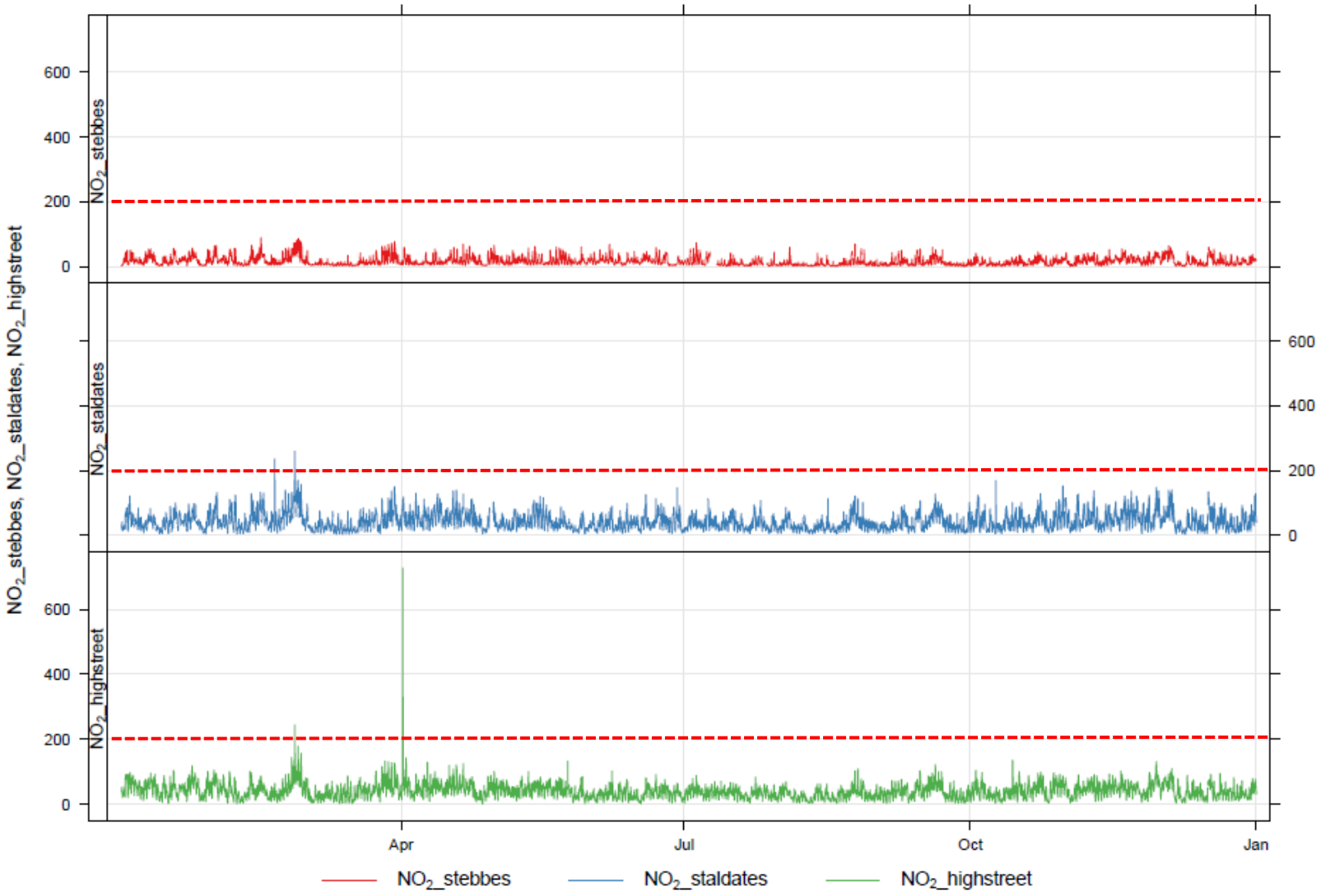
a) NO is described as a primary pollutant (meaning it is directly emitted from source). NO is not known to have any harmful effects on human health at ambient concentrations. However, it undergoes oxidation in the atmosphere to form the secondary pollutant $NO_2$.

b) $NO_2$ 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 2019. 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 $\mu gm^{-3}$.

**Figure 3-1 - Time series of hourly averaged concentrations of $NO_2$ ($\mu gm^{-3}$) at automatic monitoring sites, 2019.**



The AQS objective for hourly mean $NO_2$ concentration is 200 $\mu gm^{-3}$, and may be exceeded up to 18 times per calendar year. Figure 3.1 shows that during 2019 there were few hourly mean $NO_2$ measurements exceeding 200 $\mu gm^{-3}$. In total, 3 exceedances were reported at Oxford Centre roadside, and 2 exceedances at Oxford High Street. The highest hourly mean $NO_2$ measured in 2019 was of 727.2 $\mu gm^{-3}$ and was registered on the 1st April 13:00 at Oxford High Street. The air pollution levels registered at the same date and time at AURN Oxford Centre Roadside (which lies only at 370 meters away) were of 109.6 $ugm^{-3}$. This is a clear indication that the origin of that high reading was quite local and probably related with emissions from an idling vehicle that could have been parked in front of the monitoring station during that period. Table A.4 in Appendix A summarises the $NO_2$ hourly mean exceedances of the 200 $\mu gm^{-3}$ 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 $\mu gm^{-3}$. $NO_2$ levels at all 3 sites were recorded within the DEFRA *"Low"* band for most of the year, with the exception of the exceedances mentioned above. As none of the automatic monitoring sites have registered more than 18 exceedances of the AQS hourly objective for $NO_2$, this objective was therefore met in 2019.

The annual mean AQS objective for $NO_2$ is 40 $\mu gm^{-3}$. In 2019, Oxford High Street annual mean for $NO_2$ was 40 $\mu gm^{-3}$ and Oxford Centre Roadside 42 $\mu gm^{-3}$. At St. Ebbes, the $NO_2$ annual mean was 16 $\mu gm^{-3}$. This objective was therefore met at Oxford High Street and Oxford St Ebbes, and not met at Oxford Centre Roadside.

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 $\mu gm^{-3}$. Figure 3.2 (below) shows the 15 year long term trend for levels of measured $NO_2$ at continuous monitoring stations. The results are expressed in $\mu gm^{-3}$.

**Figure 3-2 – Long term trends of Annual Mean $NO_2$ ($\mu gm^{-3}$) at Oxford's continuous monitoring stations, 2004-2019.**

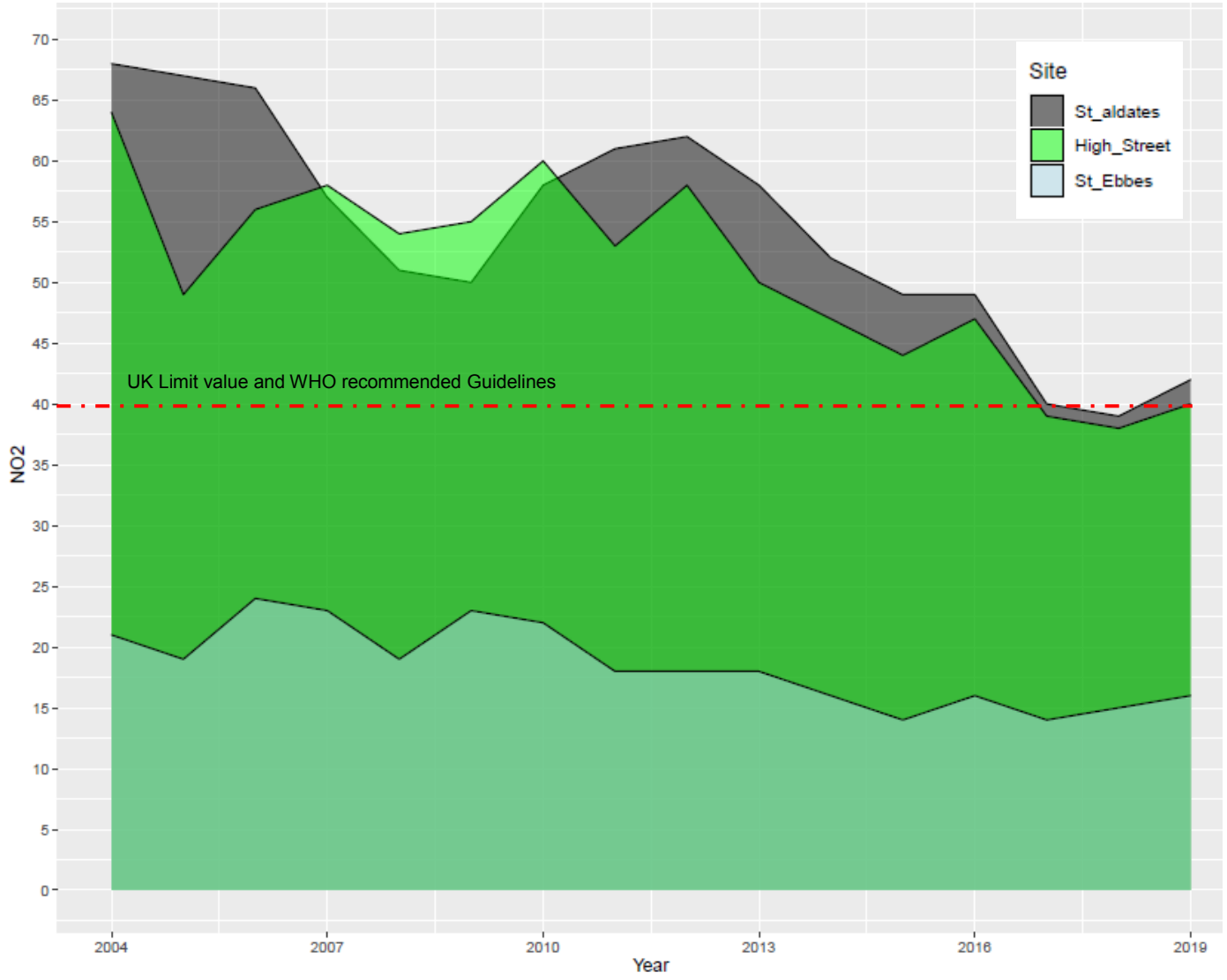


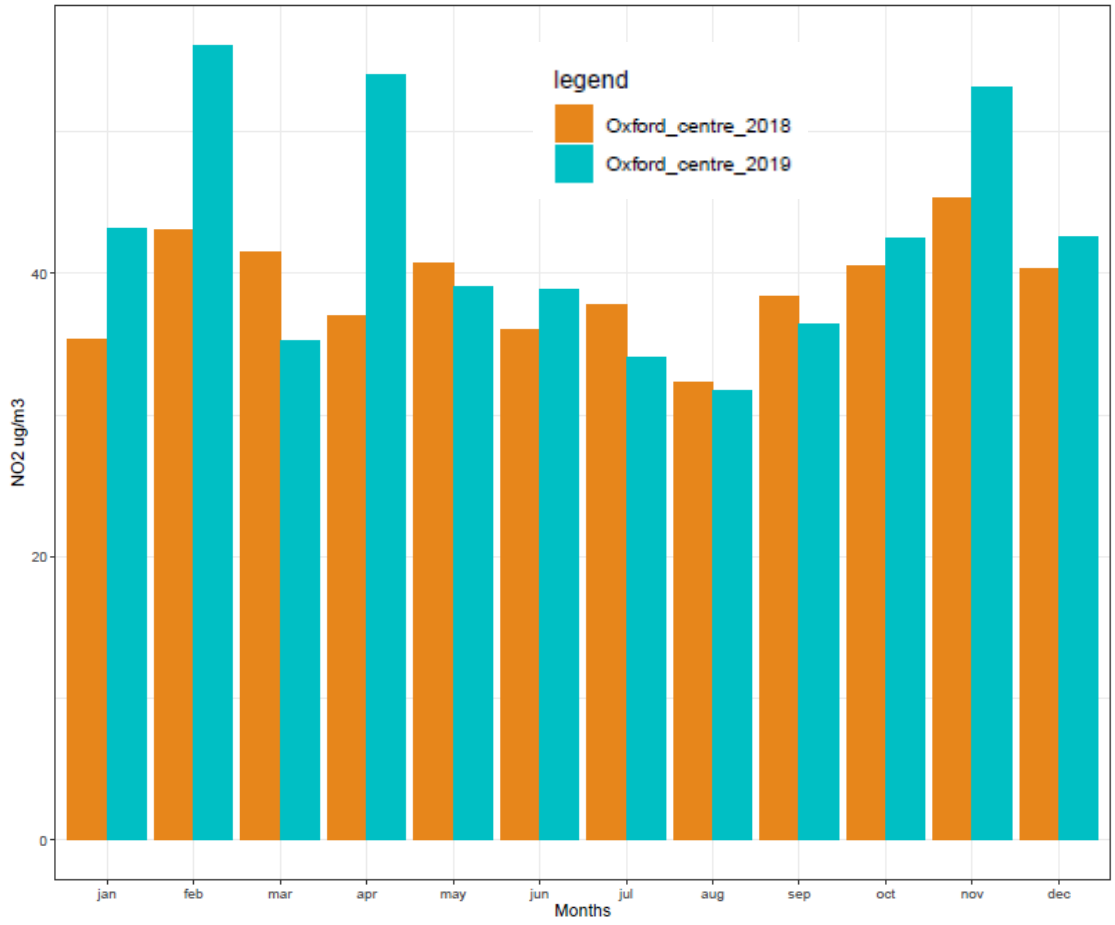
Figure 3.2 shows that the $NO_2$ levels measured in Oxford at the locations of our automatic monitoring roadside sites have increased by 2-3 ug/$m^3$ in 2019. Information provided by Oxfordshire County Council, the highways authority in Oxford, has shown that these slight increases are not the result of any increase in traffic levels in those areas.

Smaller fluctuations of the annual Mean $NO_2$ can normally be expected from year to year. The uncertainty of the $NO_2$ automatic monitoring method (±15%) can normally help explaining some of those differences; however, in 2019 we believe these can be completely attributed to weather.

Figure 3.3 below shows the comparison between the $NO_2$ monthly averages that were measured at AURN Oxford Centre Roadside (St Aldates) in 2018 and 2019 in an attempt to show the contribution of weather to the observed increase of annual mean $NO_2$ levels in Oxford.

AURN Oxford Centre Roadside is the only monitoring roadside site in Oxford that forms part of the UK's national air quality network (AURN), which makes it the most suitable site for this analysis. AURN sites have to obey to specific QA/QC procedures as well as to the specific location requirements of the AQ European Directive (Annex 3, section B) in terms of macro-scale representativeness[12] – these are in place to ensure that: (a) the air quality data reported from these sites is as accurate as it can possibly be, (b) the air quality data reported from these sites is representative of air pollution levels over larger areas.

**Figure3-3– Comparison of $NO_2$ monthly averages at St Aldates (2018-2019)**




$NO_2$ levels tend to be typically higher during the winter months in urban environments, when emissions may be higher, and periods of cold, still weather reduce pollutant dispersion, and lower during summer months, where the increase of temperature levels promote vertical mixing and the dispersion of air pollutants.

Figure 3.3 shows that $NO_2$ monthly averages at AURN St Aldates were relatively similar in 2018 and 2019 for most of the months of the year, following the typical urban trend described above, with the exception of the months of January/February, April and November, where 2019 $NO_2$ monthly averages seem to be a lot higher.

The analysis of Figure 3.3 clearly shows that the observed increase in the 2019 $NO_2$ annual mean measured levels at AURN Oxford Centre Roadside has to do with the significant $NO_2$ monthly mean increases that were measured at those particular months.

According to the Met Office[11], 2019 was a year of extremes, with record-breaking heat and rain, along with notable spells of cold and windy weather. Met Office's

website shows that a considerable amount of days in January/February, April and November have registered lower than average temperatures coupled with episodes of high atmospheric stability (high pressure systems). High pressure systems and low temperatures are normally linked to episodes of still weather, where we see very poor atmospheric dispersion causing air pollution to build up.

For detailed information on time variations of $NO_2$ over the entire calendar year of 2019 at Oxford's three automatic monitoring stations please refer to Appendix C.

**Non-Automatic Monitoring**

Non-automatic monitoring using diffusion tubes took place at 71 locations in 2019. 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 $\mu gm^{-3}$ for $NO_2$ specified by DEFRA was exceeded at 6 of the 71 monitoring locations where $NO_2$ levels were measured in 2019. All the diffusion tube monitoring locations are within the existing AQMA. Seven locations were not considered representative of public exposure (as per LAQM TG16 guidelines)[15]; therefore for those there was the need to correct the results for distance. The main observations of the monitoring carried out in 2019 using non-automatic monitoring are as follow:

- 71 locations in the City of Oxford were part of the 2019 air quality diffusion tube monitoring campaign. Of those, 7 locations were new monitoring sites, and the remaining 64 sites were sites where air quality had been monitored in the previous year;

- For the third consecutive year, none of the City's $NO_2$ diffusion tube monitoring sites presented an annual mean $NO_2$ equal or above 60 $ugm^{-3}$. According to LAQM (TG16), this is an indication that exceedances of the hourly mean objective for $NO_2$ are not likely to have occurred in the city in 2019;

- In 2019, $NO_2$ was measured at 7 new locations in the city. The new monitoring sites were located at Old Abingdon Road, Hollow Way Road, Cowley

Road/Union Street, Summertown Parade, Botley Road and St Clements. None of the new monitoring locations measured annual mean $NO_2$ concentrations above the current annual mean limit value for this pollutant;

- Diffusion tube results show that the annual mean AQS objective of 40 $\mu gm^{-3}$ for $NO_2$ was exceeded at six of the 71 monitoring locations in 2019. This represents an increase of two sites when compared with 2018. The locations where the annual mean $NO_2$ limit value was exceeded in 2019 are: St. Clements Street (2x), George Street, St Aldates, High Street and Long wall street.
- From all the 64 sites where $NO_2$ was monitored in both 2018 and 2019 with diffusion tubes, 70% showed increases of air quality levels; 16% measured the same levels as the previous year and only 9% showed slight decreases in $NO_2$ values.
- 24.4% percent of these increases were of only 1 $ug/m^3$, which is within the margin of error for the monitoring method. This means that the $NO_2$ levels measured at those locations in 2019 cannot be considered statistically significant. However, the majority of the increases (51.1%) were of 2-3 $ug/m^3$, and seen at more than 20 locations across the city. The remaining sites with increases observed (24.4%) were of 4-6 $ug/m^3$ and were seen at most of our air pollution hotspots and at locations where air pollution is historically high;
- Subsequent analysis of the 2019 air quality monitoring data indicates that the vast majority of $NO_2$ increases that were measured across the city by both monitoring methods (automatic and diffusion tubes) are related to specific weather events (record-breaking spells of cold and still weather)[11] occurring in the months of January/February, April and November, which have led to pollutant entrapment and air pollution build-up in several locations across the city, rather than to specific increases due to traffic and/or congestion;
- In 2019 the second full year of monitoring was completed since the opening of the Westgate Shopping Centre. Air quality was monitored at a total of 12 locations around the Westgate Centre. The vast majority of these sites showed slight increases of up to 2 $ugm^{-3}$, which are consistent with the air

pollution increment that we see across the city and that we attribute to weather. Overall, the results of the monitoring around the Westgate indicate little change in $NO_2$ levels when compared with the previous year;

- Of the 71 locations where $NO_2$ levels were monitored in 2019, only 6 exceeded the annual mean limit value for $NO_2$. All of these sites are located in the City Centre (George Street, St Clements (2x), High Street, Long wall St and St Aldates);

- One site is now, for the first time, in compliance with the annual mean limit value for $NO_2$; the site located at the North West boundary of the City (Cutteslowe Roundabout). The concentration obtained at this location has reach the threshold for compliance (40 $ugm^{-3}$), but given the degree of uncertainty associated with the diffusion tube methodology a further year of consistent results are required to verify the result.

- The monitoring location with the highest annual mean for $NO_2$ in 2019 was DT55 - St. Clements Street/The Plain - with a value of 53 $\mu gm^{-3}$. This represents an increase of 15% of the $NO_2$ levels of this location when compared with data from the previous year (46 $\mu gm^{-3}$). Discussions held with transport planners from Oxfordshire County Council didn't allow the identification of any particular intervention work that could explain this increase in the levels of $NO_2$ measured in 2019. However, this has always been Oxford's most significant $NO_2$ hotspot, and it is expected that locations of the city that are already historically known for having high $NO_2$ emissions, will have a much more substantial increase of air pollution entrapment translated into a $NO_2$ annual mean increase as a result of the still weather episodes identified above than in any other location in the city where air pollution is not as problematic.

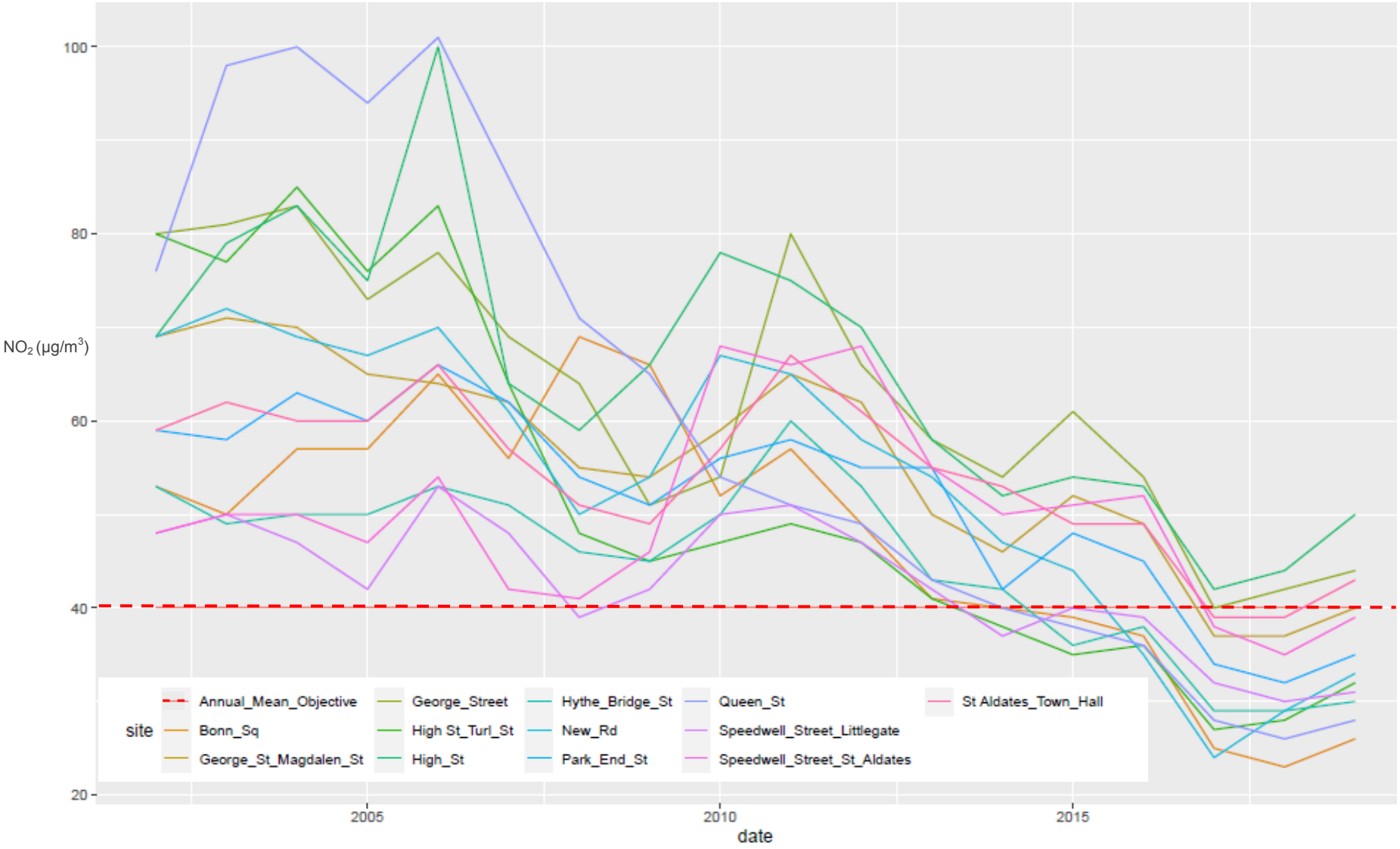
- The second site with large $NO_2$ increase (moving from 44 $ug/m^3$ in 2018 to 50 $ug/m^3$ in 2019) was DT56 - High Street. However, in 2019 there was a substantial amount of construction and scaffolding work immediately around the area of the monitoring site. It is therefore highly likely that this increase results from a combination of the meteorology events described above, with

the effects of construction on traffic flows leading to an increase of $NO_2$ at this location.

- One site is now, for the first time, in compliance with the annual mean limit value for $NO_2$: Cutteslowe Roundabout on Banbury Road. The concentration registered at this location in 2019 (40 $ugm^{-3}$) is at the threshold for compliance. However, this only represents a reduction of 1$ugm^{-3}$ when compared with the results obtained at this location in 2018, and given the degree of uncertainty associated with the diffusion tube methodology a further year of consistent results are required to verify the result.

Figure 3.4 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 $\mu gm^{-3}$. It is quite clear that there has been a significant downward trend in measured levels of $NO_2$ at most of these locations since historic monitoring began in 2003. However, in 2019, air quality levels seem to have slightly increased in the city Centre mainly believed to be driven by weather. Overall, the annual mean objective for $NO_2$ was only exceeded at 6 of the 71 locations in 2019.

**Figure3-4– Long Term Trends in Annual Mean $NO_2$ ($ugm^{-3}$) at Oxford's diffusion tube monitoring locations, 2003-2019.**



### 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 2019, $PM_{10}$ data was monitored by automatic continuous monitors at Oxford St. Ebbes and Oxford High Street. $PM_{2.5}$ was monitored at Oxford St. Ebbes.

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

The result of $PM_{10}$ measurements in 2019 show 7 exceedances of the 50 $\mu gm^{-3}$ 24h mean on High Street, and 5 exceedances at St Ebbes. All the registered exceedances occurred during the following periods: 25th - 28th February and from 17th-19th April 2019. According to Kings College[13], these exceedances are not directly related with pollution generated in the city of Oxford but instead, from the following trans-boundary air pollution episodes:

**'High' and 'very high' $PM_{10}$ and $PM_{2.5}$ particulate pollution incident notification for 23rd to 28th February 2019 from King's College London**

*"The episode was caused by a combination of poor dispersion of locally emitted air pollution and the import of air particle pollution from Europe. The imported particle pollution was dominated by organic and nitrate particles, with very little sulphate. This reflects the types of emissions sources in the near continent, with little coal combustion and therefore little sulphur. Instead emissions are likely to have been dominated by traffic and natural gas combustion. During the episode as a whole, 88 monitoring sites measured particle pollution that was 'moderate', 'high' or 'very high'. Within our networks high and very high air pollution was confined to London and west Kent. 'Moderate' particle pollution was measured across Surrey, Sussex and the Southampton area. Nationally the air pollution episode affected all of the UK with the exception of the north of Scotland".*

**'Moderate' and 'High' $PM_{10}$ and $PM_{2.5}$ Pollution Incident Notification for Monday 15th to Wednesday 17th April 2019 from King's College London**

*"'Moderate' $PM_{10}$ and $PM_{2.5}$ particulate air pollution was measured widely across London and south-east England from Monday 15th to Wednesday 17th April. This was due to easterly winds bringing pollution from the Continent which combined with local emissions.*

*On Monday 15th, particulate levels began to increase at several sites from early morning. This corresponded with the arrival of air that had passed at low altitude over large areas of Europe, accumulating pollution from urban and industrial sources en route. This air feed remained all day and continued through into Wednesday 17th along with low wind speeds, thereby resulting in poor dispersion of locally-generated emissions and a build-up of the imported particulate pollution."*

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 AQS objective for 24-hour mean $PM_{10}$ was fully met at Oxford High Street and Oxford St Ebbes in 2019.

The annual mean AQS objective for $PM_{10}$ is 40 $\mu gm^{-3}$. Table A.5 in Appendix A compares the monitored $PM_{10}$ annual mean concentrations for the past 5 years with the air quality objective of 40$\mu gm^{-3}$. In 2019, Oxford High Street registered a $PM_{10}$ annual mean of 19 $\mu gm^{-3}$. Oxford St. Ebbes of 14$\mu gm^{-3}$. This objective was therefore met in 2019.

No AQS objective exists for $PM_{2.5}$; however a non-mandatory compliance target of 25 $\mu gm^{-3}$ to be met by 2020 exists. The monitored annual mean for this pollutant was 9 $\mu gm^{-3}$ at Oxford St. Ebbes. Table A.7 in Appendix A presents the monitored $PM_{2.5}$ annual mean concentrations for the past 5 years.

Figure 3.5 below show the 9 year long term trend for levels of measured $PM_{10}$ at continuous monitoring stations in Oxford, along with the current recommended WHO guideline values, which are significantly lower for $PM_{10}$ and $PM_{2.5}$ than the UK limit values. Figure 3.6 shows the same analysis but for $PM_{2.5}$. All the results are expressed in $\mu gm^{-3}$.

**Figure3-5– Long term trends of Annual Mean $PM_{10}$ ($\mu gm^{-3}$) at Oxford's continuous monitoring stations, 2011-2019.**

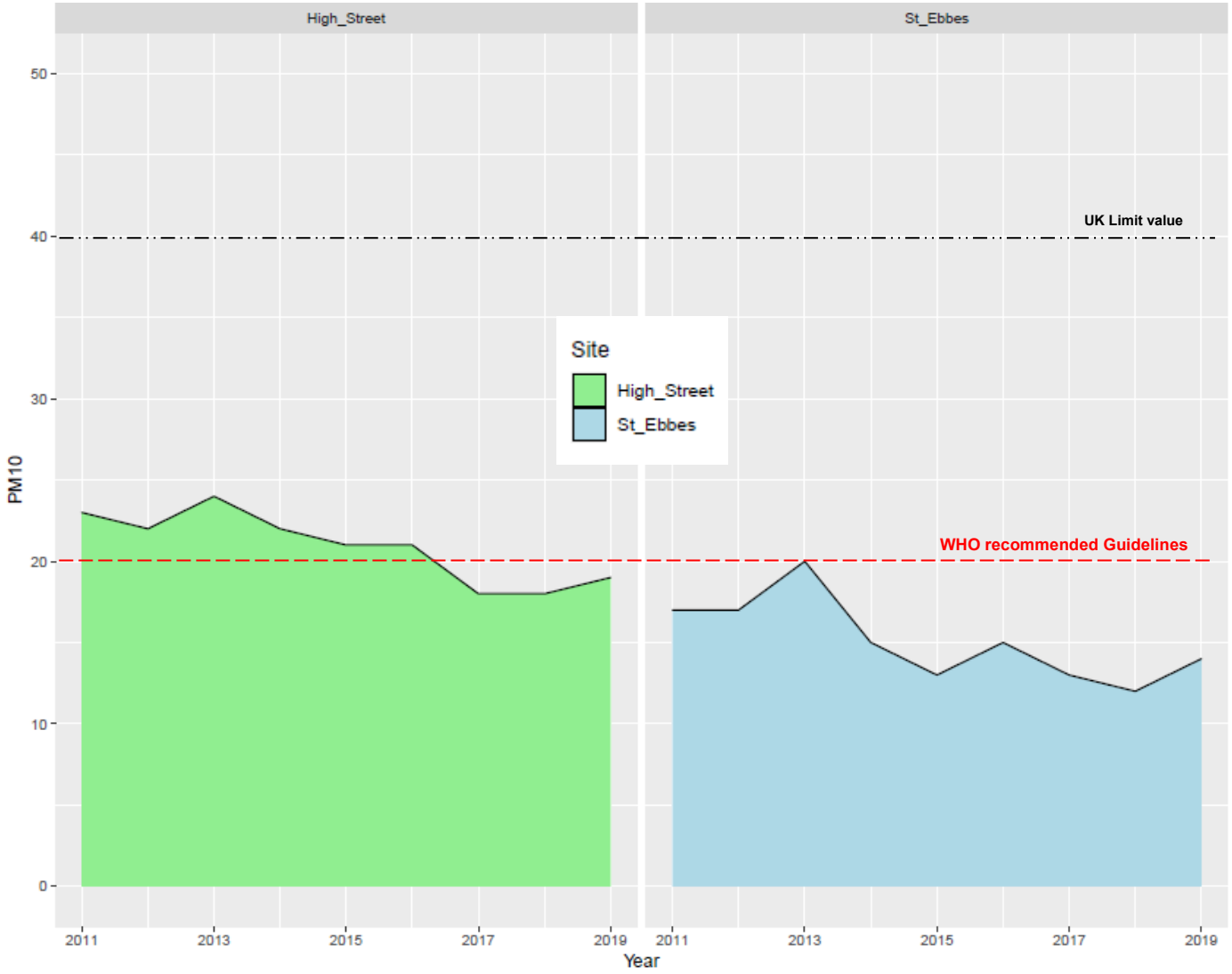


**Figure3-6– Long term trends of Annual Mean $PM_{2.5}$ ($\mu gm^{-3}$) at Oxford's continuous monitoring stations, 2011-2019**

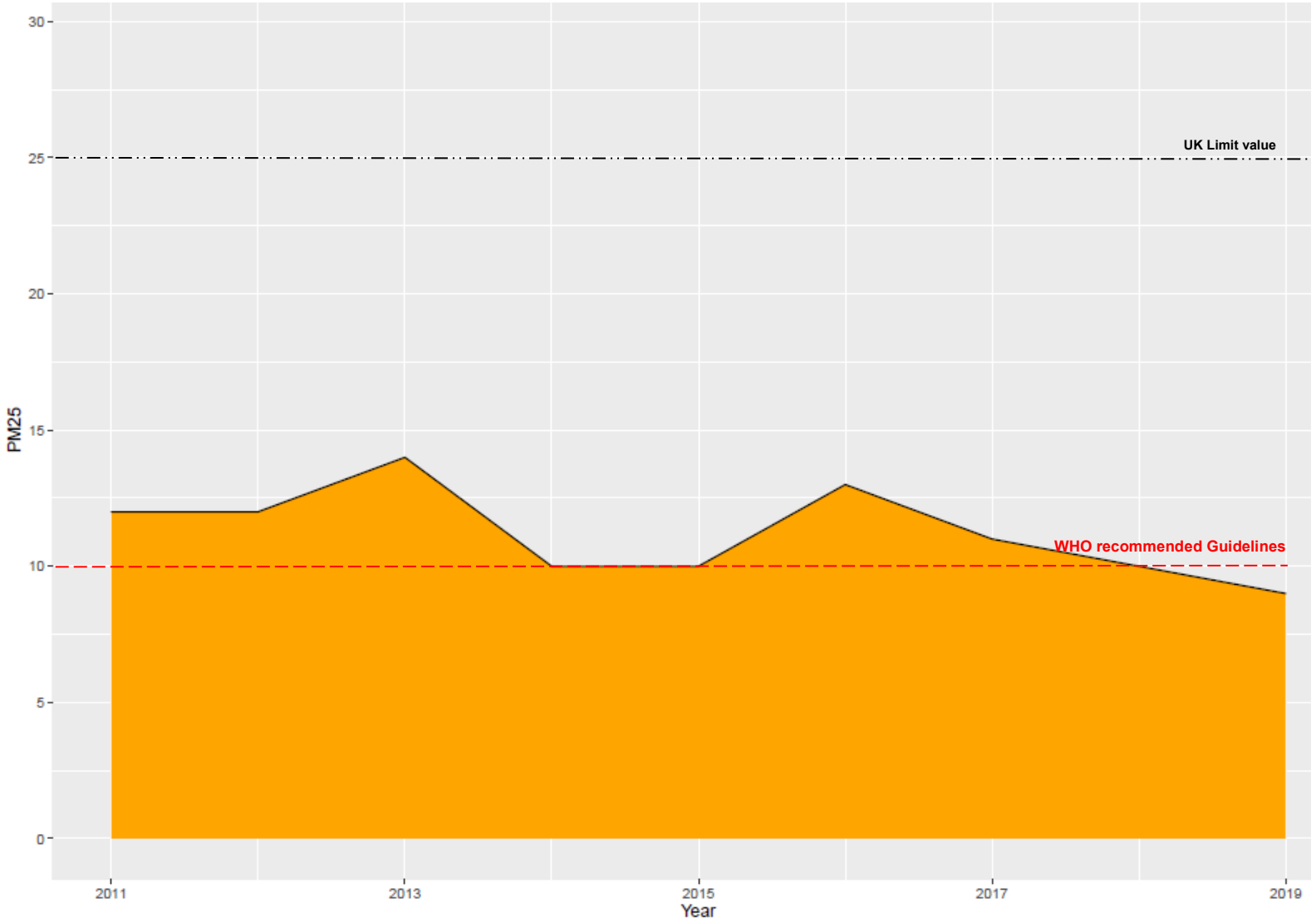


Figure 3.5 shows that the overall trend of $PM_{10}$ levels that were measured at our 2 automatic monitoring sites has been going downward since 2011. Figure 3.5 also shows that both automatic monitoring sites are in compliance with the annual mean UK limit value and the annual mean recommended by the WHO guidelines. The more pronounced step-change in 2013 can be attributed to the Low Emission Zone, which banned high-emission buses (i.e. buses with engines older than Euro V) from the City Centre. Bus companies began converting their vehicles in the run-up to the zone's introduction in 2014. All Euro V and Euro VI bus diesels are fitted with a Diesel Particulate Filter (DPF), which reduce the amount of Particulate Matter that is released from exhaust into the atmosphere by more than 80%.

The slight increase of local $PM_{10}$ levels at both sites in 2019 is also consistent with the levels of increases observed throughout the city for $NO_2$, which we believe can be attributed to the specific weather experienced in year 2019.

Figure 3.6 shows that the steady historic decrease that we see in Figure 3.5 for $PM_{10}$ is not so clear for $PM_{2.5}$. This has probably to do with the higher dependency of $PM_{2.5}$ on non-local emission sources. $PM_{2.5}$ is of a much smaller size than $PM_{10}$. This allows particles to stay in the air the longest facilitating their movement by winds over larger areas. In the UK, it is estimated that 65% of the contribution to the annual mean ambient $PM_{2.5}$ concentrations at Urban Background monitoring sites (such as AURN St Ebbes) are of non-local emission sources (45% - regional, and 20% - International ), with only 35% being directly attributed to the local Urban environment (traffic - 14%) and non-traffic (heating) - 21%)[16].

Figure 3.6 shows that in 2019 Oxford St Ebbes registered the lowest $PM_{2.5}$ annual mean since $PM_{2.5}$ monitoring began at this site in 2011. The annual mean obtained (9ug/$m^3$) is in compliance with the annual mean UK limit value and with the annual mean recommended by the WHO guidelines for this pollutant. It is important to highlight that on the 26th June 2019 the old FDMS unit that was used to measure $PM_{2.5}$ at this location was replaced by a brand new FIDAS instrument. Discussions with Ricardo's Energy & Environment data ratification team identified the main reason for reduction in the annual mean $PM_{2.5}$ observed in 2019 being the increased accuracy of the new unit. A more technical explanation for this can be found in Appendix B.

### 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*".

It is important to remember that ozone is an area wide pollutant, and whilst monitoring sites are relatively sparse compared to those monitoring nitrogen dioxide they represent the wider population exposure, so a single site may represent the ozone concentrations that hundreds of thousands of people have been exposed to.

$O_3$ is measured at Oxford St. Ebbes. The AQS objective for daily maximum on an 8 hour running mean is 100 $\mu gm^{-3}$ not to be exceeded more than 10 days a year. Oxford St. Ebbes met the AQS objectives for this pollutant in 2019.

Oxford St. Ebbes data capture of $O_3$ was of 94.5 % in 2019. The site exceeded the AQS daily objective for ozone 40 times, during a total of 10 days during the year.

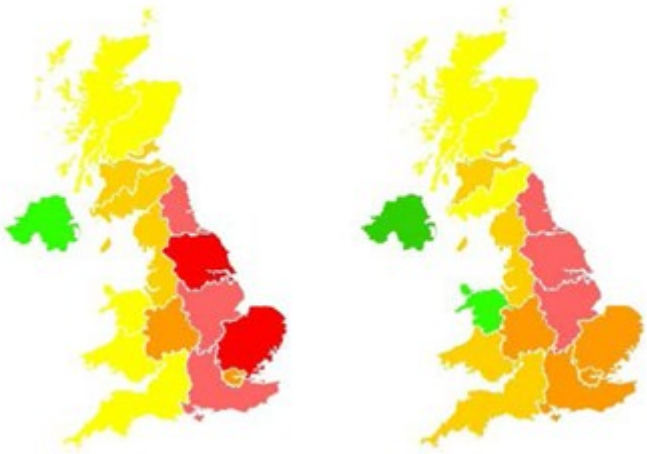
In 2019 there was a significant decrease in the number of exceedances (-109) and days (-17) where $O_3$ was registered above the legal threshold, when compared with the results from 2018. The highest readings of $O_3$ registered at Oxford St Ebbes occurred on the 29th June, 23rd July and 25th- 26th August and were all the result of regional air pollution episodes.

The Automatic Rural and Urban Network –Autumn 2019 Newsletter[14] refers to 3 major ozone episodes occurring during those periods of time:

*"Over the summer months of 2019, dry and sunny weather along with light winds caused three notable periods of ozone pollution, during which hourly mean $O_3$ concentrations exceeded the EU Public Information Threshold (180 µg $m^{-3}$). The first of these affected sites in the east of England, on the evening of 29th June: the second longer episode occurred over the period 23rd – 27th July. The eastern half of the UK was also worst affected during this second episode, with ozone concentrations in the 'High' band of the Daily Air quality Index over most of the eastern regions of the UK. A third summer air pollution episode, also caused by ozone pollution, occurred over the period 24th – 28th August."*

Figure 3.7 shows the maximum Daily Air Quality Index (DAQI) value measured in each of the UK's reporting zones on 25th July and on 25th August, when the majority of the UK had DAQI levels in the *'Moderate'* or *'High'* bands due to $O_3$.

**Figure3-7 – Regional DAQI Bands, 25th July (left) and 25th August (right)**



**Source**: Automatic Urban and Rural Network, Autumn Newsletter (2019)

# Appendix A: Monitoring Results

## Table A 1 – Details of automatic monitoring sites 2019

| 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 | Oxford Centre Roadside (AURN) | Roadside | 451359 | 206157 | $NO_2$ | YES | Chemiluminescence | 1 | 3 | 2.5 |
| CM2 | Oxford High Street | Roadside | 451677 | 206272 | $NO_2$ $PM_{10}$ | YES | Chemiluminescence TEOM | 1 | 2 | 1.5 |
| CM3 | Oxford St Ebbes (AURN) | Urban Background | 451118 | 205353 | $NO_2$ $PM_{10}$ $PM_{2.5}$ $O_3$ | YES | Chemiluminescence FIDAS 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 2019

| 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 | UB | 451118 | 205353 | $NO_2$ | YES | 10 | 2 | YES | 2.5 |
| DT2 | Weirs Lne./Abingdon Rd. LP1 | RS | 451904 | 204215 | $NO_2$ | YES | 2 | 2 | NO | 3 |
| DT3 | LP 52 Abingdon Rd. | RS | 451914 | 204154 | $NO_2$ | YES | 3 | 2 | NO | 3 |
| DT4 | Boundary Brook Rd/ Iffley Rd | RS | 452961 | 204662 | $NO_2$ | YES | 0 | 2 | NO | 3 |
| DT5 | Lenthall Rd Allotments | UB | 452818 | 203448 | $NO_2$ | YES | 5 | N/A | NO | 1.5 |
| DT7 | Oxford Rd/ Between Towns Rd | RS | 454472 | 204246 | $NO_2$ | YES | 3 | 2 | NO | 3 |
| DT8 | Oxford Rd(Cowley) LP13 | RS | 454355 | 204296 | $NO_2$ | YES | 0 | 1 | NO | 3 |
| DT12 | Churchill Drive/Old Rd | RS | 454493 | 206367 | $NO_2$ | YES | 1 | 1 | NO | 3 |
| DT14 | Windmill Rd. W | RS | 454554 | 207102 | $NO_2$ | YES | 0 | 2.5 | NO | 3 |
| DT15 | London Rd./BHF | RS | 454433 | 207058 | $NO_2$ | YES | 0 | 2.5 | NO | 3 |
| DT16 | Headley Way/London Rd. LP2 | RS | 453982 | 206817 | $NO_2$ | YES | 1 | 2 | NO | 3 |
| DT17 | 49 London Rd. /Latimer/Sandfield Rds | RS | 454138 | 206903 | $NO_2$ | YES | 2 | 2 | NO | 3 |
| DT18 | The Roundway | RS | 455596 | 207367 | $NO_2$ | YES | 0 | 5 | NO | 3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DT20 | Barton Lane LP2 | RS | 454999 | 207759 | $NO_2$ | YES | 3 | 1 | NO | 3 |
| DT21 | North Way /Barton Village Rd LP20 | RS | 455116 | 207796 | $NO_2$ | YES | 0 | 0.5 | NO | 3 |
| DT25 | Cuttleslowe Rbout 3 Elsfield Rd. | RS | 450419 | 210256 | $NO_2$ | YES | 5 | 2 | NO | 3 |
| DT26 | Cuttleslowe Rbout 3 Summers Place | RS | 450389 | 210189 | $NO_2$ | YES | 1 | 2 | NO | 3 |
| DT27 | Wolvercote Rbout 78 Sunderland Ave. | RS | 449824 | 210198 | $NO_2$ | YES | 1 | 1 | NO | 3 |
| DT28 | Wolvercote Rbout 51 Sunderland Ave | RS | 449856 | 210162 | $NO_2$ | YES | 1 | 1 | NO | 3 |
| DT29 | Pear Tree P&R N Gateway | RS | 449530 | 210734 | $NO_2$ | YES | 10 | 4 | NO | 3 |
| DT30 | Osney Lne/Hollybush Row | RS | 450668 | 206053 | $NO_2$ | YES | 2 | 2 | NO | 3 |
| DT31 | Beckett St. | RS | 450566 | 206227 | $NO_2$ | YES | 5 | 2 | NO | 3 |
| DT32 | Royal Oxford Hotel | RS | 450674 | 206273 | $NO_2$ | YES | 0 | 2.5 | NO | 3 |
| DT33 | Botley RD/ Mill St | RS | 450409 | 206224 | NO2 | YES | 1 | 1 | NO | 3 |
| DT35 | Botley Rd /Hillview Rd | RS | 450029 | 206207 | $NO_2$ | YES | 1 | 2 | NO | 3 |
| DT36 | Botley Rd N (Prestwich Place) | RS | 449657 | 206245 | $NO_2$ | YES | 0 | 2 | NO | 3 |
| DT39 | St Aldate's | RS | 451359 | 206157 | $NO_2$ | YES | 0 | 2 | NO | 2.5 |
| DT40 | Queen St. | RS | 451270 | 206144 | $NO_2$ | YES | 0 | 2 | NO | 3 |
| DT41 | Bonn Square | RS | 451216 | 206133 | $NO_2$ | YES | 0 | 2 | NO | 3 |
| DT42 | New Rd. | RS | 451073 | 206191 | $NO_2$ | YES | 2 | 3.5 | NO | 3 |
| DT43 | Park End St. | RS | 450885 | 206275 | $NO_2$ | YES | 2 | 1 | NO | 3 |
| DT44 | Hythe Bridge St. | RS | 450795 | 206343 | $NO_2$ | YES | 0 | 2 | NO | 3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DT45 | Worcester St. | RS | 450942 | 206424 | $NO_2$ | YES | 2 | 2 | NO | 3 |
| DT46 | Beaumont St. | RS | 451167 | 206519 | $NO_2$ | YES | 2 | 1 | NO | 3 |
| DT47 | George St. / Magdalen St. | RS | 451222 | 206387 | $NO_2$ | YES | 2 | 0.5 | NO | 3 |
| DT48 | George St. | RS | 450981 | 206344 | $NO_2$ | YES | 0 | 0.5 | NO | 3 |
| DT49 | Cornmarket St. | RS | 451322 | 206242 | $NO_2$ | YES | 0 | 2 | NO | 3 |
| DT50 | High St. / Turl St. | RS | 451467 | 206222 | $NO_2$ | YES | 1 | 2.5 | NO | 3 |
| DT51 | 50 High St. | RS | 451900 | 206250 | $NO_2$ | YES | 0 | 2.5 | NO | 3 |
| DT52 | Longwall St. | RS | 451972 | 206283 | $NO_2$ | YES | 1 | 1 | NO | 3 |
| DT53 | Magdalen Bridge | RS | 452099 | 206117 | $NO_2$ | YES | 0 | 2 | NO | 3 |
| DT54 | York Place | RS | 452325 | 206015 | $NO_2$ | YES | 0 | 2 | NO | 3 |
| DT55 | St Clements | RS | 452326 | 205992 | $NO_2$ | YES | 1 | 1 | NO | 3 |
| DT56 | High St. | RS | 451576 | 206232 | $NO_2$ | YES | 2 | 1 | NO | 3 |
| DT57 | Speedwell St. / St. Aldate's | RS | 451407 | 205807 | $NO_2$ | YES | 1 | 3 | NO | 3 |
| DT58 | Folly Bridge | RS | 451437 | 205529 | $NO_2$ | YES | 0 | 1 | NO | 3 |
| DT59 | Thames St. | RS | 451353 | 205643 | $NO_2$ | YES | 1 | 3 | NO | 3 |
| DT60 | New Butterwyke Place/ Thames St. | RS | 451248 | 205710 | $NO_2$ | YES | 5 | 2 | NO | 3 |
| DT61 | Friars Wharf | RS | 451219 | 205707 | $NO_2$ | YES | 0 | 3 | NO | 3 |
| DT62 | 1 Blackfriars Rd. | RS | 451072 | 205750 | $NO_2$ | YES | 0 | 3 | NO | 3 |
| DT63 | Thames St. / Trinity St. | RS | 450926 | 205797 | $NO_2$ | YES | 0 | 10 | NO | 3 |
| DT64 | Thames St. / Oxpens Rd. | RS | 450887 | 205825 | $NO_2$ | YES | 0 | 1 | NO | 3 |
| DT65 | Speedwell St. / Littlegate | RS | 451206 | 205780 | $NO_2$ | YES | 1 | 2 | NO | 3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DT66 | 36 Faulkner St. | UB | 451149 | 205859 | $NO_2$ | YES | 1 | 20 | NO | 3 |
| DT67 | Old Greyfriars St | RS | 451149 | 205947 | $NO_2$ | YES | 5 | 5 | NO | 3 |
| DT68 | Norfolk St. | RS | 451030 | 205962 | $NO_2$ | YES | 0 | 1.5 | NO | 3 |
| DT69 | Paradise Square | RS | 450982 | 205973 | $NO_2$ | YES | 0 | 1 | NO | 3 |
| DT70 | Castle St. | RS | 451062 | 206067 | $NO_2$ | YES | 0 | 1.5 | NO | 3 |
| DT71 | BP City Motors | RS | 449617 | 210216 | $NO_2$ | YES | 5 | 5 | NO | 3 |
| DT72 | Cowley Rd./ James Street | RS | 452761 | 205745 | $NO_2$ | YES | 1 | 1 | NO | 3 |
| DT73 | Walton Street LP18 | RS | 450960 | 206590 | $NO_2$ | YES | 1 | 1 | NO | 3 |
| DT76 | St Gilles | RS | 451226 | 206504 | $NO_2$ | YES | 0 | 2 | NO | 3 |
| DT77 | St Clements 2 | RS | 452451 | 205999 | $NO_2$ | YES | 0 | 1 | NO | 3 |
| DT78 | William Lucy Way | UB | 450378 | 207135 | $NO_2$ | YES | 3 | 20 | NO | 2 |
| DT79 | Old Abingdon Rd. | RS | 451908 | 203919 | $NO_2$ | YES | 5 | 1.5 | NO | 3 |
| DT80 | Hollow way Road | RS | 454651 | 204270 | $NO_2$ | YES | 4 | 1 | NO | 3 |
| DT81 | Cowley Rd/ Union Street | RS | 452805 | 205731 | $NO_2$ | YES | 0 | 2 | NO | 3 |
| DT82 | Summertown Parade | RS | 450806 | 208978 | $NO_2$ | YES | 2 | 1 | NO | 3 |
| DT83 | A44 Woodstock Rd. | RS | 449681 | 210263 | $NO_2$ | YES | 8 | 0.5 | NO | 2 |
| DT84 | 226 Botley Rd. | RS | 449273 | 206274 | $NO_2$ | YES | 10 | 1.5 | NO | 3 |
| DT85 | St Clements 3 | RS | 452625 | 206068 | $NO_2$ | YES | 2.5 | 1 | 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 2019

| Site ID | Site Name | Monitoring Type | Valid Data Capture for Monitoring Period (%) (1) | Valid Data Capture 2019 (%) (2) | $NO_2$ Annual Mean Concentration (µg/m$^3$) (3) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2015 | 2016 | 2017 | 2018 | 2019 |
| CM1 | Oxford Centre Roadside (AURN) | Automatic | 97.2 | 97.2 | **49** | **49** | 40 | 39 | **42** |
| CM2 | Oxford High Street | Automatic | 99.6 | 99.6 | **44** | **47** | 39 | 38 | 40 |
| CM3 | Oxford St Ebbes (AURN) | Automatic | 97.4 | 97.4 | 14 | 16 | 14 | 15 | 16 |
| DT1 | St Ebbes | Passive | 100 | 100 | 16 | 18 | 14 | 15 | 16 |
| DT2 | Weirs Lne./Abingdon Rd. LP1 | Passive | 100 | 100 | 39 | 34 | 28 | 27 | 29 |
| DT3 | LP 52 Abingdon Rd. | Passive | 100 | 100 | **42** | 38 | 31 | 29 | 34 |
| DT4 | Boundary Brook Rd/ Iffley Rd | Passive | 75 | 75 | NM | 34 | 28 | 27 | 28 |
| DT5 | Lenthall Rd Allotments | Passive | 100 | 100 | 15 | 14 | 10 | 14 | 14 |
| DT7 | Oxford Rd/ Between Towns Rd | Passive | 100 | 100 | NM | 36 | 31 | 28 | 32 |
| DT8 | Oxford Rd(Cowley) LP13 | Passive | 100 | 100 | NM | 34 | 29 | 27 | 31 |
| DT12 | Churchill Drive/Old Rd | Passive | 25 | 25 | NM | NM | 22 | 24 | 21 |
| DT14 | Windmill Rd. W | Passive | 100 | 100 | **44** | **43** | 33 | 32 | 35 |
| DT15 | London Rd./BHF | Passive | 92 | 92 | 34 | 34 | 26 | 25 | 27 |
| DT16 | Headley Way/London Rd. LP2 | Passive | 92 | 92 | NM | 35 | 27 | 25 | 27 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DT17 | 49 London Rd. /Latimer/Sandfield Rds | Passive | 100 | 100 | NM | 37 | 24 | 25 | 25 |
| DT18 | The Roundway | Passive | 100 | 100 | 32 | 33 | 23 | 26 | 28 |
| DT20 | Barton Lane LP2 | Passive | 100 | 100 | 31 | 29 | 25 | 27 | 28 |
| DT21 | North Way /Barton Village Rd LP20 | Passive | 100 | 100 | 30 | **30** | 26 | 24 | 27 |
| DT25 | Cuttleslowe Rbout 3 Elsfield Rd. | Passive | 100 | 100 | 40 | **48** | 35 | 35 | 35 |
| DT26 | Cuttleslowe Rbout 3 Summers Place | Passive | 100 | 100 | **42** | 40 | **41** | **41** | 40 |
| DT27 | Wolvercote Rbout 78 Sunderland Ave. | Passive | 92 | 92 | 39 | 34 | 29 | 29 | 29 |
| DT28 | Wolvercote Rbout 51 Sunderland Ave | Passive | 92 | 92 | 34 | 32 | 26 | 27 | 26 |
| DT29 | Pear Tree P&R N Gateway | Passive | 100 | 100 | 38 | 36 | 28 | 25 | 26 |
| DT30 | Osney Lne/Hollybush Row | Passive | 100 | 100 | 32 | 33 | 27 | 28 | 27 |
| DT31 | Beckett St. | Passive | 100 | 100 | 30 | 39 | 29 | 31 | 32 |
| DT32 | Royal Oxford Hotel | Passive | 92 | 92 | 40 | 38 | 32 | 31 | 32 |
| DT33 | Botley RD/ Mill St | Passive | 100 | 100 | 28 | 29 | 23 | 26 | 24 |
| DT35 | Botley Rd /Hillview Rd | Passive | 100 | 100 | 40 | 40 | 34 | 32 | 34 |
| DT36 | Botley Rd N (Prestwich Place) | Passive | 100 | 100 | 29 | 35 | 27 | 27 | 25 |
| DT39 | St Aldate's | Passive | 100 | 100 | **49** | **49** | 39 | 39 | **43** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DT40 | Queen St. | Passive | 100 | 100 | 38 | 36 | 28 | 26 | 28 |
| DT41 | Bonn Square | Passive | 92 | 92 | 39 | 37 | 25 | 23 | 26 |
| DT42 | New Rd. | Passive | 92 | 92 | **44** | 35 | 24 | 29 | 33 |
| DT43 | Park End St. | Passive | 100 | 100 | **48** | **45** | 34 | 32 | 35 |
| DT44 | Hythe Bridge St. | Passive | 100 | 100 | 36 | 38 | 29 | 29 | 30 |
| DT45 | Worcester St. | Passive | 92 | 92 | **50** | **51** | 38 | 37 | 40 |
| DT46 | Beaumont St. | Passive | 92 | 92 | **44** | **45** | 31 | 31 | 31 |
| DT47 | George St. / Magdalen St. | Passive | 92 | 92 | **52** | **49** | 37 | 37 | 40 |
| DT48 | George St. | Passive | 83 | 83 | **61** | **54** | 40 | **42** | **44** |
| DT49 | Cornmarket St. | Passive | 92 | 92 | 31 | 30 | 23 | 24 | 26 |
| DT50 | High St. / Turl St. | Passive | 100 | 100 | 35 | 36 | 27 | 28 | 32 |
| DT51 | 50 High St. | Passive | 100 | 100 | **45** | **43** | 34 | 33 | 37 |
| DT52 | Longwall St. | Passive | 100 | 100 | **50** | **49** | 38 | 38 | **41** |
| DT53 | Magdalen Bridge | Passive | 100 | 100 | 27 | 28 | 22 | 23 | 23 |
| DT54 | York Place | Passive | 100 | 100 | 30 | 28 | 23 | 23 | 26 |
| DT55 | St Clements | Passive | 100 | 100 | **67** | **61** | **47** | **46** | **53** |
| DT56 | High St. | Passive | 92 | 92 | **54** | **53** | **42** | **44** | **50** |
| DT57 | Speedwell St. / St. Aldate's | Passive | 100 | 100 | **51** | **52** | 38 | 35 | 39 |
| DT58 | Folly Bridge | Passive | 100 | 100 | 40 | **41** | 31 | 33 | 34 |
| DT59 | Thames St. | Passive | 100 | 100 | 30 | 32 | 25 | 27 | 26 |
| DT60 | New Butterwyke Place/ Thames St. | Passive | 100 | 100 | 38 | 39 | 29 | 30 | 33 |
| DT61 | Friars Wharf | Passive | 100 | 100 | 25 | 27 | 20 | 19 | 20 |
| DT62 | 1 Blackfriars Rd. | Passive | 100 | 100 | 26 | 27 | 20 | 20 | 20 |
| DT63 | Thames St. / Trinity St. | Passive | 100 | 100 | 20 | 23 | 16 | 20 | 19 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DT64 | Thames St. / Oxpens Rd. | Passive | 100 | 100 | 27 | 32 | 25 | 23 | 23 |
| DT65 | Speedwell St. / Littlegate | Passive | 100 | 100 | 40 | 39 | 32 | 30 | 31 |
| DT66 | 36 Faulkner St. | Passive | 100 | 100 | 30 | 31 | 22 | 23 | 25 |
| DT67 | Old Greyfriars St | Passive | 100 | 100 | 26 | 30 | 21 | 20 | 20 |
| DT68 | Norfolk St. | Passive | 100 | 100 | 30 | 35 | 23 | 24 | 27 |
| DT69 | Paradise Square | Passive | 100 | 100 | 24 | 27 | 26 | 24 | 26 |
| DT70 | Castle St. | Passive | 100 | 100 | **47** | **42** | 28 | 29 | 29 |
| DT71 | BP City Motors | Passive | 100 | 100 | **44** | NM | **41** | 38 | 40 |
| DT72 | Cowley Rd./ James Street | Passive | 100 | 100 | NM | NM | 29 | 29 | 31 |
| DT73 | Walton Street LP18 | Passive | 100 | 100 | NM | NM | 27 | 26 | 24 |
| DT76 | St Gilles | Passive | 100 | 100 | NM | NM | NM | 33 | 35 |
| DT77 | St Clements 2 | Passive | 100 | 100 | NM | NM | NM | 36 | **42** |
| DT78 | William Lucy Way | Passive | 100 | 100 | NM | NM | NM | 22 | 23 |
| DT79 | Old Abingdon Rd. | Passive | 100 | 100 | NM | NM | NM | NM | 24 |
| DT80 | Hollow way Road | Passive | 100 | 100 | NM | NM | NM | NM | 37 |
| DT81 | Cowley Rd/ Union Street | Passive | 100 | 100 | NM | NM | NM | NM | 22 |
| DT82 | Summertown Parade | Passive | 92 | 92 | NM | NM | NM | NM | 27 |
| DT83 | A44 Woodstock Rd. | Passive | 100 | 100 | NM | NM | NM | NM | 40 |
| DT84 | 226 Botley Rd. | Passive | 83 | 83 | NM | NM | NM | NM | 27 |
| DT85 | St Clements 3 | Passive | 92 | 92 | NM | NM | NM | NM | 36 |

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

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

**Notes:**

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

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

(1) 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 B for details.

## Table A 4 – $NO_2$ Monthly Diffusion Tube Results - 2019

| Site ID | $NO_2$ Mean Concentrations (µg/m$^3$) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual Mean | | |
| | | | | | | | | | | | | | Raw Data | Bias Adjusted (0.94) and Annualised (1) | Distance Corrected to Nearest Exposure (2) |
| DT1 | 22 | 21 | 15 | 15 | 11 | 9 | 9 | 10 | 15 | 15 | 23 | 15 | 15.0 | 16* | |
| DT2 | 33 | 44 | 26 | 31 | 26 | 24 | 28 | 24 | 33 | 32 | 37 | 30 | 30.7 | 29 | |
| DT3 | 45 | 49 | 32 | 29 | 35 | 27 | 30 | 31 | 37 | 42 | 38 | 38 | 36.1 | 34 | |
| DT4 | 41 | NR | NR | 17 | 27 | NR | 24 | 26 | 32 | 31 | 39 | 31 | 29.9 | 28 | |
| DT5 | 20 | 22 | 12 | 13 | 8 | 9 | 7 | 8 | 14 | 15 | 21 | 15 | 13.5 | 14* | |
| DT7 | 38 | 48 | 25 | 29 | 29 | 30 | 23 | 32 | 35 | 38 | 35 | 40 | 33.6 | 32 | |
| DT8 | 40 | 47 | 31 | 30 | 25 | 26 | 23 | 22 | 33 | 36 | 48 | 36 | 33.1 | 31 | |
| DT12 | 31 | NR | NR | NR | NR | NR | 21 | NR | NR | NR | 38 | NR | 30.2 | 21 | |
| DT14 | 46 | 48 | 40 | 28 | 36 | 25 | 33 | 34 | 36 | 38 | 44 | 44 | 37.7 | 35 | |
| DT15 | 37 | 40 | 28 | 32 | 27 | 26 | 22 | 21 | 27 | 30 | NR | 29 | 29.0 | 27 | |
| DT16 | 38 | 42 | 28 | 28 | 24 | 20 | NR | 18 | 25 | 30 | 36 | 26 | 28.7 | 27 | |
| DT17 | 40 | 34 | 31 | 31 | 25 | 22 | 17 | 16 | 25 | 27 | 35 | 21 | 27.1 | 25 | |
| DT18 | 39 | 37 | 29 | 31 | 28 | 25 | 22 | 24 | 31 | 29 | 38 | 29 | 30.2 | 28 | |
| DT20 | 37 | 35 | 30 | 33 | 28 | 25 | 22 | 18 | 29 | 30 | 40 | 26 | 29.4 | 28 | |
| DT21 | 39 | 43 | 31 | 25 | 19 | 19 | 19 | 20 | 27 | 30 | 37 | 31 | 28.5 | 27 | |
| DT25 | 47 | 53 | 38 | 33 | 31 | 29 | 31 | 31 | 36 | 36 | 42 | 40 | 37.3 | 35 | |
| DT26 | 48 | 45 | 42 | 55 | 39 | 44 | 37 | 31 | 45 | 43 | 47 | 39 | 43.0 | 40 | 37 |
| DT27 | 42 | 48 | 35 | NR | 23 | 24 | 25 | 16 | 29 | 30 | 38 | 33 | 31.2 | 29 | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DT28 | 38 | 35 | NR | 31 | 19 | 27 | 26 | 22 | 27 | 22 | 38 | 20 | 27.6 | 26 | |
| DT29 | 39 | 39 | 32 | 20 | 20 | 21 | 22 | 23 | 28 | 28 | 35 | 29 | 28.0 | 26 | |
| DT30 | 36 | 40 | 28 | 28 | 27 | 23 | 25 | 21 | 29 | 29 | 36 | 27 | 29.1 | 27 | |
| DT31 | 45 | 40 | 30 | 36 | 33 | 29 | 27 | 25 | 34 | 31 | 43 | 30 | 33.5 | 32 | |
| DT32 | 41 | 46 | 35 | 39 | 28 | 29 | 29 | 24 | 36 | 40 | NR | 32 | 34.5 | 32 | |
| DT33 | 33 | 31 | 24 | 35 | 22 | 23 | 19 | 11 | 25 | 28 | 39 | 23 | 26.0 | 24 | |
| DT35 | 45 | 46 | 40 | 38 | 29 | 30 | 27 | 32 | 31 | 38 | 45 | 34 | 36.3 | 34 | |
| DT36 | 35 | 36 | 27 | 26 | 20 | 19 | 19 | 19 | 26 | 28 | 33 | 27 | 26.2 | 25 | |
| DT39 | 46 | 64 | 43 | 54 | 42 | 41 | 36 | 32 | 44 | 50 | 52 | 39 | 45.3 | **43** | |
| DT40 | 39 | 34 | 31 | 36 | 27 | 27 | 22 | 21 | 30 | 31 | 39 | 27 | 30.3 | 28 | |
| DT41 | 37 | NR | 29 | 30 | 25 | 23 | 21 | 21 | 26 | 27 | 38 | 26 | 27.4 | 26 | |
| DT42 | 40 | 42 | NR | 43 | 31 | 30 | 27 | 25 | 37 | 34 | 47 | 33 | 35.3 | 33 | |
| DT43 | 44 | 40 | 40 | 39 | 35 | 31 | 33 | 34 | 38 | 33 | 41 | 34 | 36.8 | 35 | |
| DT44 | 42 | 38 | 37 | 30 | 29 | 30 | 30 | 28 | 29 | 30 | 34 | 28 | 32.0 | 30 | |
| DT45 | 48 | 48 | NR | 47 | 42 | 44 | 40 | 34 | 40 | 42 | 44 | 38 | 42.4 | 40 | 32 |
| DT46 | NR | 42 | 33 | 40 | 27 | 29 | 32 | 28 | 31 | 33 | 36 | 35 | 33.4 | 31 | |
| DT47 | 55 | 49 | 47 | 44 | NR | 33 | 31 | 35 | 39 | 47 | 51 | 37 | 42.5 | 40 | 37 |
| DT48 | 47 | 58 | 49 | 48 | 43 | 39 | NR | 40 | 46 | NR | 51 | 42 | 46.4 | **44** | **40** |
| DT49 | 35 | 38 | NR | 28 | 21 | 20 | 23 | 20 | 27 | 29 | 38 | 29 | 28.0 | 26 | |
| DT50 | 37 | 37 | 34 | 44 | 32 | 30 | 27 | 30 | 32 | 33 | 34 | 38 | 34.0 | 32 | |
| DT51 | 45 | 45 | 39 | 48 | 39 | 35 | 30 | 26 | 40 | 38 | 47 | 36 | 38.9 | 37 | |
| DT52 | 56 | 54 | 46 | 41 | 38 | 39 | 36 | 35 | 44 | 47 | 48 | 45 | 44.1 | **41** | |
| DT53 | 29 | 28 | 24 | 30 | 21 | 21 | 19 | 14 | 27 | 26 | 35 | 23 | 24.8 | 23 | |
| DT54 | 34 | 38 | 28 | 27 | 18 | 20 | 19 | 19 | 24 | 32 | 39 | 31 | 27.4 | 26 | |
| DT55 | 63 | 67 | 64 | 50 | 53 | 51 | 48 | 48 | 61 | 56 | 64 | 52 | 56.4 | **53** | **50** |
| DT56 | 58 | 63 | NR | 57 | 48 | 46 | 44 | 44 | 54 | 54 | 59 | 53 | 52.8 | **50** | **45** |
| DT57 | 49 | 43 | 43 | 43 | 39 | 37 | 39 | 34 | 42 | 41 | 44 | 38 | 41.0 | 39 | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DT58 | 44 | 44 | 34 | 38 | 31 | 30 | 32 | 28 | 37 | 39 | 45 | 32 | 36.3 | 34 | |
| DT59 | 35 | 32 | 28 | 33 | 27 | 22 | 22 | 16 | 25 | 28 | 38 | 24 | 27.6 | 26 | |
| DT60 | 45 | 37 | 35 | 40 | 32 | 33 | 30 | 24 | 34 | 32 | 42 | 31 | 34.6 | 33 | |
| DT61 | 26 | 25 | 21 | 26 | 17 | 17 | 15 | 12 | 20 | 22 | 34 | 18 | 21.1 | 20 | |
| DT62 | 33 | 27 | 22 | 25 | 16 | 14 | 14 | 11 | 18 | 21 | 32 | 20 | 21.2 | 20 | |
| DT63 | 31 | 25 | 20 | 25 | 17 | 16 | 14 | 10 | 19 | 20 | 30 | 18 | 20.6 | 19 | |
| DT64 | 29 | 26 | 27 | 31 | 22 | 21 | 19 | 14 | 23 | 24 | 33 | 19 | 24.0 | 23 | |
| DT65 | 47 | 45 | 34 | 34 | 26 | 25 | 22 | 24 | 31 | 33 | 41 | 32 | 32.8 | 31 | |
| DT66 | 34 | 30 | 25 | 22 | 16 | 17 | 17 | 17 | 22 | 25 | 33 | 25 | 23.6 | 25* | |
| DT67 | 33 | 28 | 23 | 22 | 15 | 14 | 12 | 13 | 19 | 23 | 30 | 22 | 21.3 | 20 | |
| DT68 | 34 | 36 | 33 | 32 | 24 | 22 | 20 | 22 | 27 | 29 | 35 | 27 | 28.6 | 27 | |
| DT69 | 35 | 39 | 27 | 28 | 20 | 21 | 19 | 19 | 27 | 29 | 41 | 26 | 27.5 | 26 | |
| DT70 | 38 | 39 | 33 | 35 | 24 | 25 | 22 | 21 | 30 | 32 | 44 | 27 | 30.7 | 29 | |
| DT71 | 49 | 60 | 40 | 44 | 37 | 36 | 40 | 34 | 42 | 43 | 51 | 36 | 42.7 | 40 | |
| DT72 | 42 | 41 | 34 | 35 | 30 | 27 | 22 | 22 | 31 | 33 | 44 | 31 | 32.5 | 31 | |
| DT73 | 34 | 35 | 21 | 29 | 20 | 25 | 21 | 17 | 22 | 26 | 32 | 23 | 25.5 | 24 | |
| DT76 | 44 | 56 | 42 | 28 | 32 | 25 | 34 | 38 | 36 | 36 | 41 | 36 | 37.3 | 35 | |
| DT77 | 54 | 62 | 47 | 41 | 38 | 42 | 40 | 41 | 40 | 46 | 48 | 42 | 45.1 | **42** | |
| DT78 | 27 | 30 | 20 | 16 | 17 | 16 | 18 | 21 | 19 | 23 | 28 | 26 | 21.7 | 23* | |
| DT79 | 37 | 39 | 24 | 25 | 17 | 18 | 18 | 20 | 27 | 28 | 31 | 27 | 26.0 | 24 | |
| DT80 | 46 | 49 | 42 | 33 | 37 | 34 | 33 | 38 | 41 | 39 | 44 | 36 | 39.3 | 37 | |
| DT81 | 35 | 34 | 21 | 22 | 20 | 19 | 17 | 13 | 23 | 25 | 34 | 19 | 23.4 | 22 | |
| DT82 | 39 | 41 | 31 | 26 | NR | 19 | 22 | 19 | 27 | 30 | 36 | 30 | 29.1 | 27 | |
| DT83 | 53 | 61 | 39 | 31 | 37 | 30 | 33 | 43 | 45 | 43 | 45 | 49 | 42.4 | 40 | |
| DT84 | 39 | 41 | 29 | 26 | 21 | NR | 21 | NR | 24 | 26 | 31 | 28 | 28.5 | 27 | |
| DT85 | 45 | 46 | 38 | 42 | 36 | 37 | 32 | 28 | 35 | 42 | 45 | NR | 38.8 | 36 | |

☒ **Local bias adjustment factor used**

☐ **National bias adjustment factor used**

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

☒ **Where applicable, 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) See Appendix B for details on bias adjustment and annualisation.

(2) Distance corrected to nearest relevant public exposure. 7 Monitoring sites were corrected for distance in 2019 upon specific advice taken from Bureau Veritas in 2018, acting on behalf of Defra. The Council decided not to correct for distance site DT52 as air quality exposure levels at nearest receptor are comparable to the ones obtained at the monitoring location and correcting for distance would underestimate true exposure levels.

* Tubes corrected using local bias adjustment obtained from urban background co-location study (details available in Appendix B)

## Table A 5 – 1 Hour Annual mean $NO_2$ monitoring results 2019

| Site ID | Site Type | Monitoring Type | Valid Data Capture for Monitoring Period (%) (1) | Valid Data Capture 2019 (%) (2) | $NO_2$ 1-Hour Means > 200µg/m$^3$ (3) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2015 | 2016 | 2017 | 2018 | 2019 |
| CM1 | Roadside | Automatic | 97.2 | 97.2 | 2 | 0 | 0 | 1 | 3 |
| CM2 | Roadside | Automatic | 99.6 | 99.6 | 0 | 0 | 0 | 0 (106) | 2 |
| CM3 | Urban Background | Automatic | 97.4 | 97.4 | 0 | 0 (76) | 0 | 0 | 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 99.8$^{th}$ percentile of 1-hour means is provided in brackets.

## Table A 6 - Annual mean $PM_{10}$ monitoring results 2019

| Site ID | Site Type | Valid Data Capture for Monitoring Period (%) (1) | Valid Data Capture 2019 (%) (2) | $PM_{10}$ Annual Mean Concentration ($\mu g/m^3$) (3) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2015 | 2016 | 2017 | 2018 | 2019 |
| CM2 | Roadside | 99.0 | 99.0 | 21 | 20 | 18 | 18 | 19 |
| CM3 | Urban Background | 97.5 | 97.5 | 13 | 15 | 13 | 12 | 14 |

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

**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 B for details.

## Table A 7 – 24 Hour mean $PM_{10}$ monitoring results 2019

| Site ID | Site Type | Valid Data Capture for Monitoring Period (%) (1) | Valid Data Capture 2019 (%) (2) | $PM_{10}$ 24-Hour Means > 50µg/m$^3$ (3) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2015 | 2016 | 2017 | 2018 | 2019 |
| CM2 | Roadside | 99.0 | 99.0 | 1 | 4 | 2 | 0 (30) | 7 |
| CM3 | Urban Background | 97.5 | 97.5 | 6 | 0 (24) | 2 | 1 | 5 |

**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 90.4$^{th}$ percentile of 24-hour means is provided in brackets.

## Table A 8 – $PM_{2.5}$ monitoring results 2019

| Site ID | Site Type | Valid Data Capture for Monitoring Period (%) [1] | Valid Data Capture 2019 (%) [2] | $PM_{2.5}$ Annual Mean Concentration ($\mu g/m^3$) [3] | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2015 | 2016 | 2017 | 2018 | 2019 |
| CM3 | Urban Background | 95.7 | 95.7 | 10 | 13 | 11 | 10 | 9 |

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

**Notes:**

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

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

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

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

**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[17].

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

**Data capture**

During the course of 2019, all Oxford City Council's automatic monitoring stations have registered data capture rates above 95% for all the monitored pollutants; therefore there was no need to follow LAQM TG 16 annualisation methodology for those sites.

**Replacement of $PM_{10}$ and $PM_{2.5}$ TEOM-FDMS Analysers by new FIDAS Unit and its effect on the annual mean of these pollutants in 2019**

The annual mean $PM_{2.5}$ obtained in 2019 (9 $\mu gm^{-3}$) have reduced by 1$\mu gm^{-3}$ when compared with the figure obtained in 2018 (10 $\mu gm^{-3}$). On the contrary, the annual mean $PM_{10}$ obtained in 2019 (14 $\mu gm^{-3}$) have increased by 2 $\mu gm^{-3}$ when compared with the figure obtained for this pollutant in 2018 (12 $\mu gm^{-3}$). This increase is also consistent with the 2 $\mu gm^{-3}$ increase that was generally observed for $NO_2$ throughout the city of Oxford in 2019 which is attributable to weather.

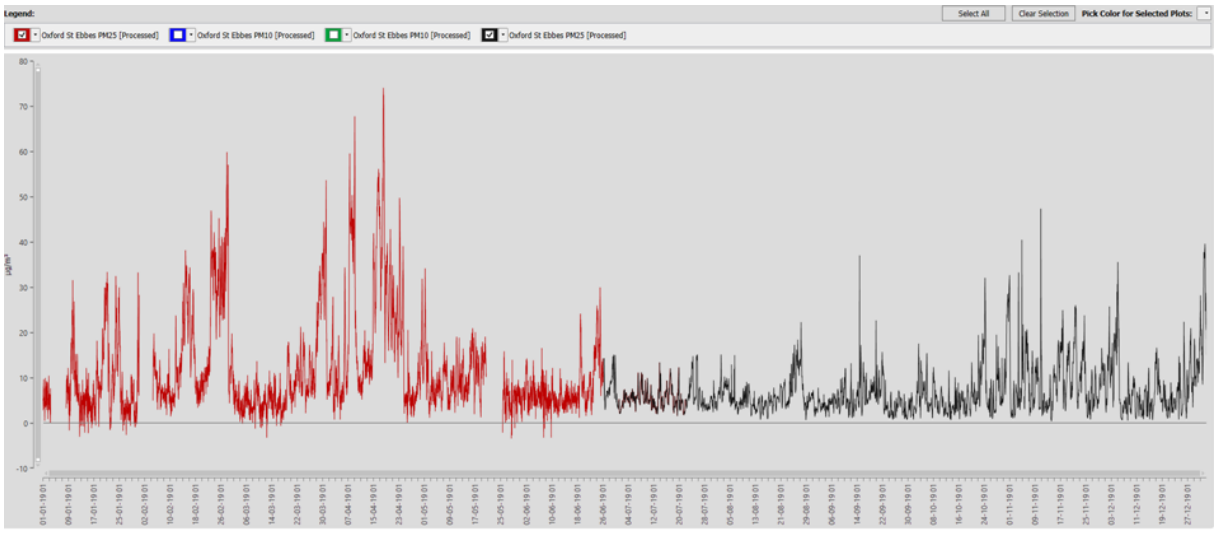
Why do we see a reduction in $PM_{2.5}$ that is not consistent with the increases observed on both $PM_{10}$ and $NO_2$ pollutants?

On the 26th June 2019 the old FDMS units that were used to measure $PM_{2.5}$ and $PM_{10}$ at the automatic monitoring site AURN St Ebbes were replaced by a brand new Palas FIDAS 200 instrument.

The FIDAS are part of the new generation of automatic monitors to measure PM. These instruments have been certified to the highest level by TUV, MCERTS and to DEFRA's UK PM Pollution Climate Standard, and approved for monitoring in accordance with EU and UK legislation. This new instruments are able to perform slightly better than the TEOM – FDMS, and allow simultaneous measurements of Total Suspended Particles (TSP), $PM_{10}$, $PM_4$, $PM_{2.5}$, and $PM_{1.}$

Figures B1 and B2 below, have been provided by Ricardo Energy & Environment's ratification team, and show the complete dataset of $PM_{2.5}$ and $PM_{10}$ data for the year 2019, by instrument type.

## Figure B 1 – $PM_{2.5}$ data comparison between FDMS (red) and FIDAS (black)




## Figure B 2 – $PM_{10}$ data comparison between FDMS (blue) and FIDAS (green)

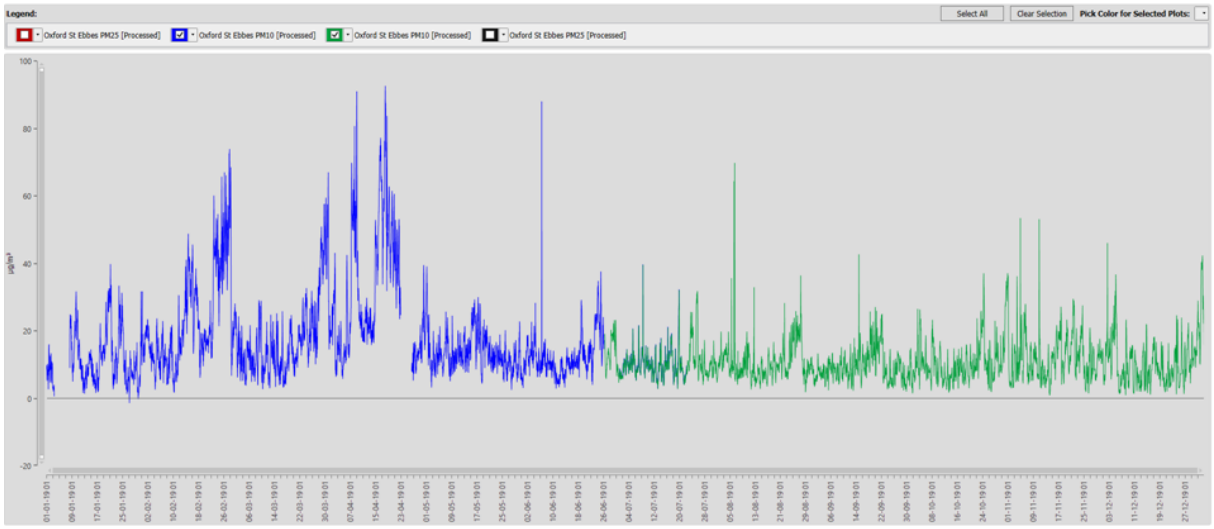



Figure B1 shows that the old $PM_{2.5}$ TEOM-FDMS was significantly noisier when compared with the new FIDAS. Discussions with Ricardo's Energy & Environment data ratification team revealed that the reduced level of noise from the new instrument have improved the way $PM_{2.5}$ baseline data is now being processed during QA/QC ratification procedures. This improved processing of $PM_{2.5}$ data ended up having the effect of bringing the annual mean of this pollutant slightly down.

Figure B2 shows that the old $PM_{10}$ FDMS was not as noisy as the $PM_{2.5}$ one. In this case, the replacement of this instrument by the new FIDAS has not caused any significant effect on the annual mean of this pollutant.

**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 its 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 two co-location studies annually, and has used the results of these studies to calculate two locally derived bias adjustment factors.

In 2019, the following bias correction factors were derived from the following Oxford's AURN sites:

AURN Oxford Centre (Roadside) - **0.94**

AURN Oxford St Ebbes (Urban Background) – **1.05**

In March 2010, Local Air Quality management Helpdesk have issued a briefing note[18] with regards to the influence of location on diffusion tube bias and whether roadside collocation studies should be used to adjust background diffusion tubes and vice versa.

The document concludes the below:

***"The value of a collocation study (and the subsequent bias adjustment) will be improved if the concentrations being measured are similar to those in the wider survey".***

***"Care should be taken to avoid applying a bias adjustment factor derived from a local collocation study carried out for concentrations that are very different to those being measured in the wider survey"***.

In other words, co-location results from a low concentration site (typically a background site) should not be used to derive a bias adjustment factor for survey results from high concentration sites (typically roadside sites) and vice versa.

In light of the above, Oxford City Centre decided to apply both bias adjustment factors that were obtained locally in 2019 to correct the diffusion tube data from its air quality network, following the following approach:

- The local bias of **0.94** obtained from local AURN roadside site was applied to adjust all monitoring roadside sites;
- The local bias of **1.05** obtained from local AURN urban background site was applied to adjust all monitoring urban background sites.

The average of the national bias correction factor for diffusion tubes that were tested using the same Acetone method (50% TEA) – considering the National Diffusion Tube Bias Adjustment Factor Spreadsheet version3/20[19] - was of **0.79** in 2019.

The two locally derived bias adjustment factors were used, instead of the national bias adjustment factor due to the following:

a) The bias adjustment factors of our local studies are slightly higher than the one that was obtained nationally. Using the calculated local bias to adjust Oxford's $NO_2$ diffusion tube results represents therefore a much more conservative approach;

b) For a question of methodology and consistency with previous AQ AS reports;

c) Due to the fact that our local co-location studies have both presented *"good"* precision for the diffusion tubes in 2019, together with high quality chemiluminescence results, and an extremely high data capture rate for $NO_x$ (>95%) obtained from our AURN monitoring sites of Oxford Centre roadside and Oxford St Ebbes.

**Annualisation**

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

In 2019, diffusion tube results were annualised at 1 location:

- DT12: Churchill Drive/Old Road

Details of the data and monitoring sites used for the calculation of the annualisation of NO2 annual mean at DT12 can be observed in Figure B1 below:

### Table B 1 - Data used in the calculation procedure of $NO_2$ annual mean of DT12 Churchill Drive/Old Road

| Urban Background site | Distance to DT12 | Annual Mean 2019 (Am) | Period Mean 2019 (Pm) | Data capture (Annual) | Ratio (Am/Pm) | Annualisation |
|---|---|---|---|---|---|---|
| Leamington Spa (AURN) | 39 miles | 17.7 | 22.4 | 96.4% | 0.79 | |
| Chilbolton Observatory (AURN) | 42 miles | 8.9 | 13.3 | 87.5% | 0.67 | |
| St Ebbes (AURN) | 05 miles | 15.9 | 18 | 97.4% | 0.88 | |
| Swindon Walcot (AURN) | 27 miles | 13.5 | 17.1 | 99.2% | 0.79 | |
| AVG | | | | | **0.78** | |
| | | | | | | |
| **DT12** | | | **28.37** | | | 22.2 |

# Appendix C: Calendar Plots of Oxford's automatic monitoring

## Figure C 1- Daily $NO_2$ averages at AURN automatic monitoring station of Oxford Centre roadside along calendar year 2019

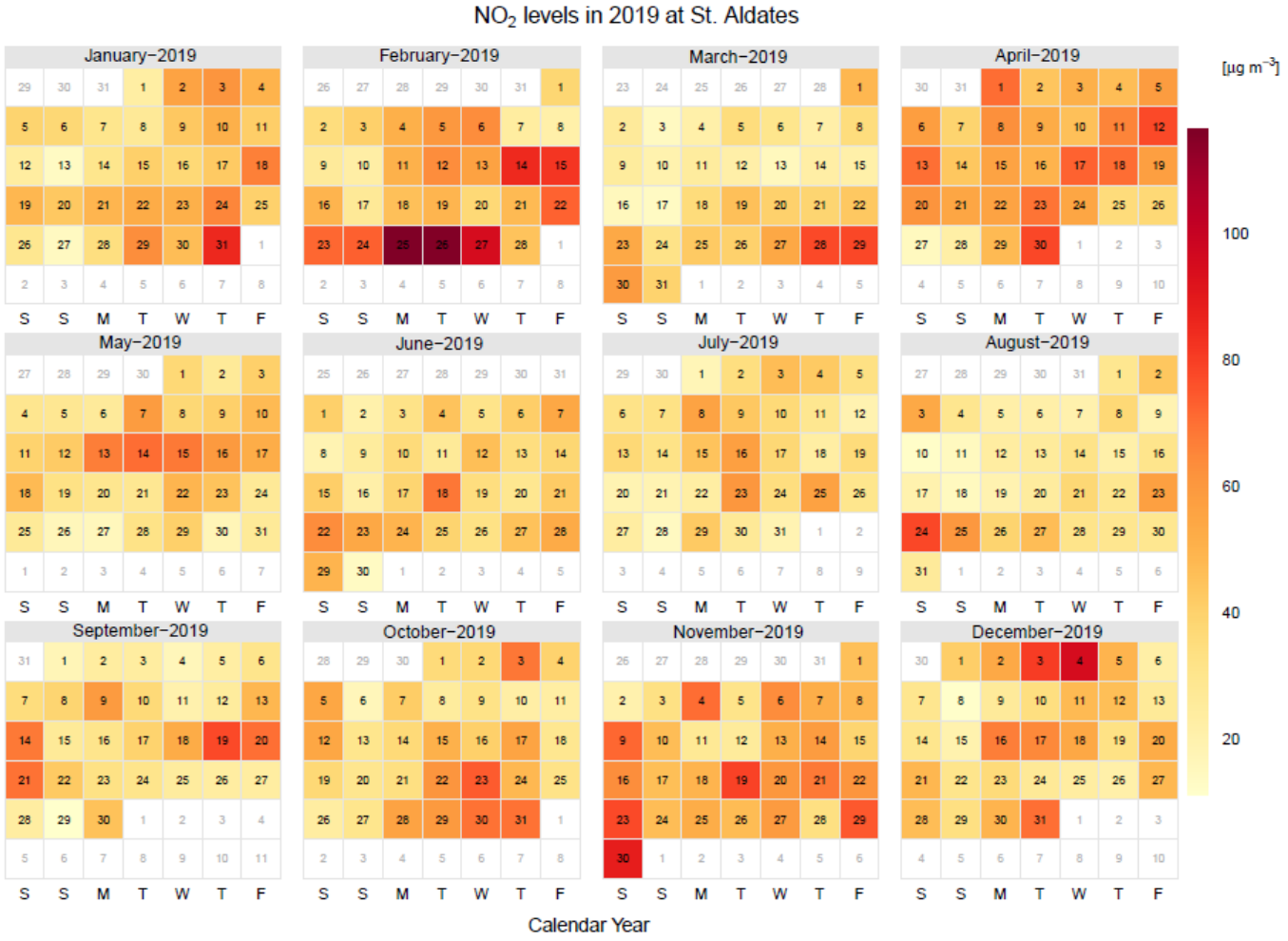
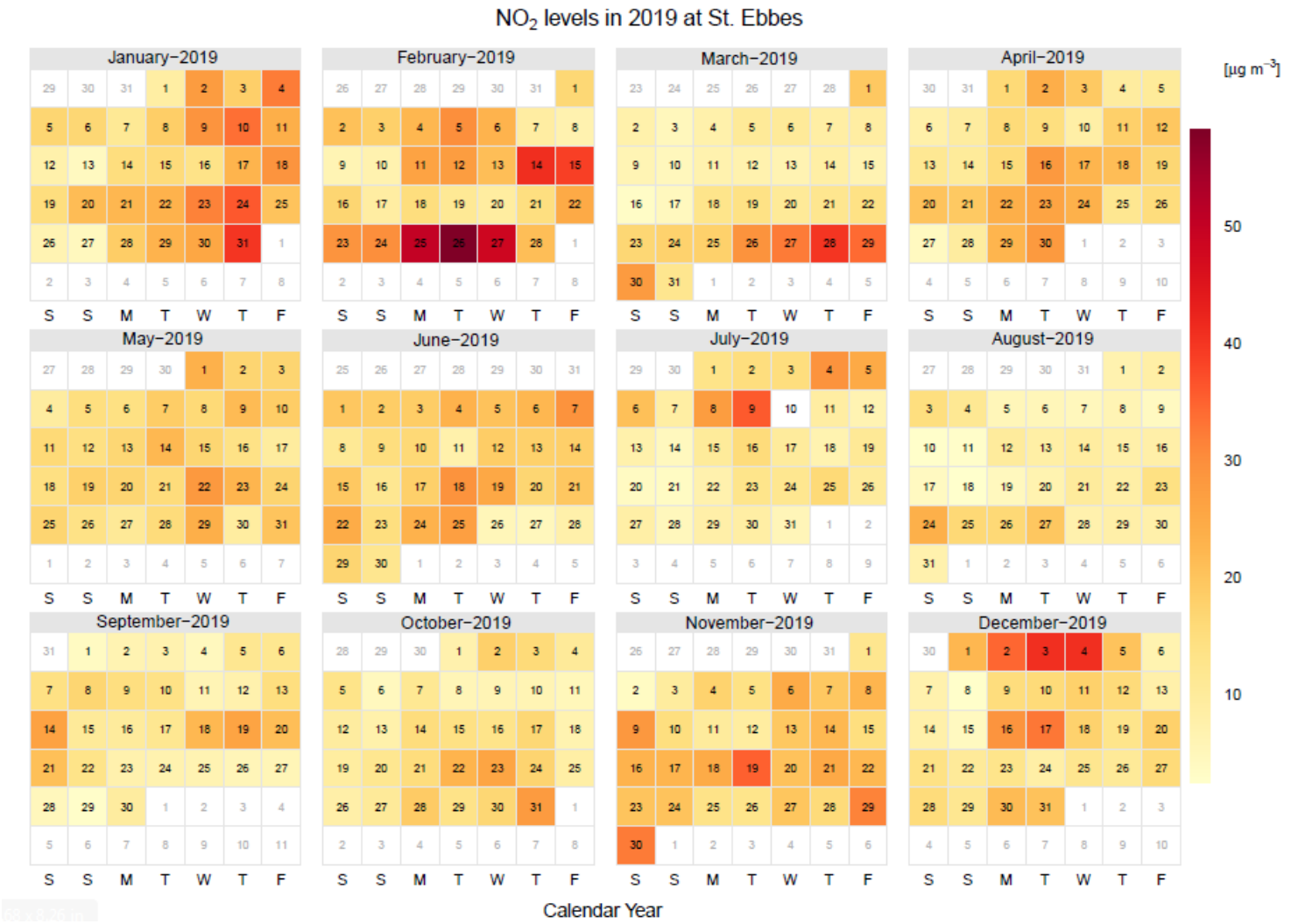


**Figure C 2- Daily $NO_2$ averages at AURN automatic monitoring station of Oxford St Ebbes along calendar year 2019**



## Figure C 3- Daily $NO_2$ averages at automatic monitoring station of Oxford High Street along calendar year 2019

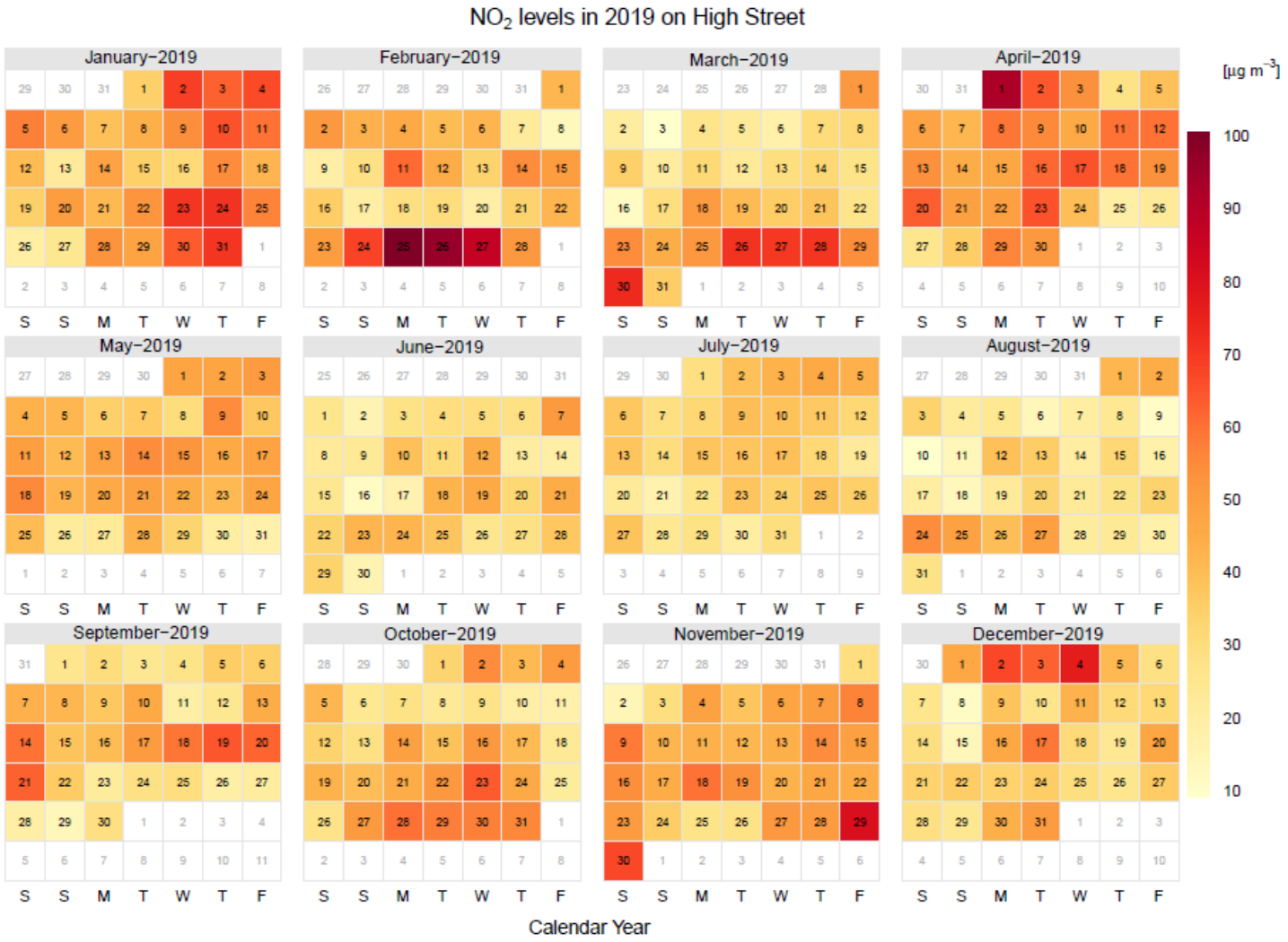
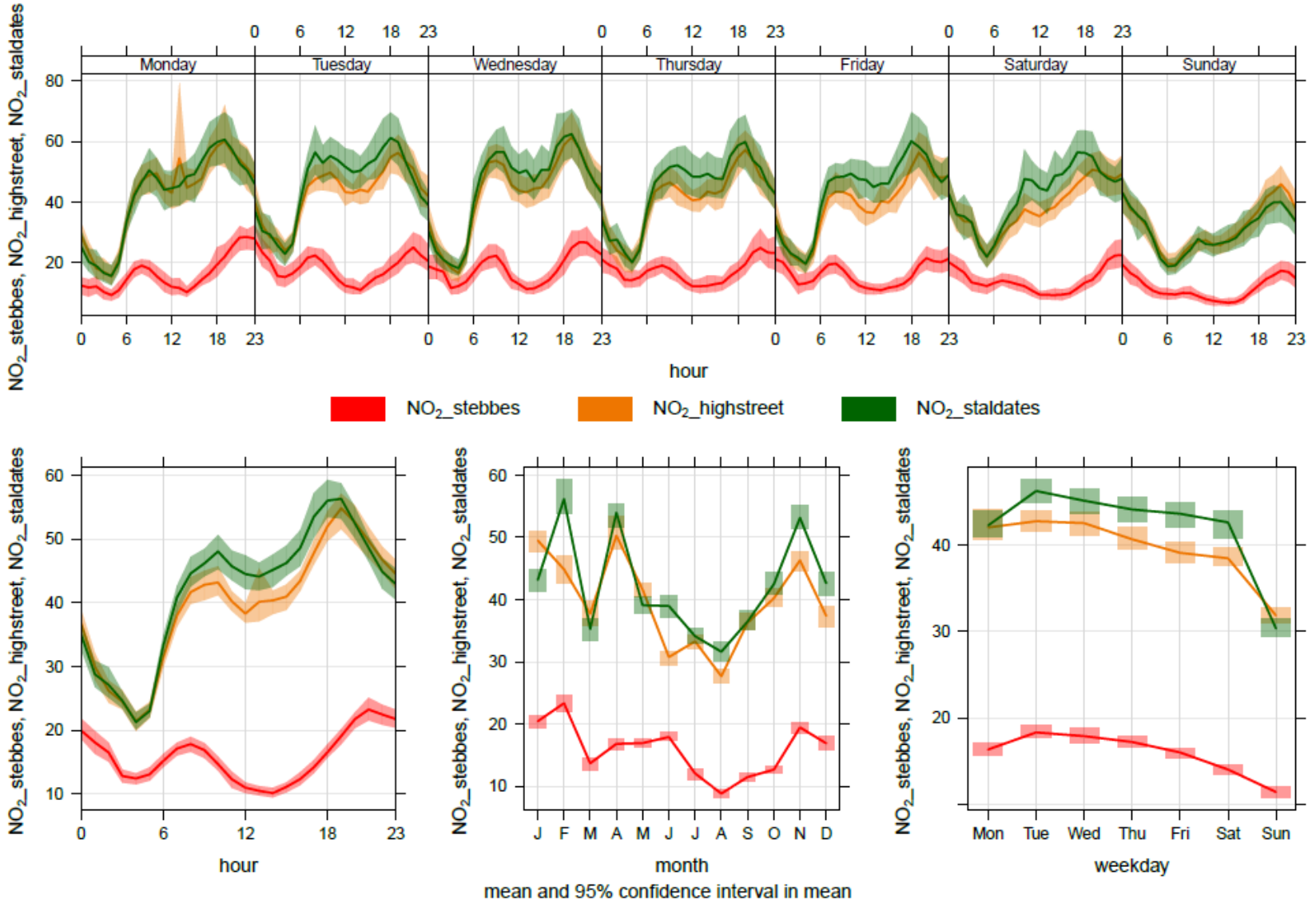
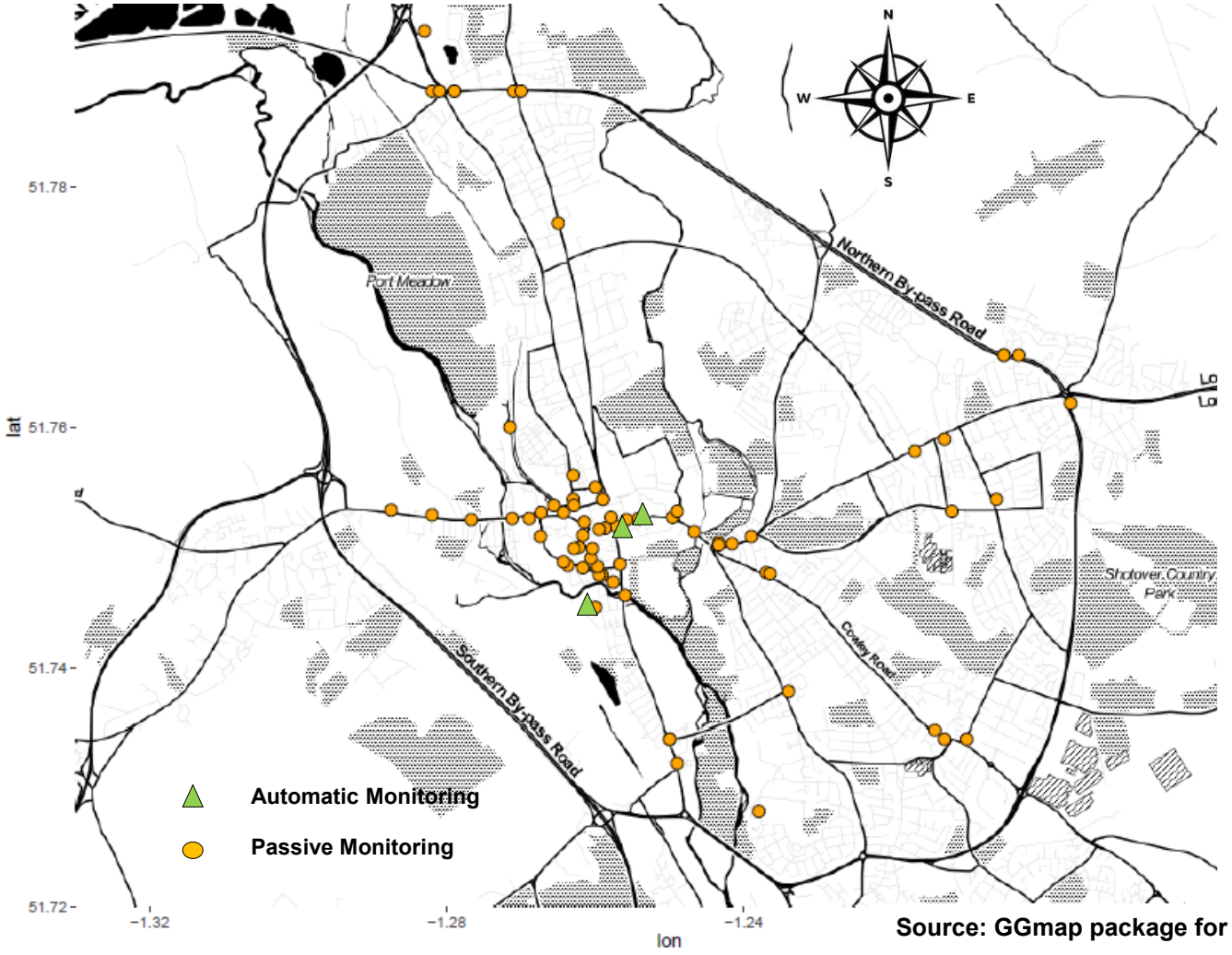


**Figure C 4- $NO_2$ time variations at Oxford's 3 automatic monitoring sites along calendar year 2019**



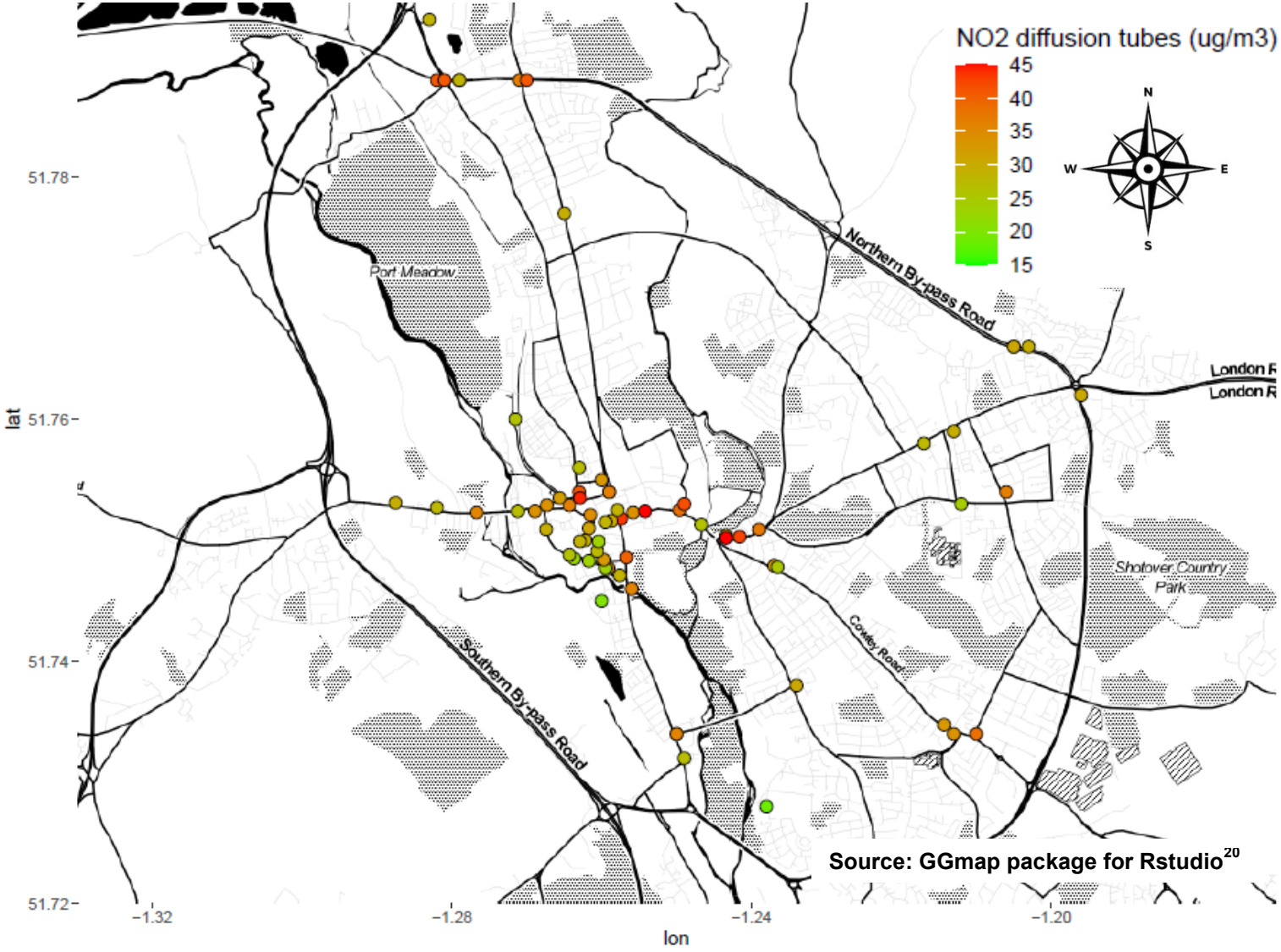
# Appendix D: Maps of Monitoring Locations and $NO_2$ Levels

## Figure D 1– Oxford's automatic and passive monitoring locations, 2019



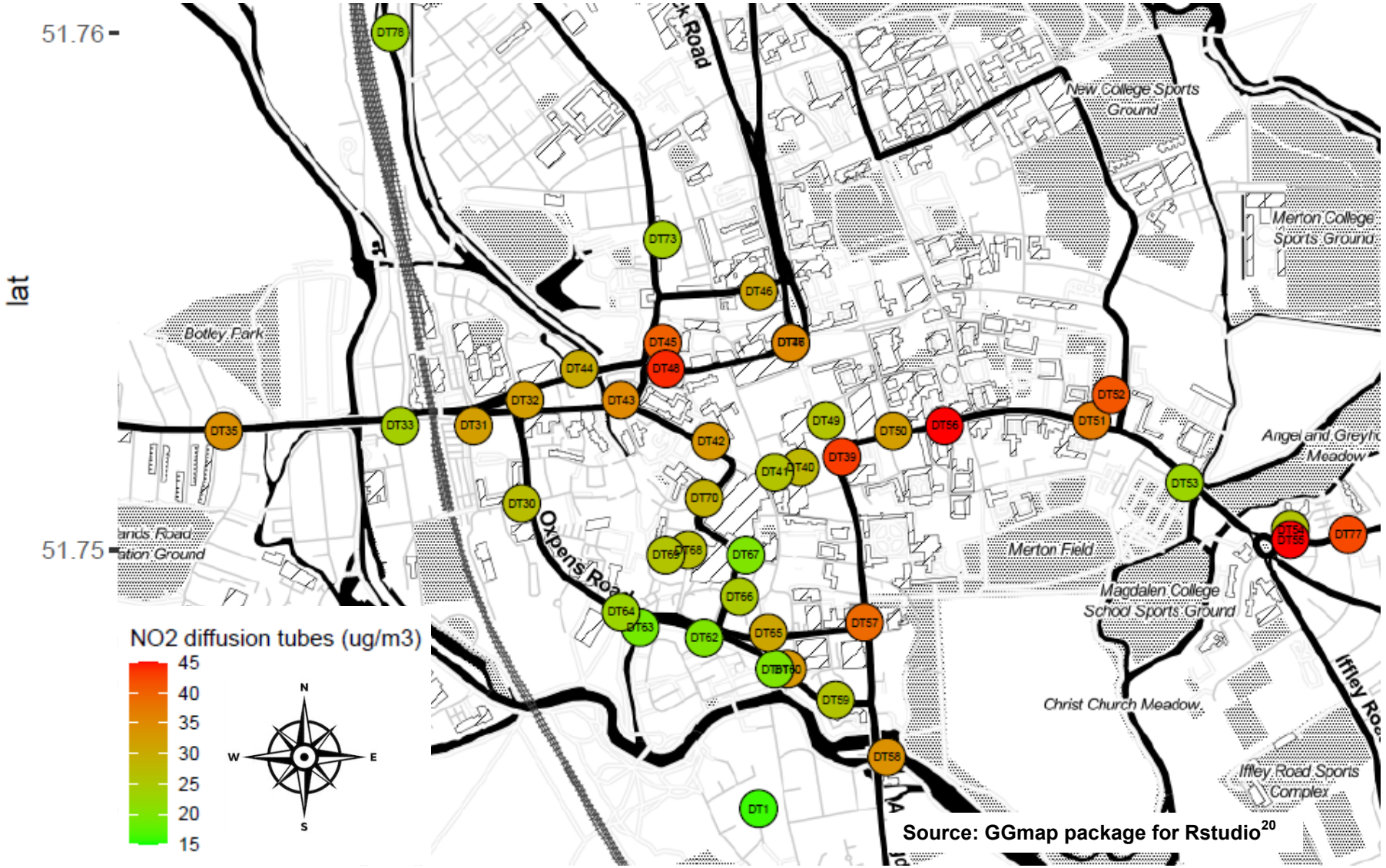

Source: GGmap package for Rstudio[20]

## Figure D 2– Oxford's diffusion tube locations by level of $NO_2$, 2019



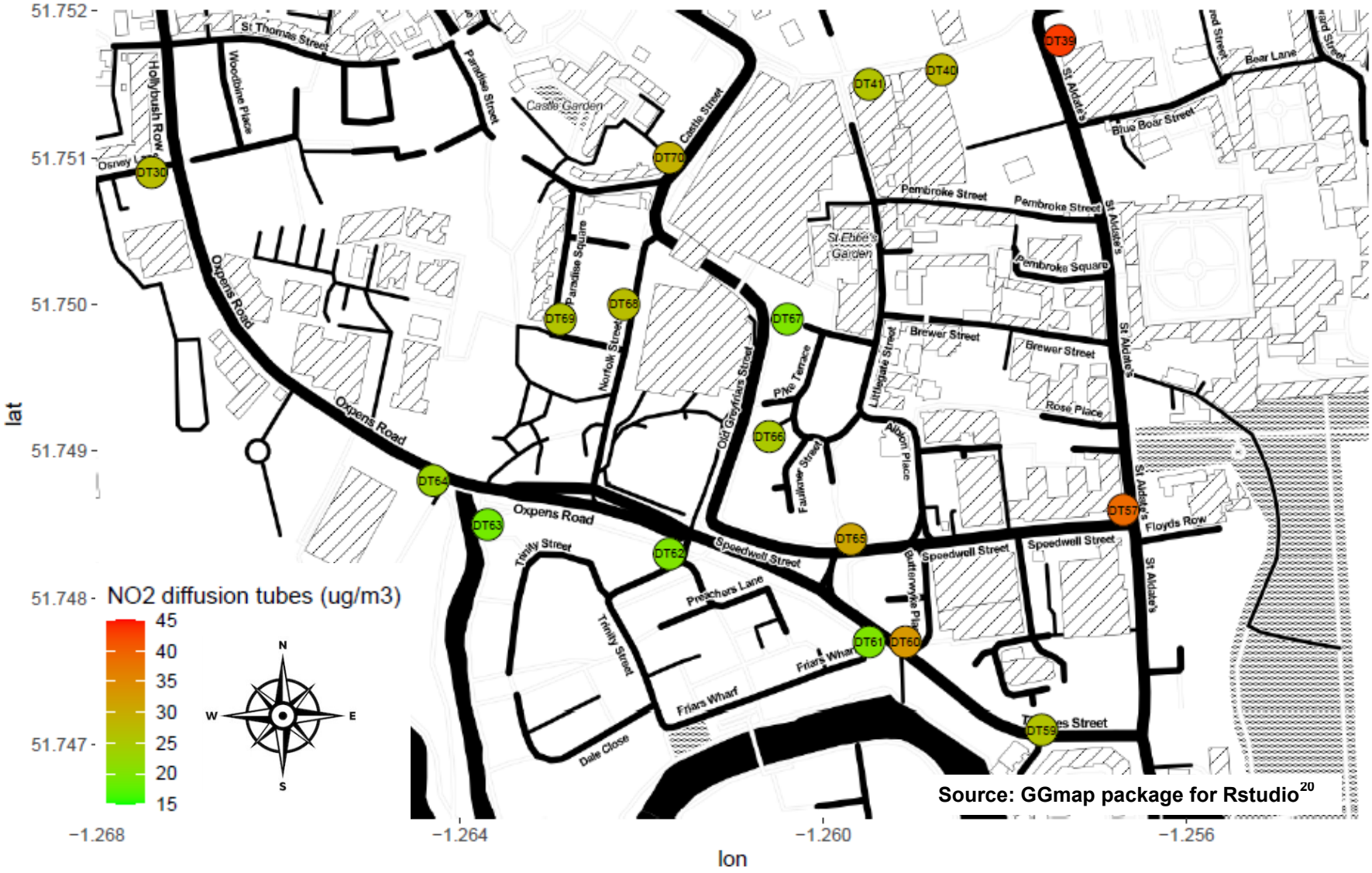

Source: GGmap package for Rstudio[20]

**Figure D 3– Oxford city centre area: diffusion tube locations by level of $NO_2$, 2019**




Source: GGmap package for Rstudio[20]

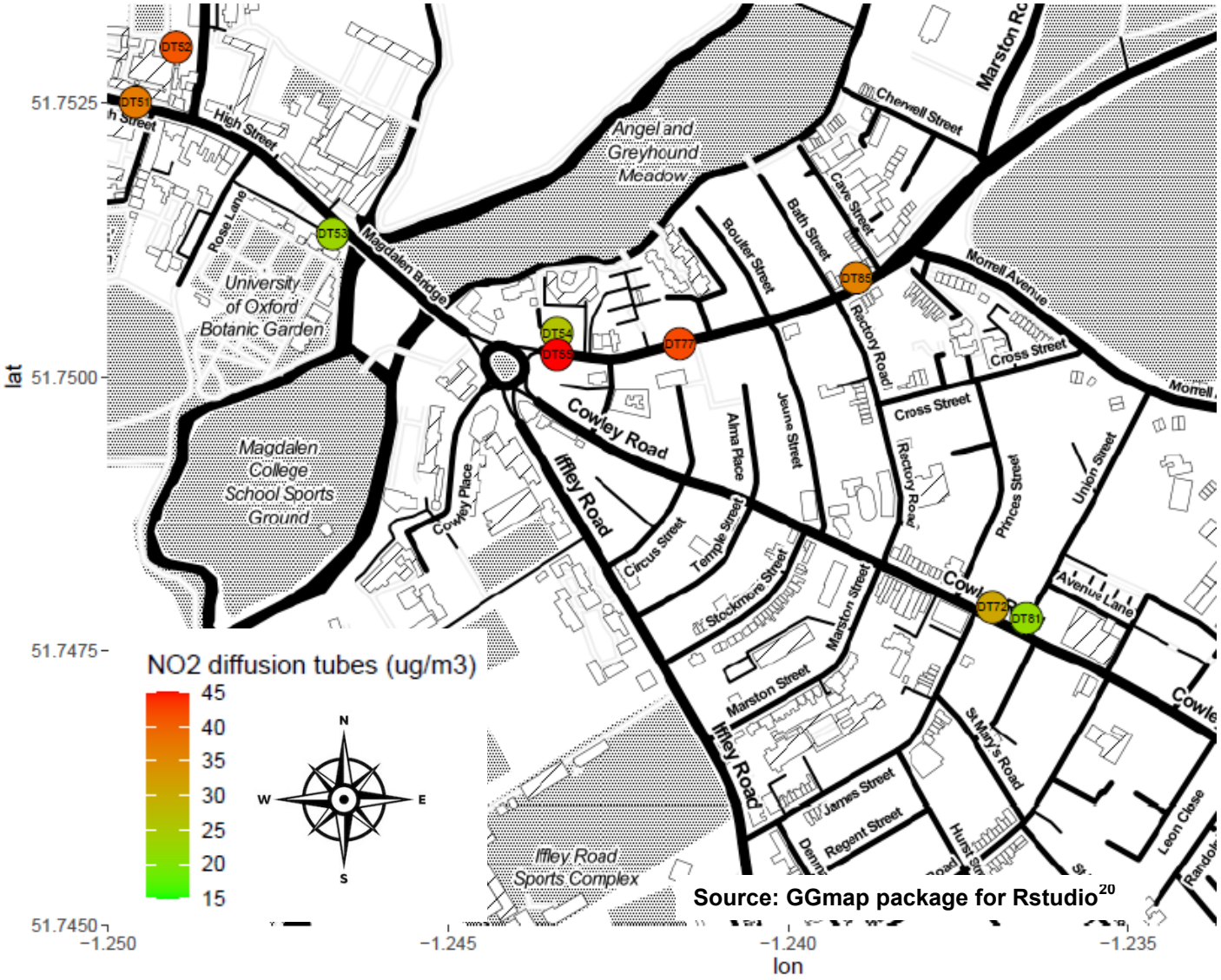
## Figure D 4– West Gate area: diffusion tube locations by level of $NO_2$, 2019



## Figure D 5– Botley area: diffusion tube locations by level of $NO_2$, 2019

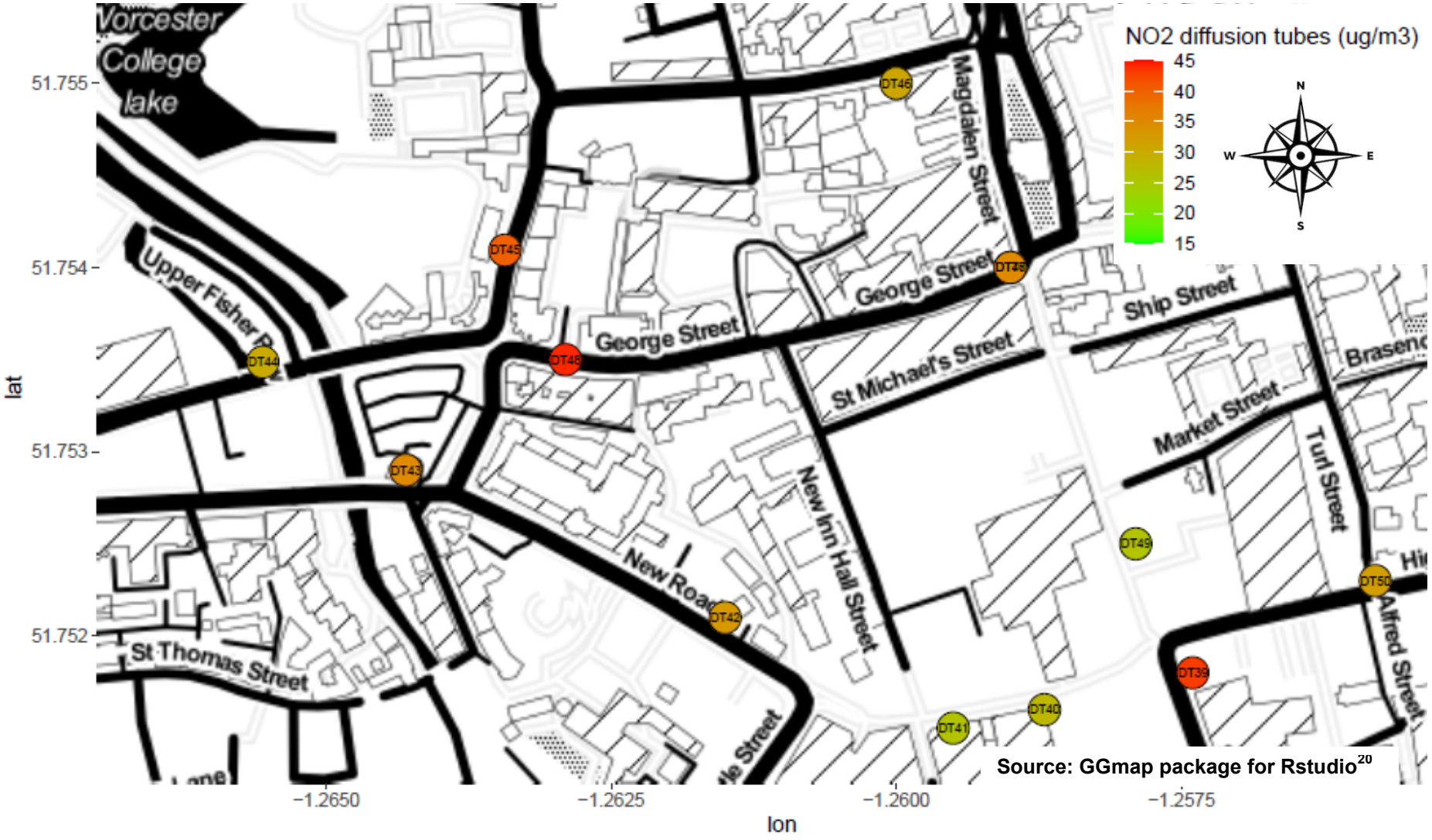

**Source: GGmap package for Rstudio[20]**

## Figure D 6– St Clements area: diffusion tube locations by level of $NO_2$, 2019

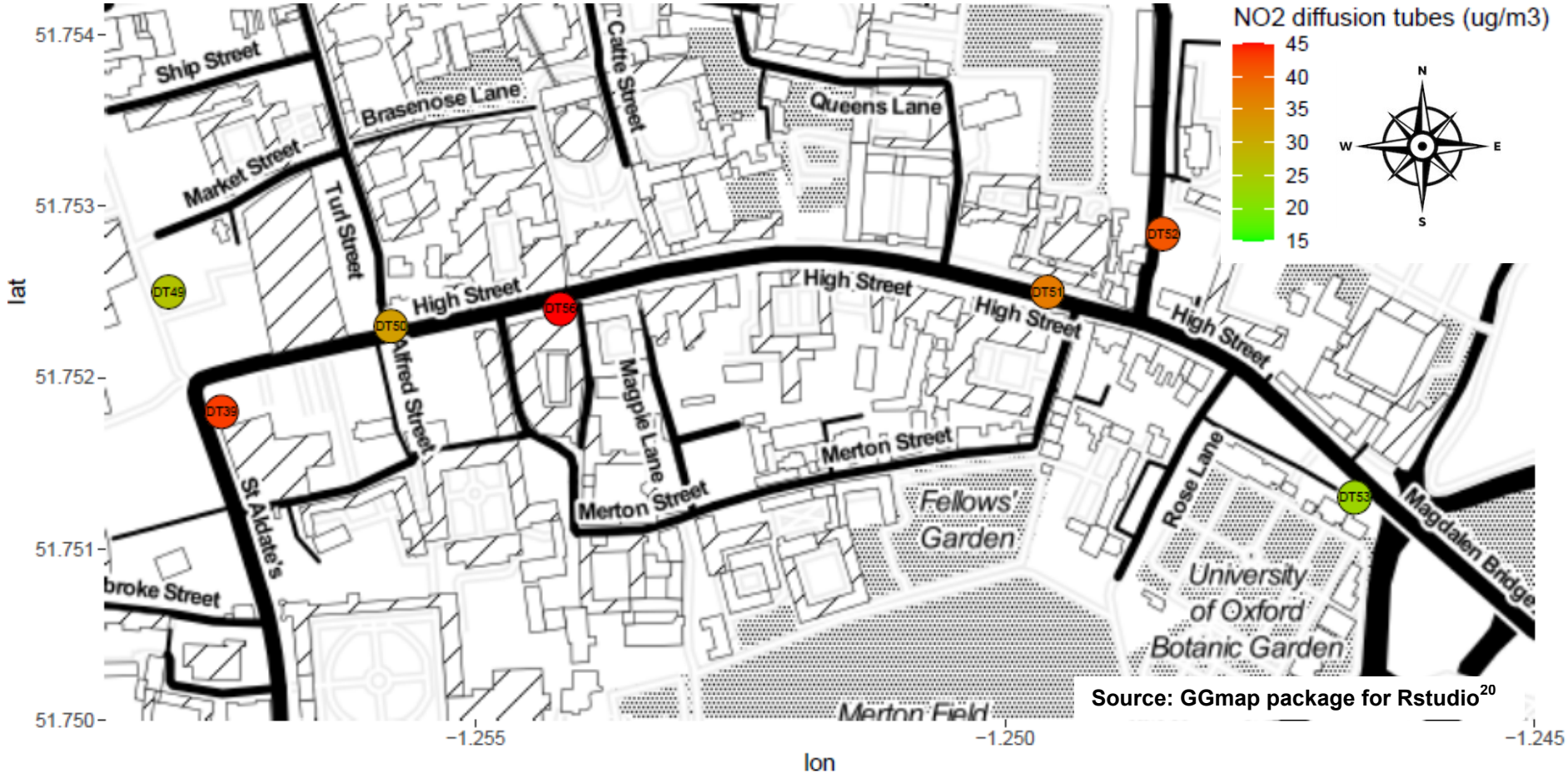



Source: GGmap package for Rstudio[20]

**Figure D 7– George Street area: diffusion tube locations by level of $NO_2$, 2019**

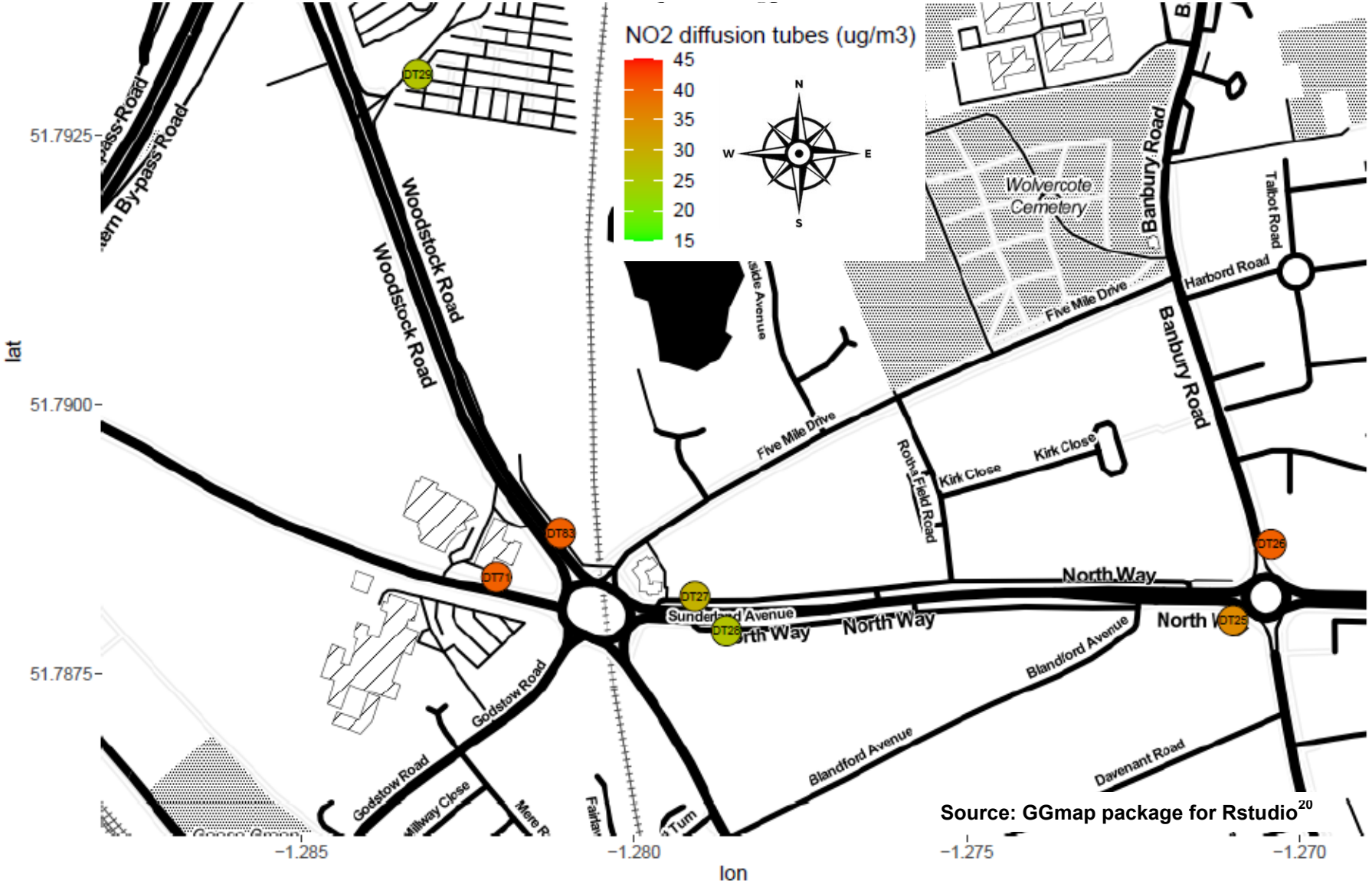


## Figure D 8– High Street area: diffusion tube locations by level of $NO_2$, 2019




**Source: GGmap package for Rstudio[20]**

**Figure D 9– Cutteslowe/Wolvercote area: diffusion tube locations by level of $NO_2$, 2019**




Source: GGmap package for Rstudio[20]

# Appendix E: Summary of Air Quality Objectives in England

## Table 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 ($PM_{2.5}$) [2] | 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 |

## Table E 2 – World Health Organisation recommended guidelines

| Pollutant | Guidelines for each pollutant | |
|---|---|---|
| | Concentration | Measured as |
| Nitrogen Dioxide ($NO_2$) | 200 µg/m$^3$ | 1-hour mean |
| | 40 µg/m$^3$ | Annual mean |
| Particulate Matter ($PM_{10}$) | 50 µg/m$^3$ | 24-hour mean |
| | 20 µg/m$^3$ | Annual mean |
| Particulate Matter ($PM_{2.5}$) | 25 µg/m$^3$ | 24-hour mean |
| | 10 µg/m$^3$ | Annual Mean |
| Ozone ($O_3$) | 100 µg/m$^3$ | 8-hour mean |

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

# Glossary of Terms

| Abbreviation | Description |
|---|---|
| ANPR | Automatic Number Plate Recognition System |
| AQ | Air Quality |
| 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' |
| AQI | Air Quality Index |
| 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 |
| AQS | Air Quality Strategy |
| ASR | Air quality Annual Status Report |
| AURN | Automatic Urban and Rural Network |
| CAZ | Clean Air Zone |
| CBTF | Clean Bus Technology Fund |
| COLTA | City of Oxford Licensed Taxicab Association |
| COPD | Chronic Obstructive Pulmonary Disease |
| COVID-19 | Corona Virus Disease 2019 |
| DAQI | Daily Air Quality Index |
| DEFRA | Department for Environment, Food and Rural Affairs |
| DPF | Diesel Particulate Filter |
| DSPs | Delivery & Service Plans |
| DT | Diffusion Tube |
| EC | European Commission |
| ESO | Energy Super Hub Oxford |

| | |
|---|---|
| ED | European Directive |
| EWNI | England, Wales and Northern Ireland |
| EU | European Union |
| EV | Electric Vehicle |
| FDMS | Filter Dynamics Measurement System |
| FIDAS | Fine Dust Analysis System |
| FoE | Friends of the Earth |
| GULO | Go Ultra Low Oxford |
| JCB | Joseph Cyril Bamford Excavator |
| JSNA | Joint Strategic Needs Assessment |
| LA | Local Authority |
| LAQM | Local Air Quality Management |
| LAQM PG16 | Local Air Quality Management Policy Guidance 16 |
| LAQM TG16 | Local Air Quality Management Technical Guidance 16 |
| LES | Low Emission Strategy |
| LEZ | Low Emission Zone |
| LTP | Local Transport Plan |
| NO | Nitric Oxide |
| $NO_2$ | Nitrogen Dioxide |
| $NO_x$ | Nitrogen Oxides |
| $O_3$ | Ozone |
| OAQG | Oxfordshire's Air Quality Group |
| OLEV | Office for Low Emission Vehicles |
| OxAir | Oxford's local group with the interest to measure air quality in Oxford from a human, spatial and temporal perspective |
| $PM_{10}$ | Airborne particulate matter with an aerodynamic diameter of 10µm (micrometres or microns) or less |

| | |
|---|---|
| $PM_{2.5}$ | Airborne particulate matter with an aerodynamic diameter of 2.5µm or less |
| QA/QC | Quality Assurance and Quality Control |
| SCR | Selective Catalytic Reduction |
| STOP | Schools Tackling Oxford's Air Pollution |
| TEA | Triethanolamine ($NO_2$ Absorbent) |
| UK | United Kingdom |
| WHO | World Health Organisation |
| WPL | Workplace Parking Levy |
| ZEZ | Zero Emission Zone |

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