Air Quality Monitoring at Westgate Development 2018/2019

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1. Introduction

This briefing note provides details of the AQ monitoring conducted using two AQ Mesh pods around the Westgate Centre, Oxford during 2018/2019. The acquisition of the pods was secured through a Section 106 agreement with the Westgate developer.

2. Objectives

The Air Quality monitoring work was conducted by Oxford City Council and is aimed at providing additional information on Nitrogen Dioxide (NO_2) levels around the Westgate. The monitoring results are intended to provide additional data on air quality in this location, in addition to the established air quality monitoring carried out by the City Council. This note also aims to assess compliance of the monitored levels with relevant air quality objectives for NO_2.

3. Monitoring Programme

AQ Mesh is an air quality monitor manufactured in the UK. The advantage of measuring NO_2 levels with the AQ Mesh technology is the fact that they deliver localised real-time readings, which allow an improved assessment of the air quality levels in the study area.

Despite their real time measurements, AQ Mesh technology is currently not approved by Defra for the monitoring of air quality in line with Local Air Quality Monitoring guidelines. This is because there is currently no evaluation process in place to determine low cost air quality sensor system suitability. At the moment, only diffusion tubes and large automatic monitoring stations are approved for this use.

The two AQ Mesh were installed in locations around the Westgate where it was predicted most likely to be impacted by the effects of traffic from the development, namely, Norfolk Street (Paradise Square) and Thames Street. This briefing note presents the analysis of results that were collected from the period from 18/10/2018 to 18/10/2019. The figure below shows the location of diffusion tube monitoring work around the Westgate to measure nitrogen dioxide levels (orange circles), and the locations where the 2 AQ Mesh are installed (red stars).

Figure 1 – Study Area and relevant AQ monitoring locations

4. Monitoring locations

Thames Street
In Thames Street the AQ Mesh is located on a lamp post along the pedestrian path that provides access to the residential properties facing Thames Street and immediately opposite the Westgate development (South entry).

The site is adjacent to urban residential houses with the Westgate 40m to the North of the monitoring location. This monitoring location was chosen as these residential properties represent the closest receptors impacted by Thames Street traffic emissions. The AQ mesh has been position in line with relevant technical monitoring guidance from Defra (LAQM TG 16).

Thames Street has no traffic restrictions and air quality is hence impacted by all vehicle types.

Paradise Square
In Norfolk Street the AQ Mesh is located at the façade of a residential property in the corner of Paradise Square with Norfolk Street. The site is located in an area with several urban residential houses to the North. The Westgate development lies just 20m to the South and 80m West of this location.

Norfolk Street is closed to general traffic. Only local buses, cycles and also taxis (from 7am to 7pm) are currently allowed to operate in the street.

5. Quality Assurance/Quality Control Procedures

NO_2 levels have been measured on Paradise Square and Thames Street for the period 18/10/2018 to 18/10/2019. For the purpose of this study, data has been removed from both AQ Mesh datasets each time that the measurements were not considered to be representative of air quality at those locations. The data gaps include days where the instruments were not performing adequately (i.e. instrument malfunctions, firmware upgrades, etc).

Assessing AQ Mesh Uncertainty

Alternative air pollution sensors are attracting more and more attention. They offer air pollution monitoring at a lower cost than conventional methods, in theory making air pollution monitoring possible in many more locations. However, measurements with alternative sensors are often of lower data quality than the results from official monitoring stations. This is why it is very important to be able to estimate for every monitoring study the margin of error (also known as uncertainty) of a sensors measurement. This will allow the determination of the range of values likely to represent the true measurements of air quality at any given location.

The margin of error of what is considered to be the current reference method (automatic monitors) for measuring NO_2 is quoted as ± 15%. Diffusion tubes, the other method approved by DEFRA to measure NO_2, has a margin of error quoted as ± 25%, which can eventually be minimised by applying a correction factor derived from the results of co-location studies with the reference method.

In the previous monitoring campaign (2017/2018), we undertook co-location studies using the two AQ Mesh monitors with automatic monitor at the DEFRA approved Oxford St Ebbes monitoring station. This allowed us to estimate the margin of error for these AQ Mesh to be around ± 25%.

6. Results & Discussion

The summary statistics for the period studied are presented with the calculated error margins associated with the AQ Mesh instruments (± 25%) and can be found in Table 01 below.

Table 01 – AQ Mesh NO_2 Monitoring Statistics and associated error margin

AQ Mesh	Maximum hourly mean (ugm^{-3})	Annual Average (ugm^{-3})	Data capture (%)
Legal Limit Value	200 *(may be exceeded up to 18 times per calendar year)*	40	
Paradise Square	107 ± 27	22 ± 6	91.1
Thames Street	103 ± 26	24 ± 6	99.9

6.1 NO_2 Hourly Mean Limit Value

The Air Quality Standard objective for hourly mean NO_2 concentration is 200 μgm^{-3}, and may be exceeded up to 18 times per calendar year. Table 1 shows that from 18/10/2018 to 18/10/2019 there were no recorded hourly mean NO_2 measurements exceeding 200 μgm^{-3}. The highest hourly mean NO_2 measured during this period was of 107.4 μgm^{-3} and was registered on the 24^{h} August 2019 at 22:00 on Paradise Square. This period coincides with the demolition of the Critchleys building. The construction works were located 40 meters from the monitoring site.

6.2 NO_2 Annual Mean Limit Value

The annual mean Air Quality Standard objective for NO_2 is 40 μgm^{-3}. Table 1 shows that the highest annual NO_2 for the period of this study was measured on Thames Street at 24 ugm^{-3}, which is 16 ugm^{-3} below the legal limit for this pollutant.

The results obtained show that during the monitored period, none of the current limit values for NO_2 were breached, not even when the margins of error (uncertainty levels) were applied.

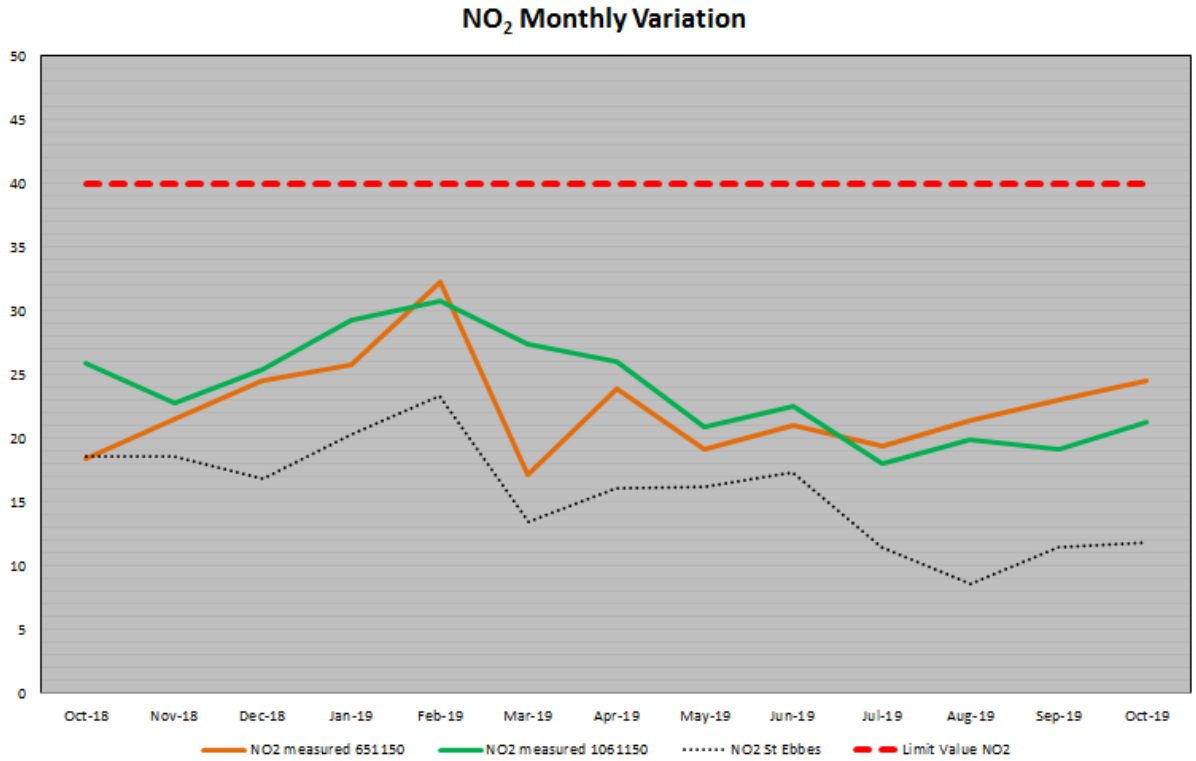

Figure 2 – NO_2 monthly variations

Figure 2 shows the NO_2 monthly averages measured by the 2 AQ Mesh and urban background automatic monitoring site located at St Ebbes Primary school during the monitoring campaign. The results show that the 2 sensors compare relatively well with each other, and that they also follow the NO_2 profile of our automatic monitor.

Air Quality sensor data from the AQ Mesh pod on Paradise Square covering the period from the 05th to the 22nd of February 2019, was considered invalid due to NO_2 sensor failure. The identified problem could not be solved on-site and the pod had to return to supplier and later to the manufacturer for repair. This period of data has therefore been removed from the original dataset.

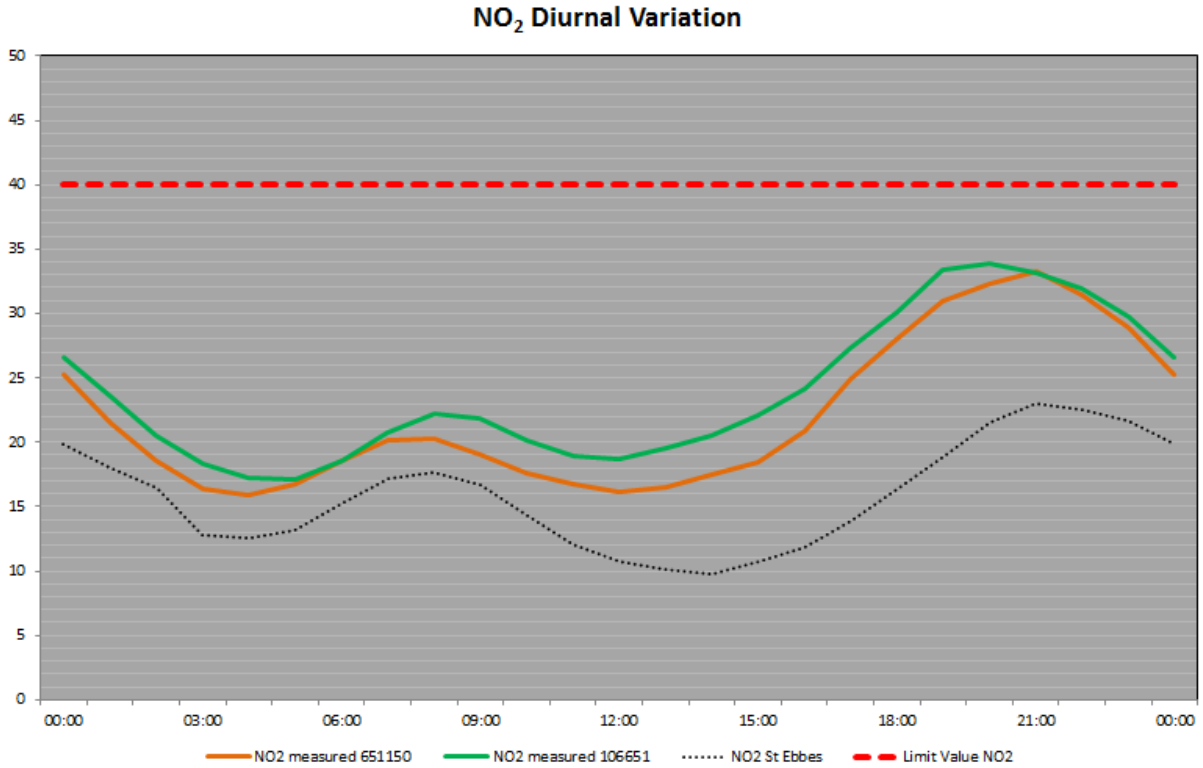

Figure 3 – NO_2 Daily variation

The diurnal variation analyses presented above for both sensors shows a typical urban area daily pattern for NO_2. Pronounced peaks can be seen for this pollutant during the mornings, corresponding to rush hour traffic at around 07:00/08:00. Concentrations tend to decrease during the middle of the day, with a much broader evening road traffic rush-hour peak in building up from early afternoon. Similar NO_2 pollution trend can also be observed at the Urban Background automatic monitoring site of St Ebbes.

7. Conclusions

The analysis of the AQ monitoring results after ratification shows that none of the current hourly and annual limit values for NO_2 were breached during the period of this study, not even when the margins of error (uncertainty) were applied.

The data from the two sensors seem to present a very clear and typical urban daily variation for this pollutant, with two pronounced peaks that match typical urban rush hour environments.

The monthly and daily air pollution profiles measured by both air quality sensors correlate well with each other and with the AURN air quality automatic Urban Background monitoring site of Oxford St Ebbes.