Science in the City

Monitoring Air Quality in the Barbican and Golden Lane Estates

mapping for change

CITY OF LONDON

"A revolution doesn't happen when a society adopts

new tools. It happens when society adopts

new behaviours and most of that change I think is still in the future."

Clay Shirky

Science in the City Project Report

This report has been produced by Mapping for Change with the support of the City of London Corporation. It has been developed as part of a one-year project led by Mapping for Change to engage local residents in the Barbican and Golden Lane Estate with the view to increase public understanding about air pollution, its causes and effects, and how concentrations vary both spatially and from day to day, and to demonstrate the effects of air quality improvement measures that have been implemented over recent years as a result of a previous citizen science project. It has been written by Hannah Stockwell and Louise Francis.

Acknowledgements

We would like to thank the residents of the Barbican and Golden Lane Estates who participated in this project for their commitment and time, and whose work is used as examples here to help others learn how they can use a citizen science approach to monitor and map local air quality in their own community. We would also like to thank Meg Lenehen for her contribution to the particulate monitoring and qualitative research undertaken as part of her MSc in Environmental Diagnosis and Management.

Content

Summary

Science in the City engaged forty-eight residents in a year-long citizen science project to monitor nitrogen dioxide with diffusion tubes and fine particulate matter using a personal exposure monitor around two large housing estates in central London. This being a repeat of a project carried out in 2013/14 allowed direct comparisons to be made with NO_2 levels at street level. The project had two main aims: to demonstrate the impact of the recent air quality improvement measures that were suggested by the residents in 2014, and to raise awareness of these measures and current local air quality among the residents.

The study found that NO_2 concentrations followed the usual seasonal variations for the northern hemisphere with the highest levels seen in winter. Overall, levels had fallen across the area and only one site had an annual mean which was still exceeding the UK legal limits of 40 $\mu g/m^3$. Whilst there is still work to be done to reach the revised World Health Organisation (WHO) recommended guidelines, this shows a vast improvement compared to the study in 2013/4 which found that 35 out of 65 sites exceeded the UK limit. The study saw little correlation between pollution levels and the height at which monitoring took place, between 1 and 112 meters above street level. Instead, the most influencing factor was the distance from the busier roads.

Residents showed a good level of understanding of air pollution at the start of the project and an awareness of the air quality improvement measures implemented by The City of London Corporation. Almost 90% of evaluation respondents reported increasing their knowledge of the air quality improvement measures as a result of the project. Ideas for improvement suggested by residents included stricter measures on restricting polluting vehicles and idling in the City, more green space and an inclusive and visible way of alerting residents to areas and times of high pollution.

Introduction

In 2014, a comprehensive one-year Air Quality Citizen Science monitoring project, commissioned by The City of London Corporation and led by Mapping for Change, was undertaken by residents of the Barbican Estate. 'Science in the City' aimed to increase understanding about air pollution amongst the residents and explore how concentrations of different pollutants varied with time and spatially across the Barbican Estate and surrounding area. At the time it was believed to be the largest, community based, citizen science air quality monitoring project to be carried out in the UK over the course of a year.

The project focused on monitoring two of the major ambient air pollutants, nitrogen dioxide (NO_2) and fine particulate matter (PM2.5), both of which are considered harmful to health. A recent study by the Environment Research Group (ERG) at Imperial College London estimated that in 2019 61,800 to 70,200 life years were lost in Greater London, due to human-made PM2.5 and NO_2 [1]. However, the same study also said that if the capital met the World Health Organisation (WHO) guideline for PM2.5 by 2030, Londoners would gain a twenty per cent increase in life years saved over the next twenty years. In light of the mounting evidence of how air pollution impacts human health, the WHO published new Air Quality Guidelines in September 2021, reducing the limits for six different pollutants. The new recommended guideline for PM2.5 levels is an annual mean of 5 $\mu g/m^3$ and NO_2 concentrations of 10 $\mu g/m^3$, with interim targets specified for each.

Both NO_2 (or NOx) and PM2.5 are created by the combustion of fossil fuels and brake or tyre wear. According to the Department for Environment, Food and Rural Affairs (Defra), in 2020, an estimated average of sixty-eight percent of roadside NOx were emitted by road transport[2]. The city-wide traffic is therefore the most important element to consider when tackling air pollution. This formed the focus for some of the residents' ideas to address the issue. At the end of the project, the 48 participants were consulted on any actions they would like to see taken by the City of London Corporation and the Barbican community over subsequent years to improve local air quality.

In response, the City of London Corporation implemented several of the initiatives put forward by the community and used the data to support the proposed improvement plans. These included a Low Emission Neighbourhood which encouraged greening up and improved the facilities for cycling and electric vehicles; Beech Street zero emission trial with

[1] http://www.erg.ic.ac.uk/research/home/resources/ERG_ImperialCollegeLondon_HIA_AQ_LDN_11012021.pdf

[2] https://www.gov.uk/government/statistics/emissions-of-air-pollutants/emissions-of-air-pollutants-in-the-uk-nitrogen-oxides-nox

a switch to electric buses on these routes; new LEZ standards for heavy vehicles across London; and the extension of the Mayor of London Ultra Low Emission Zone.

Six years later in 2021, the citizen science project was repeated and broadened to incorporate Golden Lane Estate to assess any change in air quality. The results will help to demonstrate the impact of the various measures and also highlight how citizen science and resident participation can support and influence change to tackle environmental issues.

Approach and Methodology

Residents of the Barbican and Golden Lane Estates were invited by The City of London Corporation to participate in the project through local media and outreach activities. Forty-eight residents across both the neighbouring estates volunteered to collect data over a twelve-month period on local NO_2 concentrations using diffusion tubes, mainly positioned outside their residence and a further thirteen tubes were situated in public places along the highwalks and at street level. Figure 0.1 shows the locations and heights where the diffusion tubes were positioned and appendix 1 describes the character of the locations.

Figure 0.1: Monitoring sites and their height from street level.

The diffusion tubes are made from clear plastic, with a rubber stopper at each end. They are designed for the passive monitoring of gaseous airborne NO_2. A steel mesh coated with a chemical called triethanolamine (TEA) is located at one end of the tube. This absorbs nitrogen from the air when the stopper at the other end of the tube is removed, allowing air in. Laboratory analysis provides the average concentration of the pollutant in the air over the period that the tube was exposed. Tubes were left in situ for approximately four weeks before being recapped, sent for analysis and replaced with a new tube. The equipment, methodology and changeover timetable was coordinated by Mapping for Change to follow the local authority (and Defra) protocol allowing the citizens' data and local authority data to be directly compared.

Two residents and an MSc student supplemented the NO_2 data with PM2.5 data. They monitored their personal exposure to fine particulate matter on specific routes at different times of day using a Sidepak personal aerosol monitor and a GPS tracking device over May, June and August 2021.

Mapping for Change held three resident meetings during the project. An initial online workshop covered the project aims; causes and problems of air pollution; air quality improvement measures taken by The City of London Corporation; and trained volunteer residents to monitor NO_2 using diffusion tubes. Potential pollution hotspots were identified and mapped on the Community Maps online interactive platform along with likely sources of local air pollution (figure 0.2).

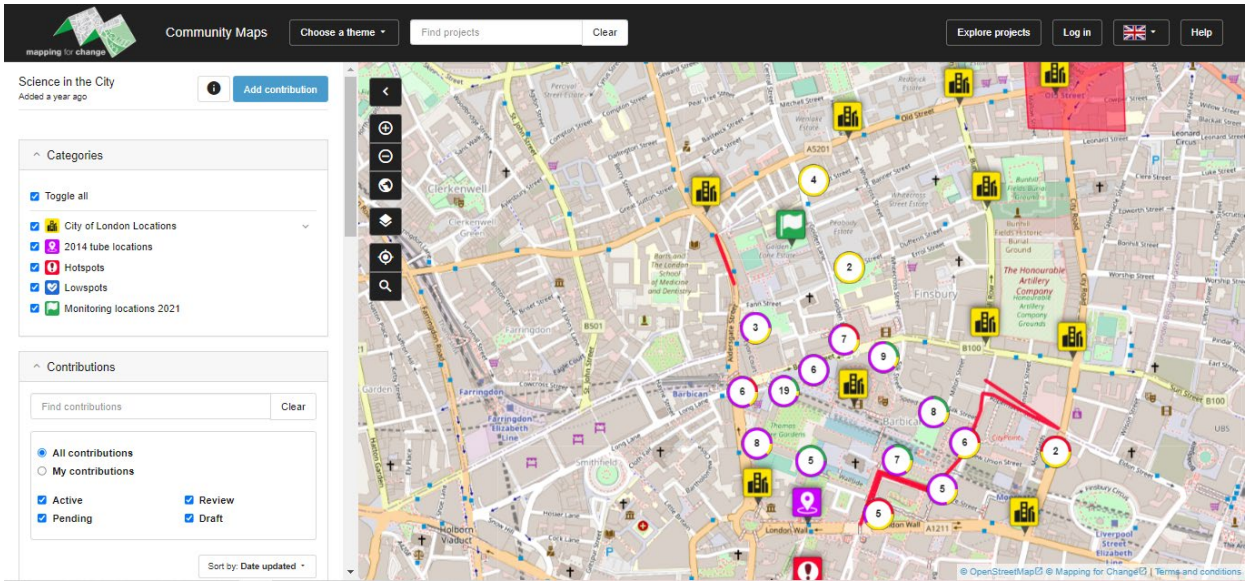

Figure 0.2: Screenshot of Community Map to collect and visualise pollution hotspots and monitoring locations

The monitoring results were shared regularly via email to maintain interest and an interim online workshop provided an opportunity for feedback and discussion of the results at the halfway point. All the participants and residents of the Barbican and Golden Lane Estates were invited to the final meeting held at the Guildhall in May 2022. Guests were reminded of the measures that the City of London Corporation had taken, and the final results were presented. A generous proportion of time was reserved for questions and discussion between the residents and The City of London Corporation.

To evaluate the impact of the project against its aim to raise awareness and encourage behaviour change, two surveys were developed. A baseline survey was distributed via email to all residents who expressed an interest in the project, prior to the first workshop. The second survey was distributed on paper at the final event and via email to all participants at the end of the project. Both surveys included questions that could be directly compared (in aggregate) to quantify any change.

Participant survey results

It is important to note that although the responses from both surveys will be directly compared, the responders are not necessarily the same individuals. The baseline survey may include responders who did not take part in any of the project beyond the first survey, whereas the second survey was only distributed to those who had participated in the monitoring and / or workshops. All responses were anonymous and analysed in aggregate. Furthermore, the participants of the project and the survey respondents were self-selecting, with a likely interest or concern around air pollution, and not necessarily a representative sample of the residents. That being said, local knowledge and lived experience is a vital building block to shape future plans and communications and so the responses still offer valuable insights.

The demographic make-up of the responders of each survey is as follows:

	Baseline		**Endpoint**	
Total	30		18	
Gender	Male - 9	Female - 21	Male - 7	Female - 11

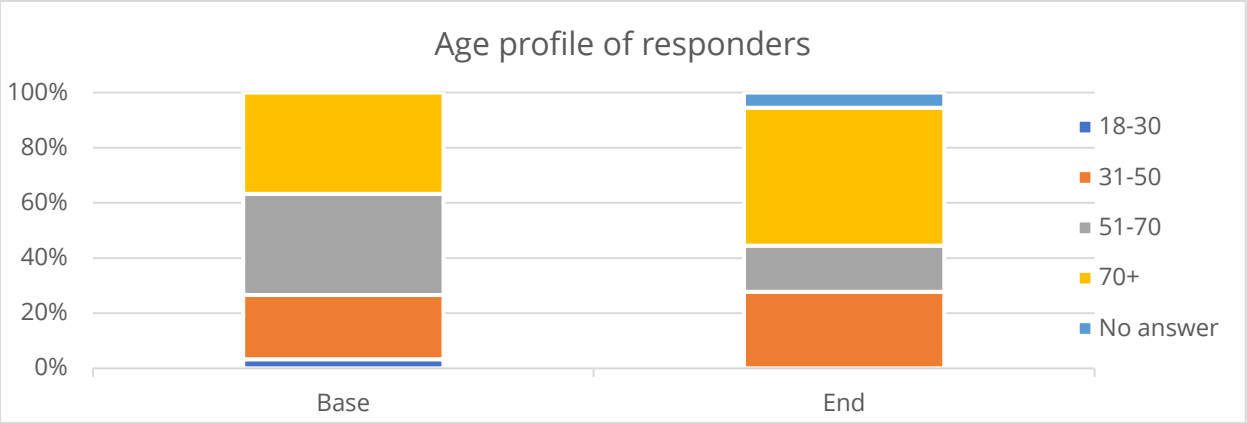

Figure 1.1: Age profile of survey responders

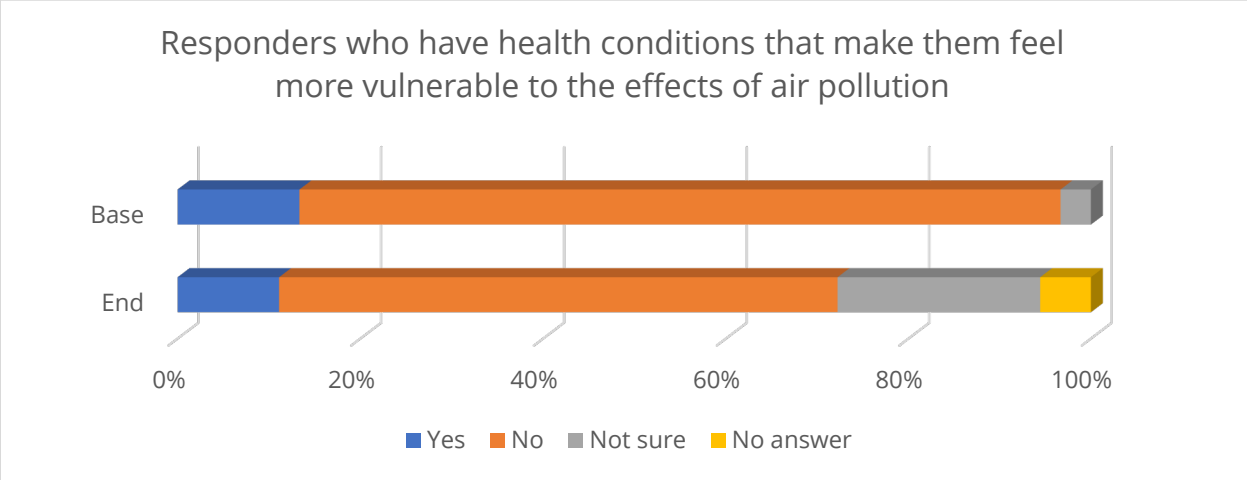

Figure 1.2: The health conditions of survey responders that could make them feel more vulnerable to air pollution

The specified health conditions listed by respondents were asthma, rhinitis and breathing problems.

To gauge the increase in awareness around air pollution and the measures taken to improve air quality, participants were asked a series of questions. Of the eighteen residents that responded to the endpoint survey, eight had never been involved in any air quality consultations and twelve hadn't taken part in any previous monitoring. Figure 1.3 below shows the respondents' perceptions of local air quality at the start and end of the project. A greater proportion felt that air quality was always poor by the endpoint survey, although the actual number in each case was 6. Nobody thought that the air quality was very poor by the endpoint compared to one respondent at the start.

When asked about the likely sources of local pollution, private vehicles, delivery vehicles and construction were the most selected options in both surveys. However, the large number selecting delivery vehicles and private vehicles at the baseline survey could be a legacy of Covid restrictions increasing home shopping and private transport. By the endpoint, construction was the most popular choice (Figure 1.4).

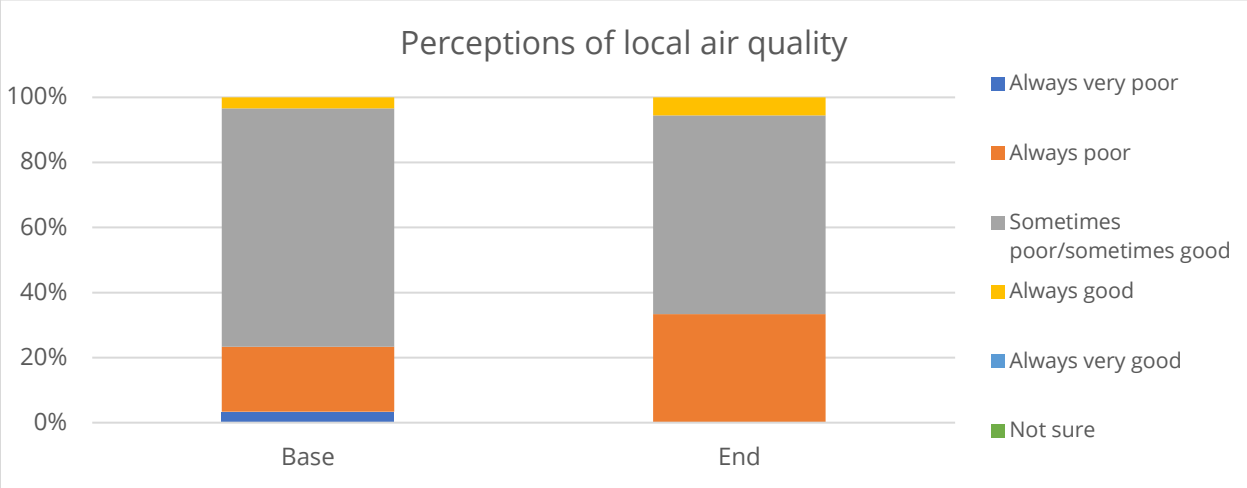

Figure 1.3: Respondents perceptions of the quality of local air

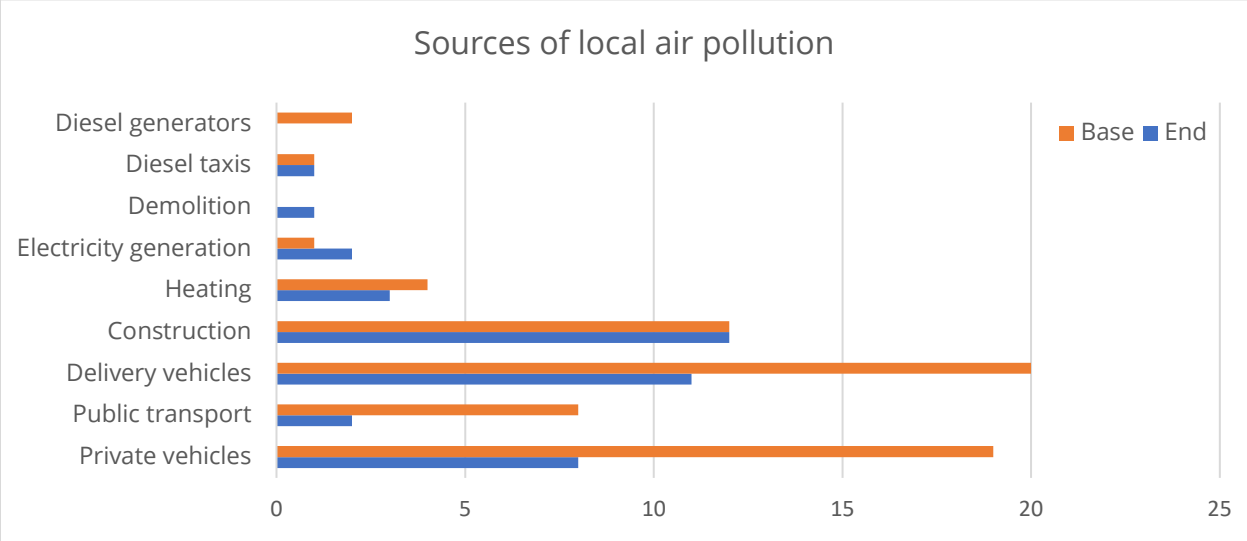

Figure 1.4: Respondents perceptions of the sources of local air pollution

At the start of the project more respondents felt that the air quality had improved in recent years, however seven of those twenty-three specified Covid lockdowns as the reason. A larger proportion of respondents felt the air quality hadn't changed in recent years by the end of the project (Figure 1.5).

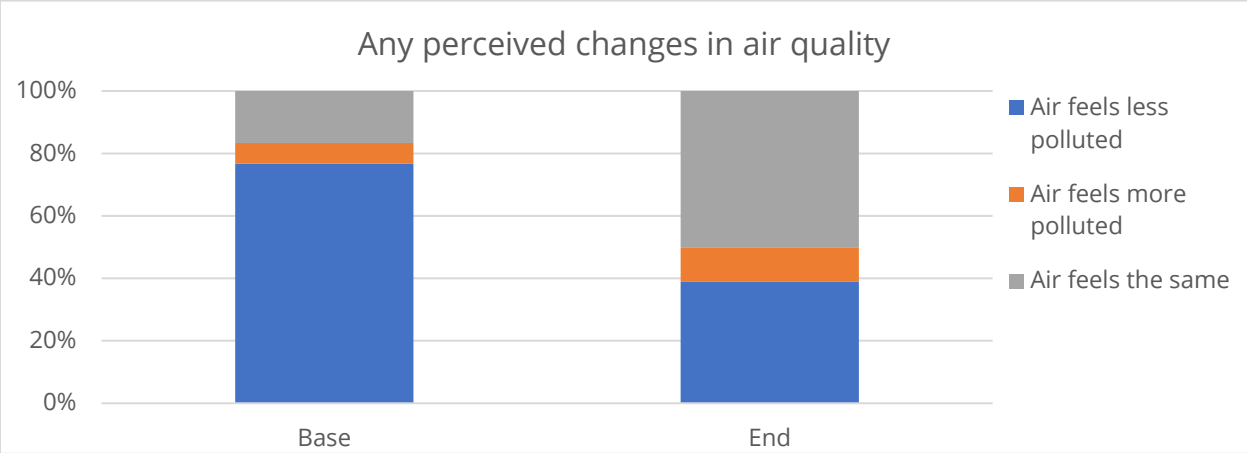

Figure 1.5: Respondents perceptions of how the local air quality has changed in recent years

Respondents were asked about their opinions on the measures that had been taken by the City of London Corporation to improve air quality and then to list all the measures they were aware of. At the start of the project, 90% of respondents said they were aware of some (83.3%) or all (6.7%) of the air quality improvement measures put in place around the Barbican and Golden Lane Estates. At the endpoint, 50% agreed that they had increased their awareness of this either a great deal or moderate amount and a further 39% chose 'a little'. Figure 1.6 groups and counts all the measures that were listed by the respondents. Most of the responses in both surveys mentioned the closure of Beech Street. More measures were listed in the baseline survey: 55 measures (1.83 average per respondent) compared with 26 (1.44 average per respondent) at the endpoint.

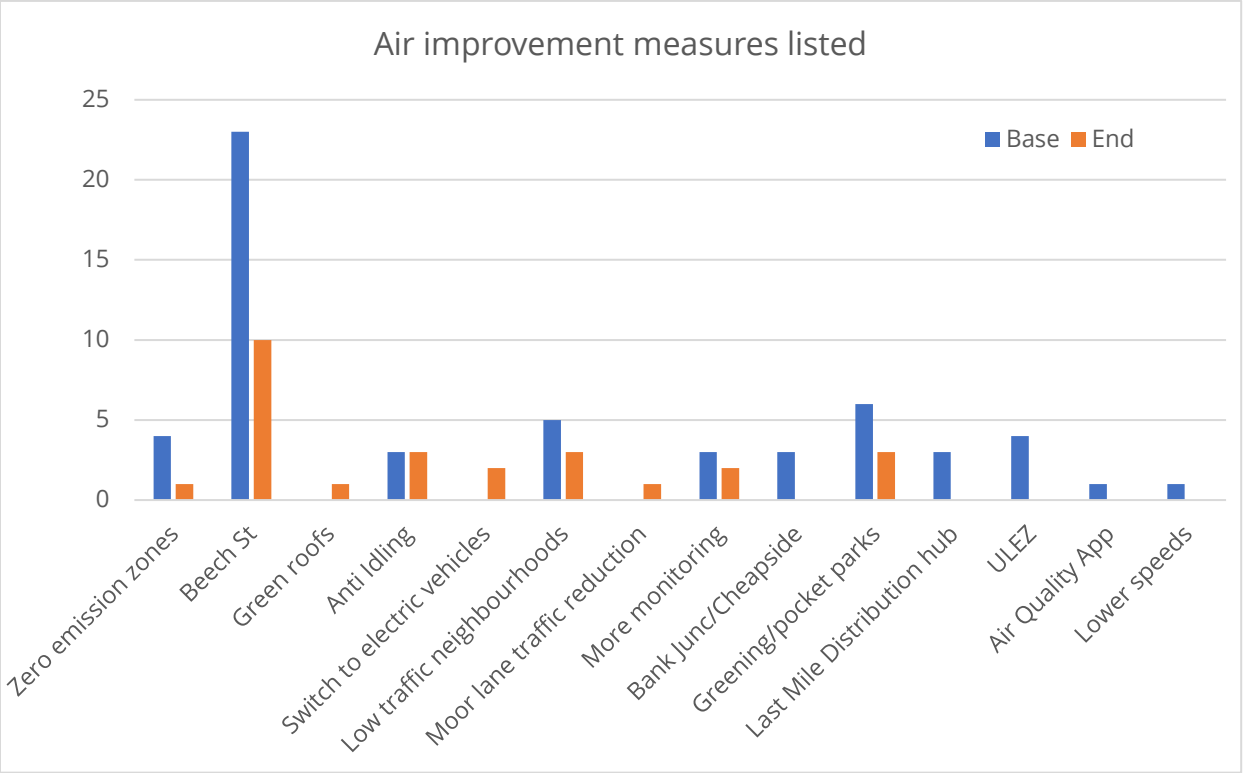

Figure 1.7: The counts of the local air quality improvement measures listed by respondents

The majority of respondents in both surveys selected that they were partly satisfied with the air quality improvement measures implemented by the City. The much larger proportion of this subgroup felt that more could be done, compared to two in each survey who thought that some measures were too inconvenient. There were more residents who were not at all satisfied by the endpoint (figure 1.8).

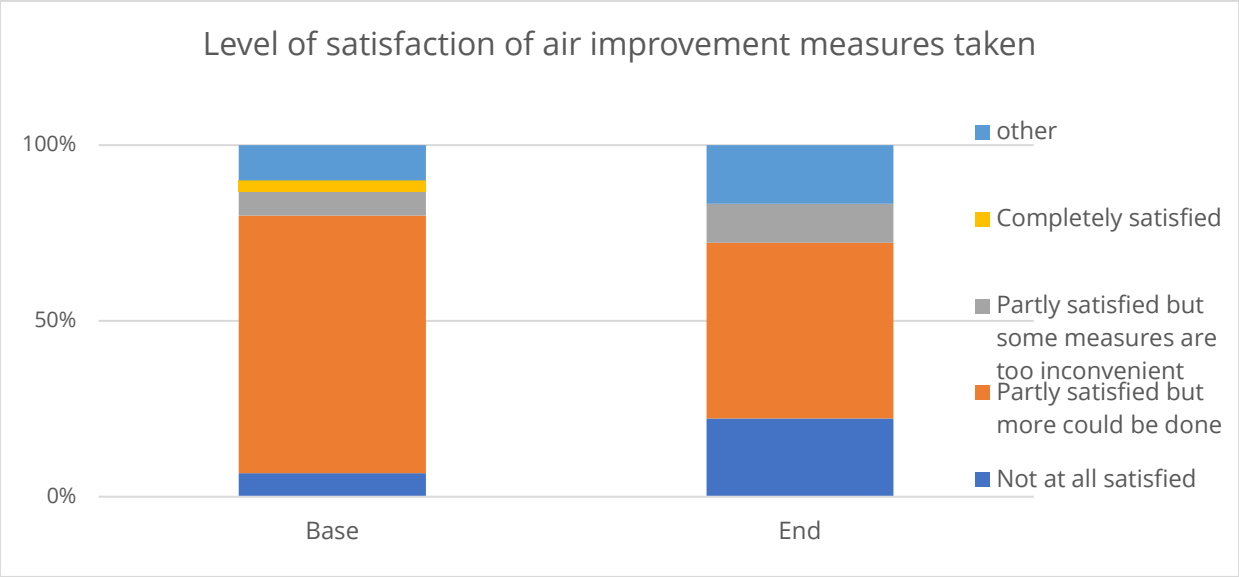

Figure 1.8: The level of respondents' satisfaction of air quality improvement measures taken by The City of London Corporation

The survey asked: Do you feel any changes in air quality are due to the measures put in place by The City of London Corporation or for another reason? This elicited a mixed response. At the baseline thirteen respondents referenced the potential impact of Covid lockdowns, nine responded positively, six negatively and three quoted other measures such as ULEZ and Congestion Charge expansion. At the endpoint, two mentioned the pandemic, five entered positive responses, one negative and ten didn't answer the question or didn't know.

To understand the impact of the project on individual behaviour change, participants were asked 1) Have you personally taken any measures to reduce local air pollution? and 2) Do you take steps to avoid areas of poor air quality? Figure 1.9 shows that both the baseline and endpoint surveys convey a similar response with not driving or limiting driving to be the most common way that respondents reduce their contribution to local air pollution, followed by adding outdoor planting and consolidating deliveries. Nine people at the baseline and five at the endpoint specified that they had no car and didn't drive so not idling would not have applied to them, otherwise the counts for this might have been higher considering the signage and anti-idling campaigns.

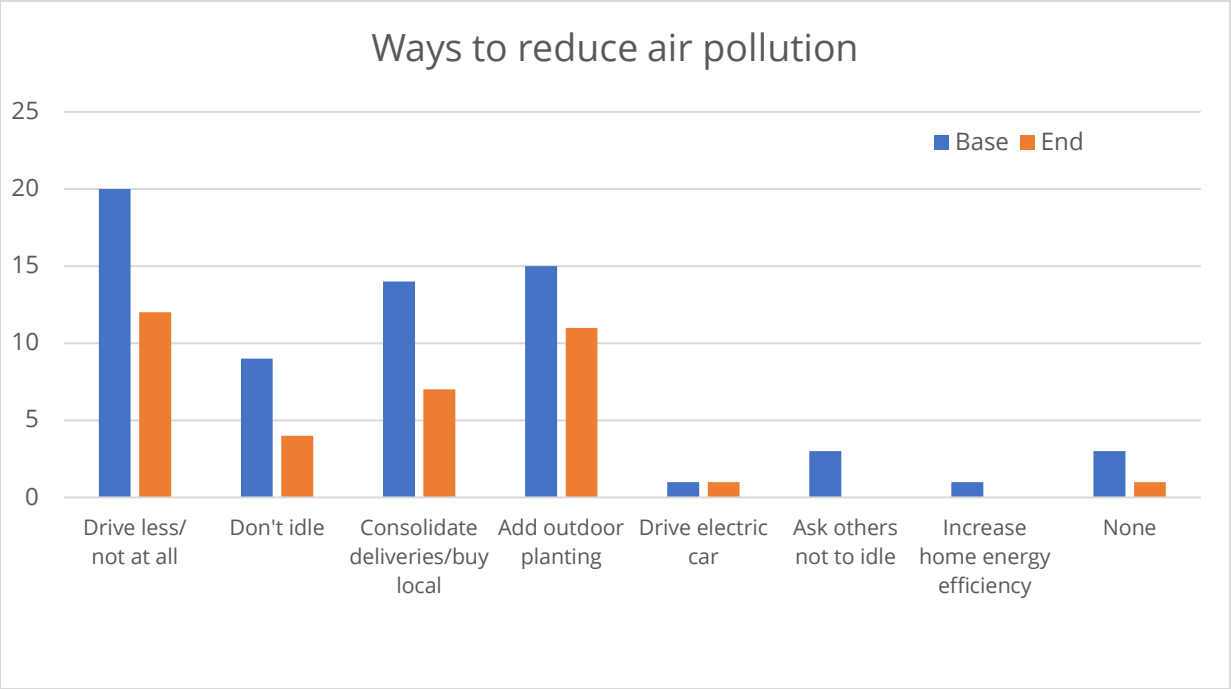

Figure 1.9: A count of the ways repondents take to reduce their contribution to air pollution

The most popular choice for reducing personal exposure to air pollution was avoiding walking along busy roads with the other options being selected almost evenly. Fewer respondents, proportionately, said they were taking no steps to avoid air pollution by the endpoint survey (figure 1.10).

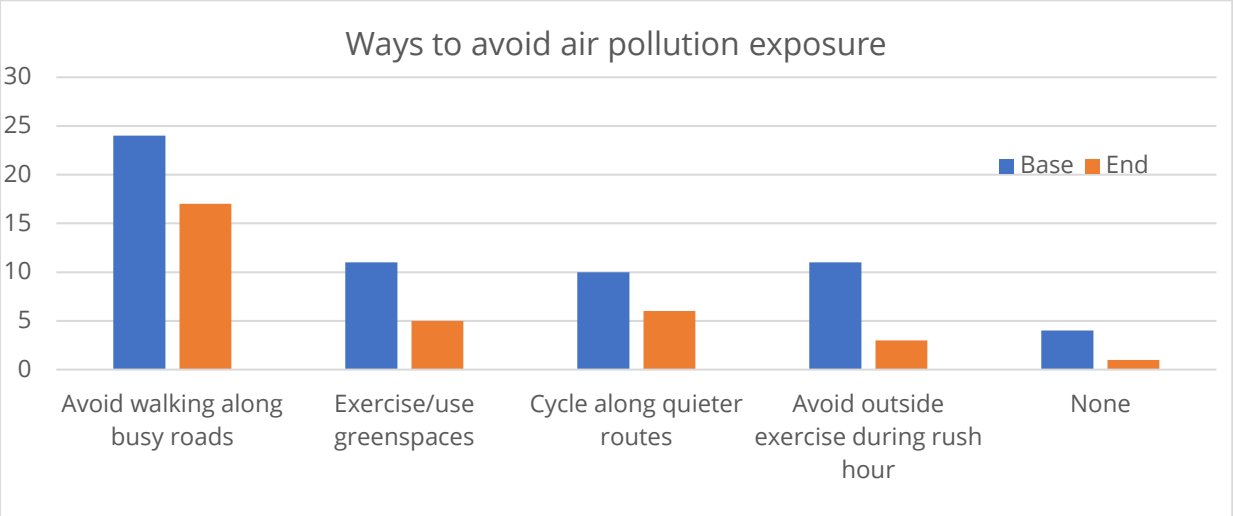

Figure 1.10: A count of the ways repondents take to reduce their personal exposure to air pollution.

The surveys offered an opportunity for respondents to add any comments or suggestions at the end. Table 1.1 provides a verbatim list of the entries.

Table 1.1: A list of the comments and suggestions made by respondents.

Comments and suggestions	
Base	**End**
I'm really pleased this second study is now going ahead. The longitudinal data will be very important to quantify air quality improvements made in the intervening years.	Distribute more information about how CoL is getting businesses and transport and construction to reduce their contributions to air pollution. More green areas - it doesn't feel like there are any more but there are loads of buildings going up.
I think we won't be able to judge until life returns to "normal".	There should be more PROPER greenspaces. There is planting done but it is not always tended thoroughly and often ignored. Often the greenery is planted in inappropriate places resulting in death of plants or trees
Double glazing in all flats that do not already have it	Review demolition policy
The construction generator also causes noise pollution (it is on at the moment), so there needs to be some 'joined-up' thinking to implement measures which work together across different City of London departments.	City needs to review its demolition / carbon release policy
Wider pavements for pedestrians. Total ban on polluting construction trucks. Only 'green' vehicles allowed access to the city.	CoL should be much bolder with traffic reduction schemes. This project provides the supporting evidence to do so.
I STRONGLY feel that any check on local area pollution here is pointless, as the	Keep going

restrictions imposed due to Covid have rendered any comparisons meaningless. Even without Covid, air sampling should have taken place long before current restrictions were imposed to give anything to compare current results with.	
With increased internet sales causing more delivery journeys through the city, improving traffic flows and electric charging availability should be a priority.	
Where some roads are now restricted (and less polluted presumably), the traffic is channelled onto other roads, which then become congested - noisy, polluted and difficult to cross. Need a solution that sees less overall volume of traffic.	

Finally, asked only at the endpoint survey, 100% of respondents said they were happy with how the project was delivered and 100% would participate in this type of project again.

Nitrogen dioxide results

The challenge when interpreting the data and comparing it to 2014 is to quantify the extent to which Covid restrictions had affected air quality and how much change could be attributed to the measures put in place by the City of London Corporation. Therefore, the monitoring calendar must be considered against the backdrop of the capital's activity. Monitoring began in March 2021 when the country was about to come out of its third lockdown, students could return to face-to face education but working from home was still advised. By April, non-essential retail and public/leisure facilities re-opened. The restrictions were relaxed further in May and almost completely lifted in June. That is not to say that The City instantly returned to 'business as usual' as many people, even one year on are still working from home and taking less journeys to the city centre. In addition, fewer tourists are visiting London, reducing footfall and potentially traffic long term.

Unsurprisingly, considering the above summary, overall, nitrogen dioxide levels were considerably lower in 2021/22 (see figure 2.1). However, when looking at the longer-term data from the City of London Corporation's permanent monitoring sites (figure 2.2), NO_2 levels have been decreasing year on year at Speed House since 2015, and indeed at all the other monitoring sites and are now all below the UK annual mean limit of 40 µg/m^3.

The results found that NO_2 concentrations when looking across the board, were lowest in June to August and highest in January (the only month to exceed UK annual mean legal limits), followed by November. This follows a very similar pattern to the 2014 results with a slight difference being that November was the highest month in 2014 and January was the third highest (figure 2.1).

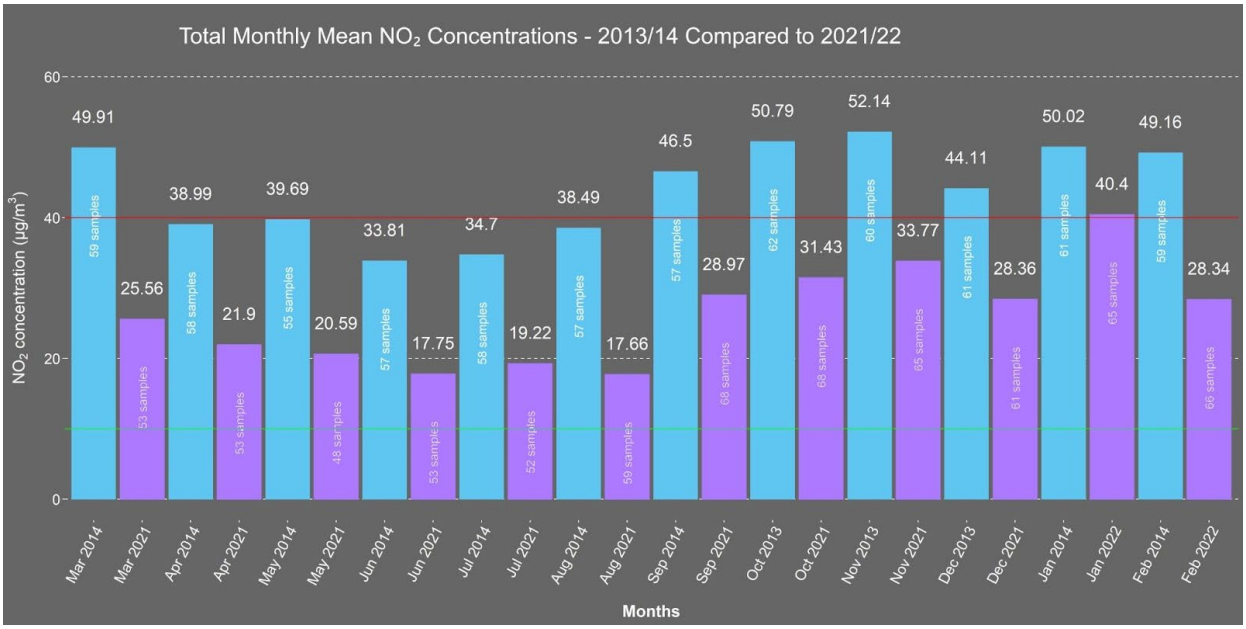

Figure 2.1: Bar chart plotting the monthly mean average across all monitoring locations for each month in 2013/4 (blue) and 2021/22 (purple). The annual mean legal limits (red) and WHO revised guidelines (green) are depicted by the horizontal lines.

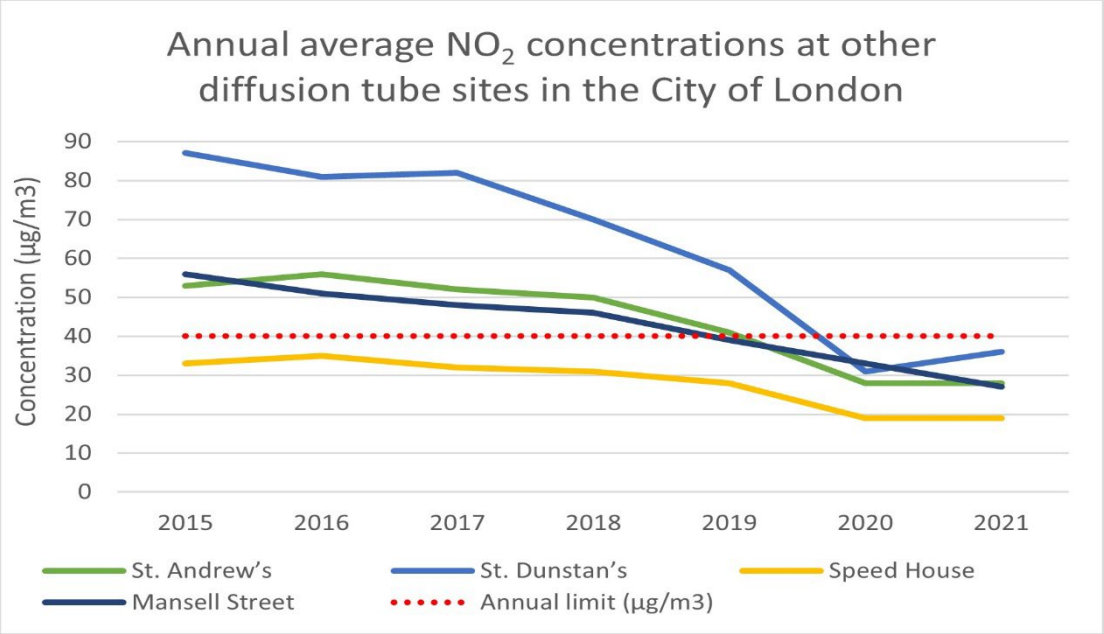

Figure 2.2: Annual mean average nitrogen dioxide levels at The City of London Corporation permanent monitoring sites

Using a citizen science approach to monitoring air quality allows data to be collected from more locations, providing a more granular and detailed picture than is possible given local authority resources. When looking at the spatial variability for the 2021/22 monitoring period (figure 2.3), all locations fell below the UK Air Quality Standard annual mean concentration limit for NO_2 (40 µg/m^3), except Beech Street which had an annual mean of 47.02 µg/m^3. However, all exceeded the recently revised WHO recommended guidelines (10 µg/m^3)[3]. The WHO recognise the challenges of reducing air pollution in areas where pollution is high and have therefore proposed interim targets to provide incremental steps in a progressive reduction of air pollution. Most of the monitoring locations for the period fell below the second WHO target of 30 µg/m^3 and those that exceeded this were almost all street level sites. The two residential exceptions included a location at Shakespeare Tower, overlooking Defoe Place (35.87 µg/m^3), and one in Hatfield House (30.11 µg/m^3), which borders the construction site for the City of London Primary Academy Islington.

[3] https://apps.who.int/iris/bitstream/handle/10665/345329/9789240034228-eng.pdf?sequence=1&isAllowed=y

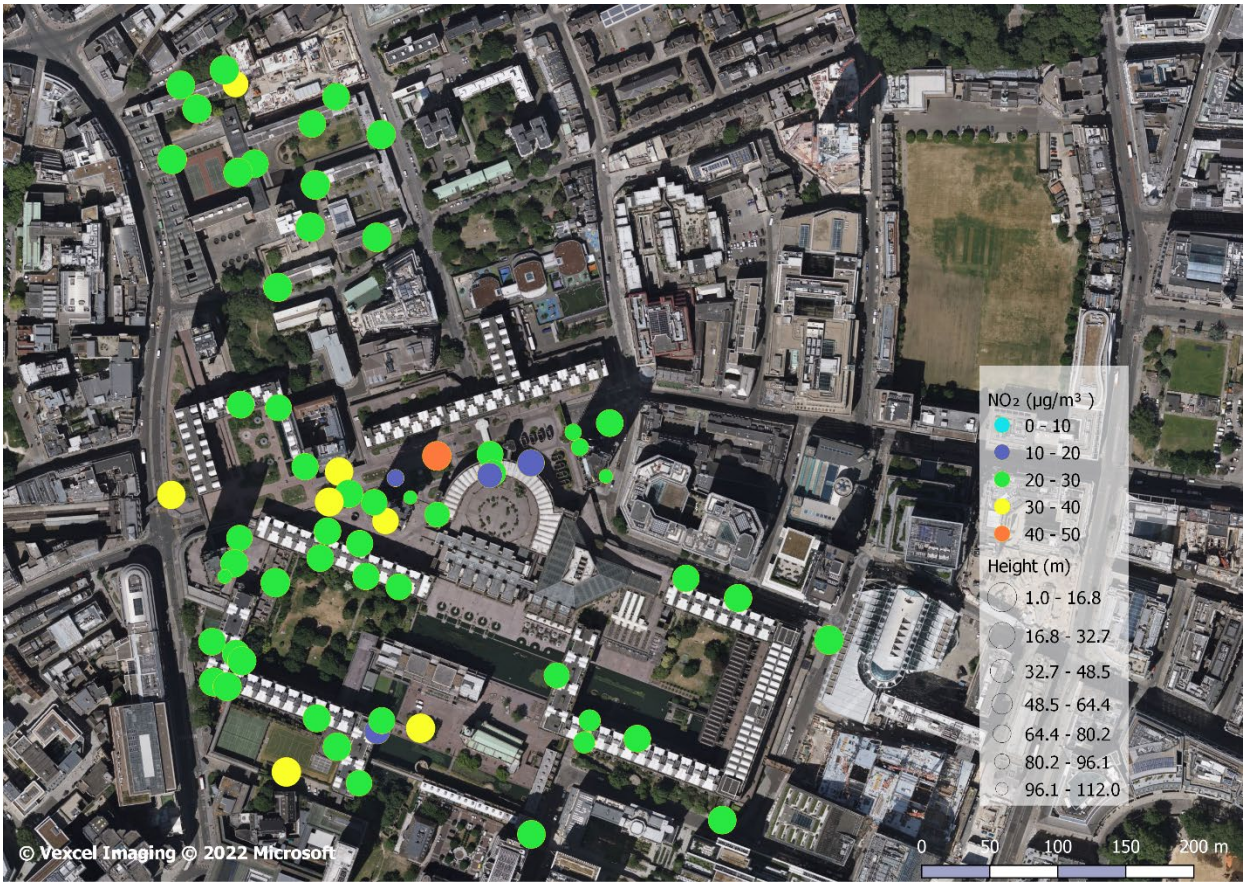

Figure 2.3: Map of the annual mean for NO_2 levels in the Barbican and Golden Lane Estates 2021/22 with height from street level.

The City of London Corporation introduced an experimental traffic scheme on Beech Street, Bridgewater Street and Golden Lane in March 2020, with the aim of reducing air pollution. The experiment, which ran for 18 months and ended on the 18th of September 2021, saw the UK's first 'zero emission street' operating 24 hours a day, 7 days a week. Subsequently, the results for the monitoring period show a marked increase of NO_2 concentration levels from September (46 µg/m^3), which doubled from that of the previous month. October saw a further increase with concentration levels reaching 72 µg/m^3. These then levelled off to between 47.94 and 55.45 µg/m^3 for the remainder of the monitoring period. It is worth noting, however, that in 2014 October also saw the highest concentration levels in Beech Street, followed by January. These temporal patterns were also seen in the results from a similar citizen science project being conducted in Dulwich, South London, during the same

period, (see figure 2.4). Given these trends, it is difficult to quantify how much of the variability recorded is directly attributable to the ending of the traffic scheme. There were, in addition, other temporary street closures during the monitoring period that are shown in table 2.1.

These annual patterns in nitrogen dioxide levels are commonly seen in the northern hemisphere where winter peak NO_2 is much higher in hot spots such as large cities and towns. This is attributed both to heavier use of combustion power plants for wintertime home heating, as well as the fact that NO_2 stays in the air longer in the winter.

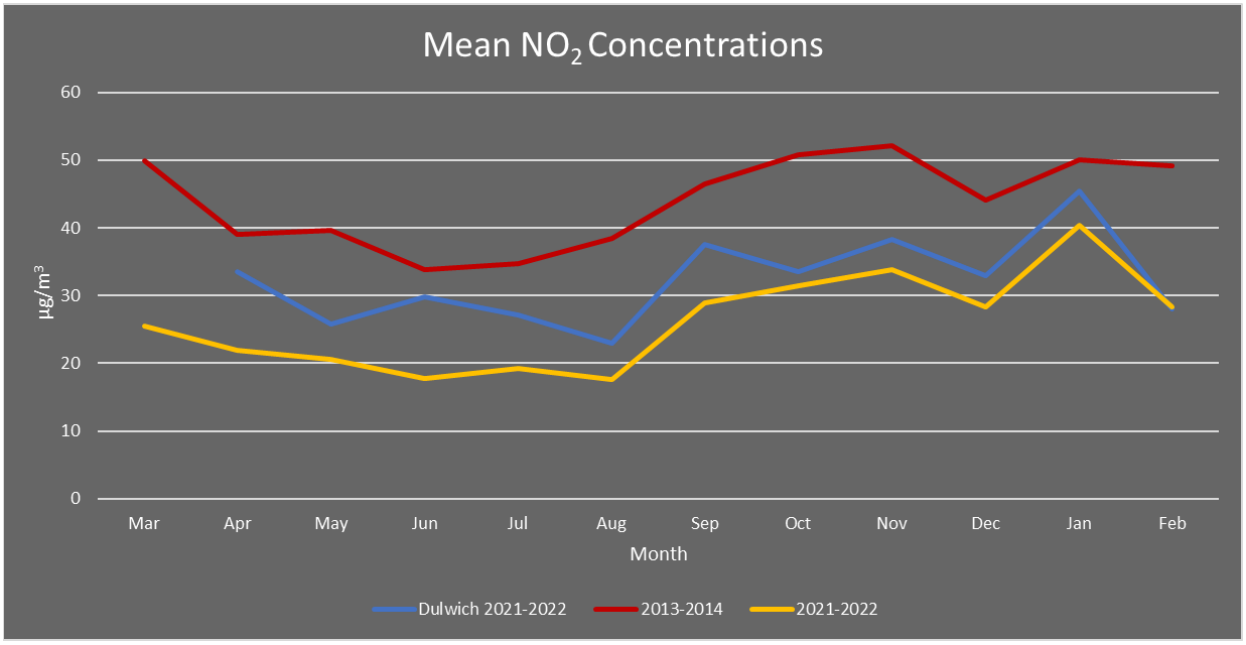

Figure 2.4: Line graph comparing the temporal variation in 2013/14 and 2021/22 with a similar study in Dulwich 2021/22

Several monitoring sites were at street level and across some of the highwalks within the Barbican Estate. These, unsurprisingly saw some of the highest nitrogen dioxide concentration levels during the period. This was not the case for the somewhat enclosed area at St Giles Courtyard where relatively low levels were seen (25.91 µg/m^3). The monitoring sites on the Barbican Highwalks, (north side of Beech Gardens and above Aldersgate) exceeded all ground level street sites, save for Beech Street, and saw mean concentration levels of 38.45 and 36.02 µg/m^3 respectively. The former was also monitored

during the first project and similarly saw the highest NO_2 concentrations of those across the highwalks on the Estate.

Table 2.1: Calendar of road closures around the Barbican and Golden Lane Estates

Date from	Date till	Where	Why
22/03/2021	09/05/2021	Beech St., Silk St. to Aldersgate St.	Project Scheme Works
31/05/2021	30/09/2021	Brackley St., Viscount St. to Golden Ln., eastbound	Footway Reconstruction
31/05/2021	30/09/2021	Fann St., Golden Ln. to Viscount St., westbound	Footway Reconstruction
18/08/2021	19/09/2021	Moor Ln., junction with Fore St.	Utility Works
20/09/2021	01/10/2021	Silk St., Moor Ln. to Milton St.	Mobile Crane
18/10/2021	23/10/2021	Fann St., Viscount St. to Golden Ln	Project Scheme Works
18/11/2021	23/11/2021	Fann St., Viscount St. to Golden Ln.	Project Scheme Works
20/11/2021	05/12/2021	London Wall, Wood St. to Fore St. Avenue westbound.	Project Scheme Works
04/01/2022	14/02/2022	Brackley St. junction with Golden Ln.	Project Scheme Works
10/01/2022	18/01/2022	South Place eastbound Dominion St.to Wilson St.	Utility Works

In addition to the spatial variability recorded, another factor that should be taken into consideration is the different heights at which each of the diffusion tubes were positioned; these ranged from 1 to 112 metres from street level (see figure 2.5). As previously noted, the roadside locations and some of the highwalks saw higher NO_2 concentrations. The exceptional residential site at Shakespeare Tower, mentioned earlier in the report, was located 21m above street level yet still recorded relatively high nitrogen dioxide concentrations (35.87 $\mu g/m^3$). Several other locations within the three towers: Lauderdale, Shakespeare, and Cromwell, where diffusion tubes were placed at heights ranging from 85 -

112m above street level recorded annual mean NO_2 concentrations between 19.84 - 25.96 µg/m^3.

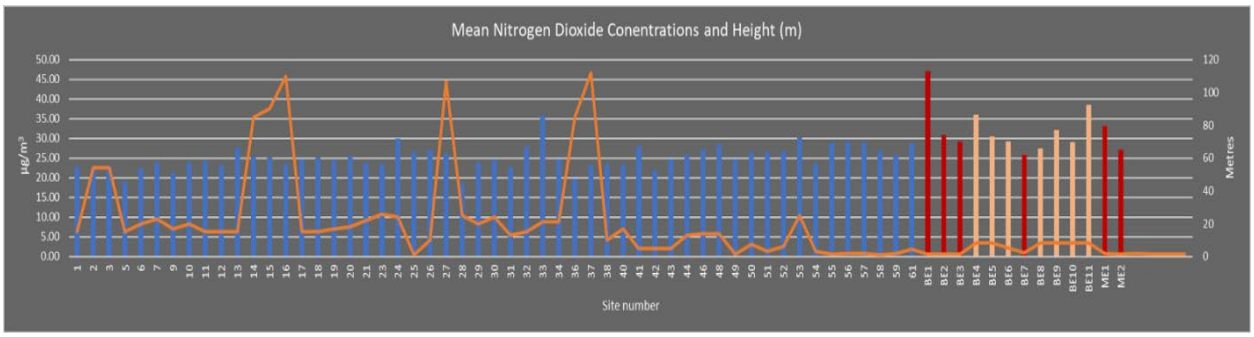

Figure 2.5: Bar chart plotting the mean NO_2 levels against the line graph of height of the monitoring locations. The blue bars are residential locations, the red bars are street level, and the orange are highwalks. Note: sites with less than six months data have not been included

Particulate pollution results

Fine particulate matter (PM2.5) was monitored on 18 days across May, June, and August (see table 2.2). Using a personal exposure monitor, designated routes were walked regularly so the concentration levels at different times and days of the week could be directly compared. The daily sampling periods have been aggregated into three timeslots am (8:00-10:00), noon (12:00-14:00), and pm (16:00-18:00). In early May, PM2.5 concentration levels were predominantly between 10-50 µg/m^3. This changed later in May, where an increase can be seen over the period between the 29th May (50-111 µg/m^3) to 3rd June, with a peak of 131 µg/m^3 during the morning on the 1st of June. Levels then dropped back to between 10-75 µg/m^3 for the remainder of the monitoring period (see figure 2.6). It should be noted that these measurements only include data that were geolocated with the GPS.

Table 2.2: Particulate monitoring schedule

Date	Day	Date	Day
20/05/2021	Thursday	10/06/2021	Saturday
22/05/2021	Saturday	12/06/2021	Saturday
25/05/2021	Tuesday	15/06/2021	Tuesday

27/05/2021	Thursday	09/08/2021	Monday
29/05/2021	Saturday	10/08/2021	Tuesday
01/06/2021	Tuesday	12/08/2021	Thursday
03/06/2021	Thursday	13/08/2021	Friday
05/06/2021	Saturday	17/08/2021	Tuesday
08/06/2021	Tuesday	22/08/2021	Sunday


29th May 2021
PM 2.5 concentration µg/m³
0 - 10
10 - 25
25 - 50
50 - 75
75 - 100
100 - 150
150 - 200
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0
100
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© Microsoft 2022


1st June 2021
PM 2.5 concentration µg/m³
0 - 10
10 - 25
25 - 50
50 - 75
75 - 100
100 - 150
150 - 200
N
0
100
200 m
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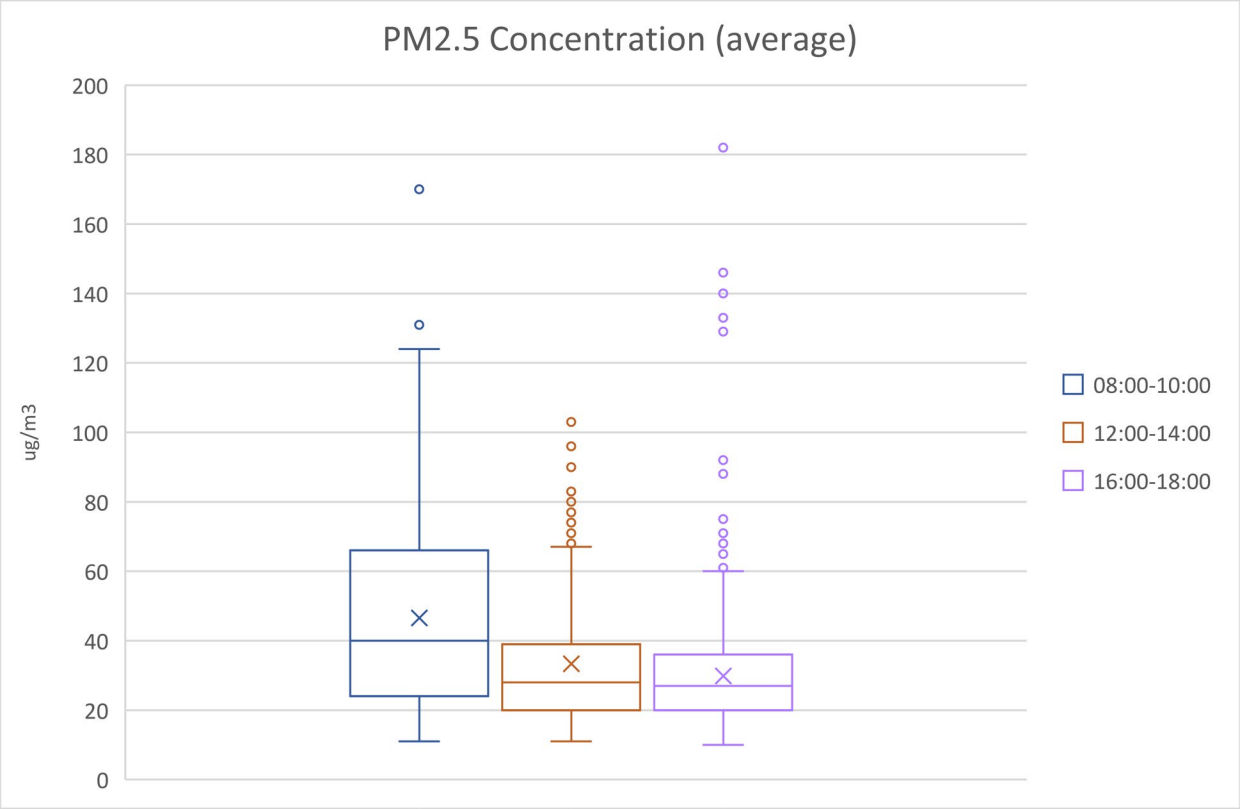
Figure 2.6: PM2.5 concentration levels for three separate days in May and June, highlighting the most polluted sampling times.

Looking specifically at the three time periods (including non-geolocated data) the mornings (8:00-10:00), on average, had higher concentration levels during the months that were monitored with a mean of 46.52 µg/m^3. This was followed by the noon period (33.38 µg/m^3), and latterly 16:00-18:00 (29.81 µg/m^3). Although the later time had lower PM2.5 concentration levels, on average, as shown in figure 2.7, it saw the highest measurement during which the monitoring was undertaken (182 µg/m^3).

Although not comparable due to the sampling rate and timeframe, it is worth noting the Air Quality Standards Regulations (2010) require that concentrations of PM2.5, in the UK, must not exceed an annual mean of 20 µg/m^3. Currently, there are no legal limits set for daily averages for PM2.5. As with NO_2 , the WHO has revised their guidelines for PM2.5, which are now set at 5 µg/m^3 (annual mean). There are however several interim targets set to between 35 to 10 µg/m^3.



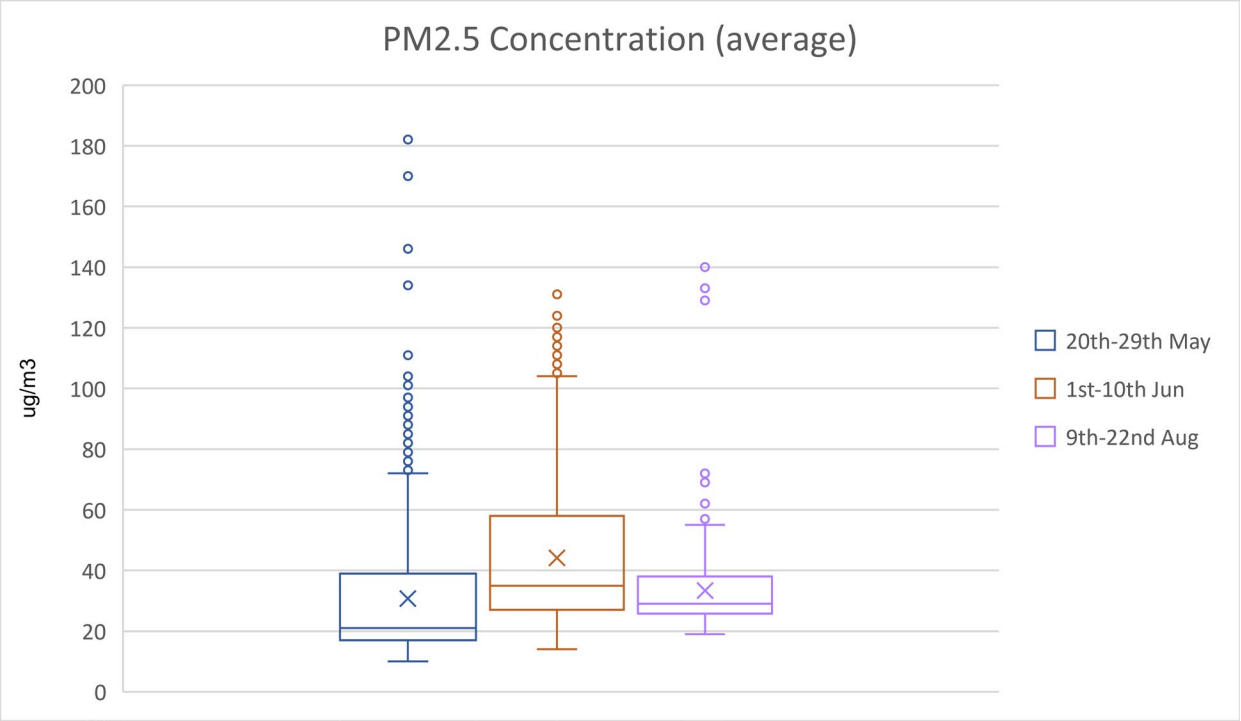


Figure 2.7. Boxplots showing concentrations of PM2.5 a) measured throughout monitoring period during morning, midday and late afternoon periods and (b) the periods of 20th - 29th May, 1st -10th Jun, and 9th -22nd Aug. The horizontal lines across each box denote the median and the crosses the mean concentration. The boxes extend between the lowest and highest quartile of the data, the whiskers show the minimum and maximum and the dots plot the outliers.

Discussion and recommendations

The only site to breach the UK legal annual mean limits for NO_2 was at Beech Street, despite it being closed to emitting vehicles for six of the twelve months that were monitored. The levels have reduced remarkably since 2013/14 showing that the air quality improvement measures, including the zero-emission zone were a success. Survey responses and anecdotal evidence broadly convey support for reinstating the vehicle restrictions at Beech Street although there was some concern around the displacement of traffic. Therefore, it is recommended that clear communication and monitoring should be included in any future plans to restrict traffic.

The majority of residents who responded to the surveys were partly satisfied with the measures put in place by The City of London Corporation but felt that more could be done. Most were well informed about some of the measures, but a more effective communication plan could increase awareness further which may lead to greater satisfaction.

Considering the large proportion of survey respondents who selected that they avoid walking along busy roads to avoid air pollution, more research and education could be focussed on mapping the less polluted routes. The PM2.5 monitoring could be deployed in a systematic way to gather robust and useable data. An alternative could be to use cheaper and less accurate monitors to provide real-time pollution measurements if the aim is for comparative purposes as opposed to absolute values.

Next to driving less, outdoor planting was cited as the second most common way of reducing air pollution, therefore more support and education/outreach could focus on this action for the wider community and greening up public spaces would be welcomed. Any planting should be planned strategically to block and filter, rather than trap, air pollution.

All respondents to the survey said they were happy to take part in other projects such as this and interviews with residents uncovered that they felt empowered by being involved and making a difference. A repeat of the survey in future years may alleviate some of the scepticism around the pandemic lockdowns skewing the results.

Appendix 1

Table of sites with location descriptions

Site	Character
1	Within Barbican, not near a road
2	Overlooking gardens/lake
3	Steady traffic flow from Wood St & Moor Lane. London Wall is visible with heavy traffic
5	South facing overlooking the podium
6	Above recently blocked junction
7	Above podium so no traffic
9	Southeast facing towards Beech St
10	Off main road in pedestrian Barbican area. Beech St tunnel below left
11	Balcony
12	Indoors
13	Overlooking junction Beech St and Silk St
14	Facing into Barbican no traffic
15	Overlooking podium
16	Facing east from Cromwell Tower
17	Overlooking gardens/lake. No traffic but building works ongoing at 21 Moorfields
18	Overlooking pedestrian Defoe Place above Beech St tunnel
19	Overlooking garden
20	Overlooking podium and Shakespeare Tower
21	Overlooking big barbican gardens (indoors)
22	South facing from Frobisher
23	Overlooking the lakes
24	Traffic from Smithfield Market
25	Small amount of traffic to west at level 3 and some from Lauderdale Place /Beech St
26	No traffic except vehicle parking and minimal engine running
27	Overlooking gardens/lake.

28	Very quiet, no building work
29	Above lake
30	Overlooking lake
31	Overlooking Thomas More Garden. No traffic
32	Busy road building works on Aldersgate St
33	Facing south overlooking Defoe Place
34	West overlooking Defoe Place/north podium
35	Faces over Estate
36	Above Beech St
37	East facing from Shakespeare
38	Traffic diverted from using Beech St
40	Overlooking Silk St
41	Quite busy road
42	Overlooking lawn
43	Occasional traffic
44	Very quiet, no building work
46	Building site to north, Golden Lane to east
48	North side of Golden Lane Estate. Building site just beyond boundary
49	Overlooking road
50	Building works
51	Overlooking podium/garden area of Golden Lane Estate. Building site
52	Roadworks. Vehicle service ramp
53	Near construction site
54	Traffic diversion and building site for 14 storey flats
55	Vehicles on service road driving to garages/deliveries/ workers
56	Internal courtyard. No traffic
57	Ramp to underground carpark
58	Delivery vehicles always moving

59	Near carpark, street level
61	Lots of cars turning on Fann St, access ramp to carpark
BE1	Beech St bus stop
BE2	Moor Lane zebra crossing
BE3	Thomas More carpark
BE4	Highwalk
BE5	Highwalk
BE6	Above Beech St
BE7	St Giles Courtyard
BE8	Highwalk
BE9	Highwalk
BE10	Highwalk
BE11	Highwalk
ME1	Middlesex Estate car park
ME2	Middlesex St lampost
ME3	Middlesex Estate Staircase
ME4	Middlesex Estate Staircase
ME5	Middlesex Estate Harrow Pl
ME6	Middlesex Estate temporary boiler