Clean Air Routes Monitoring Report

February 2021
Revision 03

Delivered as part of the Clean Air Villages 3 (CAV3) project, funded by the Defra Air Quality Grant.

CROSS RIVER PARTNERSHIP
Delivering London's Future Together

Tranquil City

Executive Summary

Cross River Partnership (CRP) is a public-private partnership working with 10 London boroughs, 17 private sector partners and 6 strategic agencies to deliver innovative projects that contribute to the social, environmental and economic health of London.

Purpose of this study

In August 2020, CRP commissioned Tranquil City to monitor pollution concentrations along 15 contrasting walking and cycling route pairs. This forms part of the **Clean Air Villages 3 (CAV3)** project, funded by the Defra Air Quality Grant. The purpose of this monitoring was to:

- Quantify the health benefits of alternative walking and cycling routes;
- Support the development of new Clean Air Routes; and
- Support wider communications regarding route choice and to encourage public behaviour change.

Route selection

The initial route pairs were selected by CRP, in collaboration with Local Authority and Business Improvement District partners on the CAV3 project. Quieter routes were identified as an alternative to more well-known and busier 'standard' routes between stations and popular destinations. These decisions were informed by Environmental and Healthy Streets Index data maps, provided by Tranquil City, as well as site visits to identify any accessibility or other concerns.

Monitoring

Air quality monitoring was carried out in October 2020 by Tranquil City, using Aeroqual Series 500 handheld air quality sensors during peak hours. Nitrogen dioxide (NO_2) was monitored, as the air pollutant of most concern in relation to public health and regulatory compliance.

Levels of particulate matter (PM_{10} and $PM_{2.5}$) were also monitored. For each route pair, the Clean Air Route and the standard route were monitored simultaneously to enable direct comparison and quantification of the benefits. Route monitoring was repeated to ensure consistency in pollutant concentration results.

Nitrogen dioxide results

The results show that by taking the Clean Air Routes, rather than the standard route, people can significantly reduce their exposure to NO_2.

Average exposure to NO_2 was between 6% and 23% lower on the Clean Air Routes, with a maximum reduction of up to 41%.

The long-term reductions in exposure will be significant when these Clean Air Routes are included as part of a regular routine.

Other benefits

Comparisons of other modelled environmental parameters show that:

The Clean Air Routes provided up to 28% higher exposure to greenery and nature than the standard routes.

These routes were also shown to have consistently lower average noise levels (based on modelled road and rail sources). In many cases, improvements were 10 dB or more, which is typically perceived as a halving of the sound level. Exposure to quieter and greener environments have been shown to improve wellbeing as well as improving the overall walking or cycling experience.

Executive Summary

Particulate matter results

Due to the low levels of particulate matter monitored, results for PM_{10} and $PM_{2.5}$ were not conclusive. Some of the surveys indicated benefits, but no consistent pattern was seen. However, it is considered, based on knowledge of the sources of particulate matter and the NO_2 results, that concentrations on the Clean Air Routes are likely to be consistently lower than on standard routes.

Summary

CRP and partners have developed 14 new Clean Air Routes across London as part of the CAV3 programme. Monitoring undertaken by Tranquil City has demonstrated that by taking a Clean Air Route rather than a standard route, people can significantly reduce their exposure to nitrogen dioxide (NO_2). The Clean Air Routes also provide a number of other positive characteristics, such as increased views of natural elements and reduced noise levels. Overall, these results form a strong basis for encouraging lasting behaviour change.

Next steps

CRP will continue to work with public and private sector partners to demonstrate the benefits of taking Clean Air Routes. Each of the new routes have been added to CRP's **Clean Air Route Finder**, an interactive journey planner developed in partnership with King's College London to help identify low pollution walking and cycling routes in London.

For the latest information relating to this project, please visit the CRP website, **crossriverpartnership.org**.

Figure 0.1. Aeroqual handheld monitors in Piccadilly Circus.

Revision History

Version	Date	Comments	Author/s	Approved by
R00	22/11/2020	First issue for comment	Grant Waters (Director, Tranquil City) Ben Warren (Director, Tranquil City)	Ben Warren (Director, Tranquil City)
R01	02/12/2020	Revised issue	Grant Waters (Director, Tranquil City) Ben Warren (Director, Tranquil City)	Ben Warren (Director, Tranquil City)
R02	14/12/2020	Revised issue	Grant Waters (Director, Tranquil City)	Ben Warren (Director, Tranquil City)
R03	28/01/2021	Revised issue	Abby McDougall (Cross River Partnership) Grant Waters (Director, Tranquil City)	Susannah Wilks (Director, Cross River Partnership) Ben Warren (Director, Tranquil City)

Contents

Definitions & abbreviations

AQFAs – Air Quality Focus Areas, as defined by the GLA (2016).
BID(s) – Business Improvement District(s).
Clean Air Routes – a walking or cycling route with low levels of air pollution.
EU – European Union.
GLA – Greater London Authority.
GOSH – Great Ormond Street Hospital.

Pollutants

NO_2 – nitrogen dioxide.
$PM_{2.5}$ – fine particulate matter. Particles with an aerodynamic diameter of 2.5 microns or less.
PM_{10} – coarse particulate matter. Particles with an aerodynamic diameter of 10 microns or less.
O_3 – ozone.

1. Introduction

1.1 Cross River Partnership

Cross River Partnership (CRP) is a public-private partnership working with 10 London boroughs, 17 private sector partners and 6 strategic agencies to deliver innovative projects that contribute to the social, environmental and economic health of London.

1.2 Clean Air Villages

The **Clean Air Villages 3 (CAV3) project** is being delivered on behalf of 16 partners, including 12 Local Authorities and 4 Business Improvement Districts (BIDs) across London. **Fig. 1.1** shows the 16 focus areas as part of this one-year project funded by the Defra Air Quality Grant. CRP is engaging with businesses, hospitals and wider communities to encourage behaviour change and support activities to reduce air pollution and congestion.

1.3 Clean Air Routes

In 2017, as part of the Clean Air Better Business (CABB) programme, CRP and partners identified and developed London's first on-street clean air walking routes. The purpose of a Clean Air Route is to encourage pedestrians to take quieter backstreets, thereby reducing their exposure to harmful air pollution. In August 2020, CRP commissioned Tranquil City to monitor pollution concentrations along 15 new routes as part of the CAV3 project. Initial routes were identified by CRP, with support from the CAV3 Local Authority and BID partners, shown beneath **Fig. 1.1**. It was agreed that an additional Clean Air Route would not be developed for Northbank BID to avoid duplicating existing and extensive work that has been carried out within the BID footprint.

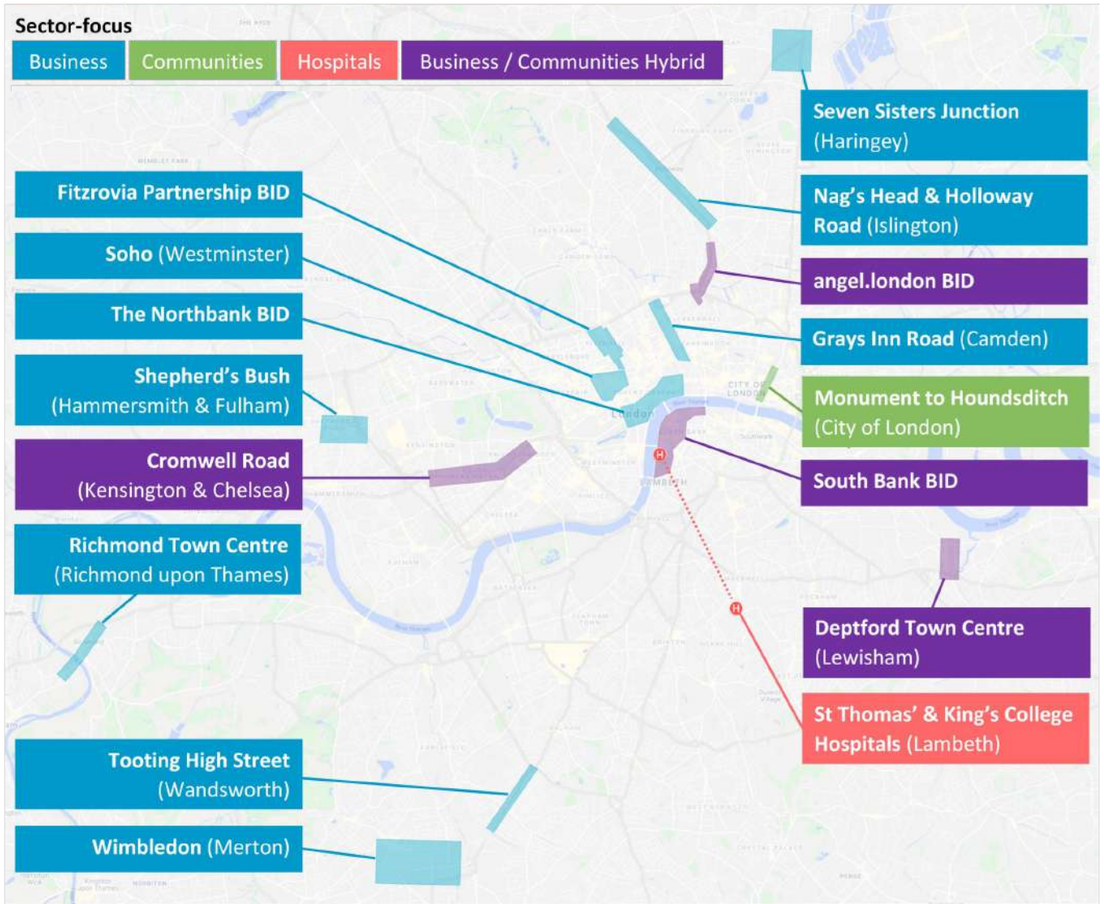


Figure 1.1. Map of focus areas, or Clean Air Villages, as part of the CAV3 project.

1. Introduction

1.4 Tranquil City

4.4 billion people around the world live in cities. This is expected to reach 6.6 billion people by 2050. Living in a city offers amazing opportunities for wellbeing by encouraging innovation, enabling social connection, and facilitating active lifestyles. However, without the right planning and individual action, city life can also be stressful, polluting and unhealthy. Surveys show that environmental issues are a significant public concern. **Tranquil City** is an environmental data analytics company providing data to enable people from all walks of life to lead healthy, balanced and environmentally aware lives in cities. Tranquil City Directors Grant Waters and Ben Warren conducted the 2020 Clean Air Route study and produced this report on its findings, with support from CRP.

Figure 1.2. Tranquil City's event as part of Green Sky Thinking Festival.
Image courtesy of Michael Colman.

1.5 Air pollution in London

Poor air quality is the UK's largest environmental health risk, contributing to over 9,000 premature deaths in London alone each year (King's College London, 2015). The two pollutants of most concern in London are nitrogen dioxide and particulate matter. Accounting for around half of total nitrogen dioxide emitted, road vehicles are the principal driver of London's pollution problem.

Nitrogen dioxide (NO_2) is formed as a result of the combustion of fossil fuels. Motor vehicles with internal combustion engines are the main source of NO_2 in London, and concentrations are highest near to busy roads. NO_2 is a toxic gas that aggravates respiratory symptoms, such as asthma. Long-term exposure has also been shown to suppress children's lung development.

In the European Union (EU), the legal mean annual limit for NO_2 is 40 micrograms per m^3 ($\mu g/m^3$). The EU have also set an hourly limit of 200 $\mu g/m^3$, which should not be exceeded more than 18 times per year. While air quality in London has shown improvements in recent years, 24% of roads in inner London still exceed annual EU limits (Mayor of London, 2020).

The Greater London Authority (GLA) have defined 187 Air Quality Focus Areas (AQFAs) where they believe the problem to be most acute. These are locations in London that both exceed the EU annual limit for NO_2 and have a high level of human exposure. The CAV3 programme is targeting action within AQFAs to maximise the impact of interventions undertaken to reduce levels of pollution.

1. Introduction

1.5 Air pollution in London (cont.)

Particulate matter is a collective term referring to tiny particles or droplets suspended in the air. *Fine* particulate matter ($PM_{2.5}$) and *coarse* particulate matter (PM_{10}) can arise from natural or human-made sources. Around a third of $PM_{2.5}$, and a quarter of PM_{10}, emitted in London comes from road transport. This arises from the combustion of fuels in the engine, but also as a result of tyre, break and road degradation.

Exposure to particulate matter can have a range of adverse effects, including impacting the respiratory and cardiovascular systems. Particles can reach deeper into the respiratory tract depending on their size. $PM_{2.5}$ is able to penetrate deeper into the lungs than PM_{10} and is therefore more significant in terms of its impact on human health. The risk of adverse outcomes has been shown to increase with exposure and the World Health Organisation suggests that is no safe limit for particulate matter.

Sources of pollution in London

Road vehicles are responsible for emitting around half of London's NO_2. Non-transport sources, however, play a more significant role in the production of particulate matter. A large proportion of particulate matter is the result of construction, wood burning and commercial cooking. Around half of $PM_{2.5}$ in the city also originates from outside of London.

Concentrations of particulate matter are a weaker indicator of traffic pollution sources than NO_2. During monitoring, measurements of particulate matter are expected to vary less between standard routes and Clean Air Routes. Despite this, $PM_{2.5}$ and PM_{10} are being investigated in this study, due to their significance for human health.

1.6 Other benefits

The purpose of this study is to quantify the health benefits of alternative walking and cycling routes. While the monitoring of pollution levels is the primary focus, it is recognised that a demonstration of a reduction in pollutants alone is not sufficient to encourage walking and cycling. Monitoring needs to be supported by a consideration of other factors important to human experiences, in order to incentivise significant change in behaviour.

The following factors have been assessed in this study, using mapping and modelling techniques:

- **Noise level** (in decibels, dB) – a reduction of 10 dB is generally perceived as a halving of the sound level;
- **Green space** – average area (in m^2) of green elements;
- **Blue space** – average area (in m^2) of blue or water elements;
- **Tree cover** – average area (in m^2) of tree cover;
- **Tranquil City Index** – a multifactor indicator that scores the potential for a location to be good for wellbeing. This index is based on empirical evidence conducted by Tranquil City in partnership with the University of Surrey;
- **Healthy Streets Index** – a multifactor indicator that scores the potential for a street to provide conditions that are positive for walking and cycling. The index is a product of the _Streets consortium comprising Tranquil City, Healthy Streets Ltd and the University College London.

For a full list of data references used in this report, please see section 6.

2. Methodology

2.1 Route selection

The initial route pairs were selected by CRP, in collaboration with Local Authority and Business Improvement District partners on the CAV3 project. These decisions were informed by Environmental and Healthy Streets Index data maps, provided by Tranquil City. Seven modelled layers were produced for each of the focus areas (as shown in **Fig**. **1.1**), including annual average concentration of NO_2, $PM_{2.5}$ and PM_{10} per road segment, derived from the London Atmospheric Emissions Inventory (LAEI) 2016. Once initial routes had been selected, site visits were carried out to identify any concerns, such as accessibility or safety issues.

2.2 Monitoring approach

Air pollutants

NO_2, $PM_{2.5}$ and PM_{10} concentrations were monitored along each Clean Air Route and paired standard route. These are the pollutants of highest regulatory concern in London and are most representative of road traffic related pollution levels and the associated health impacts.

Accounting for cross-interference

It should be noted that with all sensor-based systems there is a cross interference between gases. NO_2 has a strong cross-response with ozone (O_3). As a result, most devices measuring NO_2 with sensors are measuring a combined NO_2 with ozone. To account for this, ozone concentrations were monitored simultaneously with NO_2. This allowed for ozone to be subtracted from the raw NO_2 results in order to derive an accurate final measure of NO_2 concentration. Further details are outlined in section 2.3.

Monitoring equipment

The following handheld equipment was used on the project:

- **Aeroqual Series 500 Handheld Monitor Base (AER-HH-S500L)**
  Monitor base with lithium battery and power pack, alarms, datalogging and PC software.
- **Aeroqual $PM_{2.5}$ and PM_{10} sensor head with RH correction (AER-SH-PM).**
- **Aeroqual NO_2 Sensor Head (AER-SH-ENW)**
  Fan-sampling gas sensitive electrochemical (GSE) sensor.
- **Aeroqual Ozone (O_3) Ultra Low Sensor Head (AER-SH-OZU)**
  Fan-sampling gas sensitive semiconductor (GSS) sensor.

Figure 2.1. Aeroqual Series 500 Monitor Base (left) and with NO_2 and O_3 Sensor Heads attached (right).

2. Methodology

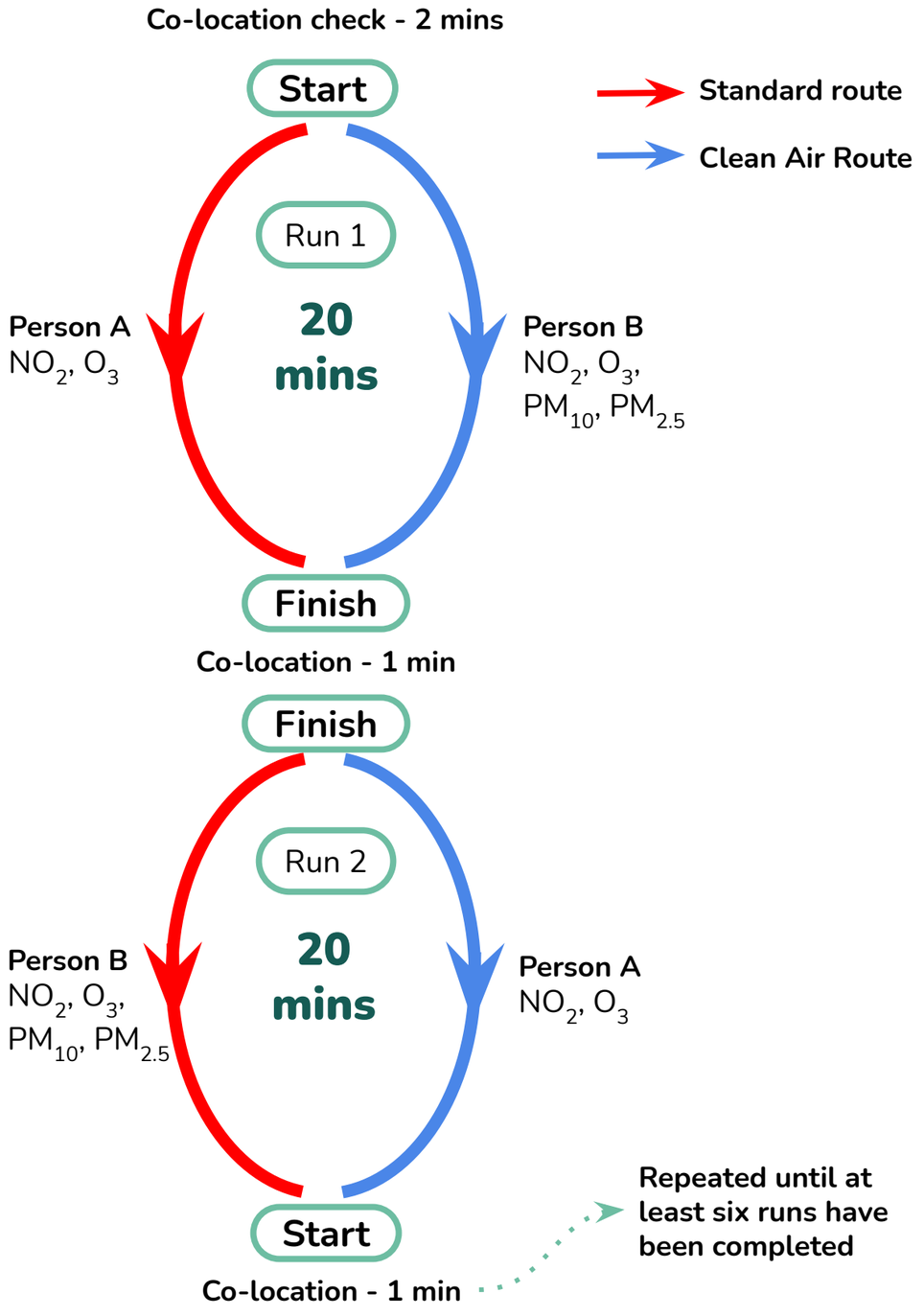
Monitoring of route pairs

Continuous measurements of pollutant concentrations were taken along each route pair, with a reading recorded automatically every 60 seconds. Simultaneous measurements along each Clean Air Route and standard route were achieved using two sets of devices operated by two consultants (see diagram opposite).

The monitors were co-located at the start and finish of each route pair monitoring 'run' to check for any systematic bias between monitors. At least six 'runs' of route pair measurements were carried out for NO_2, with the exception of the longer cycling route in Angel, where just four runs were undertaken. Each consultant, and therefore each set of devices, monitored each route at least three times. Three 'runs' of measurements were taken for $PM_{2.5}$ and PM_{10} as only one device was set up to monitor particulate matter.

The end destinations for the Clean Air Route and standard route to St George's Hospital were not in the same position. The four measurement 'runs' presented for this route therefore include both forward and backward direction of travel, totalling eight measurements overall.

Where possible, measurements were taken at a distance of 1 metre from the kerbside. This was to ensure measurements would be relevant for both pedestrians and cyclists. All measurements were conducted during peak hours (between 0630-0930 and 1600-1900) Tuesday to Thursday. Monitoring during peak hours is most relevant in order to demonstrate the greatest benefit of taking a Clean Air Route, due to the higher pollution levels typically experienced during this period. People are also most likely to travel during peak hours, such as those commuting to work.



2. Methodology

Table 2.1. Summary of monitoring conditions for each route survey conducted.

No.	CAV3 Partner	Date	Location (short title)	Time	Temperature (°C)	Cloud level	Wind (kph, direction)	Adjustment Factor
1	Angel.london	14/10/20	Angel	Morning	9	Partly	14, NE	NA
2	London Borough of Lambeth	6/10/20	Camberwell	Evening	15	Cloudy	25, W	NA
3	City of London Corporation	20/10/20	City of London	Morning	13	Cloudy	19, S	0.88
4	Royal Borough of Kensington & Chelsea	15/10/20	Cromwell Road	Evening	13	Cloudy	16, NNE	NA
5	London Borough of Lewisham	13/10/20	Deptford	Morning	8	Partly	11, NW	NA
6	The Fitzrovia Partnership	21/10/20	Fitzrovia	Evening	15	Cloudy	24, W	0.54
7	London Borough of Camden	6/10/20	Great Ormond Street Hospital	Morning	11	Partly	20, WSW	NA
8	London Borough of Islington	20/10/20	Holloway Road	Evening	18	Cloudy	22, SSW	0.85
9	London Borough of Richmond upon Thames	1/10/20	Richmond	Morning	10	Partly	9, W	NA
10	London Borough of Haringey	14/10/20	Seven Sisters	Evening	12	Cloudy	19, NE	NA
11	London Borough of Hammersmith & Fulham	22/10/20	Shepherd's Bush	Morning	13	Partly	17, SW	0.69
12	City of Westminster	15/10/20	Soho	Morning	8	Partly	14, NNE	1.09
13	South Bank BID	1/10/20	South Bank	Evening	13	Clear	10, WNW	1.32
14	London Borough of Wandsworth	7/10/20	Tooting	Morning	9	Partly	16, W	NA
15	London Borough of Merton	7/10/20	Wimbledon	Evening	15	Partly	18, W	NA

2. Methodology

2.3 Data analysis

The following data processing and analysis steps have been undertaken for each route pair.

01 **Data retrieval:** retrieval of data from monitoring devices;

02 **Ozone correction:** subtraction of ozone concentrations from the corresponding raw NO_2 measurements to produce a 'final NO_2' concentration;

03 **Check for systematic bias:** comparison of data between each monitor to determine the presence of any systematic bias;

04 **NO_2 adjustment:** calculation of appropriate NO_2 adjustment factors to enable simultaneous Clean Air Route and standard route results to be directly compared;

05 **Processing location data:** processing discrete monitoring location data for all air pollutant parameters;

06 **Determine pollutant concentrations:** NO_2, $PM_{2.5}$ and PM_{10} values assigned to each discrete location;

07 **Exposure difference:** comparison of results for each route pair and calculation of the reduction in exposure to air pollutants expected by a pedestrian (or cyclist) choosing the Clean Air Route. For each route pair, the following have been calculated:

- **Average NO_2 benefit** across all measurement 'runs'
- **Maximum NO_2 benefit** from an individual measurement 'run'

All values are provided as a percentage, in part per million (ppm) and in $\mu g/m^3$;

08 **Time-history graphs:** two types of time-history graphs produced for each route pair at 60-second intervals. These compare:

- **NO_2 concentrations** at each measurement location
- **Cumulative NO_2 exposure**

Graphs are displayed for a single 'route run' in the main report, with all graphs available upon request;

09 **Map visualisation:** generation of maps displaying the Clean Air Routes and standard routes. The average pollutant concentrations are also displayed on each map, alongside a summary of the benefit in taking the Clean Air Route. Each map and metric has been scaled to that location and therefore cannot be directly compared against other locations. This is due to a large range in concentrations between locations and enables clearer visualisation of the difference between the Clean Air Route and standard routes;

10 **Comparison of other environmental factors:** calculation of the following environmental parameters along each route pair using mapping and modelling techniques.

- **Noise level** (in decibels, dB);
- **Green space** – average area (in m^2) of green elements;
- **Blue space** – average area (in m^2) of blue or water elements;
- **Tree cover** – average area (in m^2) of tree cover;
- **Tranquil City Index** – a multifactor indicator that scores the potential for a location to be good for wellbeing;
- **Healthy Streets Index** – a multifactor indicator that scores the potential for a street to provide conditions that are positive for walking and cycling.

3. Results summary

3.1 Routes

Through engagement with partners and local stakeholders, 15 potential new Clean Air Routes were identified. The Clean Air Routes developed in this report can be explored via CRP's **Clean Air Route Finder.**

3.2 Nitrogen dioxide

A summary of the NO_2 results for each of the 15 route pairs monitored are presented in the table on the next page. Time-history graphs and map visualisations are presented for each route pair in section 4.

Average exposure to NO_2 was between 6% and 23% lower on the Clean Air Routes, with an average of 16%.

In absolute terms, the average concentration of NO_2 on the Clean Air Routes was between 10 and 33 µg/m^3 lower than on the standard routes.

The maximum NO_2 reductions observed were between 17% and 41% for the Clean Air Routes, with an average of 29%.

The maximum NO_2 benefits observed revealed concentrations up to 59 µg/m^3 lower on the Clean Air Routes.

The results for one proposed route—the Museums to Gloucester Road Station (Royal Borough of Kensington & Chelsea)—did not demonstrate a benefit in taking the proposed Clean Air Route. NO_2 concentrations were on average 6% higher than on the standard route. This outcome is discussed in greater detail in section 4.4 below.

3.3 Particulate matter

Particulate matter results are presented in Appendix A. Measured concentrations for both $PM_{2.5}$ and PM_{10} were generally very low along both Clean Air Routes and standard routes. The monitor clearly recorded high levels of particulate matter next to an obvious source, such as an idling lorry, but was poorly suited to the general ambient concentrations in London. There were numerous readings where zero concentrations for $PM_{2.5}$ and PM_{10} were recorded.

Where NO_2 concentrations were particularly high on the standard route, indicating more traffic pollution, a clear benefit was demonstrated in terms of reduced exposure to particulate matter by taking the Clean Air Route. In other cases, traffic conditions on the standard route were low. This could be explained, in part, by disruptions brought about by the Covid-19 pandemic. Where particulate matter levels were low, brief instances of high particulate matter, such as passing an idling lorry, skewed the average results. As a result, clear conclusions could not be drawn with regard to differences in exposure.

Monitored NO_2 predominantly comes from road traffic emissions, and therefore increases significantly at roadside locations on the standard routes. In contrast, large proportions of particulate matter are transported from other parts of southern England and Europe. The differences between particulate matter concentrations on the standard route and Clean Air Route are less extreme than observed for NO_2. Despite this, it is understood that concentrations of particulate matter on the Clean Air Routes are likely to be consistently lower than on the standard routes, based on a robust understanding of the sources of particulate matter,

3. Results summary

Table 3.1. Summary of nitrogen dioxide results for each potential Clean Air Route.

		Average NO_2 benefit			Maximum NO_2 benefit		
CAV3 Partner	**Location (origin and destination)**	**Percentage**	**ppm**	**µg/m^3**	**Percentage**	**ppm**	**µg/m^3**
Angel.london	Farringdon Station to Islington Green	6%	0.0054	10	17%	0.0149	29
London Borough of Lambeth	King's College Hospital to Camberwell Green	10%	0.0050	10	29%	0.0131	25
City of London Corporation	Monument to Liverpool Street Station	13%	0.0079	15	28%	0.0121	23
Royal Borough of Kensington & Chelsea	The Museums to Gloucester Road Station	-6%	-0.0030	-6	7%	0.0040	8
London Borough of Lewisham	New Cross Gate to Deptford High Street	20%	0.0147	28	32%	0.0185	35
The Fitzrovia Partnership	Euston Station to Charlotte Street	11%	0.0094	18	23%	0.0165	32
London Borough of Camden	Kings Cross to Great Ormond Street Hospital	11%	0.0066	13	18%	0.0104	20
London Borough of Islington	Holloway Road Station to Sobell Leisure Centre	13%	0.0063	12	25%	0.0097	19
London Borough of Richmond upon Thames	Thames Riverside to Richmond Station	23%	0.0172	33	30%	0.0207	40
London Borough of Haringey	Seven Sisters Station to St Ann's Hospital	16%	0.0127	24	37%	0.0307	59
London Borough of Hammersmith & Fulham	White City Place to Goldhawk Road Station	18%	0.0122	23	30%	0.0222	42
City of Westminster	Tottenham Court Road Station to Piccadilly Circus	15%	0.0111	21	26%	0.0204	39
South Bank BID	Waterloo Station to St Thomas' Hospital	26%	0.0171	33	36%	0.0245	47
	Waterloo Station to OXO Tower	19%	0.0108	21	26%	0.0133	26
London Borough of Wandsworth	Tooting Broadway to St George's Hospital	14%	0.0109	21	38%	0.0303	58
London Borough of Merton	Wimbledon Station to South Wimbledon Station	23%	0.0135	26	41%	0.0273	52

4. Route results

4.1 Farringdon Station to Islington Green

In collaboration with angel.london, CRP decided to create the first clean air cycling route, aimed at those commuting into Angel Town Centre. Farringdon Station is a London Underground and mainline National Rail station directly south of Angel. Development of a clean air cycling route between Farringdon Station and Islington Green aims to encourage active travel among business employees.

This Clean Air Route provided a *reasonable* reduction in NO_2 concentrations. There was on average a 6% reduction in the mean NO_2 concentration (0.0054 ppm or 10 µg/m^3) relative to the standard route, with the highest reduction being 17% (0.0149 ppm or 29 µg/m^3). The Clean Air Route was also significantly quieter and more relaxing to walk along as it passes through pleasant residential areas like Colebrooke Row. The standard route was more polluted as a result of the traffic congestion on Islington High Street and at the junction with City Road. Traffic levels were relatively low on other parts of the standard route and traffic flow was fairly uncongested during monitoring. This explains why the benefits of the Clean Air Route were not as high as for other routes.

While the benefits in terms of exposure to NO_2 are small for this route, these will be greater once incorporated as part of a regular routine. By choosing quieter streets and maximising the use of established cycling infrastructure, the clean air cycling route is ideal for new and less confident cyclists, alongside those wishing to minimise their exposure to pollution.

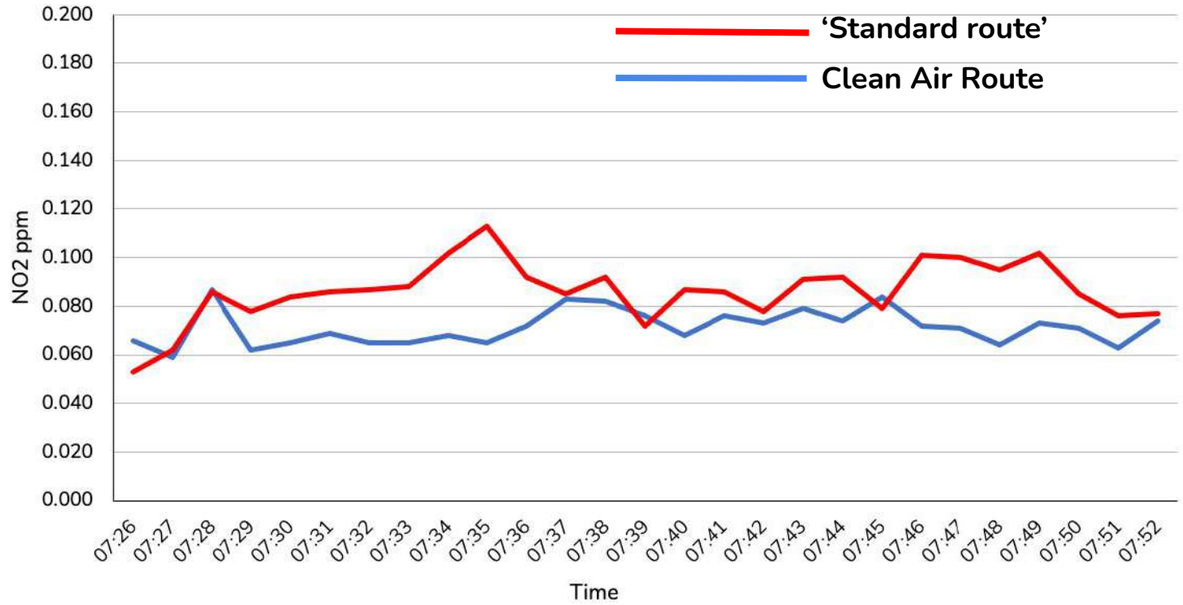


Figure 4.1a. Time history graph for NO_2 concentrations (Run 1).

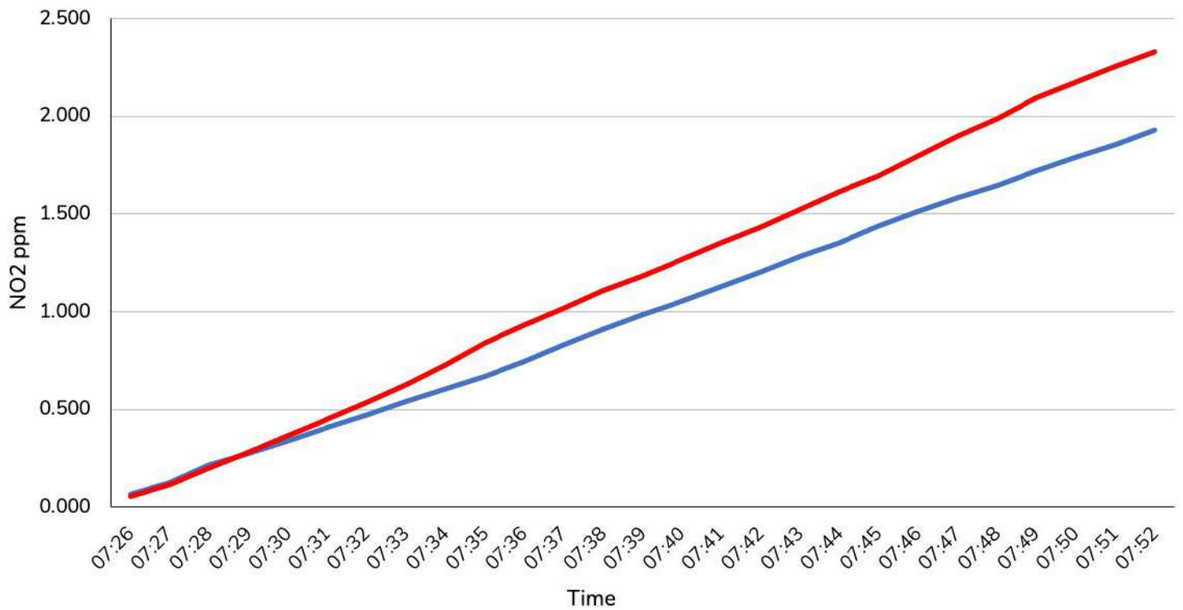


Figure 4.1b. Time history graph for cumulative NO_2 concentrations (Run 1).

4. Route results

4.1 Farringdon Station to Islington Green

4. Route results

4.2 King's College Hospital to Camberwell Green

CRP has engaged with local hospitals and health practices in the London Borough of Lambeth as part of CAV3. This Clean Air Route was devised in collaboration with King's College Hospital, a major NHS centre located in Denmark Hill close to Camberwell. It was established that a route between the Hospital and nearby Camberwell Green would offer an alternative for staff and visitors looking for a quiet, low pollution lunchtime walk.

The Clean Air Route provided a *reasonable* reduction in NO_2 concentrations. There was on average a 10% reduction in the average NO_2 concentration (0.0050 ppm or 10 µg/m^3) relative to the standard route, with the highest reduction being 29% (0.0131 ppm or 25 µg/m^3). The Clean Air Route was more pleasant than the standard route as it passes along quiet residential streets. Unfortunately, levels of NO_2 were elevated along the section of the Clean Air Route that passes along Peckham Road. However, it is necessary to travel along Peckham Road in order to access Camberwell Green. The standard route was more polluted than the Clean Air Route due to both the volume of traffic and congestion caused by traffic lights on Denmark Hill (A215).

While the benefits in terms of exposure to NO_2 are small for this route, these will be greater once incorporated as part of a regular routine. Being greener and quieter, this route offers potential to encourage staff to get outside during a break, while connecting them with the cafés and independent shops on offer along Peckham Road.

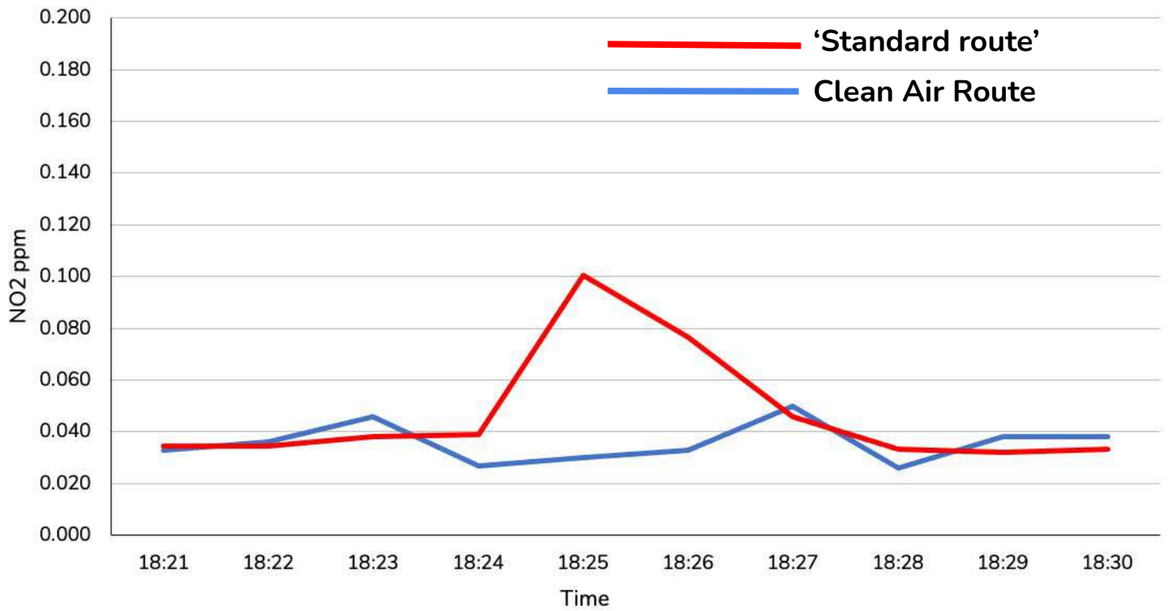


Figure 4.2a. Time history graph for NO_2 concentrations (Run 3).

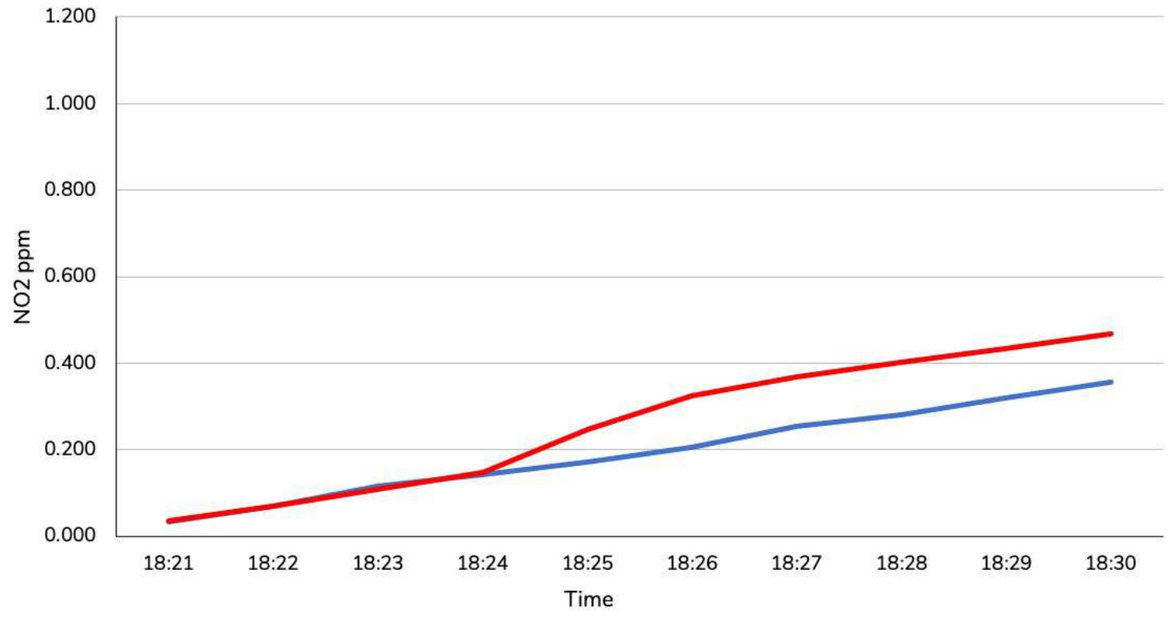
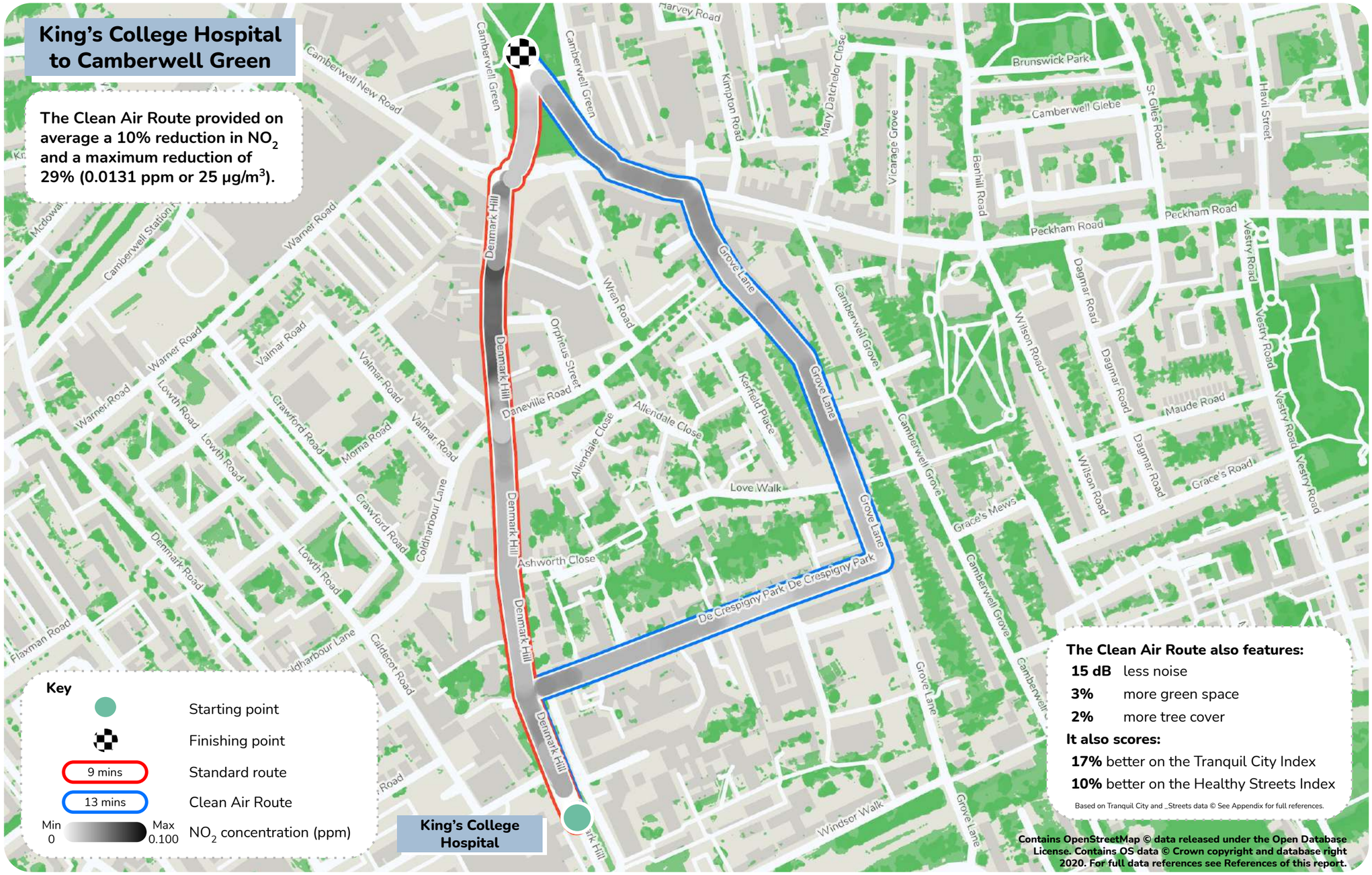


Figure 4.2b. Time history graph for cumulative NO_2 concentrations (Run 3).

4. Route results

4.2 King's College Hospital to Camberwell Green



4. Route results

4.3 Monument to Liverpool Street Station

In collaboration with the City of London Corporation, CRP has engaged with communities in the area between Monument and Houndsditch. Typically, a large number of tourists are drawn to this area for the historic building and landmarks, as well as key destinations such as Leadenhall Market. Located at the northern end of this area, Liverpool Street Station is a key central London Underground and mainline station. A new Clean Air Route was devised to connect Monument with Liverpool Street Station, while offering a scenic, interesting and quieter alternative to walking along Bishopsgate.

The Clean Air Route provided a *reasonable* reduction in NO_2 concentrations. There was on average a 13% reduction in the average NO_2 concentration (0.0079 ppm or 15 µg/m^3) relative to the standard route, with the highest reduction being 28% (0.0121 ppm or 23 µg/m^3). The Clean Air Route was more appealing than the standard route as it passes interesting architectural sites such as the Gherkin and the Leadenhall Building, as well as some of London's oldest churches. The Standard route was more polluted than the Clean Air Route because of higher levels of traffic on Gracechurch Street and Bishopsgate. However, owing to the Covid-19 pandemic, traffic levels along Bishopsgate (the standard route) were significantly reduced. As such, the observed reduction in pollution exposure was not as high as for some other Clean Air Routes. If traffic levels were to return to pre-pandemic levels, the benefits offered by the Clean Air Route would be expected to be far higher than stated here. Regardless, there is good potential for this walking route, owing to its interesting nature.

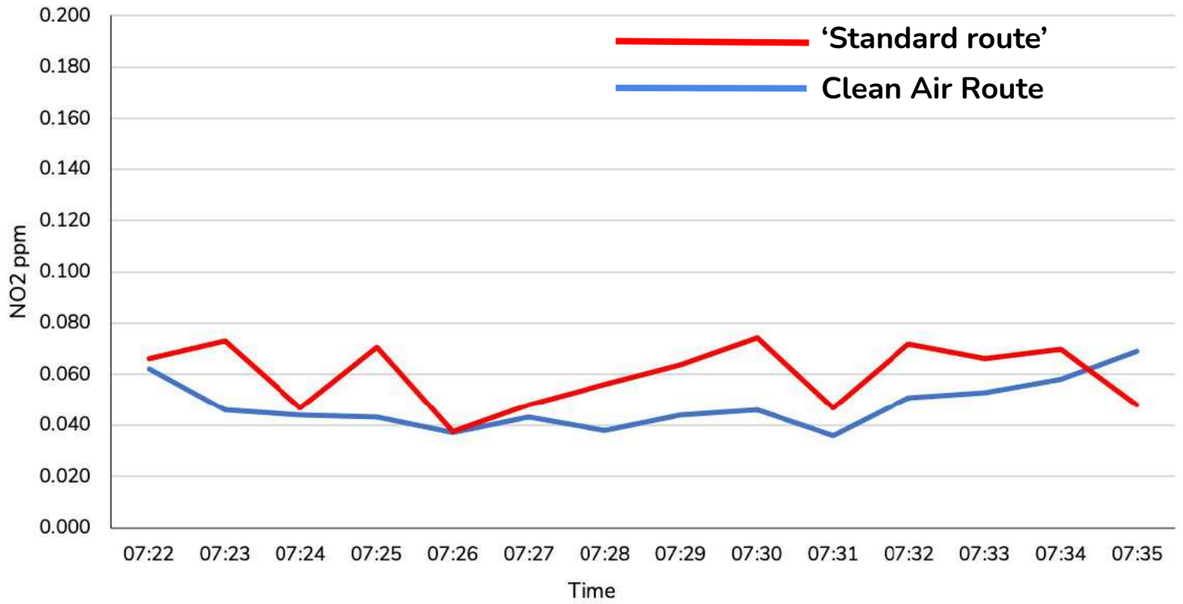


Figure 4.3a. Time history graph for NO_2 concentrations (Run 1).

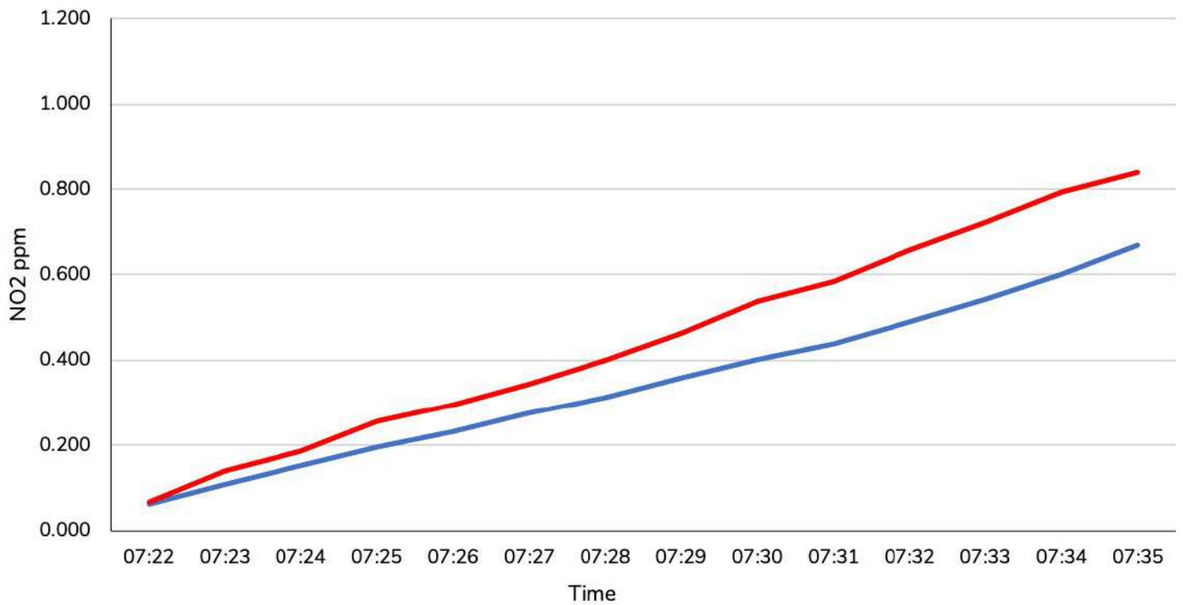
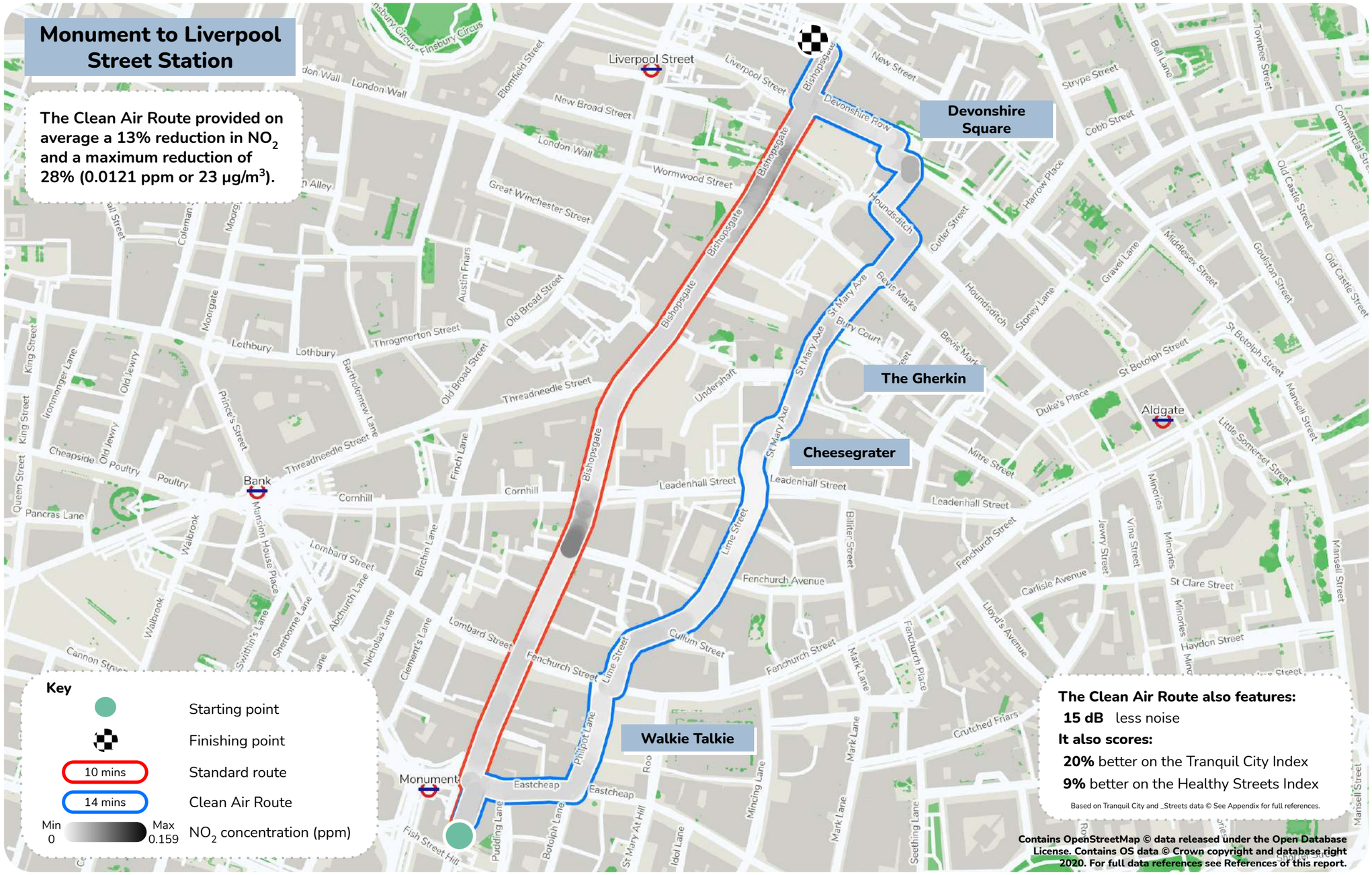


Figure 4.3b. Time history graph for cumulative NO_2 concentrations (Run 1).

4. Route results

4.3 Monument to Liverpool Street Station



4. Route results

4.4 The Museums to Gloucester Road Station

As part of the CAV3 programme, CRP has engaged with businesses along Cromwell Road. The area surrounding this busy main road is home to a number of educational and cultural sites, including the Natural History Museum, Science Museum, Victoria and Albert Museum and Imperial College London. As the closest station to these key destinations, South Kensington Underground Station is typically very busy. In collaboration with the Royal Borough of Kensington & Chelsea, CRP devised a walking route between Gloucester Road Station and the Museums on Exhibition Road to serve as an alternative for those arriving via South Kensington.

The proposed Clean Air Route provided a small *increase* in NO_2 concentrations. There was on average a 6% increase in the average NO_2 concentration (0.0030 ppm or 6 µg/m^3) relative to the standard route, with the highest reduction in a route run being 7% (0.0040 ppm or 8 µg/m^3). While the proposed Clean Air Route passes through the pedestrianised area around South Kensington Station, congested traffic flow on Harrington Road and Stanhope Gardens resulted in no overall benefits being observed. As with a number of other route pairs, traffic levels along the standard route are also likely to have been reduced by the Covid-19 pandemic. It was also noted that major roadworks, such as the closure of Hammersmith Bridge, were impacting traffic flow in the area, which may explain the higher levels of congestion observed along Harrington Road. As there was no reduction in exposure to pollution, this route will not be classified as a Clean Air Route.

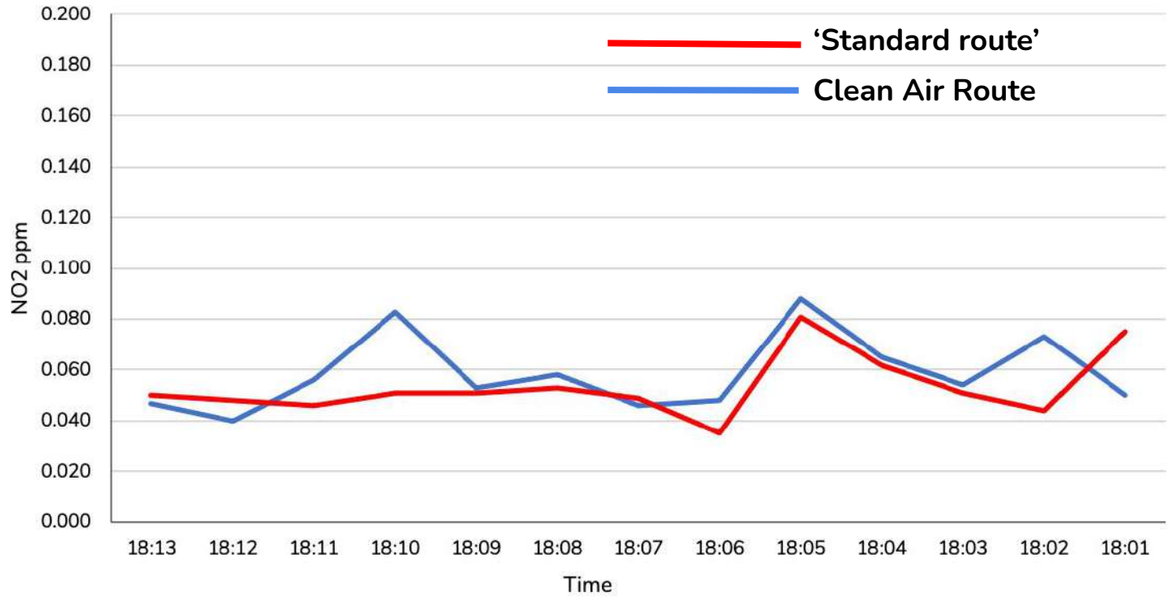


Figure 4.4a. Time history graph for NO_2 concentrations (Run 4).

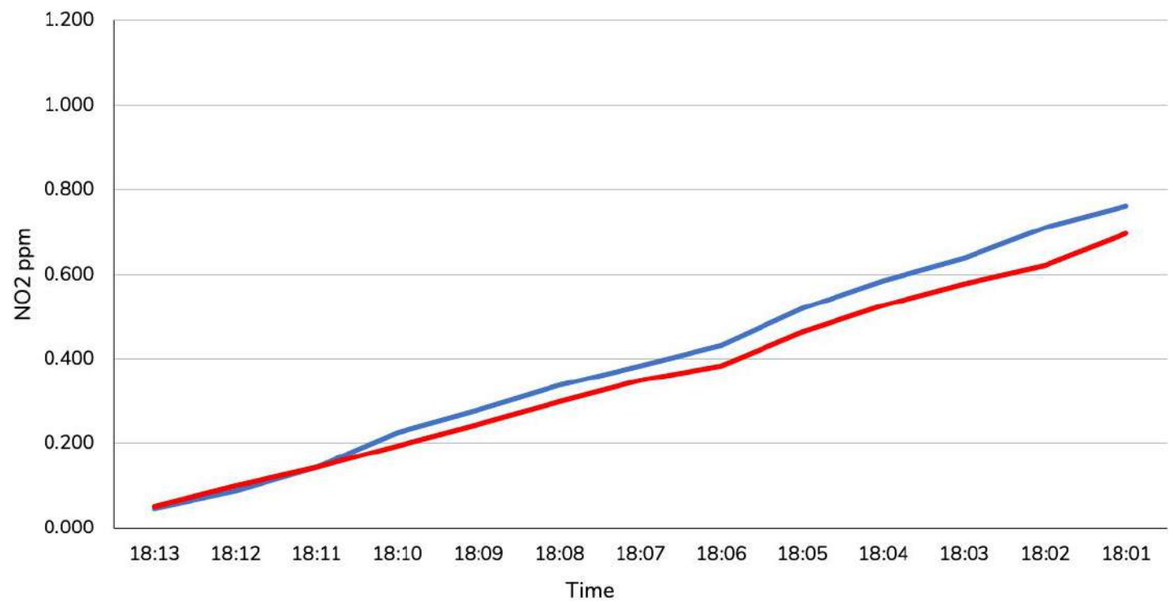
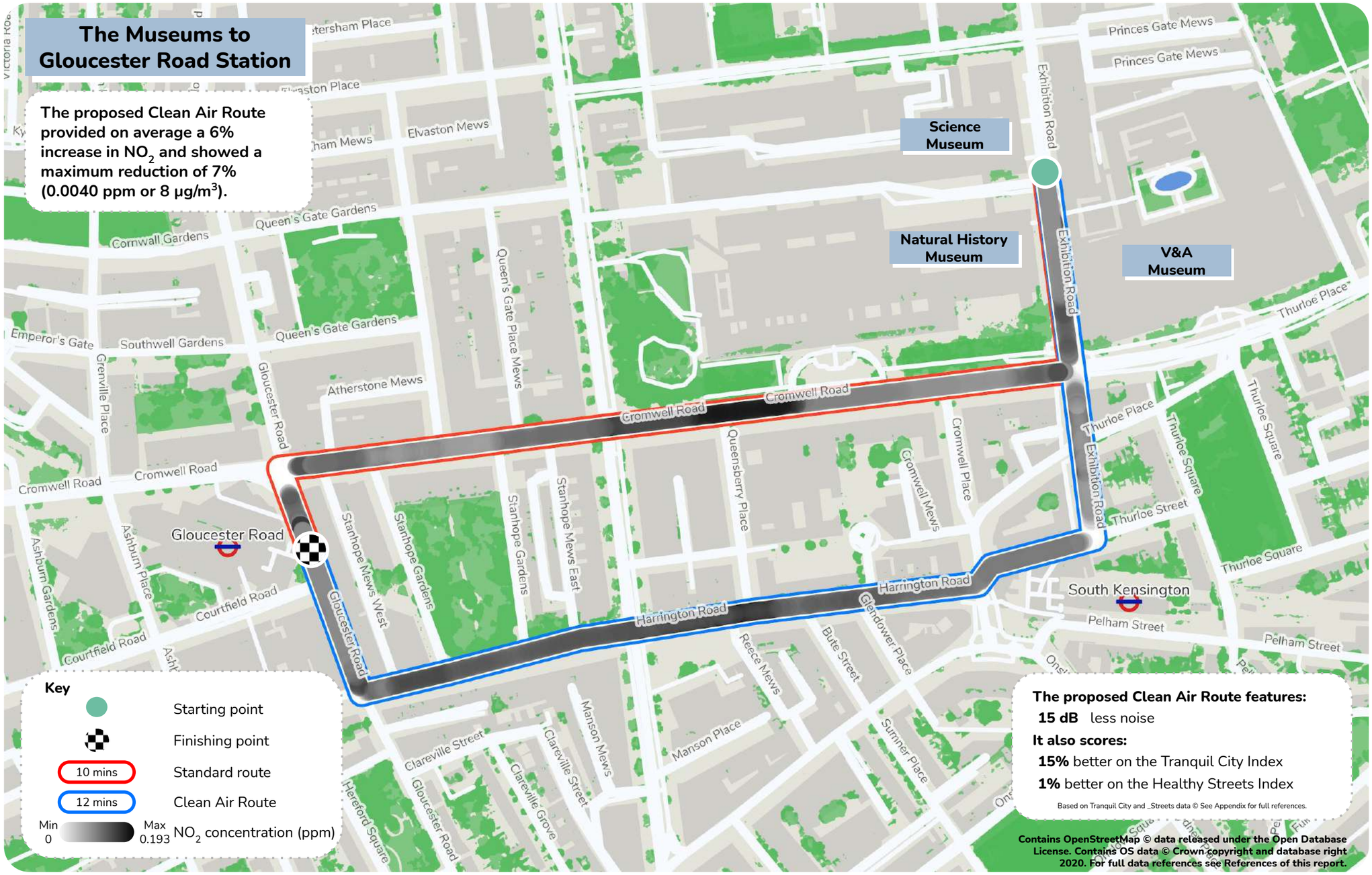


Figure 4.4b. Time history graph for cumulative NO_2 concentrations (Run 4).

4. Route results

4.4 The Museums to Gloucester Road Station



4. Route results

4.5 New Cross Gate to Deptford High Street

In collaboration with the London Borough of Lewisham, CRP has devised a walking route to connect Deptford High Street with nearby New Cross and New Cross Gate Stations. The aim for this route is to encourage new audiences to travel into the Deptford area. While there is an existing station serving Deptford High Street, New Cross and New Cross Gate offer connections with new areas of the borough and beyond. New Cross Road, which connects these stations with Deptford High Street, is a busy arterial road with typically high levels of pollution and congestion. The Clean Air Route is able to avoid this, guiding pedestrians and cyclists through Fordham Park, along Douglas Way and through Margaret McMillan Park. There are already a number of walking routes that make use of this pleasant stretch of pathways. However, for the first time, real-world pollution levels have been measured and the benefits quantified.

The Clean Air Route provided a *good* reduction in NO_2 concentrations. There was on average a 20% reduction in the average NO_2 concentration (0.0147 ppm or 28 µg/m^3) relative to the standard route, with the highest reduction being 32% (0.0185 ppm or 35 µg/m^3). The standard route was more polluted than the Clean Air Route because of congested traffic flow on New Cross Road. This was particularly evident around the junction with Florence Road. The Clean Air Route was generally more pleasant and quieter than the standard route as it passed by cultural sites and through green spaces, such as Fordham Park.

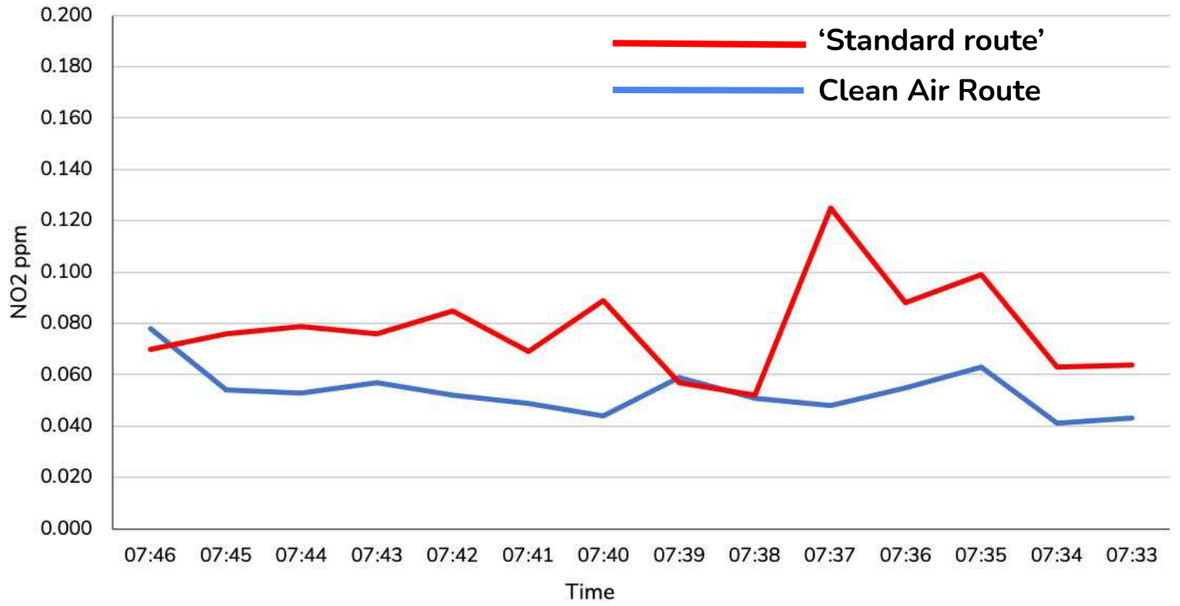


Figure 4.5a. Time history graph for NO_2 concentrations (Run 2).

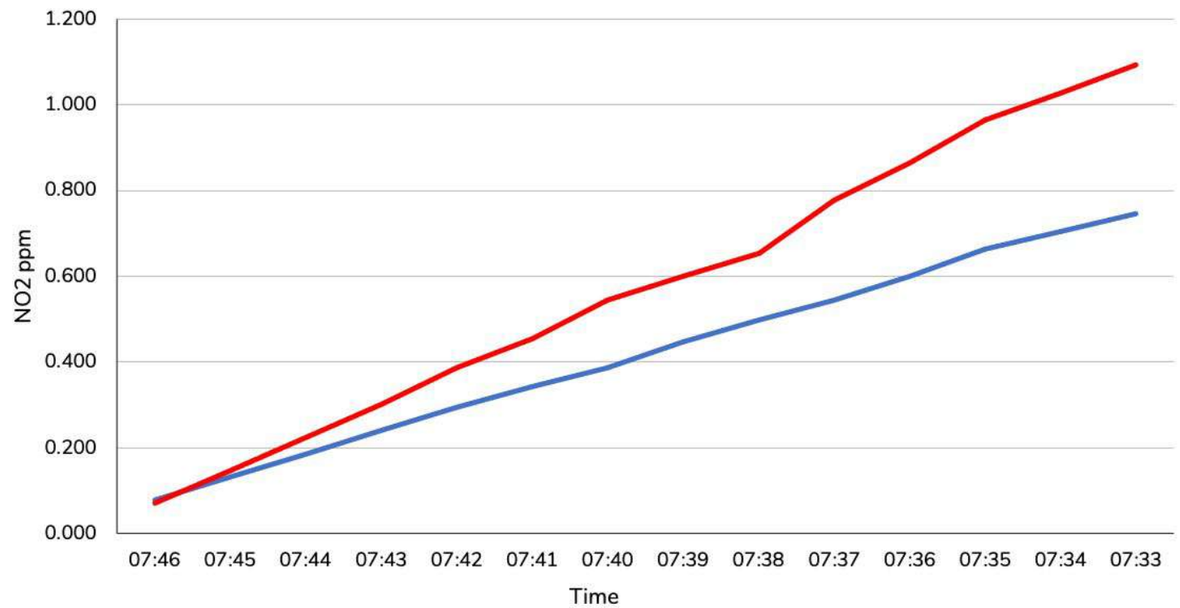
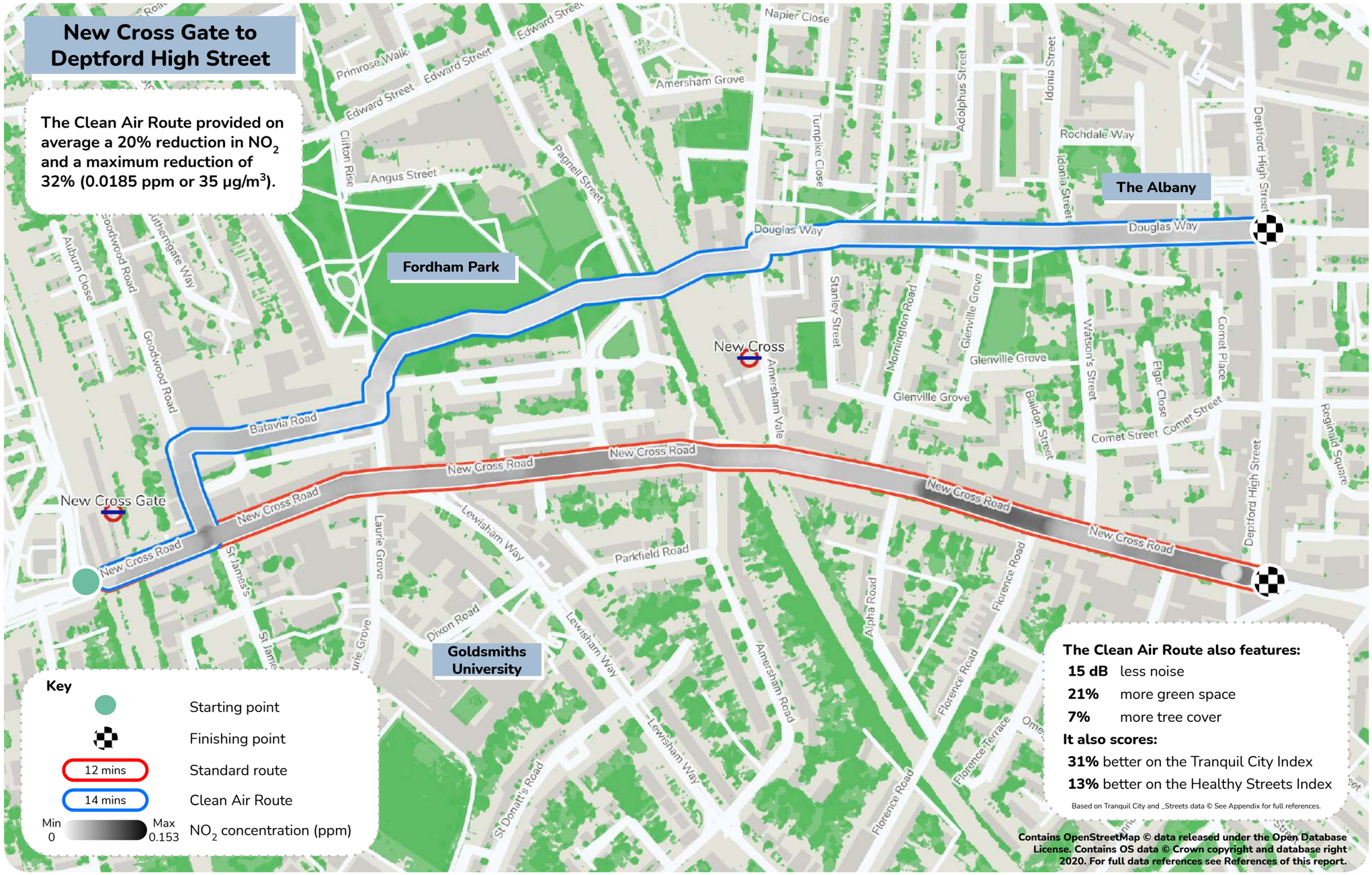


Figure 4.5b. Time history graph for cumulative NO_2 concentrations (Run 2).

4. Route results

4.5 New Cross Gate to Deptford High Street



4. Route results

4.6 Euston Station to Charlotte Street

As part of the CAV3 programme, and in collaboration with The Fitzrovia Partnership, CRP has created a walking route for commuters and visitors travelling between Euston Station and Charlotte Street South. There is already an extensive network of walking routes in this part of the city, including a circular 'Fitzrovia Mile' route developed by the BID, and a number of walking trails developed by Arup in partnership with Go Jauntly. However, it is understood that for the first time, real-world pollution levels have been measured and the benefits quantified.

The Clean Air Route provided a *reasonable* reduction in NO_2 concentrations. There was on average an 11% reduction in the average NO_2 concentration (0.0094 ppm or 18 µg/m^3) relative to the standard route, with the highest reduction being 23% (0.0165 ppm or 32 µg/m^3). The Clean Air Route passes along many interesting streets that also have low volumes of traffic. The standard route was more polluted as it passed along Euston Road and Tottenham Court Road. However, owing to the Covid-19 pandemic, traffic levels along the standard route were significantly reduced. As such, the observed reduction in pollution exposure was not as high as for some other Clean Air Routes. If traffic levels were to return to pre-pandemic levels, the benefits offered by the Clean Air Route would be expected to be far higher than stated here. There remains a good potential for this route, and the long-term reduction in exposure would be significant when incorporated as part of a regular routine.

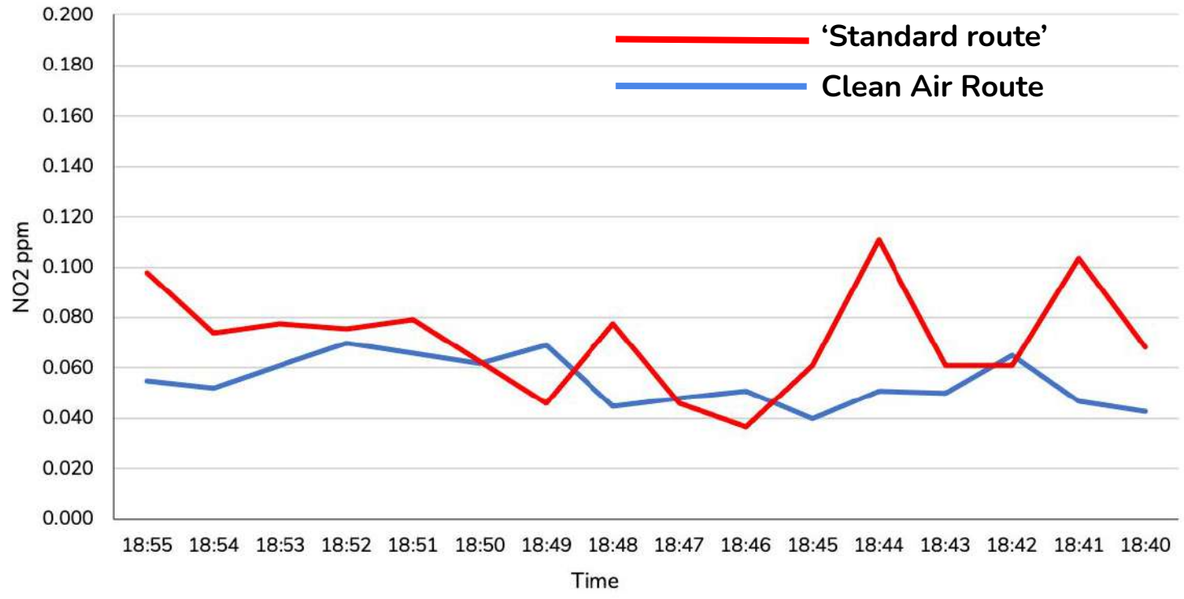


Figure 4.6a. Time history graph for NO_2 concentrations (Run 4).

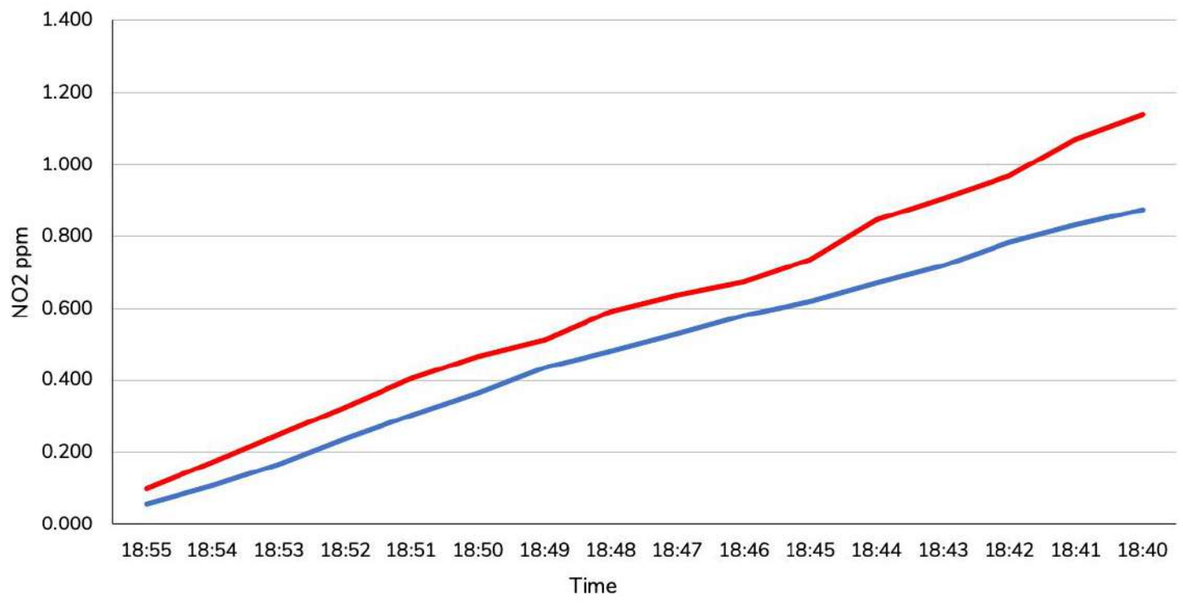
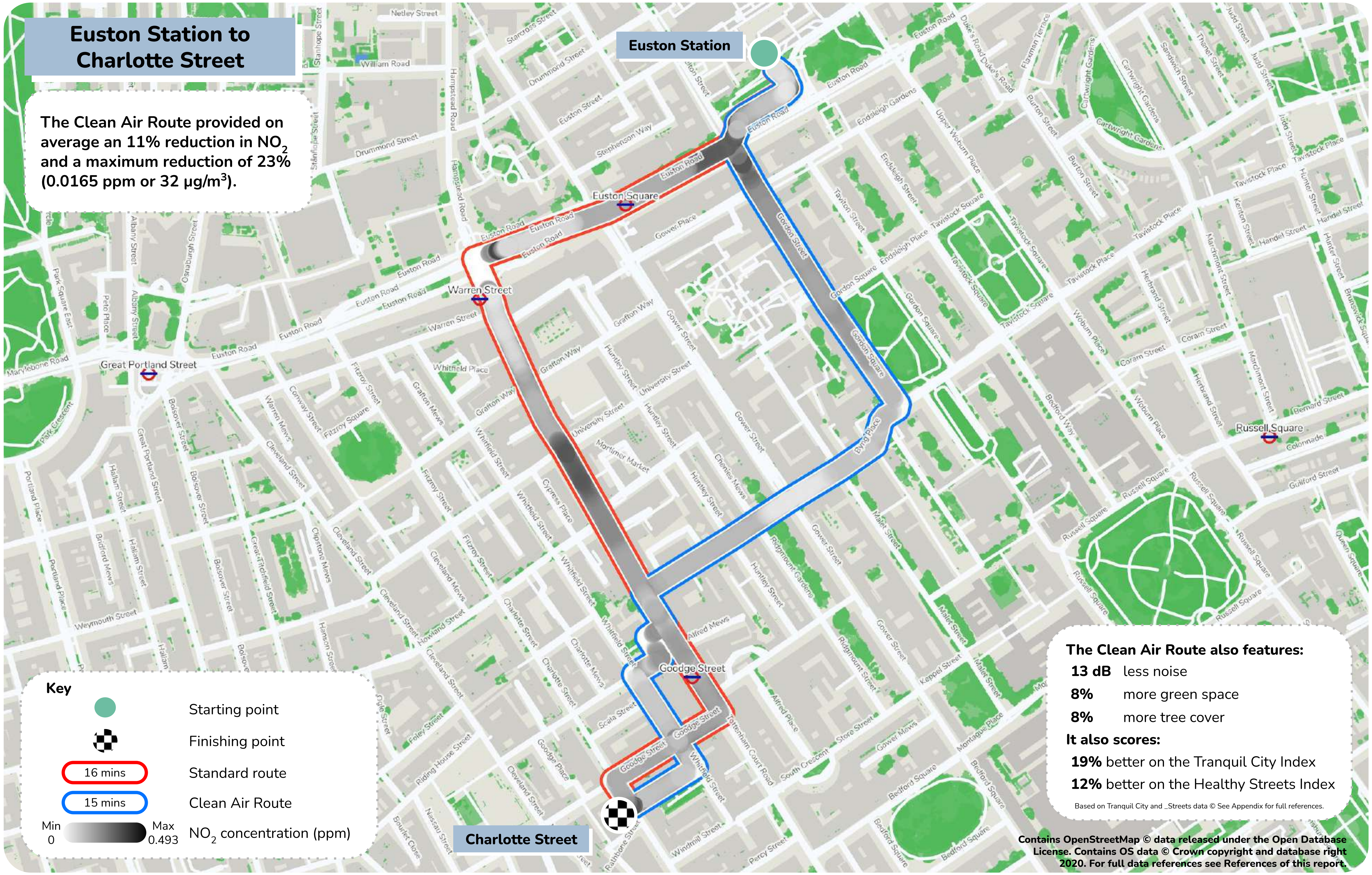


Figure 4.6b. Time history graph for cumulative NO_2 concentrations (Run 4).

4. Route results

4.6 Euston Station to Charlotte Street



4. Route results

4.7 King's Cross to Great Ormond Street Hospital

This Clean Air Route was devised in collaboration with the London Borough of Camden, with the aim to serve visitors to Great Ormond Street Hospital (GOSH). This notable children's hospital is located in the Bloomsbury area, surrounded by a number of cultural and educational institutions. GOSH have previously developed several walking routes between nearby train stations and the hospital. Monitoring of the existing route from King's Cross Station was proposed to quantify the potential benefits, and to support this route's promotion.

The Clean Air Route provided a *reasonable* reduction in NO_2 concentrations. There was on average an 11% reduction in the average NO_2 concentration (0.0066 ppm or 13 µg/m^3) relative to the standard route, with the highest reduction being 18% (0.0104 ppm or 20 µg/m^3). The Standard route was more polluted than the Clean Air Route because of higher levels of traffic on Grays Inn Road. While congestion was notably high close to King's Cross Station, traffic levels along Gray's Inn Road appeared reduced, potentially as a result of the Covid-19 pandemic. As such, the observed reduction in pollution exposure was not as high as for some other Clean Air Routes.

CRP understands that the challenge of travel to and from hospital sites, such as GOSH, has been increased by the Covid-19 situation. At the time of writing, public transport may be neither a practical nor safe option for patients and their families. CRP respects the decisions of each individual, and it is hoped that this Clean Air Route can provide a long-term alternative for those who feel safe to use it.

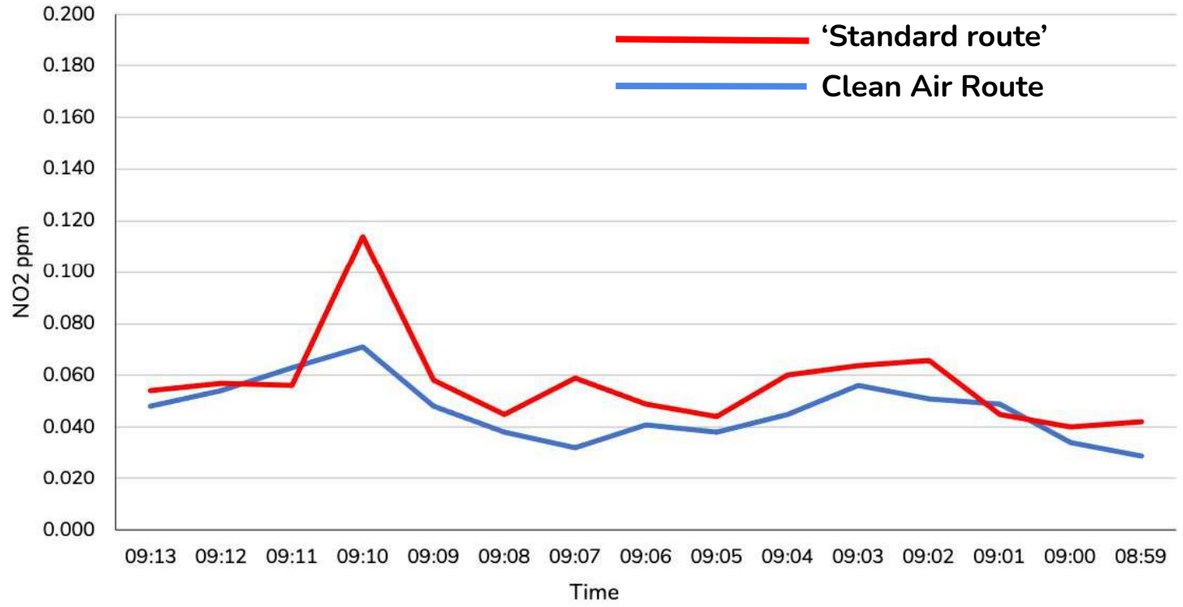


Figure 4.7a. Time history graph for NO_2 concentrations (Run 6).

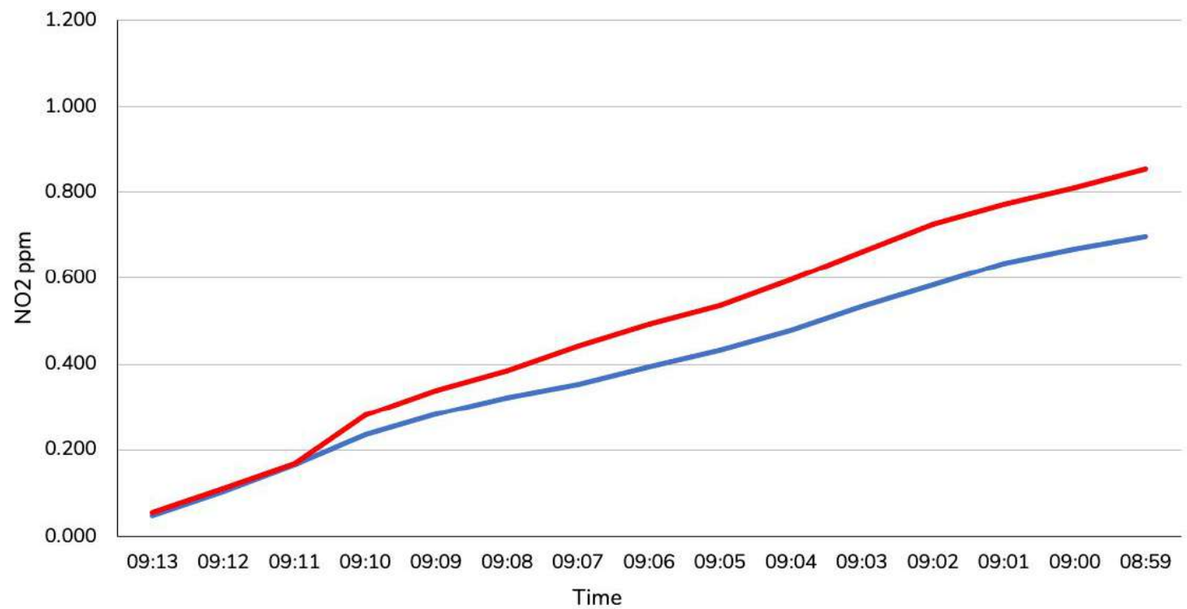
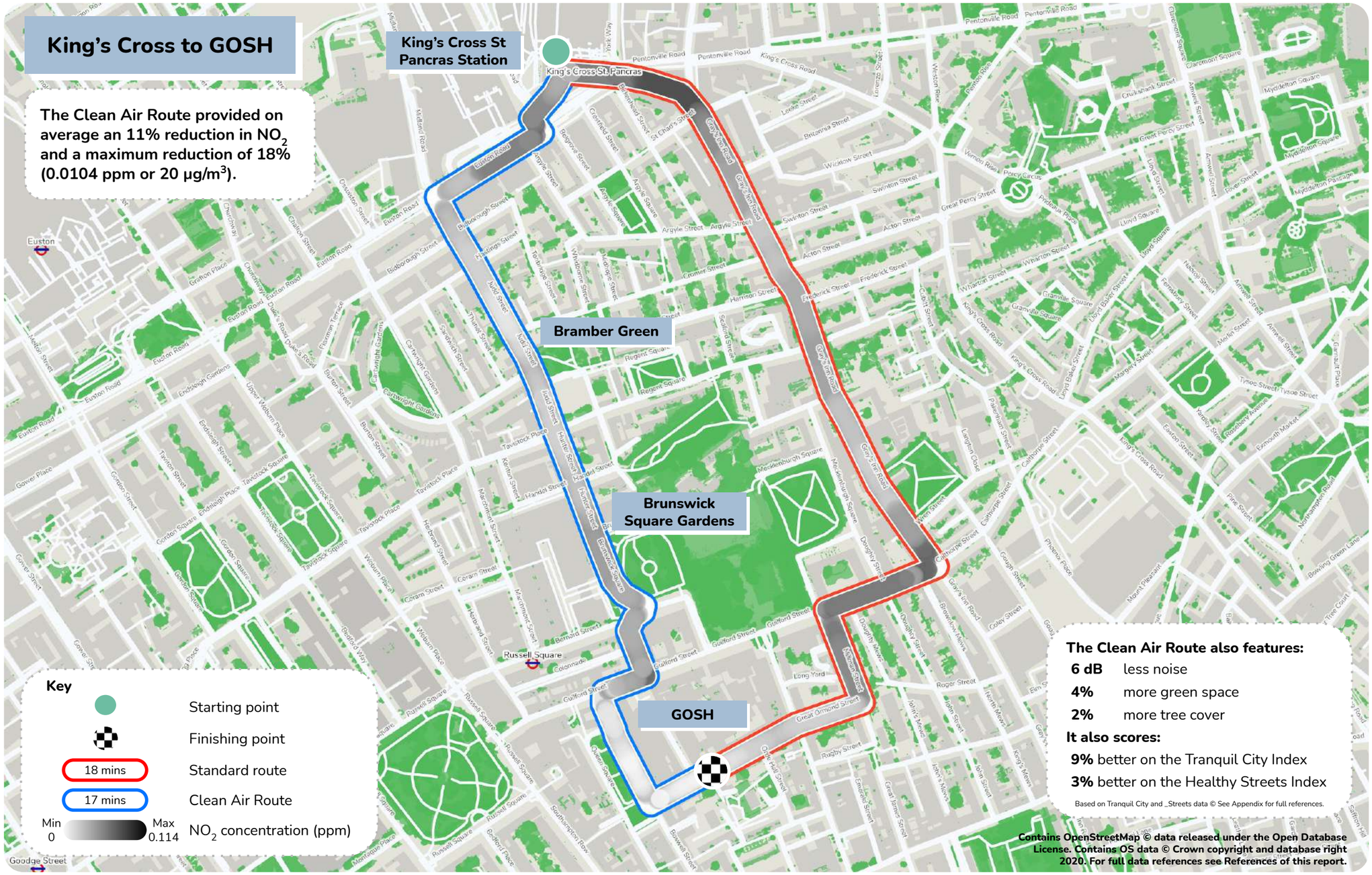


Figure 4.7b. Time history graph for cumulative NO_2 concentrations (Run 6).

4. Route results

4.7 King’s Cross to Great Ormond Street Hospital (GOSH)



4. Route results

4.8 Holloway Road Station to Sobell Leisure Centre

As part of the CAV3 programme, and in collaboration with the London Borough of Islington, CRP has engaged with businesses along Holloway Road, with a focus on the Nag's Head area. Originally, it was hoped that a walking route could be developed to incorporate Nag's Head Market. It was difficult to find a suitable origin destination, as visitors to the market largely arrive on foot or by bus. An alternative walking route between Holloway Road Underground Station and the Sobell Leisure Centre was found to be more suitable. From this route, it is easy to reach Nag's Head Market by continuing along Annette Road and on to Roden Street, both of which are quiet and pleasant streets.

The Clean Air Route provided a *reasonable* reduction in NO_2 concentrations. There was on average a 13% reduction in the average NO_2 concentration (0.0063 ppm or 12 µg/m^3) relative to the standard route, with the highest reduction being 25% (0.0097 ppm or 19 µg/m^3). The Clean Air Route was quieter and more pleasant to walk along than the standard route as it passes along residential streets. The standard route was highly polluted as a result of the volume of traffic passing along Holloway Road and Tollington Road. There was a significant amount of idling traffic, and associated emissions, at the junction between these roads.

In October 2020, Islington opened its first Covid-19 testing site in the car park of the Sobell Leisure Centre. At the time of writing it is understood that the Sobell Leisure Centre remains closed, in line with UK Government restrictions. It is hoped that this Clean Air Route can provide a long-term alternative, once it is appropriate to do so.

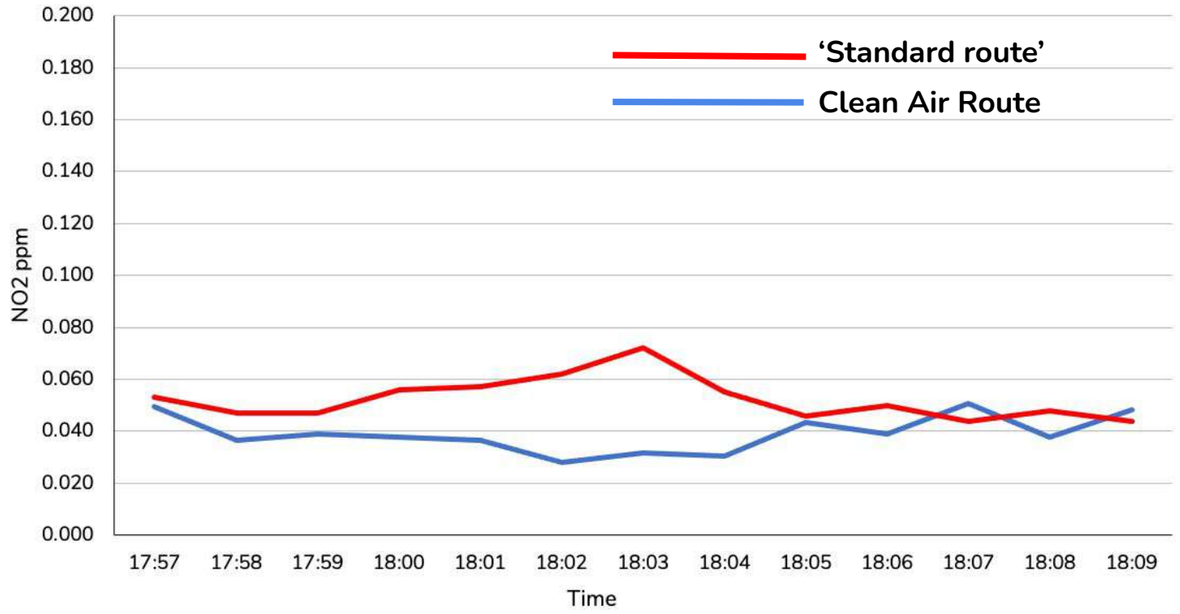


Figure 4.8a. Time history graph for NO_2 concentrations (Run 3).

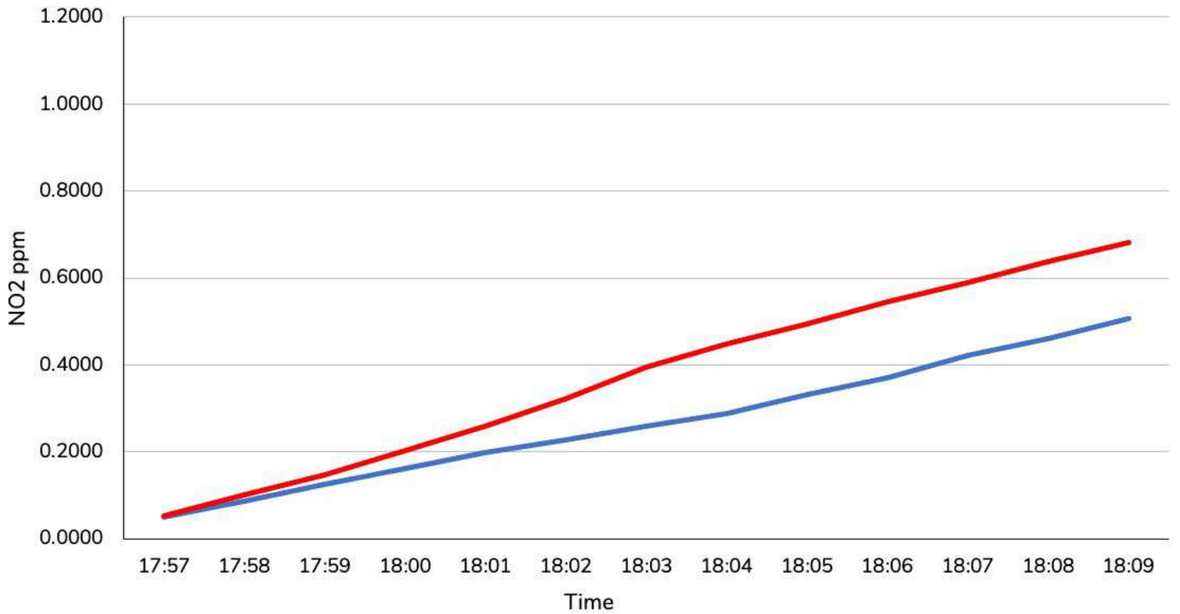
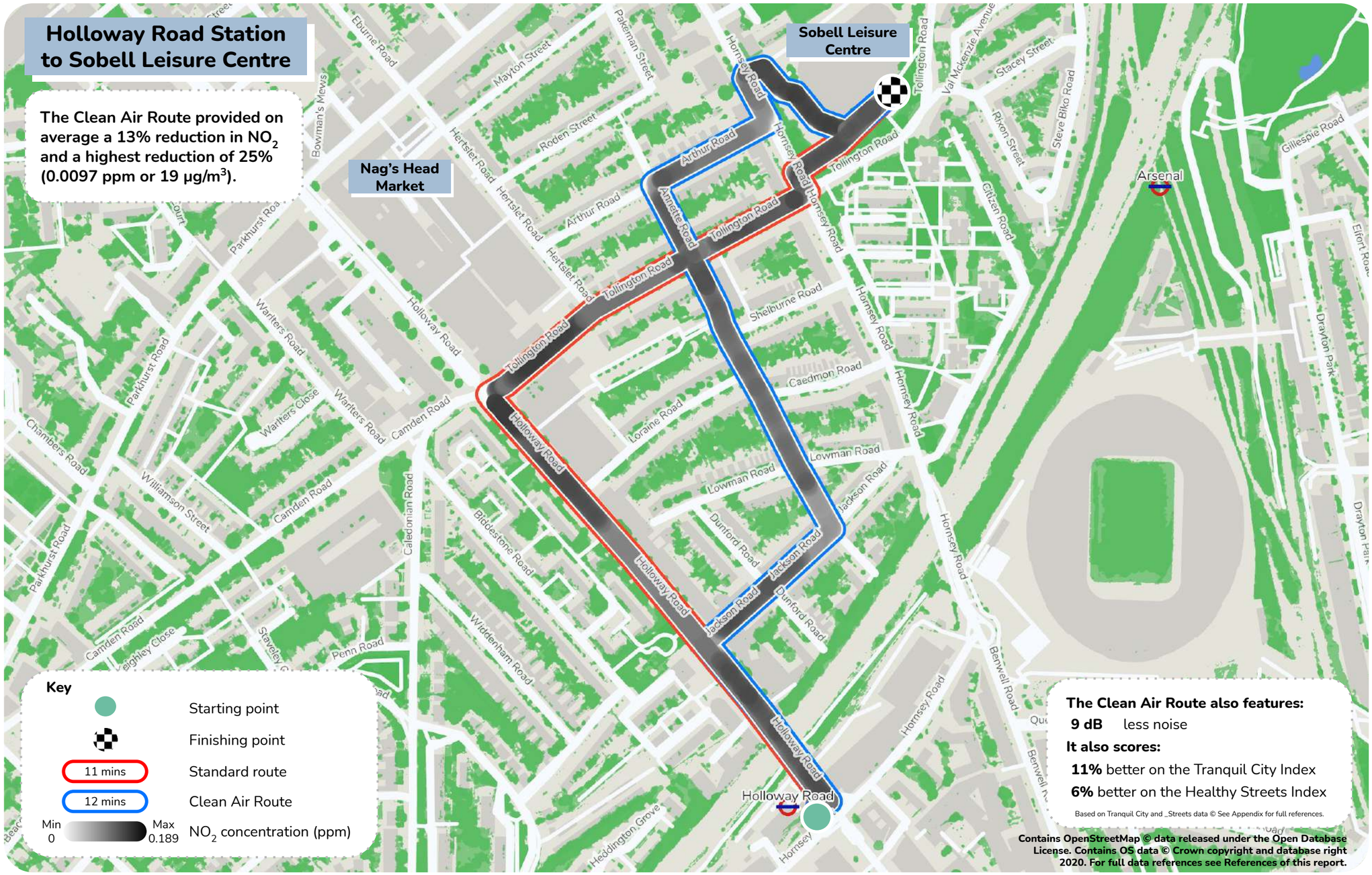


Figure 4.8b. Time history graph for cumulative NO_2 concentrations (Run 3).

4. Route results

4.8 Holloway Road Station to Sobell Leisure Centre



4. Route results

4.9 Thames Riverside to Richmond Station

CRP has engaged with businesses in Richmond Town Centre as part of the CAV3 programme. In collaboration with the London Borough of Richmond upon Thames, a Clean Air Route was devised from Richmond Bridge to Richmond Station, taking in some of the green spaces and waterways in the area. George Street and The Quadrant are considered pollution hotspots for the borough. While interventions are being implemented to address this, a Clean Air Route has been developed as an alternative for those heading towards Richmond Station. The primary audience is deemed to be residents across the river in East Twickenham. The route does not intend to negatively impact businesses along George Street and The Quadrant. There are a number of key access points to the standard route from the Clean Air Route, which can be highlighted alongside promotion of this route.

The Clean Air Route provided a *very good* reduction in NO_2 concentrations. There was on average a 23% reduction in the average NO_2 concentration (0.0172 ppm or 33 µg/m^3) relative to the standard route, with the highest reduction being 30% (0.0207 ppm or 40 µg/m^3). The Clean Air Route was generally more pleasant and quieter than the standard route because of the journey through Richmond Green and along the River Thames. The standard route was more polluted than the Clean Air Route because of congested traffic flow on The Quadrant. It is also expected that the benefits of the Clean Air Route were reduced as a result of a lorry that had been left idling near to Richmond Green. The use of a diesel fuelled hedge trimmer was also observed, which may have affected monitoring results.

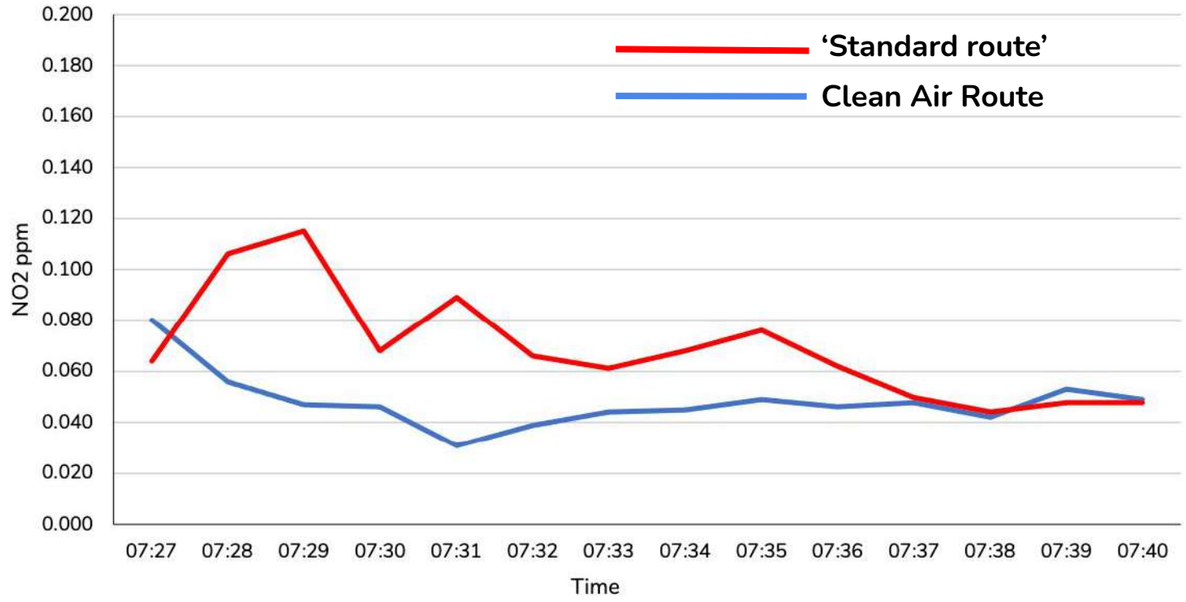


Figure 4.9a. Time history graph for NO_2 concentrations (Run 1).

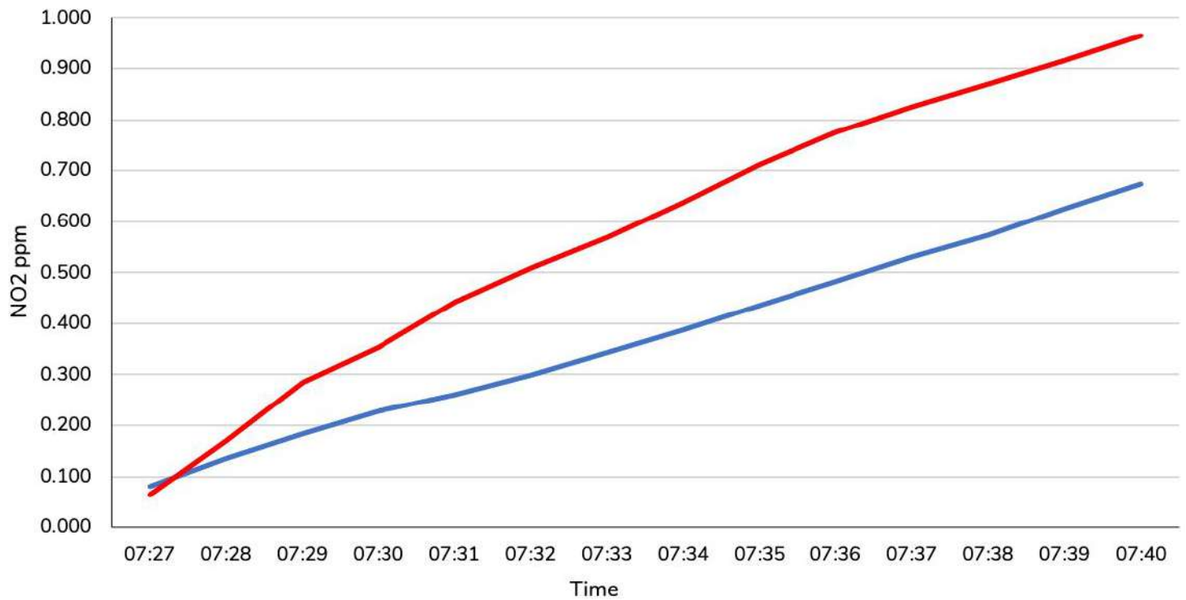
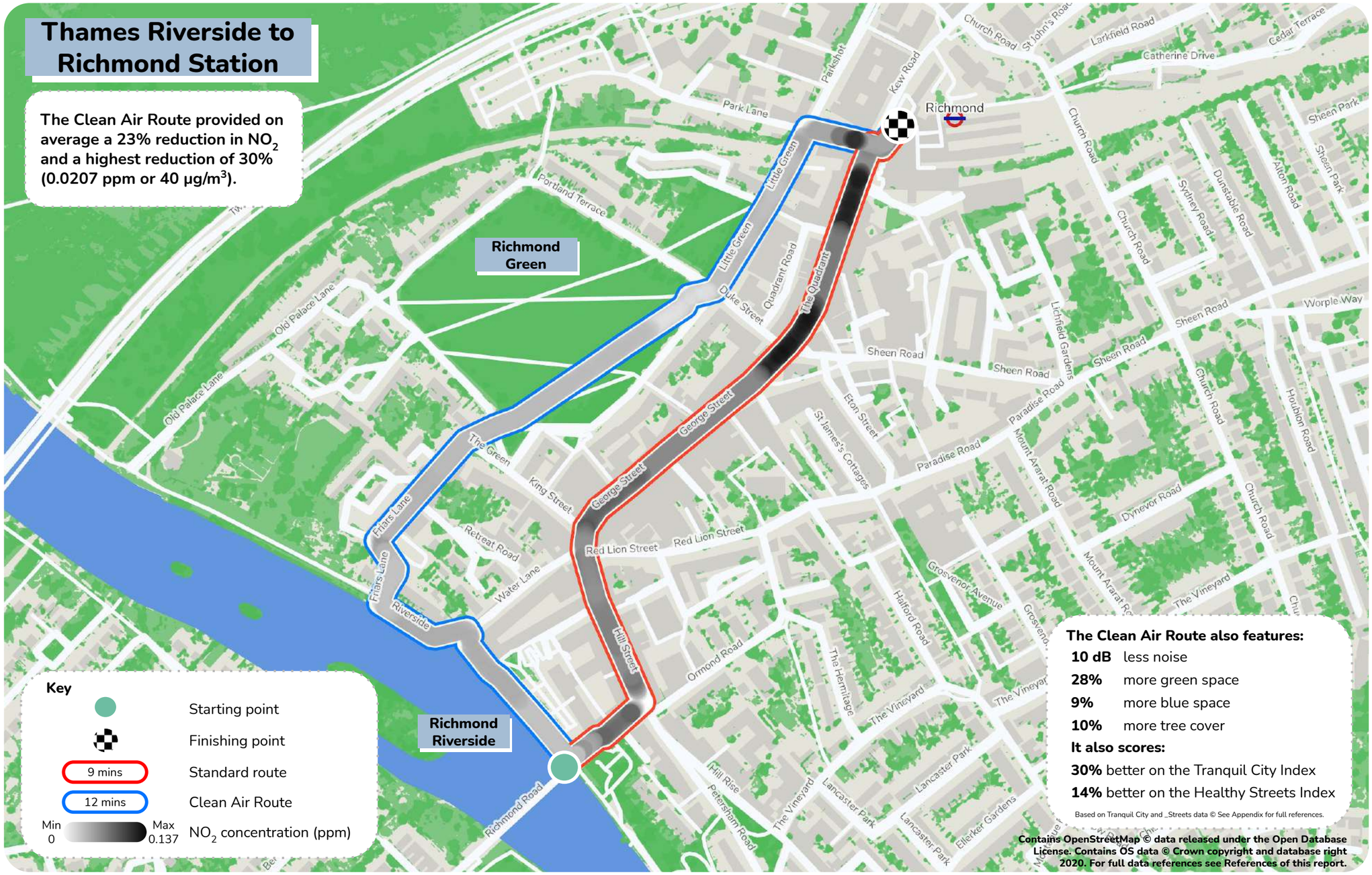


Figure 4.9b. Time history graph for cumulative NO_2 concentrations (Run 1).

4. Route results

4.9 Thames Riverside to Richmond Station



4. Route results

4.10 Seven Sisters Station to St Ann's Hospital

In collaboration with the London Borough of Haringey, CRP has developed a Clean Air Route between Seven Sisters Station and St Ann's Hospital. Seven Sisters is a busy London Underground and mainline station. The main roads between the station and St Ann's Hospital have typically high levels of congestion and pollution. A Clean Air Route has been devised directing visitors and patients to the hospital along quiet residential streets and through Chestnuts Park.

The Clean Air Route provided a *good* reduction in NO_2 concentrations. There was on average a 16% reduction in the average NO_2 concentration (0.0127 ppm or 24 µg/m^3) relative to the standard route, with the highest reduction being 37% (0.0307 ppm or 59 µg/m^3). The standard route was highly polluted as a result of the volume of traffic passing along Seven Sisters Road and St Ann's Road. Congestion and associated emissions were particularly high around Seven Sisters Station. The Clean Air Route was significantly quieter and more relaxing to walk along than the standard route as it passes along residential streets and through Chestnuts Park.

CRP understands that the challenge of travel to and from hospital sites, such as St Ann's, has been increased by the Covid-19 situation. At the time of writing, public transport may be neither a practical nor safe option for patients and their families. CRP respects the decisions of each individual, and it is hoped that this Clean Air Route can provide a long-term alternative for those who feel safe to use it.

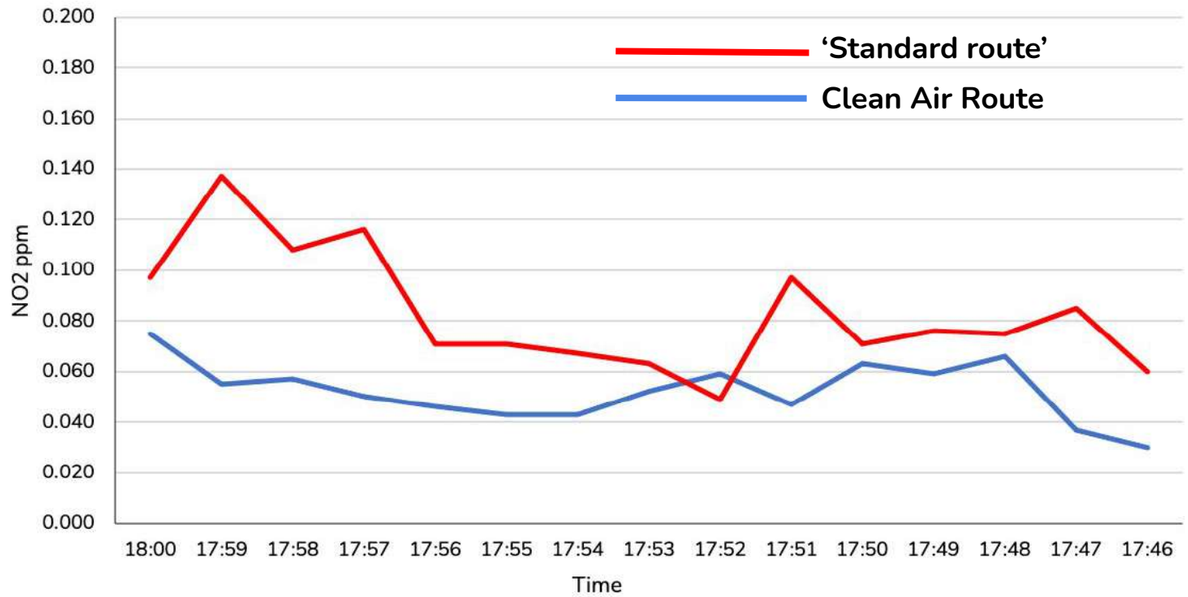


Figure 4.10a. Time history graph for NO_2 concentrations (Run 4).

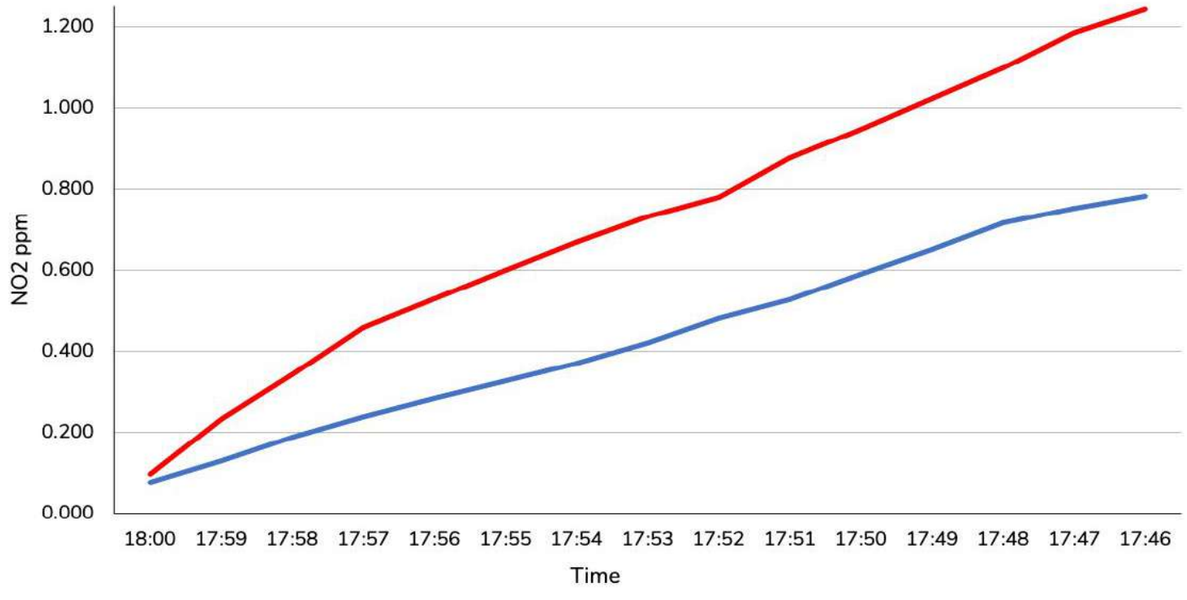
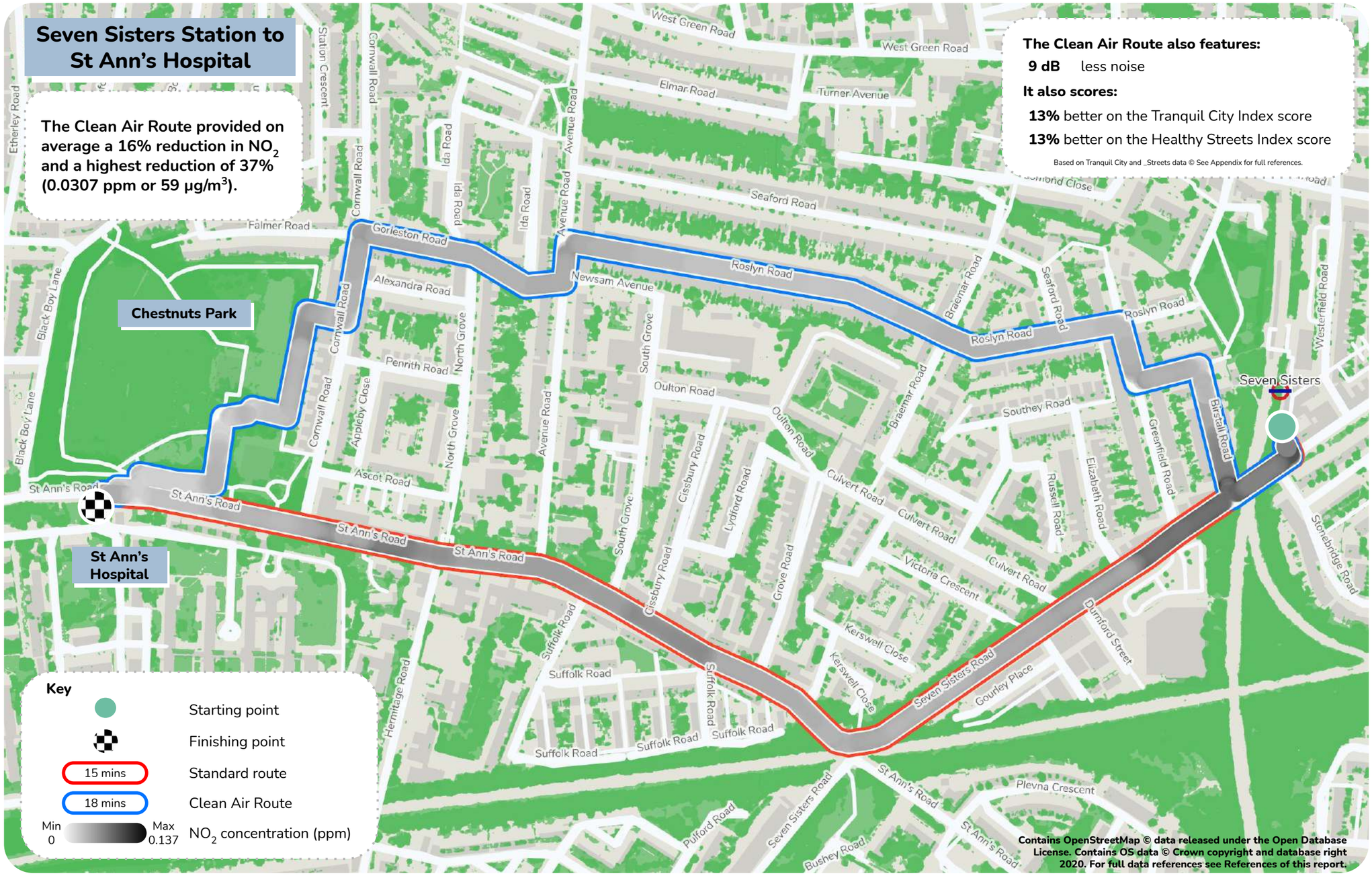


Figure 4.10b. Time history graph for cumulative NO_2 concentrations (Run 4).

4. Route results

4.10 Seven Sisters Station to St Ann's Hospital



4. Route results

4.11 White City Place to Goldhawk Road Station

As part of the CAV3 programme, CRP has engaged with businesses along Uxbridge and Goldhawk Road, close to Shepherd's Bush Green. This vibrant area contains a number of independent businesses and street markets, including Shepherd's Bush Market. White City, located roughly a kilometre north of Shepherd's Bush Market, is home to a number of large commercial developments, including the BBC Broadcast Centre. In collaboration with the London Borough of Hammersmith & Fulham, a Clean Air Route has been devised connecting businesses on Goldhawk Road and Uxbridge Road with potentially new audiences in White City. The route directs pedestrians through Hammersmith Park and along quiet residential streets, as an alternative to walking along busy Wood Lane. Recognising potential concerns of social distancing that have arisen due to the Covid-19 pandemic, the Clean Air Route was altered to pass along parallel road Lime Grove instead of through Shepherd's Bush Market.

The Clean Air Route provided a *good* reduction in NO_2 concentrations. There was on average an 18% reduction in the average NO_2 concentration (0.0122 ppm or 23 µg/m^3) relative to the standard route, with the highest reduction being 30% (0.0222 ppm or 42 µg/m^3). The standard route was highly polluted as a result of the volume of traffic passing along Wood Lane. There were also a number of idling buses around Shepherd's Bush Green, which are expected to have elevated pollutant concentrations. The Clean Air Route was significantly quieter and more relaxing to walk along than the standard route as it passed along residential streets and the beautiful Japanese Garden at Hammersmith Park.

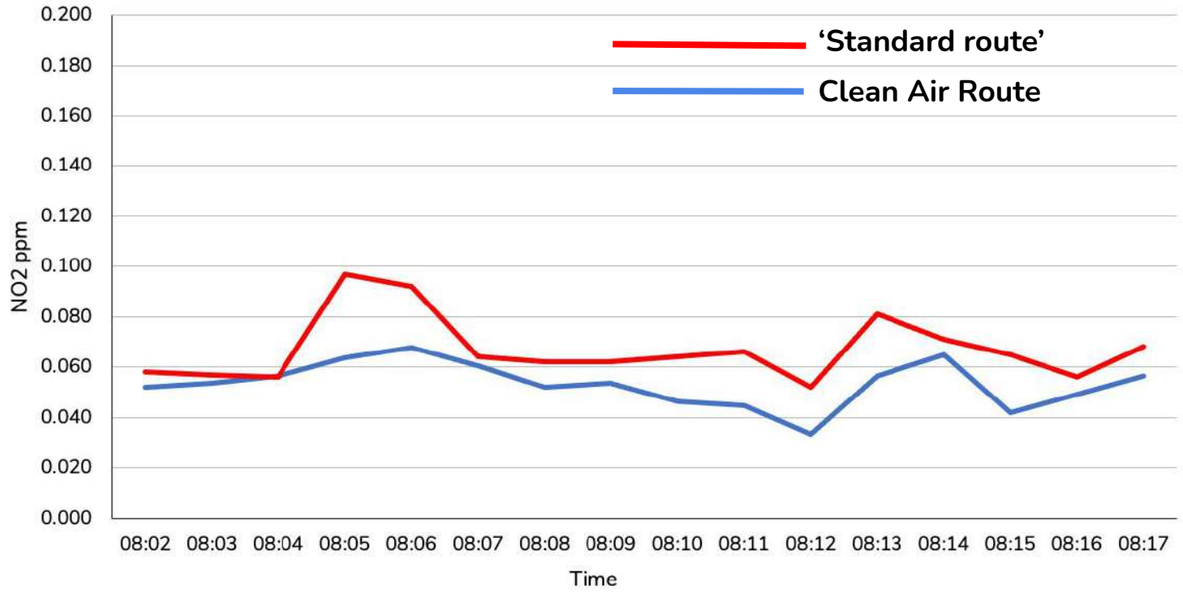


Figure 4.11a. Time history graph for NO_2 concentrations (Run 3).

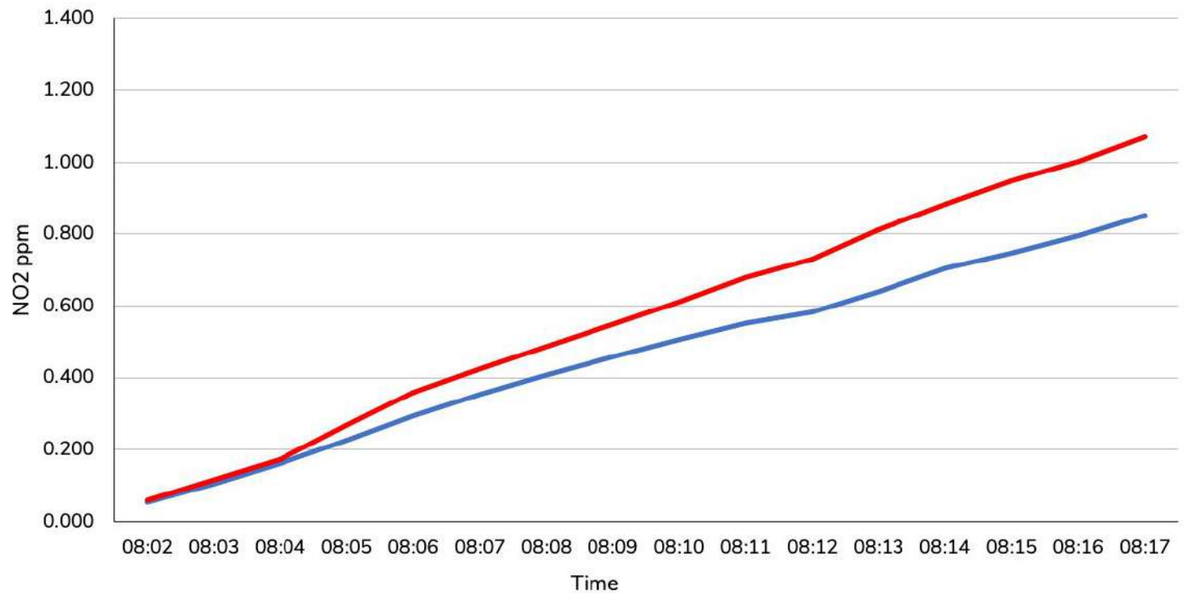
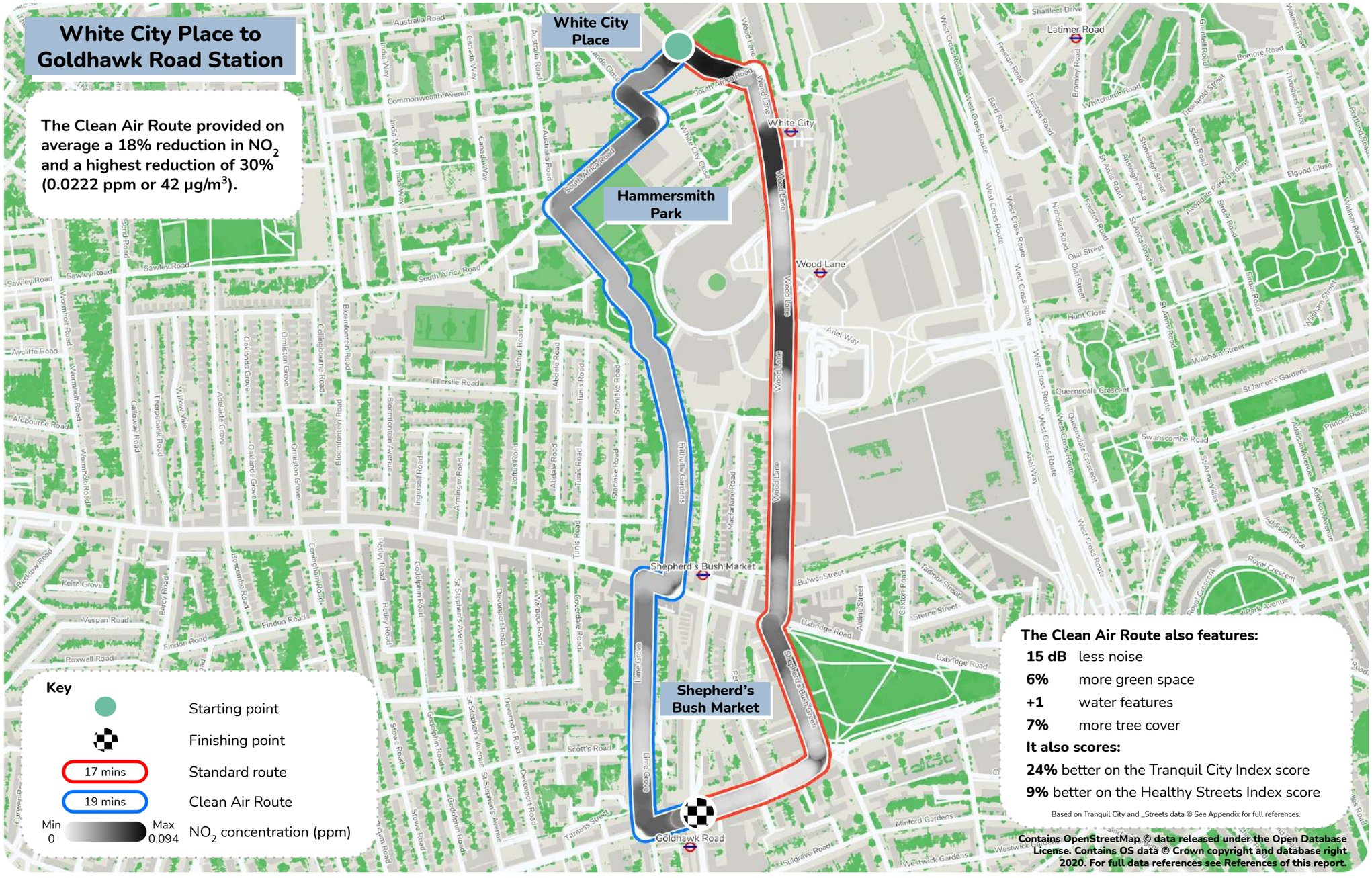


Figure 4.11b. Time history graph for cumulative NO_2 concentrations (Run 3).

4. Route results

4.11 White City Place to Goldhawk Road Station



4. Route results

4.12 Tottenham Court Road Station to Piccadilly Circus

In partnership with the City of Westminster, CRP has engaged with businesses in Soho as part of the CAV3 programme. This district of London's West End is known for its dining, nightlife and shopping destinations. A Clean Air Route has been developed between two key London Underground Stations that serve the area. This route aims to highlight the benefits of walking through Soho, both in terms of reduced exposure to traffic and pollution, but also with respect to the wealth of exciting culture and history the area has to offer.

The Clean Air Route provided a *good* reduction in NO_2 concentrations. There was on average a 15% reduction in the average NO_2 concentration (0.0111 ppm or 21 µg/m^3) relative to the standard route, with the highest reduction being 26% (0.0204 ppm or 39 µg/m^3). The Clean Air Route passes along many interesting streets that also have low volumes of traffic. The standard route was more polluted as it passed along Charing Cross Road and Shaftesbury Avenue. Traffic levels along the standard route during monitoring appeared reduced, potentially as a result of the Covid-19 pandemic. As such, the observed reduction in pollution exposure was not as high as with some other Clean Air Routes.

Like many areas across London, Soho and its businesses have been greatly impacted by restrictions imposed due to the Covid-19 pandemic. Once it is safe for these restrictions to be lifted, it is hoped that this Clean Air Route may help to encourage visitors to return to the area, and to do so safely on foot.

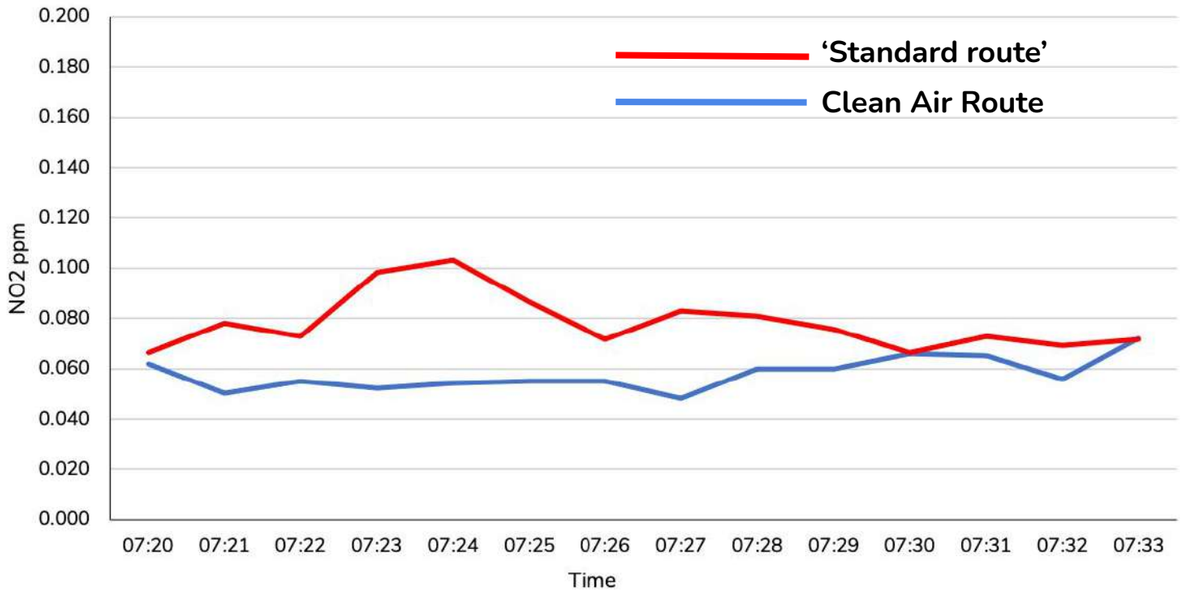


Figure 4.12a. Time history graph for NO_2 concentrations (Run 1).

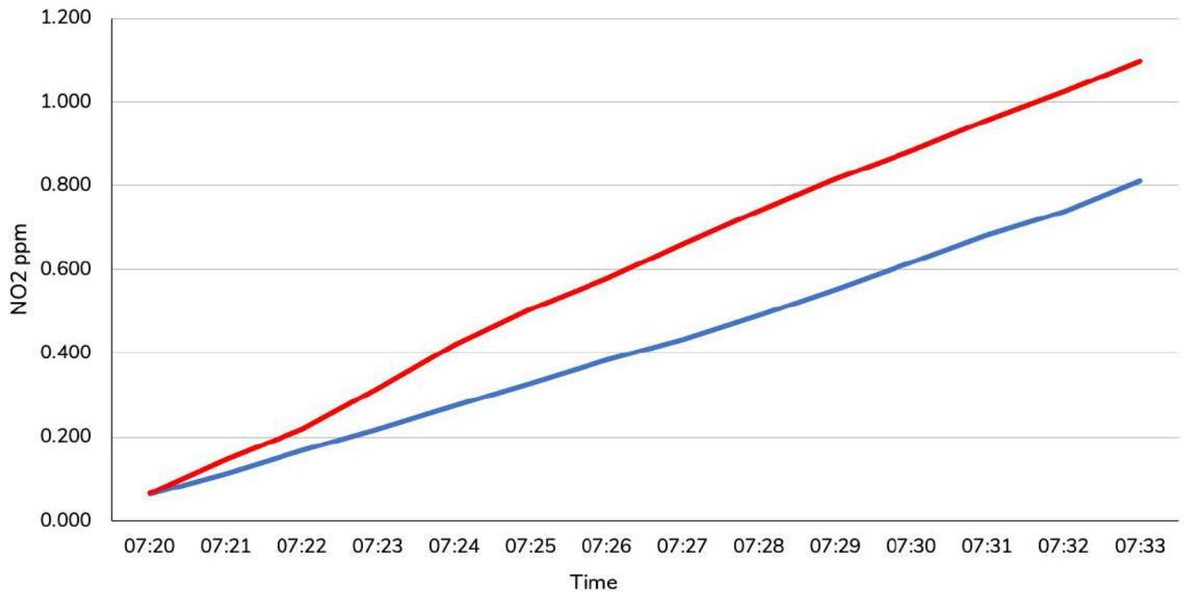
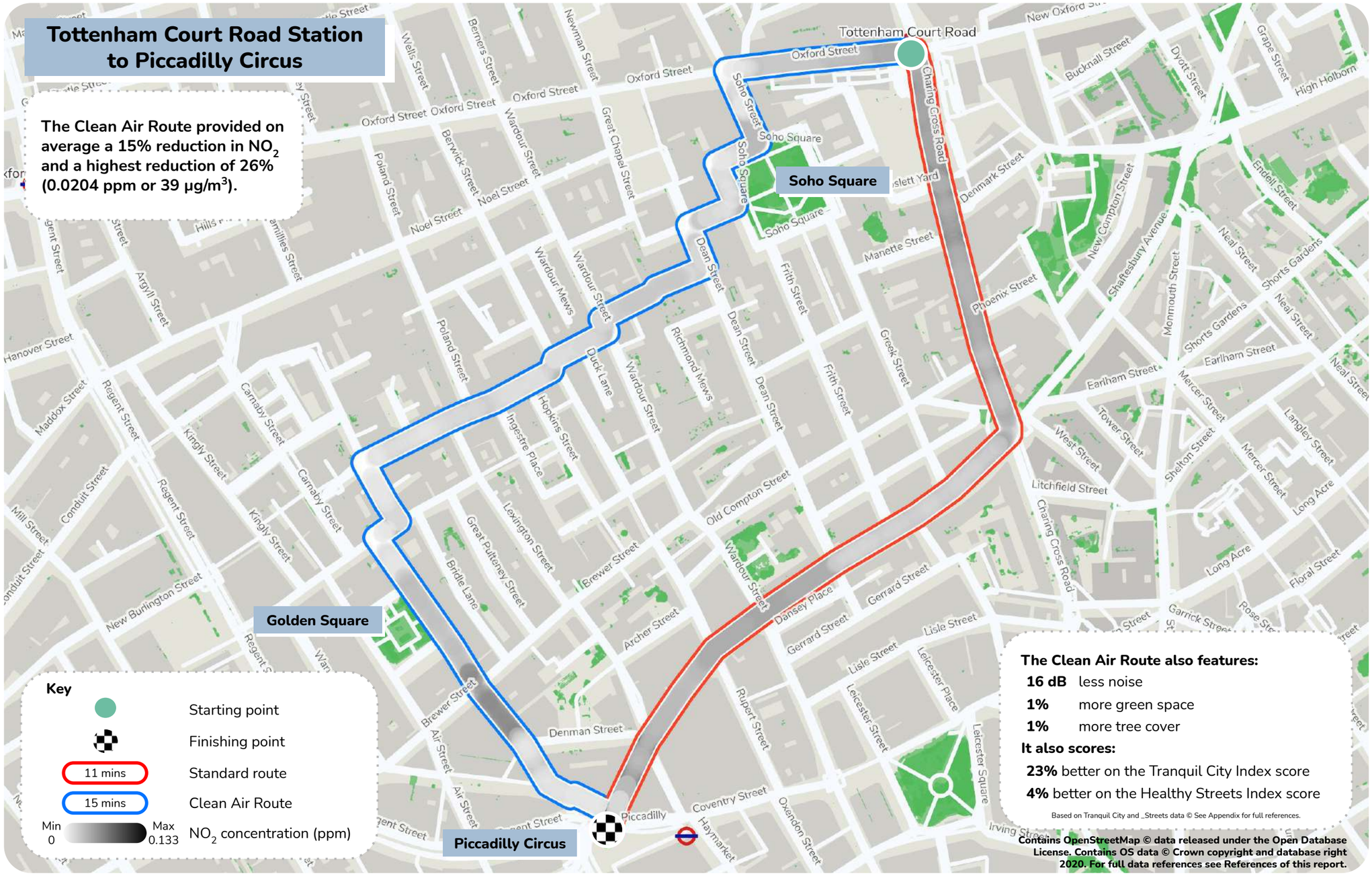


Figure 4.12b. Time history graph for cumulative NO_2 concentrations (Run 1).

4. Route results

4.12 Tottenham Court Road Station to Piccadilly Circus



4. Route results

4.13 Routes from Waterloo Station

London's South Bank is an iconic area of the city, popular with both locals and visitors. In collaboration with South Bank BID, CRP has engaged with businesses and employees to increase walking and cycling in the area. A Clean Air Route has been devised between Waterloo Station and the OXO Tower. This provided an opportunity to compare the levels of pollution along popular pedestrianised paths next to the River Thames, with roadside streets set further back from the river.

The Waterloo to OXO Tower Clean Air Route provided a *good* reduction in NO_2 concentrations. There was on average a 19% reduction in the average NO_2 concentration (0.0108 ppm or 21 µg/m^3) relative to the standard route, with the highest reduction being 26% (0.0133 ppm or 26 µg/m^3). Although the standard route passed along main roads, traffic flow and congestion was not particularly high during the survey. It is likely that vehicle levels were reduced as a result of the Covid-19 pandemic. Higher levels of pollution observed on the standard route were largely a result of idling and slow moving buses around Waterloo Station. The Clean Air Route was also more interesting and appealing than the standard route as it passed along the River Thames and a number of key cultural sites, with a majority of the route being fully pedestrianised.

Due to a collaboration with St Thomas' Hospital as part of the CAV3 programme, an extension to this route was also monitored. This route is discussed separately on the next page.

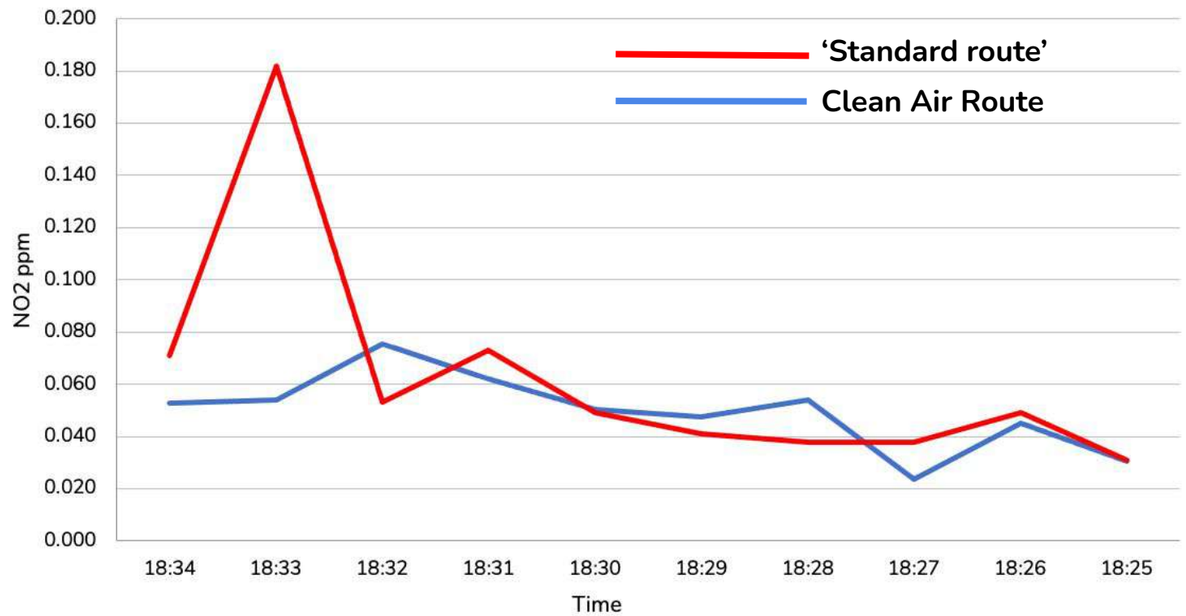


Figure 4.13a. Time history graph for NO_2 concentrations (Run 4).

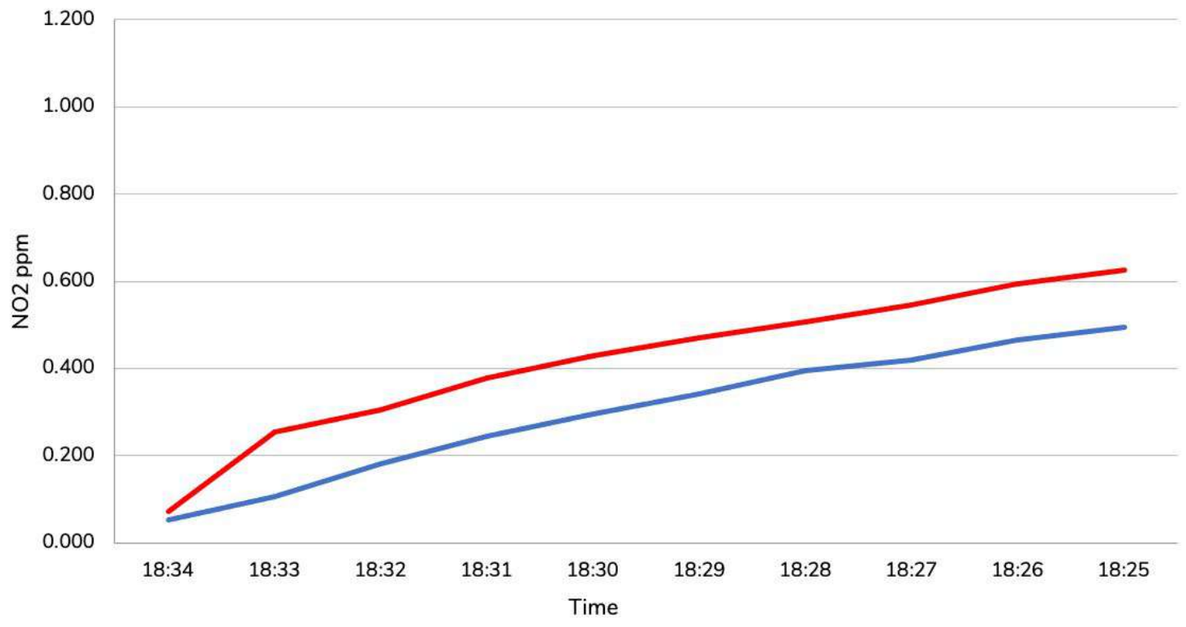


Figure 4.13b. Time history graph for cumulative NO_2 concentrations (Run 4).

4. Route results

4.13 Routes from Waterloo Station

An extension of the previous route was also monitored, between Waterloo Station and St Thomas' Hospital. York Road, which connects Waterloo Station to the hospital, can have high levels of congestion and pollution. A Clean Air Route has been devised directing visitors and patients along quieter and partly-pedestrianised alternative streets.

The Waterloo to St Thomas' Hospital Clean Air Route provided a *very good* reduction in NO_2 concentrations. There was on average a 26% reduction in the average NO_2 concentration (0.0171 ppm or 33 29 µg/m^3) relative to the standard route, with the highest reduction being 36% (0.0245 ppm or 47 29 µg/m^3). The Clean Air Route travelled along notably quieter roads as well as a small planted walkway and pedestrianised areas that were more appealing than the standard route. As with the Waterloo to OXO Tower route, traffic flow and congestion along the standard route was not particularly high during the survey. The higher levels of pollution observed on the standard route were largely a result of idling and slow moving buses around Waterloo Station. If traffic levels were to return to pre-pandemic levels, the benefits offered by the Clean Air Route would be expected to be higher than as stated here.

CRP understands that the challenge of travel to and from hospital sites, such as St Thomas', has been increased by the Covid-19 situation. CRP respects the decisions of each individual, and it is hoped that this Clean Air Route can provide a long-term alternative for those who feel safe to use it.

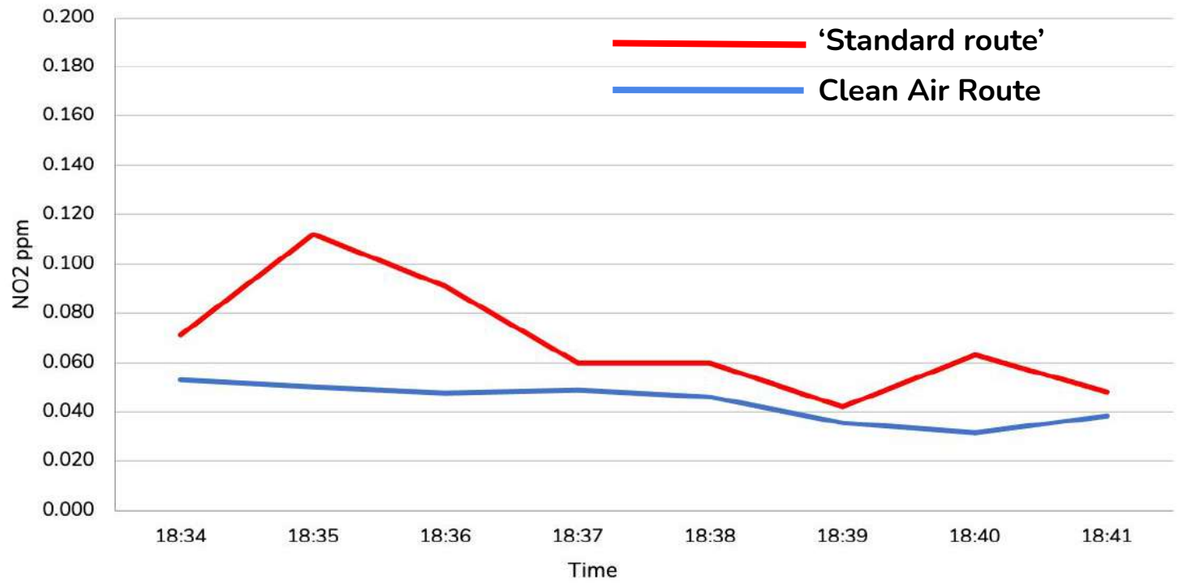


Figure 4.13c. Time history graph for NO_2 concentrations (Run 4).

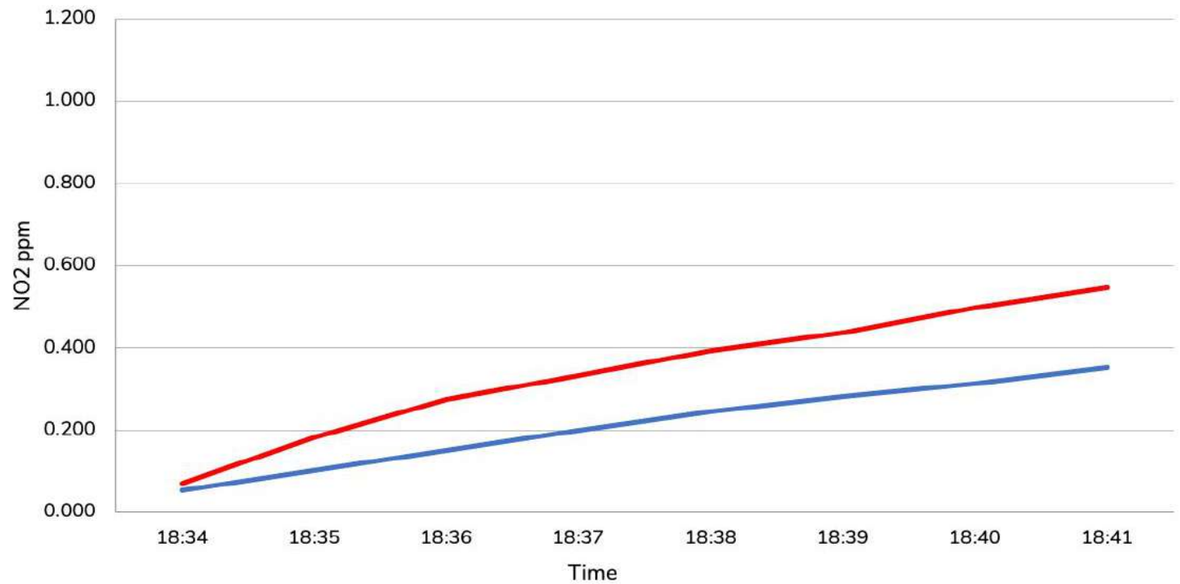
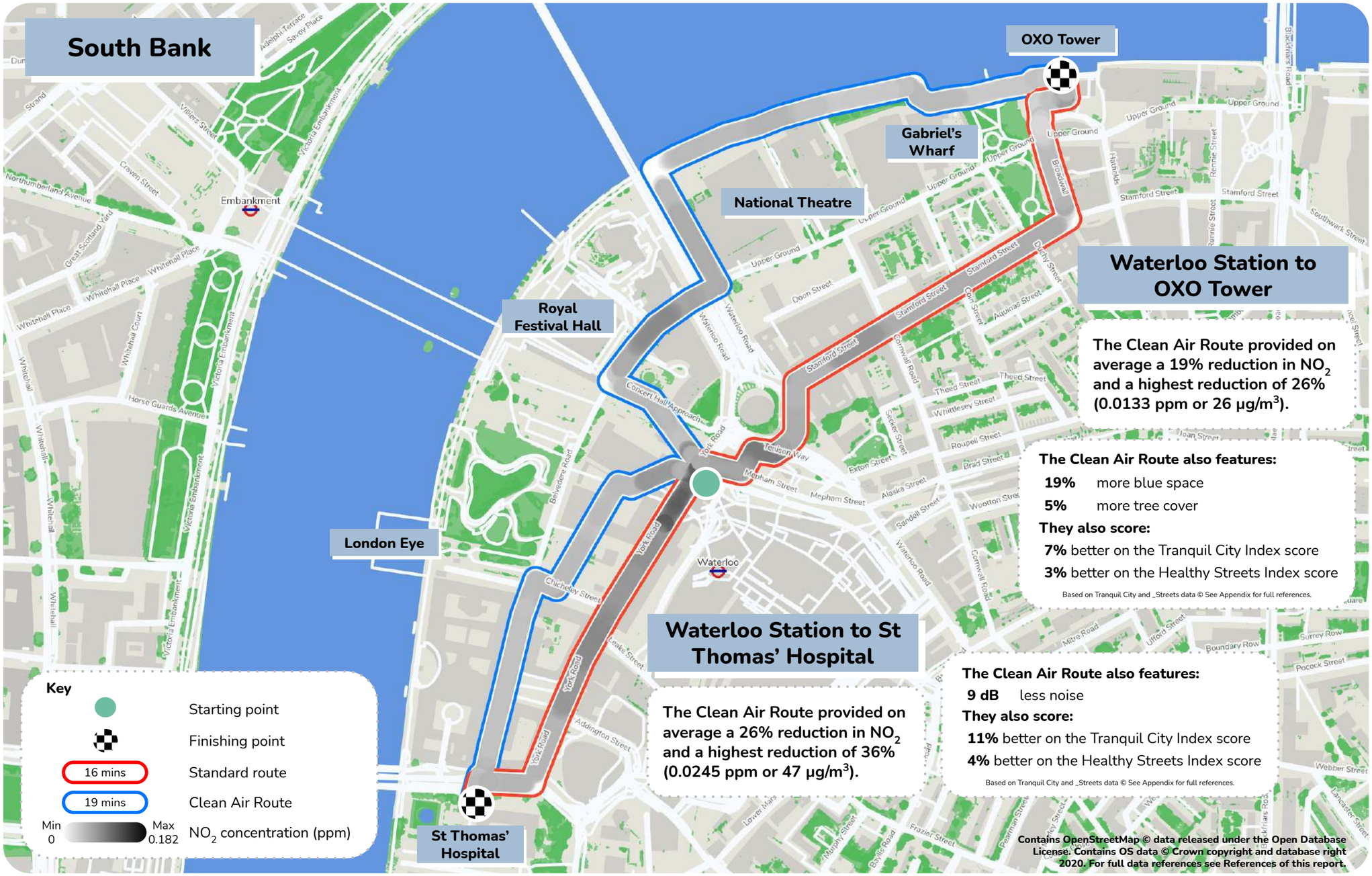


Figure 4.13d. Time history graph for cumulative NO_2 concentrations (Run 4).

4. Route results

4.13 Routes from Waterloo Station



4. Route results

4.14 Tooting Broadway to St George's Hospital

As part of the CAV3 programme, CRP has engaged with businesses along Tooting High Street and the surrounding area. A Clean Air Route has been developed to serve staff, patients and visitors to St George's Hospital travelling from nearby Tooting Broadway Station. As one of the UK's largest hospitals, St George's provides specialist care at a regional and national level. Many visitors to the hospital will therefore be unfamiliar with the area, and may benefit significantly from the simplicity of this Clean Air Route. Where possible, CRP and partners will work with St George's to raise awareness of this route.

The Clean Air Route provided a *good* reduction in NO_2 concentrations. There was on average a 14% reduction in the average NO_2 concentration (0.0109 ppm or 21 µg/m^3) relative to the standard route, with the highest reduction being 38% (0.0303 ppm or 58 µg/m^3). The Clean Air Route was significantly quieter and more relaxing to walk along than the standard route as it passed along residential streets. The standard route was highly polluted as a result of the volume of traffic passing along Tooting High Street. There was also significant vehicle idling, raising emissions at the junction with the A217 (Garratt Lane/Mitcham Road).

CRP understands that the challenge of travel to and from hospital sites, such as St George's, has been increased by the Covid-19 situation. At the time of writing, public transport may be neither a practical nor safe option for patients and their families. CRP respects the decisions of each individual, and it is hoped that this Clean Air Route can provide a long-term alternative for those who feel safe to use it.

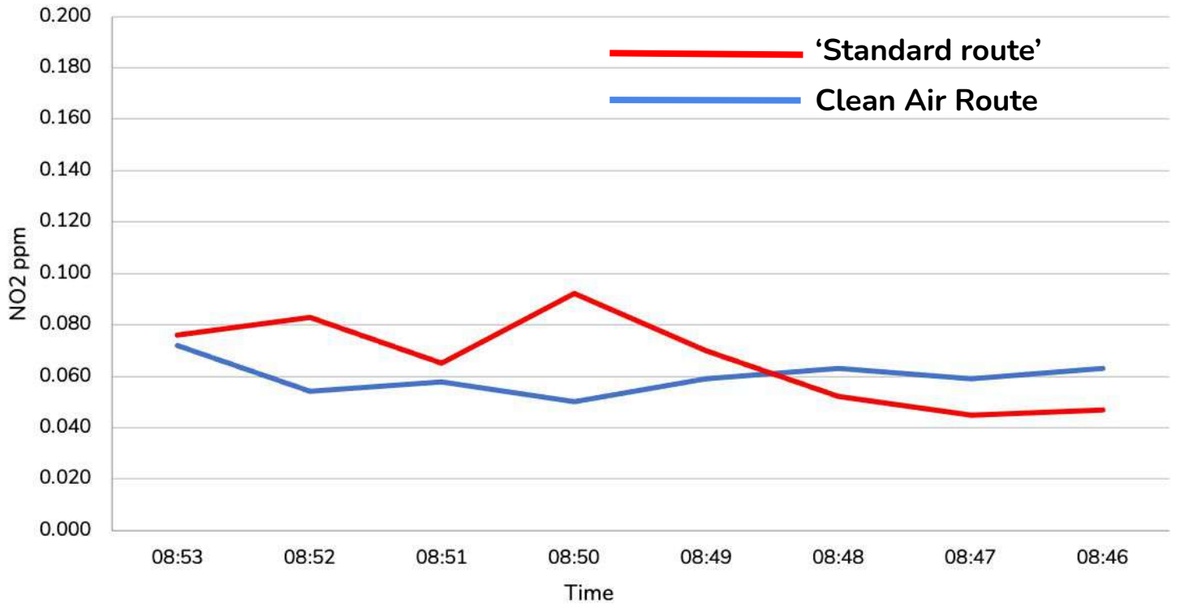


Figure 4.14a. Time history graph for NO_2 concentrations (Run 3).

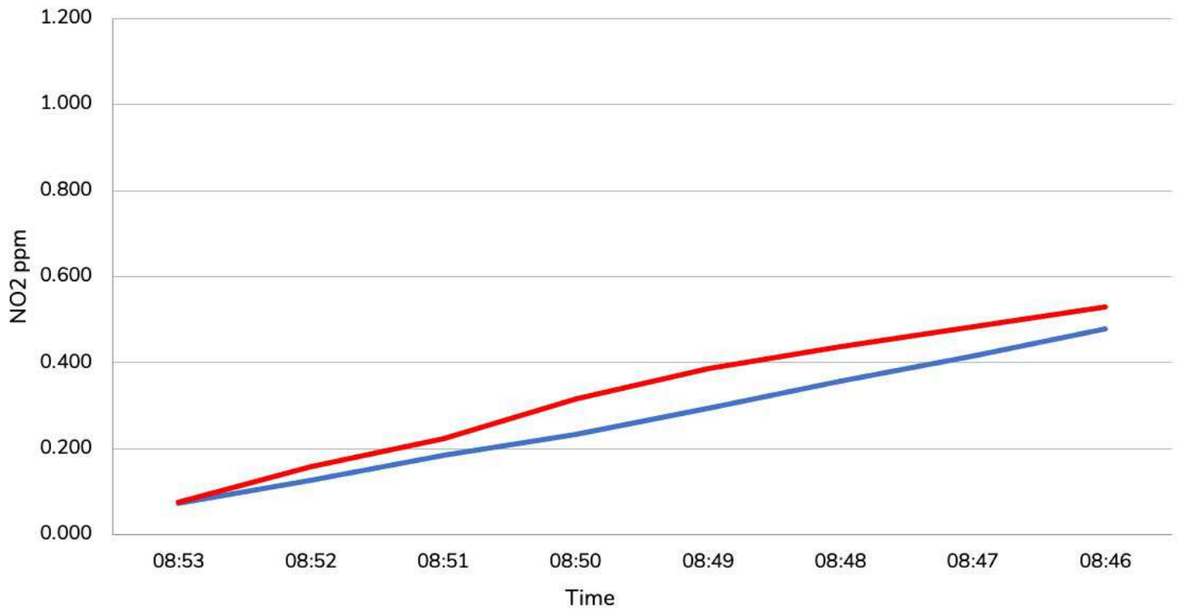


Figure 4.14b. Time history graph for cumulative NO_2 concentrations (Run 3).

4. Route results

4.14 Tooting Broadway to St George's Hospital

4. Route results

4.15 Wimbledon Station to South Wimbledon Station

In collaboration with the London Borough of Merton, CRP has engaged with businesses in Wimbledon Town Centre and the surrounding area as part of the CAV3 programme. Wimbledon Station provides a key transport interchange between the National Rail, London Underground and Tramlink networks. A Clean Air Route has been devised between Wimbledon and nearby South Wimbledon Station, which lies on the Northern Line. This route could also serve those living in South Wimbledon and travelling into Wimbledon Town Centre.

The Clean Air Route provided a *good* reduction in NO_2 concentrations. There was on average a 23% reduction in the average NO_2 concentration (0.0135 ppm or 26 µg/m^3) relative to the standard route, with the highest reduction being 41% (0.0273 ppm or 52 µg/m^3). The Clean Air Route was significantly quieter and more relaxing to walk along than the standard route as it passed along residential streets. The standard route was highly polluted as a result of the volume of traffic passing along the Broadway and Merton Road. Traffic flow was particularly congested around the junction of Merton Road with Merton High Street and Kingston Road.

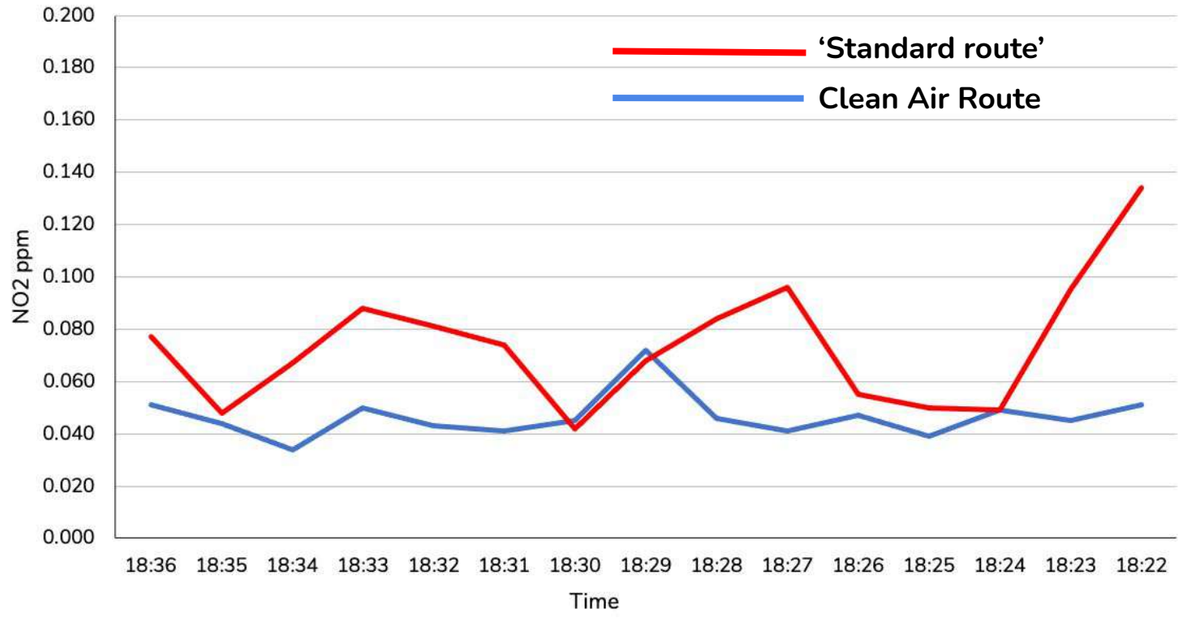


Figure 4.15a. Time history graph for NO_2 concentrations (Run 6).

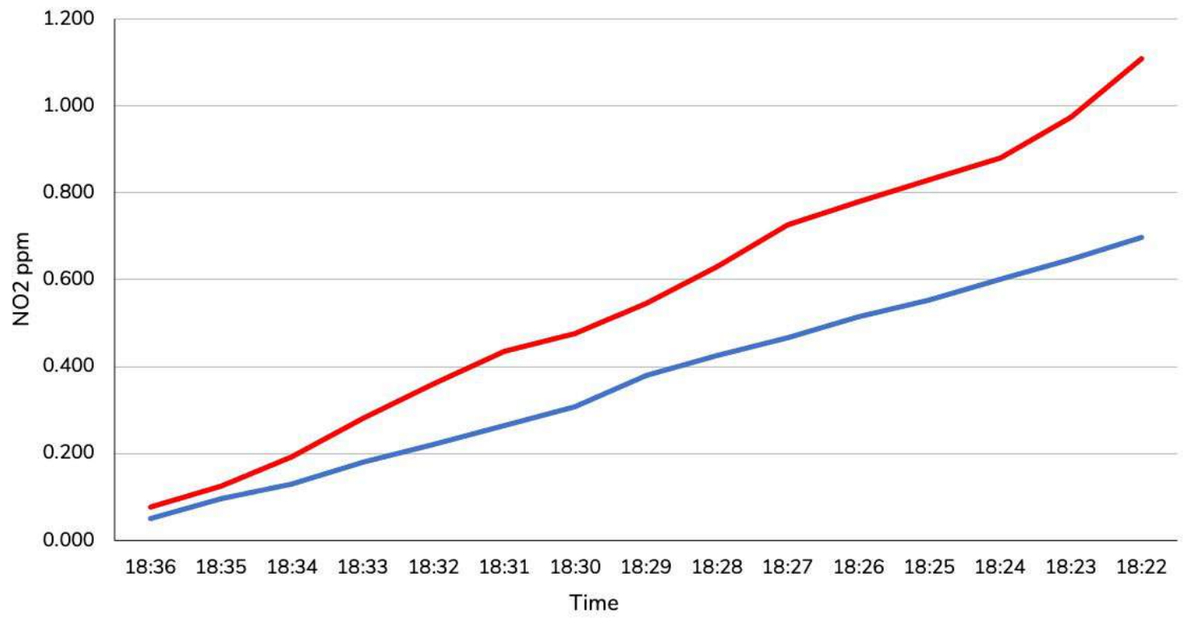
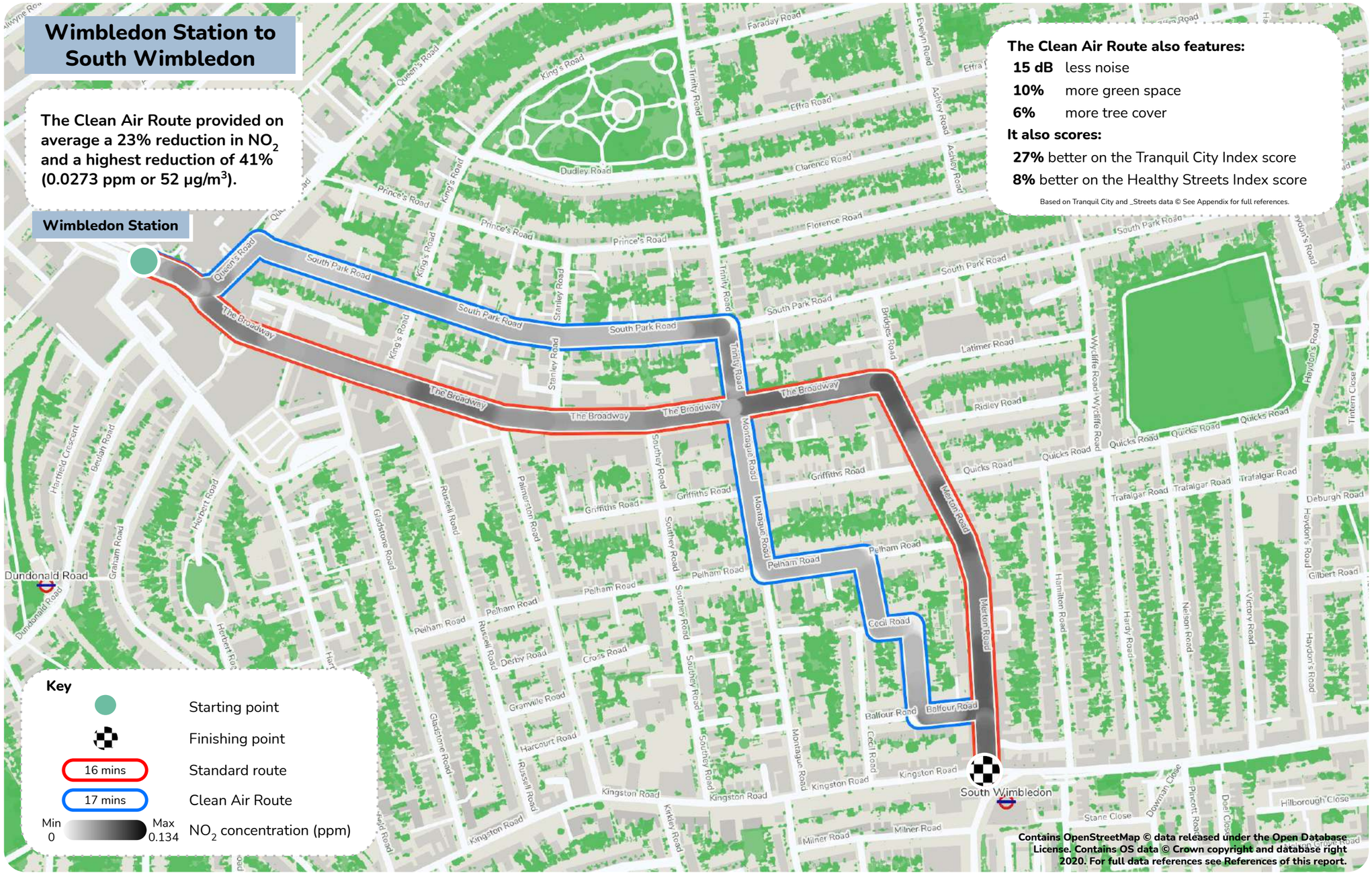


Figure 4.15b. Time history graph for cumulative NO_2 concentrations (Run 6).

4. Route results

4.15 Wimbledon Station to South Wimbledon Station



5. Summary and conclusions

CRP and partners have developed 14 new Clean Air Routes across London as part of the CAV3 programme. Monitoring undertaken by Tranquil City has demonstrated that by taking a Clean Air Route rather than a standard route, people can significantly reduce their exposure to nitrogen dioxide (NO_2).

CRP's 14 new Clean Air Routes provide:

- **Average reductions in NO_2 exposure between 6% and 23%.**
- **Maximum reductions between 17% and 41%.**

Monitoring along one of the proposed routes, near to Cromwell Road, Royal Borough of Kensington & Chelsea, showed little benefit in terms of reduced exposure to NO_2 of taking the proposed Clean Air Route. While every effort was taken to select Clean Air Routes that would have lower levels of pollution, there was no guarantee that this would be the case during monitoring. This risk was raised due to the unprecedented circumstances brought about by the Covid-19 pandemic, disrupting typical traffic patterns. All monitoring undertaken as part of this study has been impacted by Covid-19, as discussed on the next page.

Other benefits

It is recognised that demonstrating a reduction in harmful pollution alone is not sufficient to encourage more walking and cycling. Exposure to greenery, blue space, positive soundscapes and healthy street environments can all improve health, wellbeing and the likelihood of walking and cycling. By opting to walk along a new or unconventional route, people can also learn about their area and feel more connected to it, which can further boost wellbeing. In order to incentivise behaviour change, this study considered additional environmental factors relevant to human experiences using the TranquilCityData database.

In addition to air pollution benefits, the Clean Air Routes provide:

- **An average of 5% more greenery** (green space and tree cover) with a maximum increase of 28% on a single route pair.
- **An average reduction of 11 dB in noise level** (road and rail) with a maximum reduction of 16 dB on a single route pair.
- **Up to 19% more blue space.**
- **An average of 18% higher Tranquil City Index** and a 31% maximum increase.
- **An average of 7% higher Healthy Streets Index** and a 14% maximum increase.

Particulate matter results

Where NO_2 concentrations were particularly high on the standard route, indicating more traffic pollution, a clear benefit was demonstrated in terms of reduced exposure to particulate matter by taking the Clean Air Route. Unfortunately, along a number of routes, low levels of particulate matter were recorded, and results were not conclusive.

While some surveys indicated reduced exposure to particulate matter along Clean Air Routes, no consistent pattern was observed.

However, it is considered, based on knowledge of the sources of particulate matter and the NO_2 results, that concentrations on the Clean Air Routes are likely to be consistently lower than on standard routes.

5. Summary and conclusions

Impact of Covid-19

Through the course of 2020 and early 2021, the Covid-19 pandemic has had a major impact on people's daily lives. Different regions of London have faced, and continue to face, their own unique challenges. Many offices and businesses remain closed, with typical commuters furloughed or working from home. A combination of regulatory restrictions, economic impacts, changes to daily activities, as well as individual perceptions have resulted in a dramatic shift in travel behaviours and demand.

The impact on motorised road travel is of particular significance for the monitoring undertaken as part of this report. As of the end of September 2020, while levels were recovering, all modes of road traffic remained at least 20% below 2019 levels (TfL, Travel in London Report 13). Recovery was strongest in outer and inner London, at around 8% and 10% below 2019 levels respectively. In contrast, recovery in central London has been slower, and has also been influenced by the increase in the Congestion Charge in June. On a local scale, traffic has faced further disruption, with road closures and other temporary measures being brought in to support London's recovery.

At the time of writing, it is unknown how long large-scale disruption will continue as a result of the Covid-19 pandemic. It is, however, anticipated that, following such an extended period of disruption, travel behaviours are unlikely to rapidly or completely return to their pre-pandemic state. Despite this, it is clear that walking and cycling must be an intrinsic part of London's green recovery. Once it is safe to do so, these newly established Clean Air Routes will support Londoners to safely and actively move about the city, and could even help to alleviate the strain on public transport services when business and offices fully reopen.

Public engagement and promotion

The Clean Air Route results have been presented with visual maps to encourage public and stakeholder engagement, and to increase appeal. The maps provide readers with clear information on the lower levels of pollution and other positive characteristics of the Clean Air Routes, such as views, sounds, accessibility and natural features, that form a strong basis for encouraging sustained behaviour change.

CRP will continue to work with public and private sector partners to promote the benefits of taking Clean Air Routes. Each of the new routes have been added to CRP's **Clean Air Route Finder**, an interactive journey planner developed in partnership with King's College London to help identify low pollution walking and cycling routes in London.

Engagement has shown a significant public demand for healthier, less polluted, greener and more sustainable routing options. People new to cycling should be able to find quieter and less dangerous routes to gain confidence. Parents should be able to find low pollution, green and safe walking routes to school. With suitable information and encouragement, people will continue to walk more, explore local areas and recognise the benefits of walking for short journeys rather than driving or taking public transport. CRP and its partners recognise that promotion of Clean Air Routes, and other interventions to limit personal exposure, must be supported by local, regional and national action to reduce air pollution at source.

6. Data references

This report makes use of the TranquilCityData database that includes specially curated and standardised environmental quality data. The datasets provided are derived from various trustworthy sources, and are verified and processed by experts to ensure their validity. The datasets used include:

1. **Noise – Road and Rail**
   Strategic Noise Mapping Round 3 (2017) - Road noise
   Strategic Noise Mapping Round 3 (2017) - Rail noise
   © Department for Environment, Food and Rural Affairs. The data is a result of the strategic noise mapping analysis undertaken in 2017 to meet the requirements of the Environmental Noise Directive (Directive 2002/49/EC) and the Environmental Noise (England) Regulations 2006 (as amended).
   The data is licensed under the Open Government Licence v3.0.

2. **Noise – Aircraft**
   DXF noise exposure contours for specialist users
   © Department for Transport. The data is understood to be licensed under the Open Government License (OGL), where the data is available via the following address: https://www.gov.uk/government/publications/dxf-contours-for-specialist-user/dxf-contours

3. **Tree Canopy**
   Curio Canopy - London Tree Canopy Cover
   © Curio (Breadboard Labs Limited). The data is available on a Creative Commons Attribution-Share Alike License. The data is available here: https://data.london.gov.uk/dataset/curio-canopy

4. **Green & Blue Cover Density**
   London Green and Blue Cover
   © Greater London Authority. The data is available via the following address: https://data.london.gov.uk/dataset/green-and-blue-cover . It is acknowledged that the data contains OS data © Crown copyright and database rights 2019 and contains Verisk Analytics GeoInformation Group UKMap data.
   The data is licensed under the Open Government Licence v2.0.

5. **Tranquil City Index**
   © Tranquil City Ltd 2020. This data has been derived using DEFRA, DfT, GLA, TfL, OSM and Curio (Breadboard Labs Limited) data. The data is licensed on a Creative Commons Share-Alike license / Open Database License (OBdL).

6. **Healthy Streets Index**
   © _Streets 2020. This data has been derived using DEFRA, DfT, OS, GLA, TfL and Curio (Breadboard Labs Limited) data. The data is licensed on a Creative Commons Share-Alike license.

7. **Open Street Map**
   © OpenStreetMap contributors data is data released under the Open Database License. For further information, see www.openstreetmap.org/copyright

8. **Ordnance Survey (OS) Open Roads**
   © Crown copyright and database right 2020.

This report was delivered as part of the Clean Air Villages 3 (CAV3), funded by the Defra Air Quality Grant. If you would like any further information about anything included within this report, please get in touch:

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CROSS RIVER PARTNERSHIP

Delivering London's Future Together

crp@crossriverpartnership.org

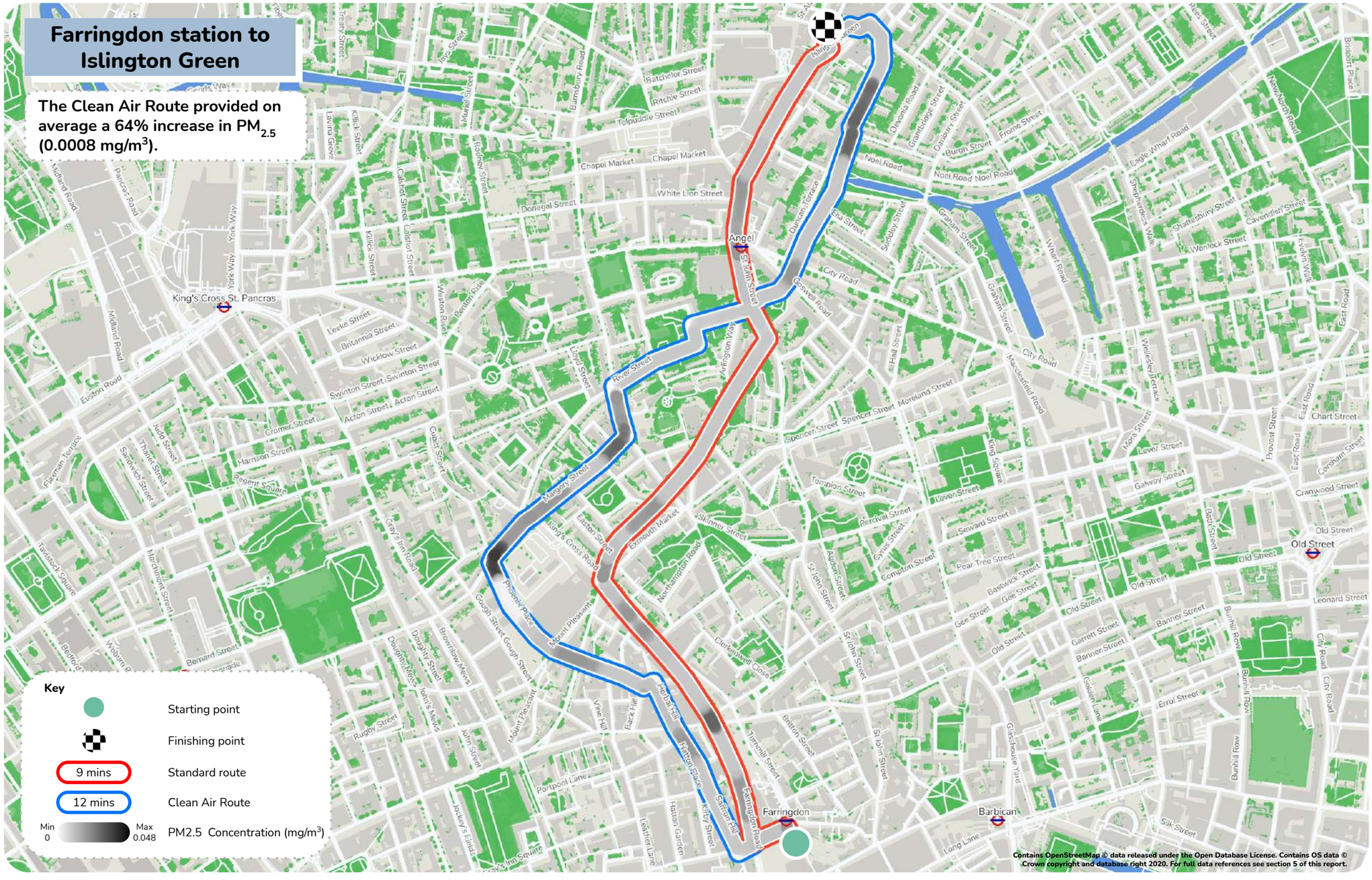
www.crossriverpartnership.org

Appendix A

$PM_{2.5}$ and PM_{10} results

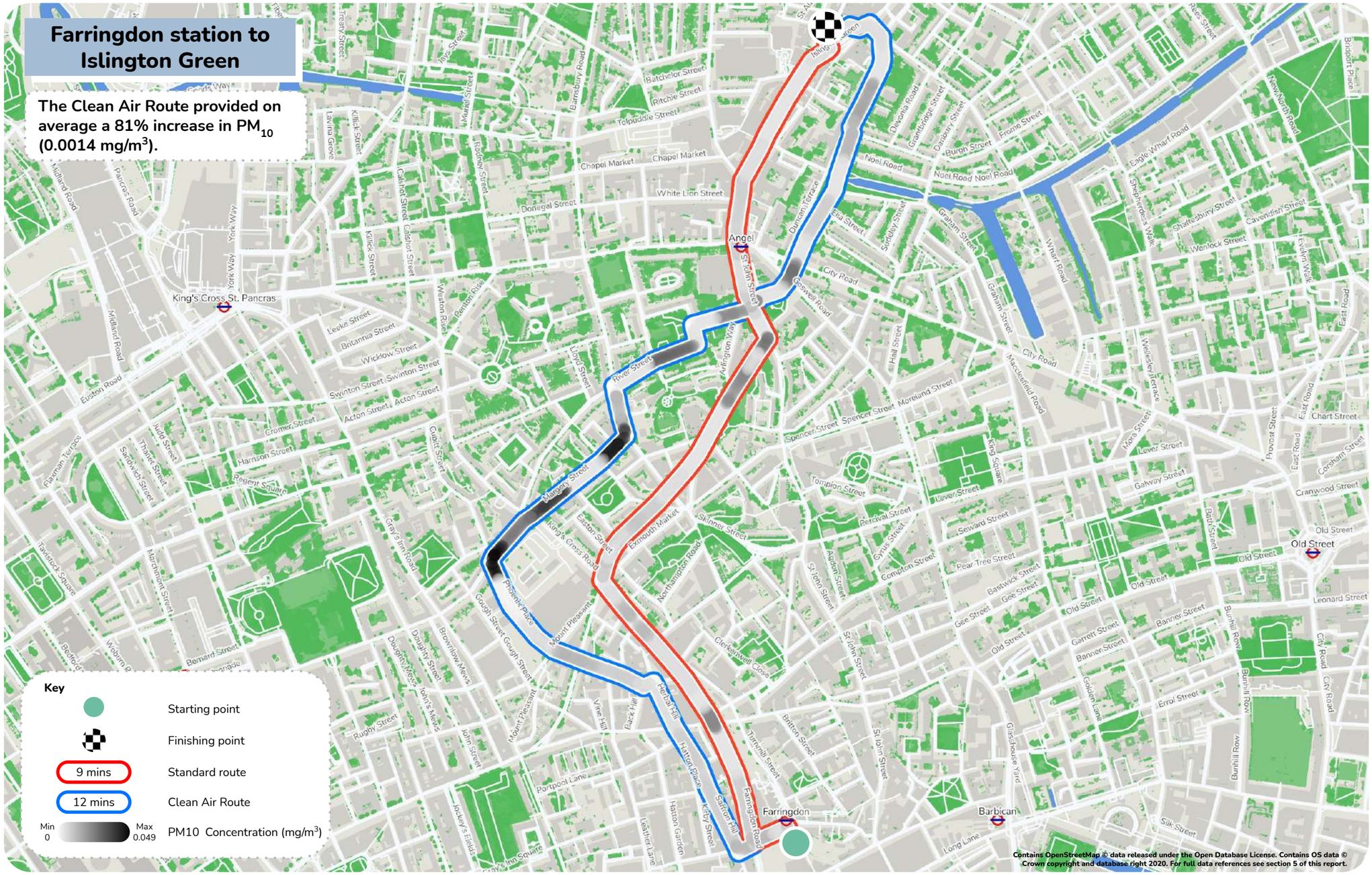
A1 Angel, Islington (angel.london BID)

$PM_{2.5}$ concentration



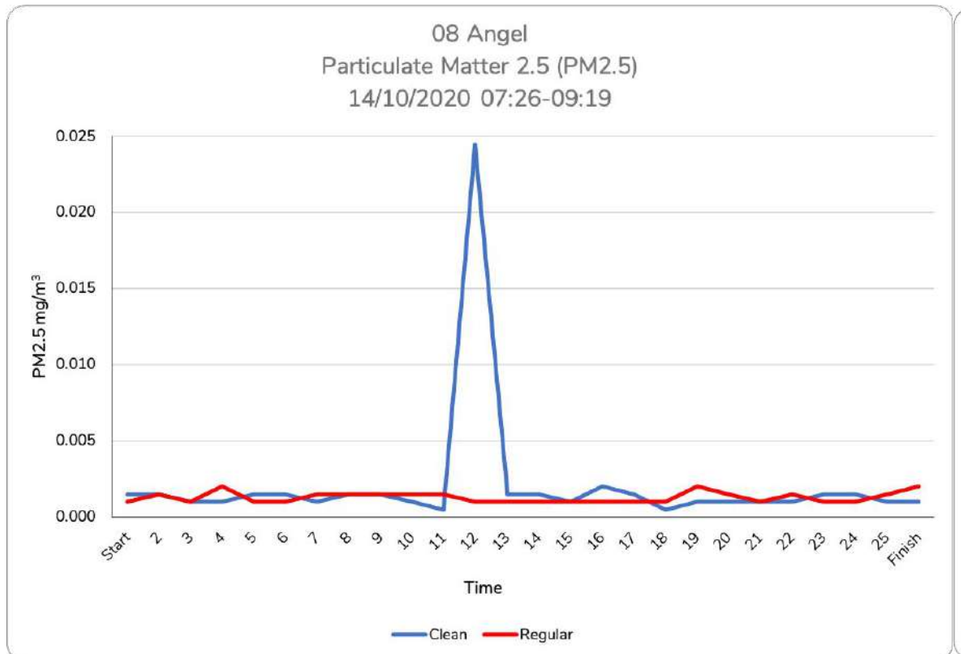
A1 Angel, Islington (angel.london BID)

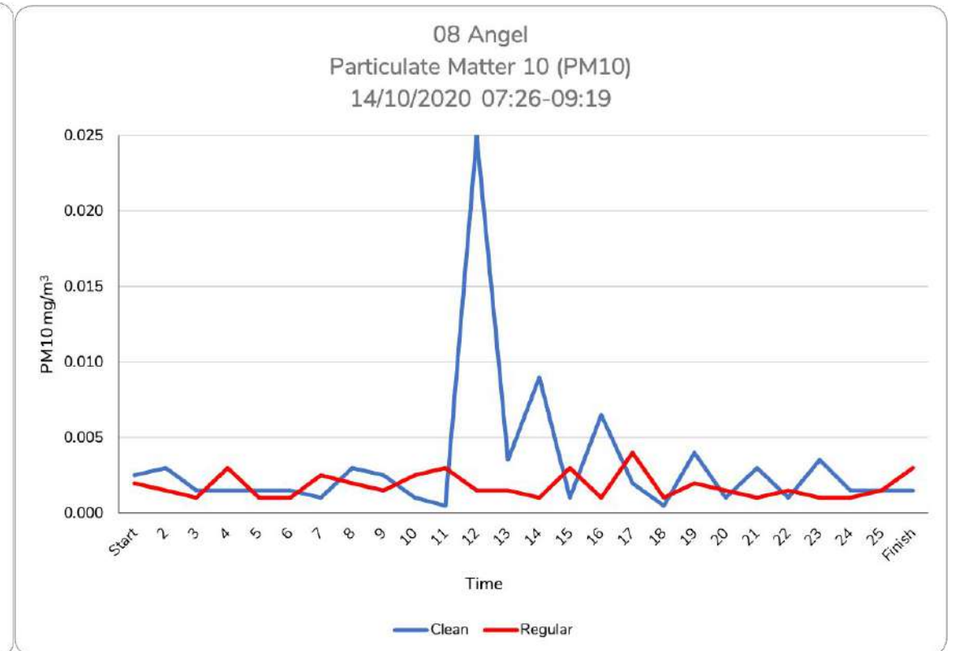
PM_{10} concentration

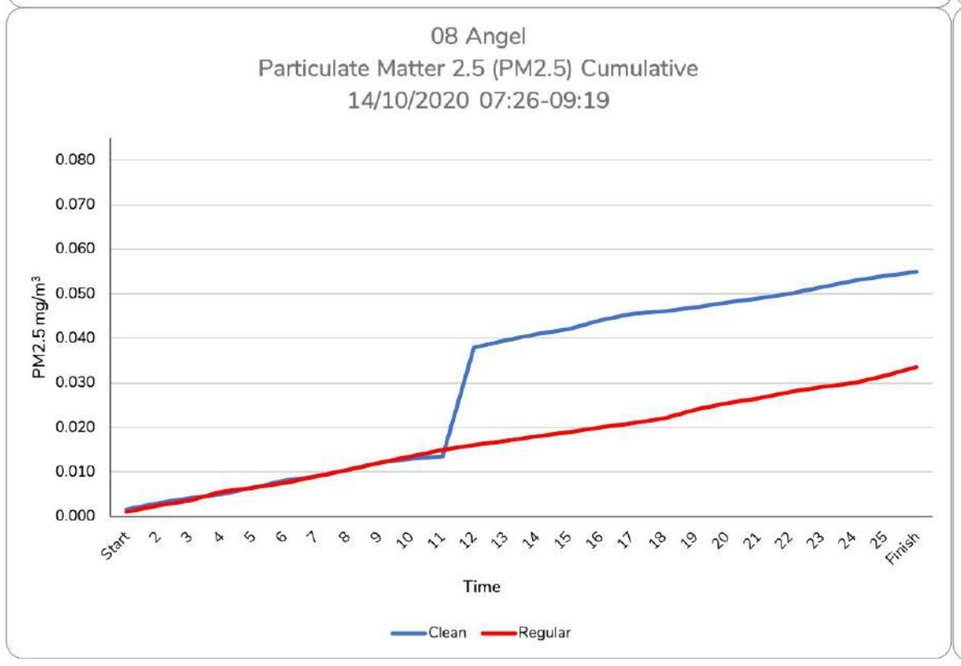


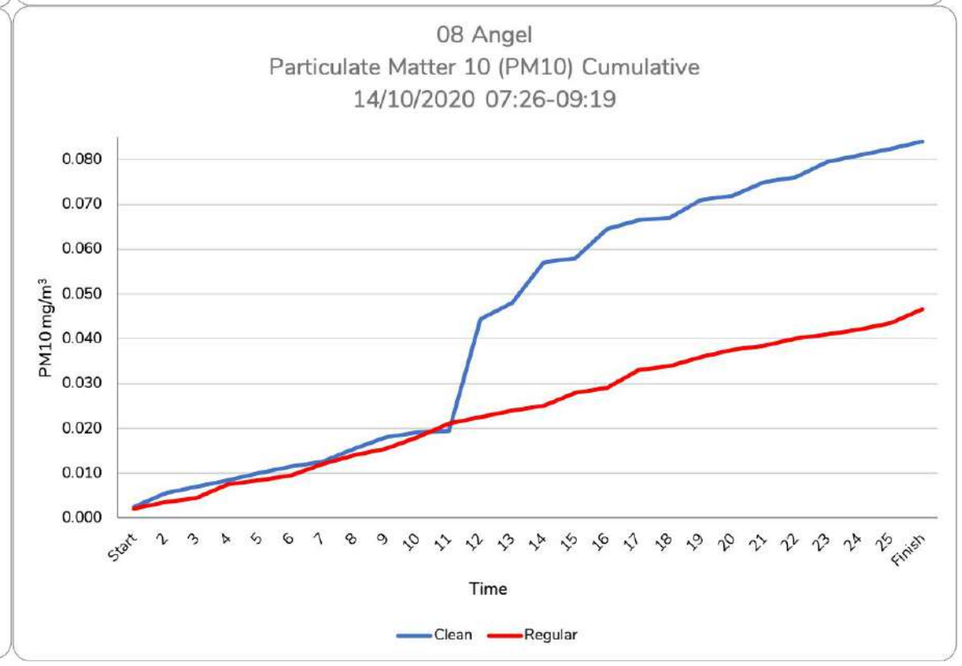
A1 Angel, Islington (angel.london BID)

Time History Graphs – Particulate Matter



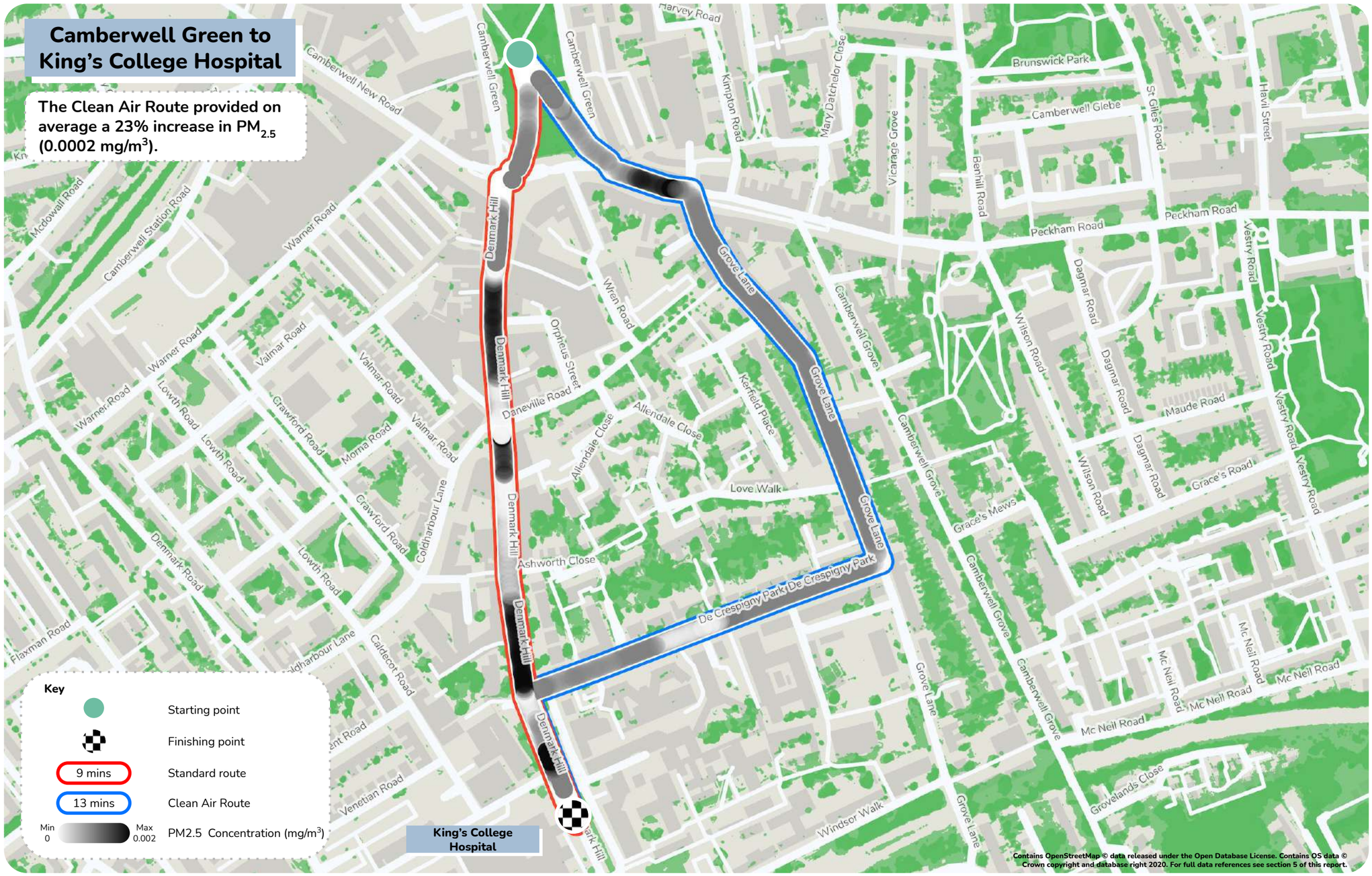






A2 Camberwell, London Borough of Lambeth

$PM_{2.5}$ concentration

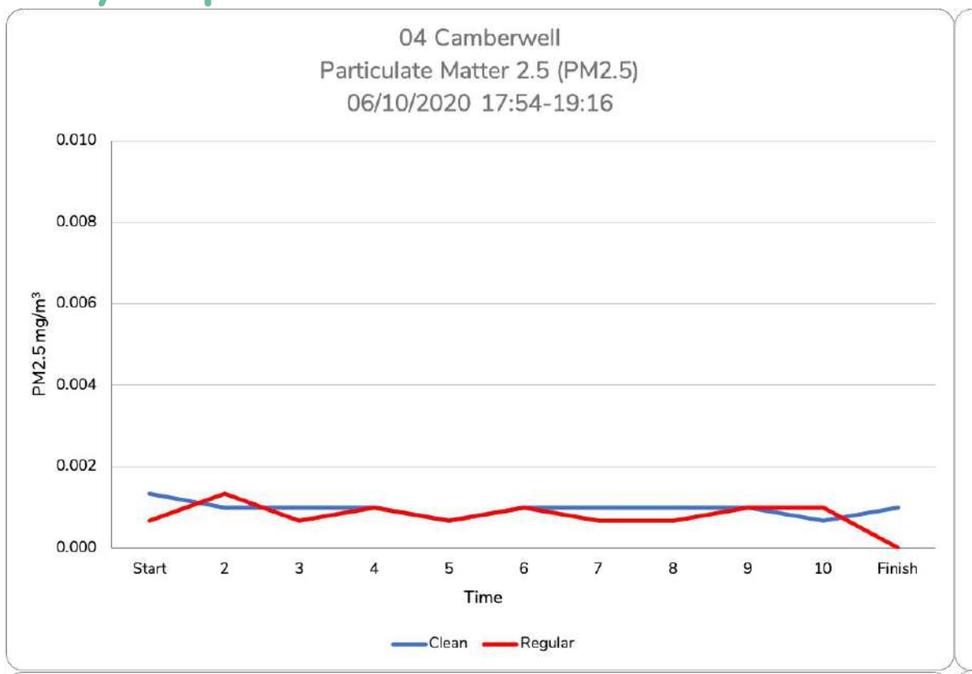


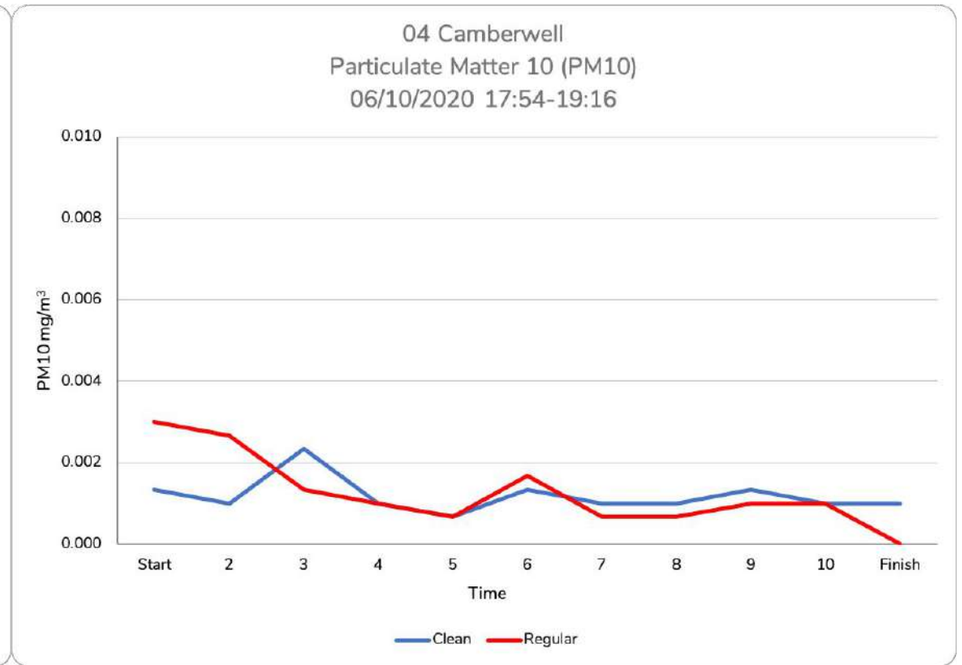
A2 Camberwell, London Borough of Lambeth

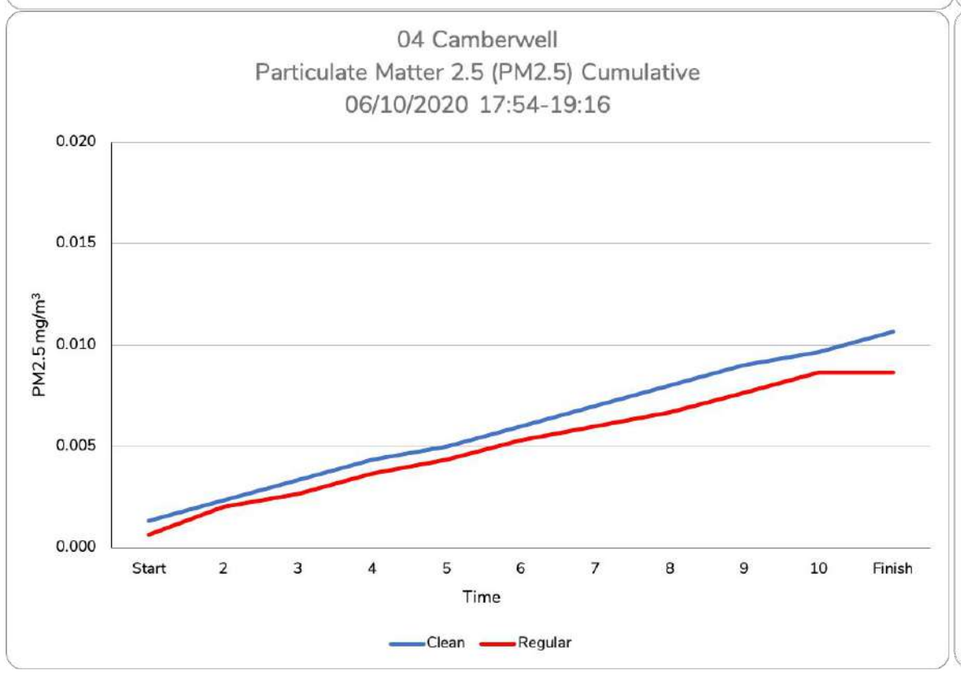
PM_{10} concentration

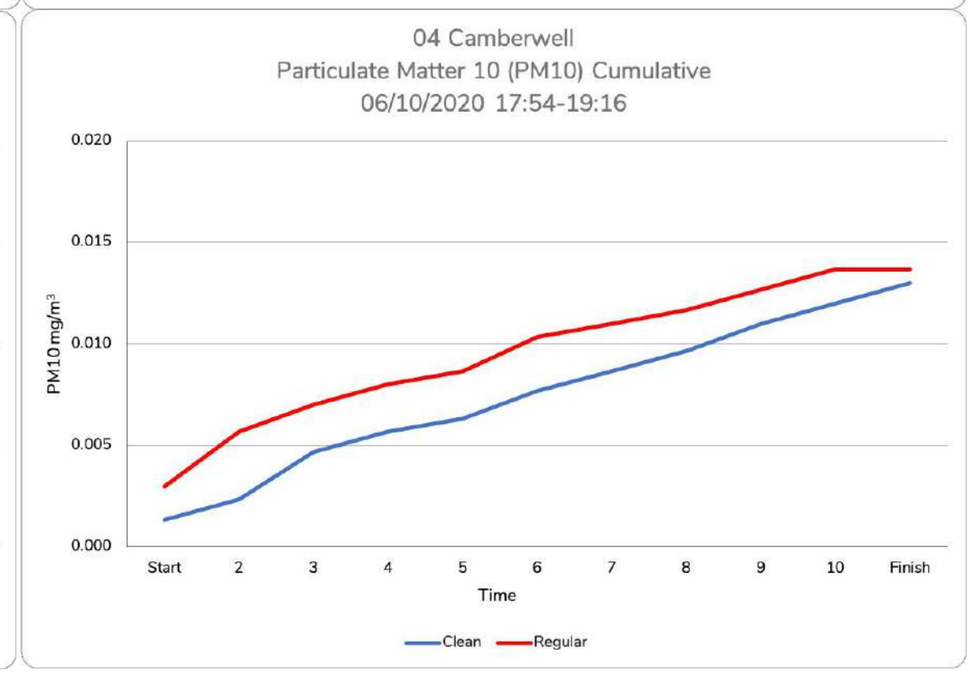
A2 Camberwell, London Borough of Lambeth

Time History Graphs – Particulate Matter



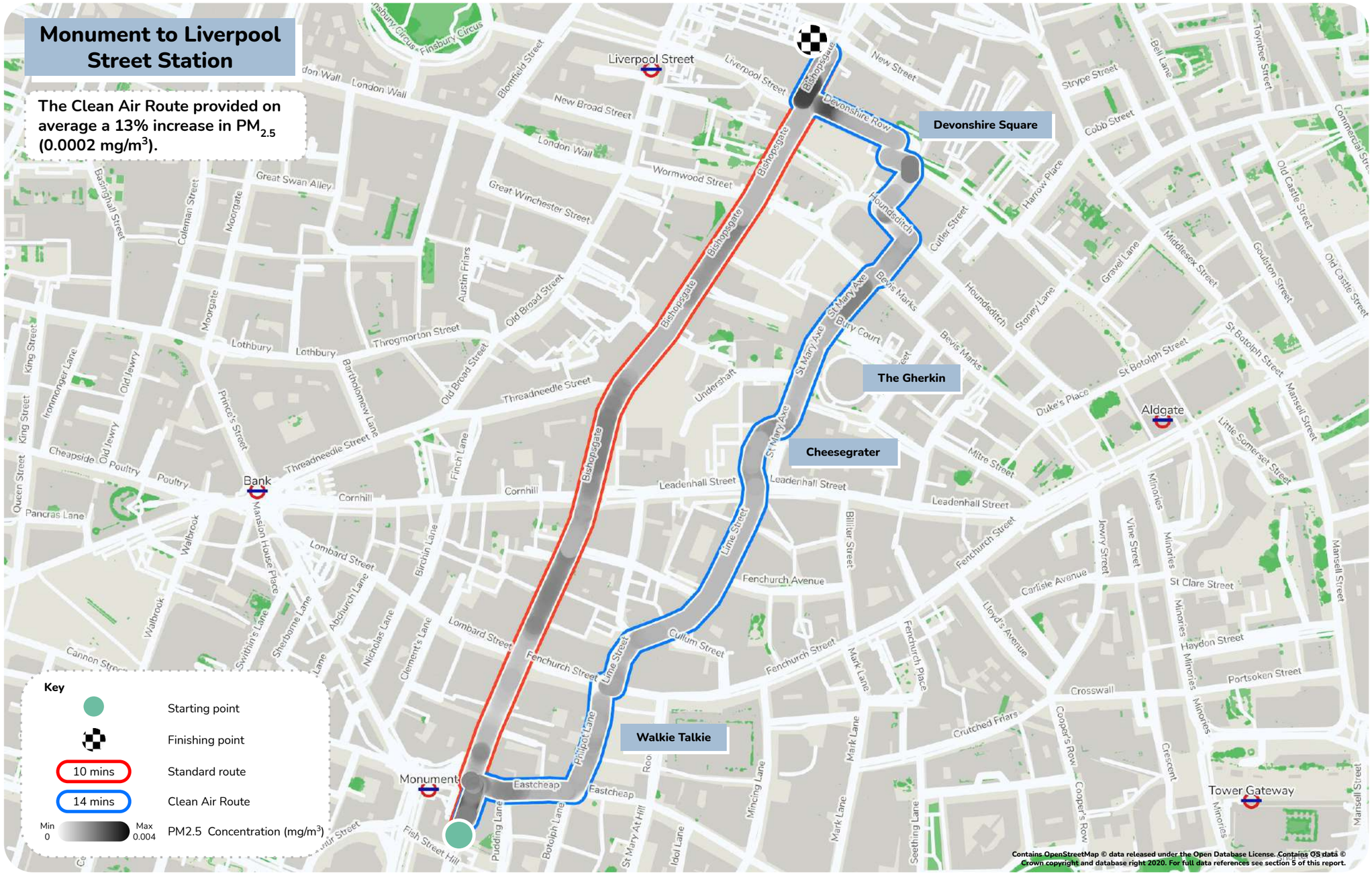






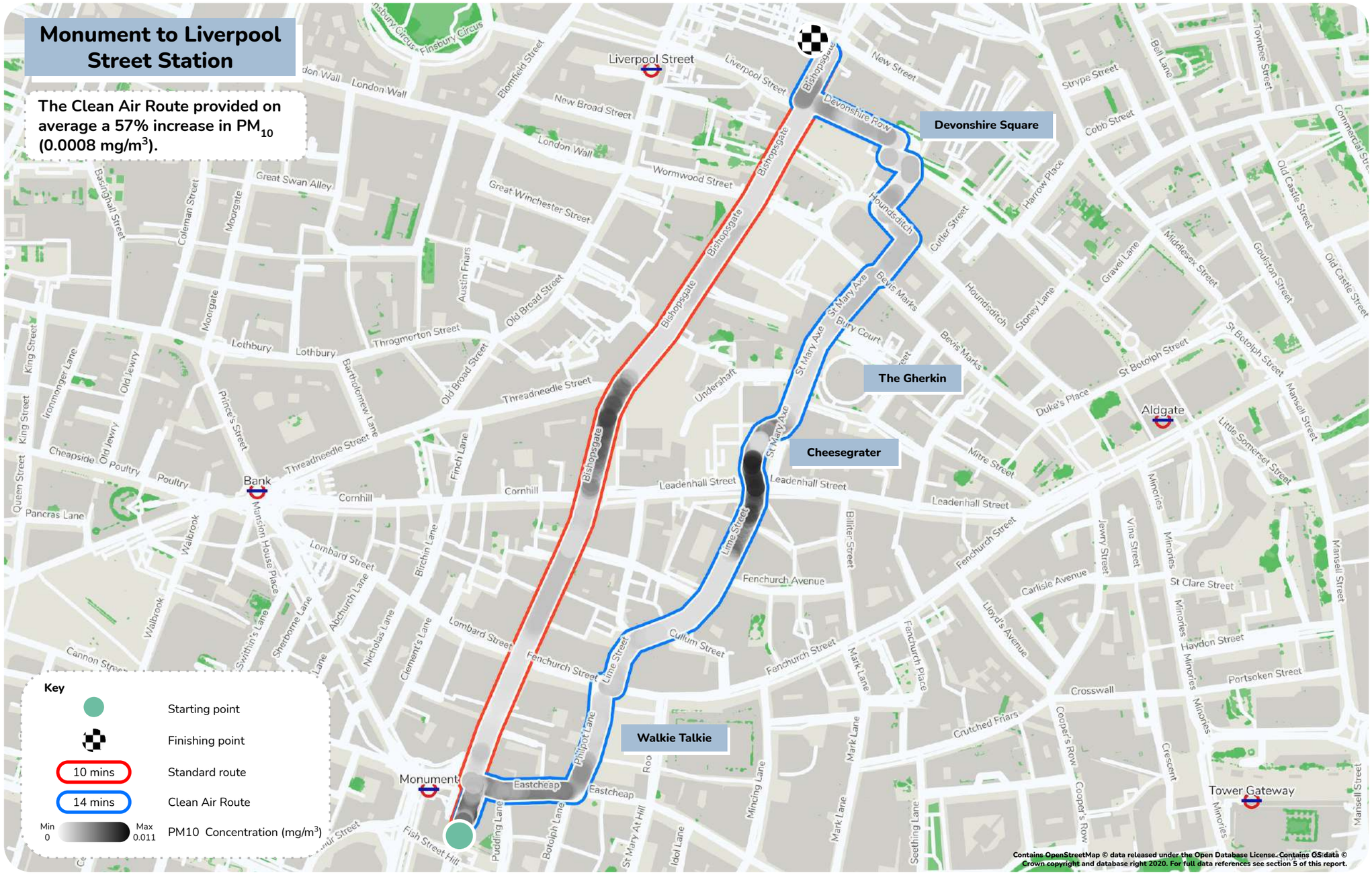
A3 City of London

$PM_{2.5}$ concentration



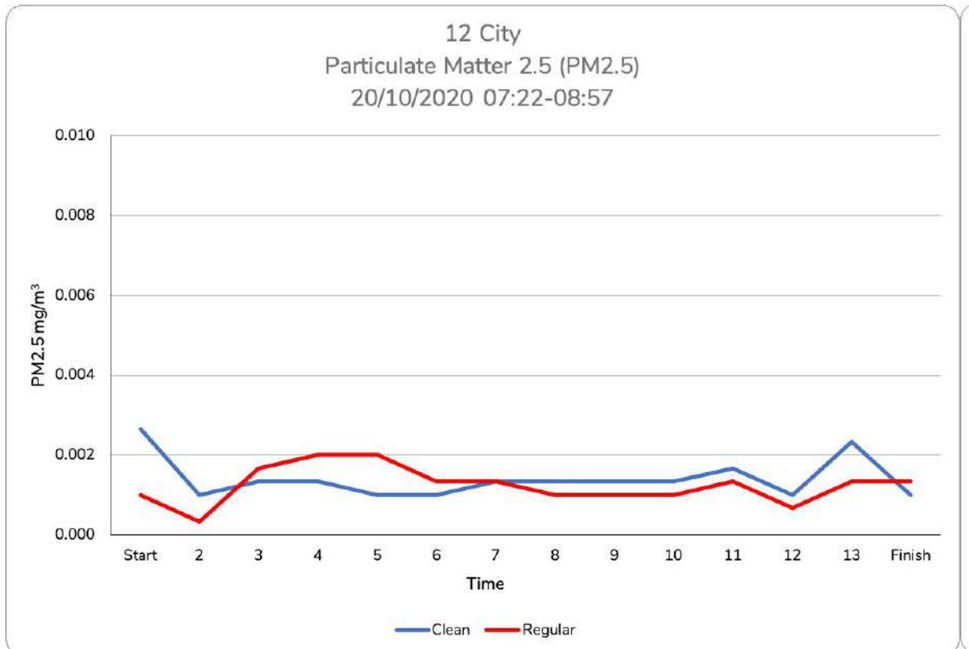
A3 City of London

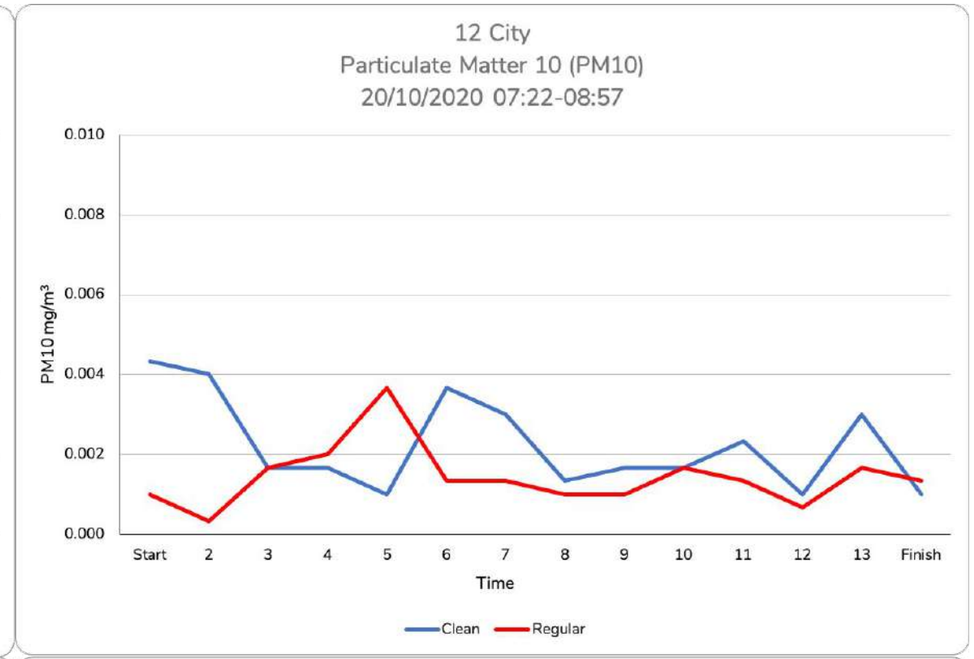
PM_{10} concentration

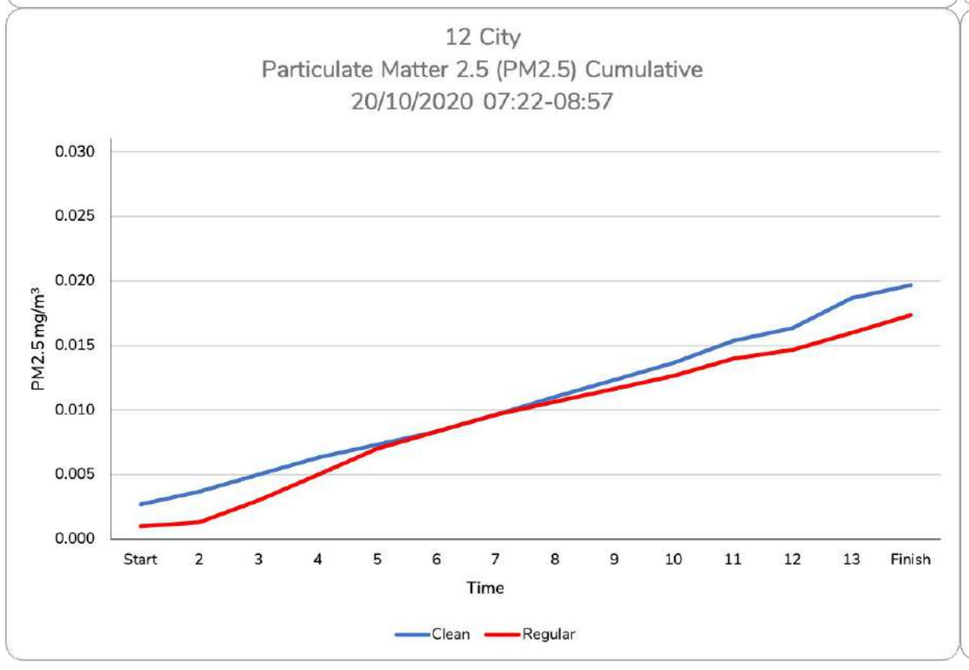


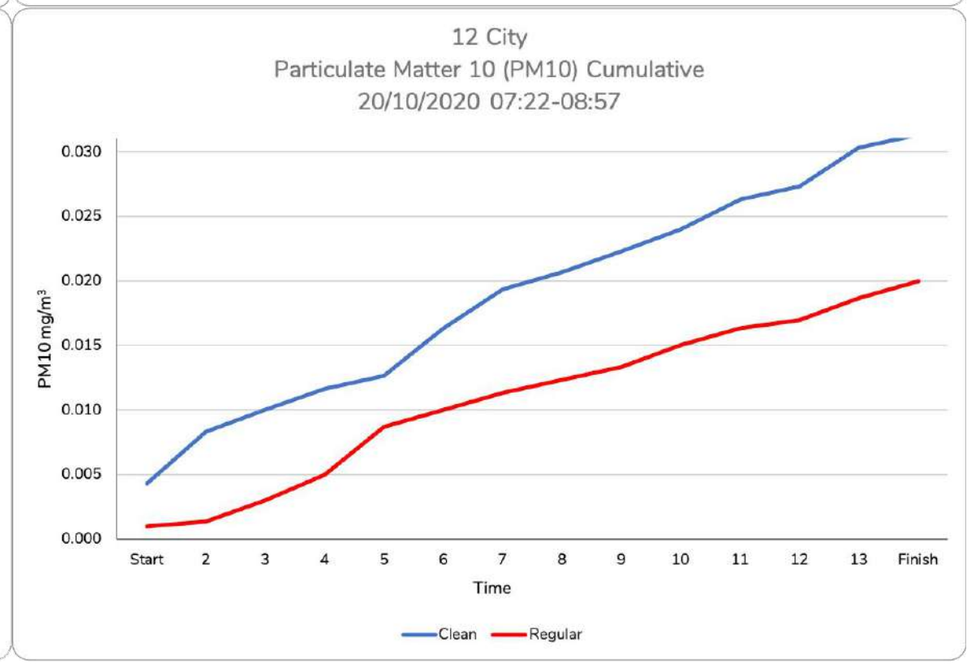
A3 City of London

Time History Graphs – Particulate Matter



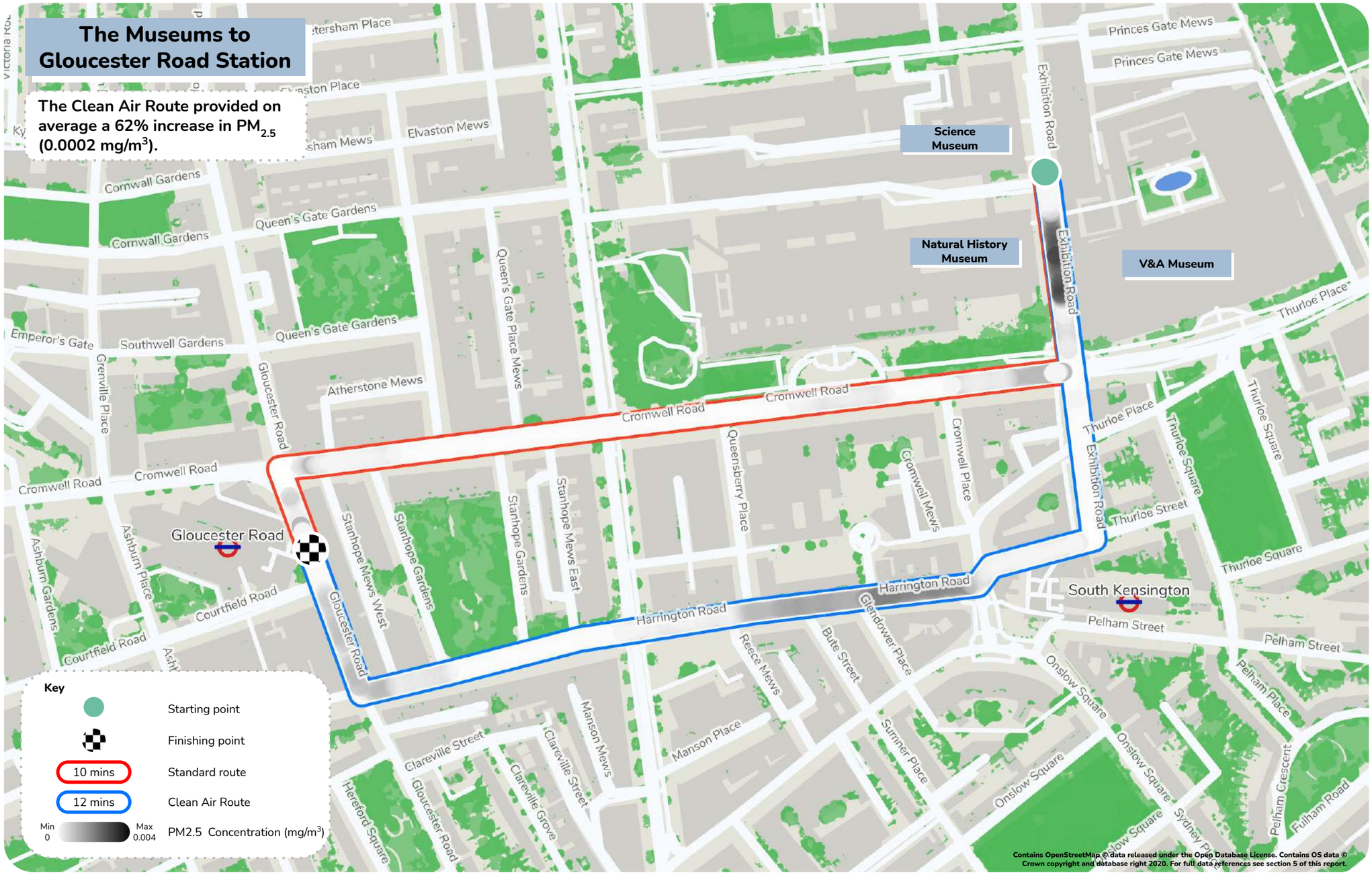






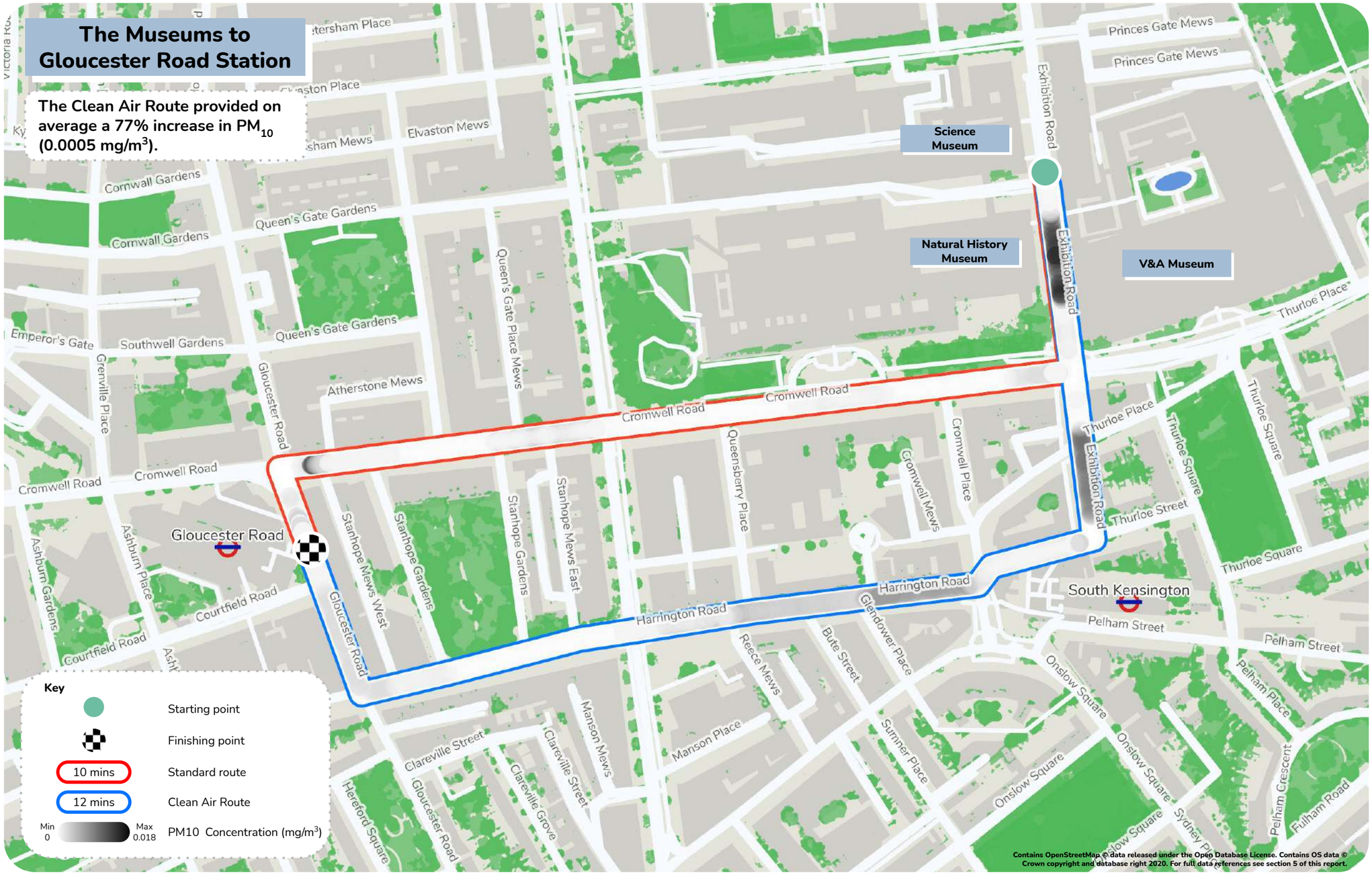
A4 Cromwell Road, Royal Borough of Kensington & Chelsea

$PM_{2.5}$ concentration



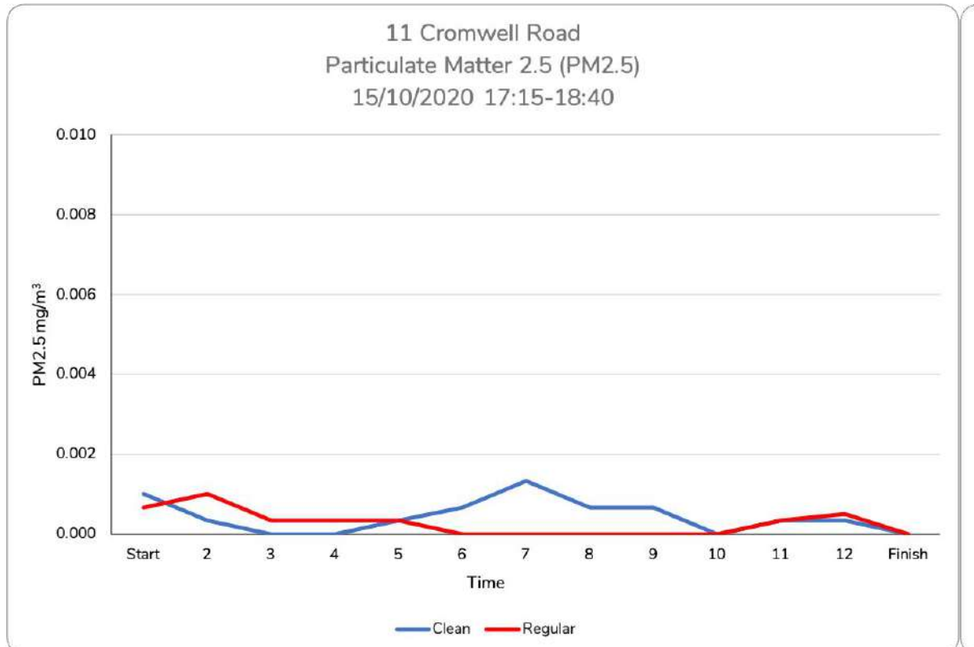
A4 Cromwell Road, Royal Borough of Kensington & Chelsea

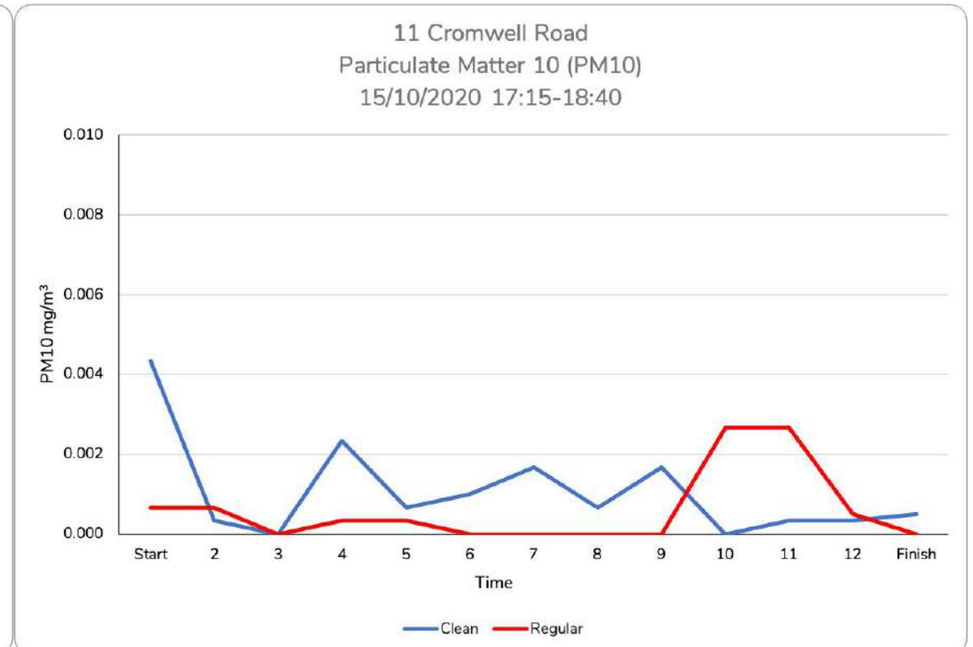
PM_{10} concentration

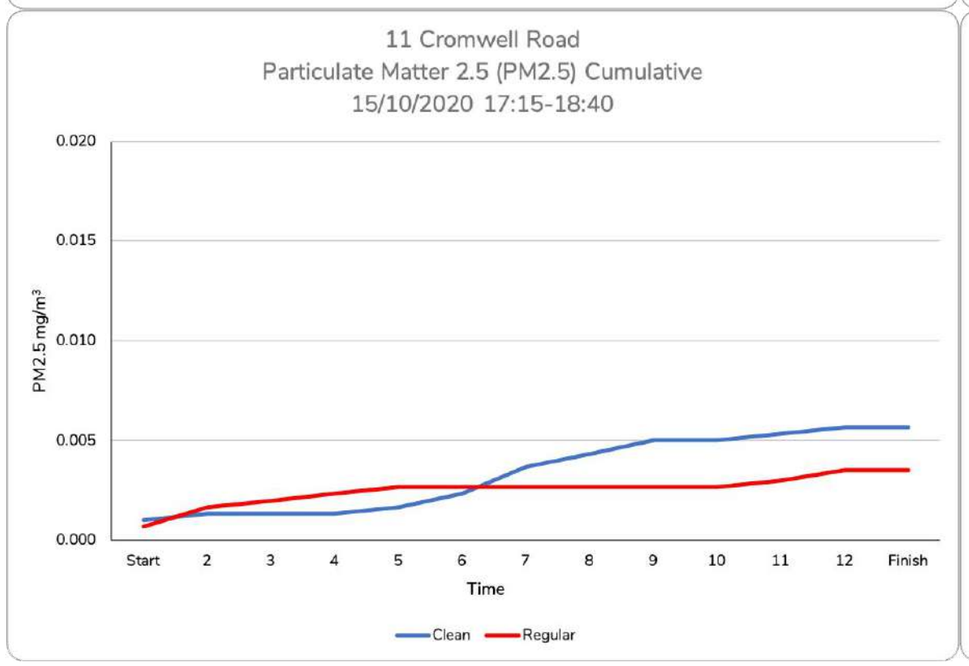


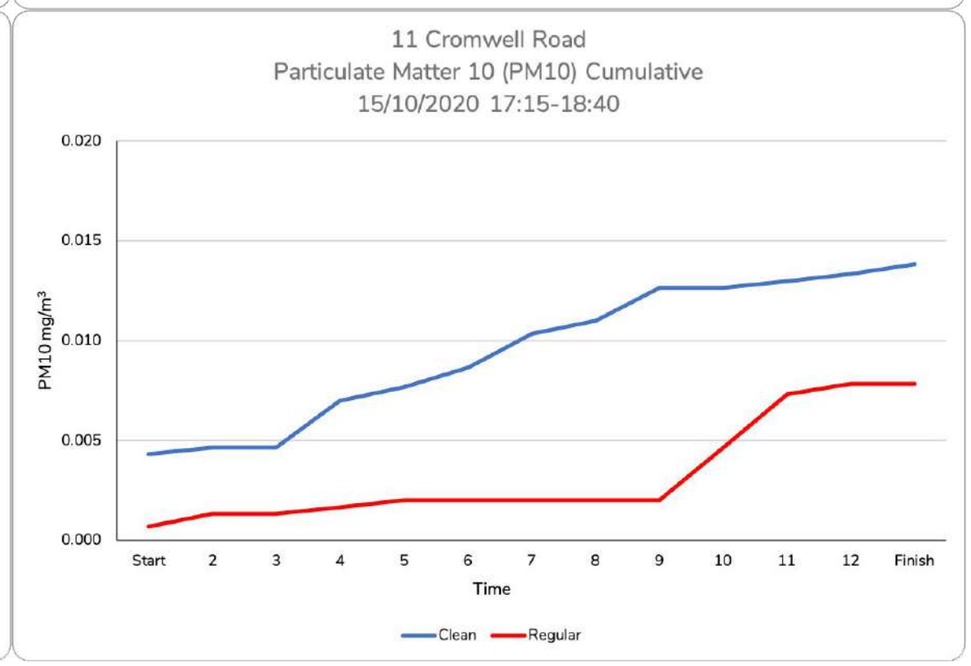
A4 Cromwell Road, Royal Borough of Kensington & Chelsea

Time History Graphs – Particulate Matter



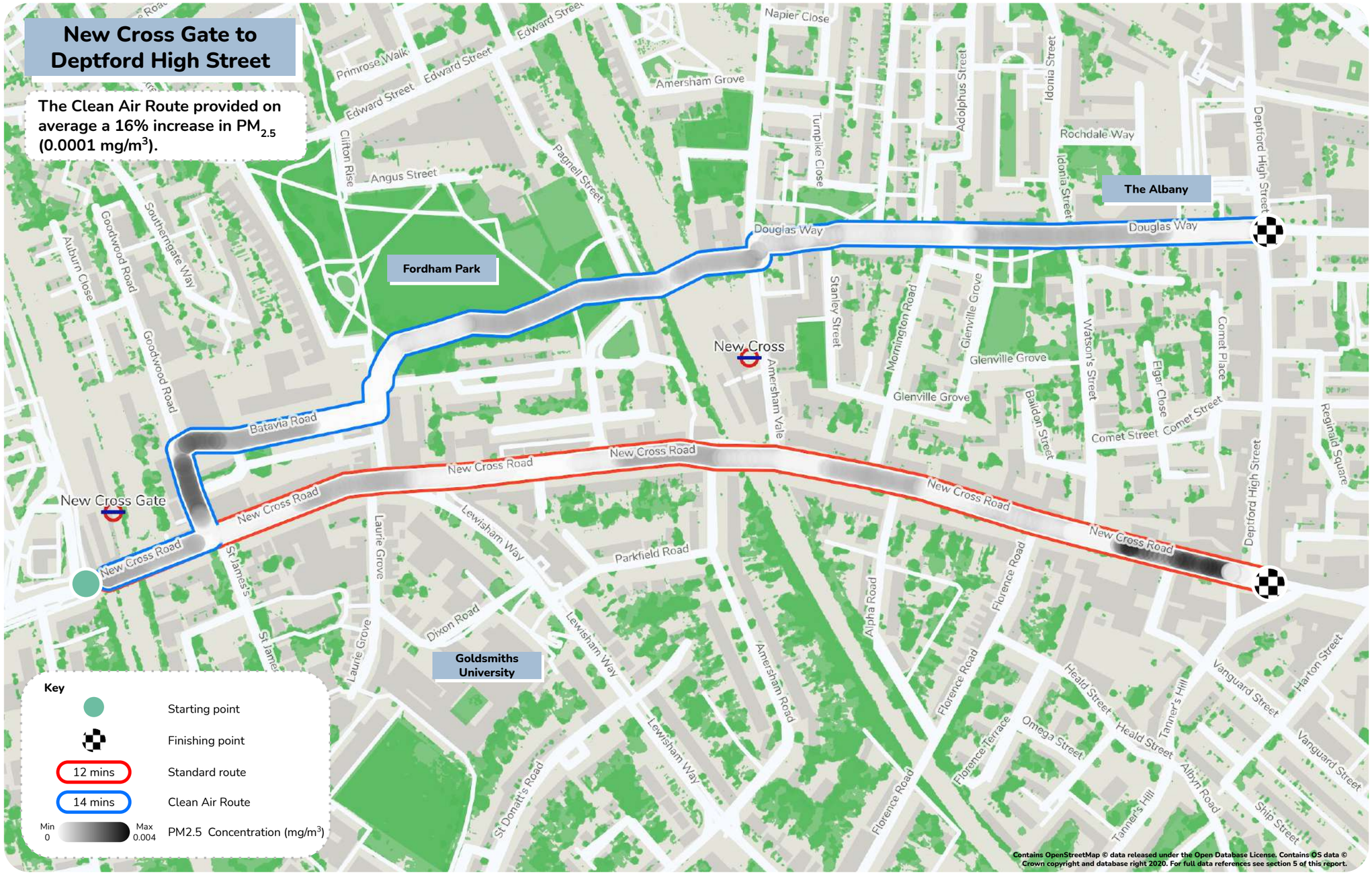






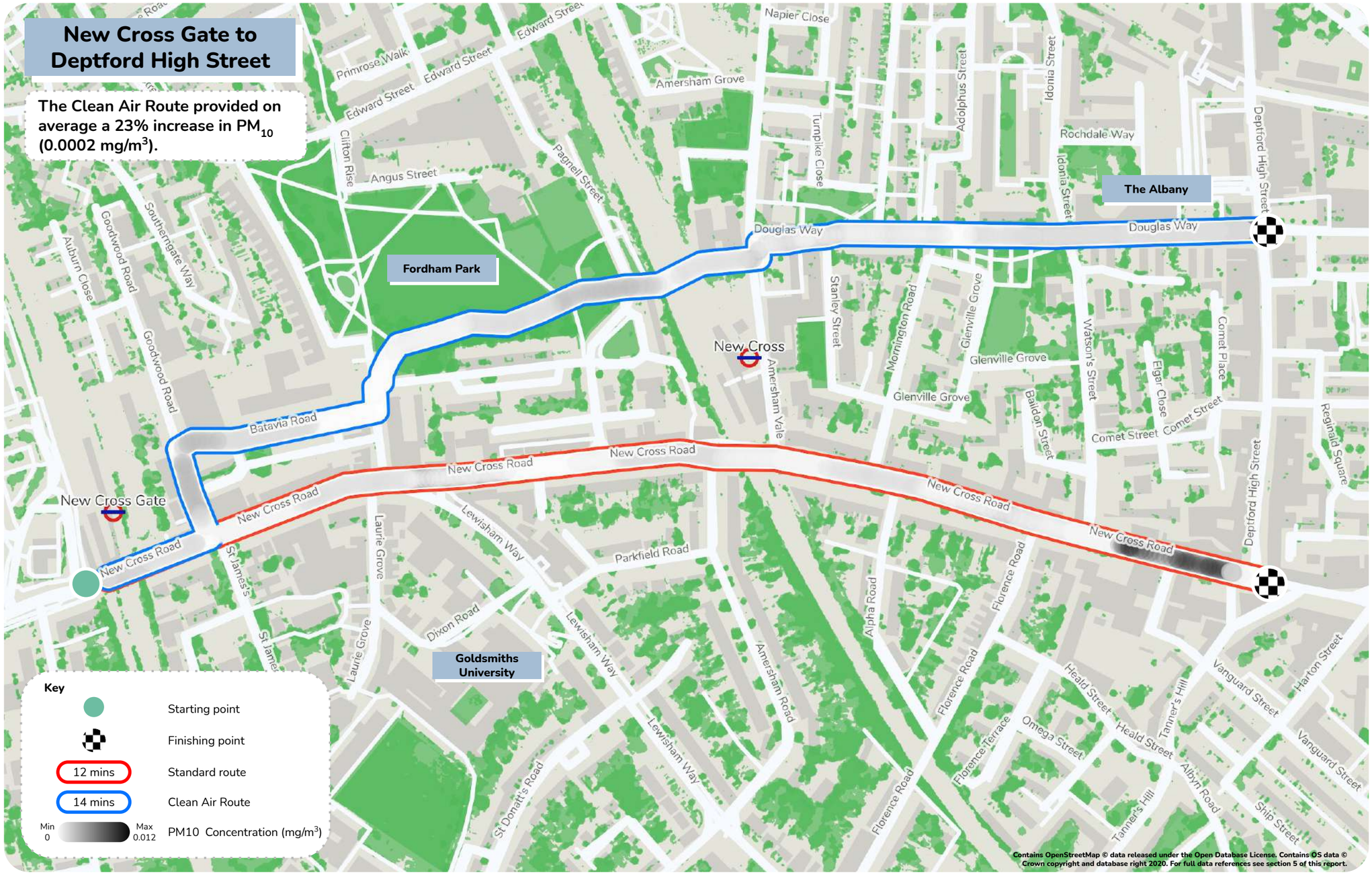
A5 Deptford, London Borough of Lewisham

$PM_{2.5}$ concentration



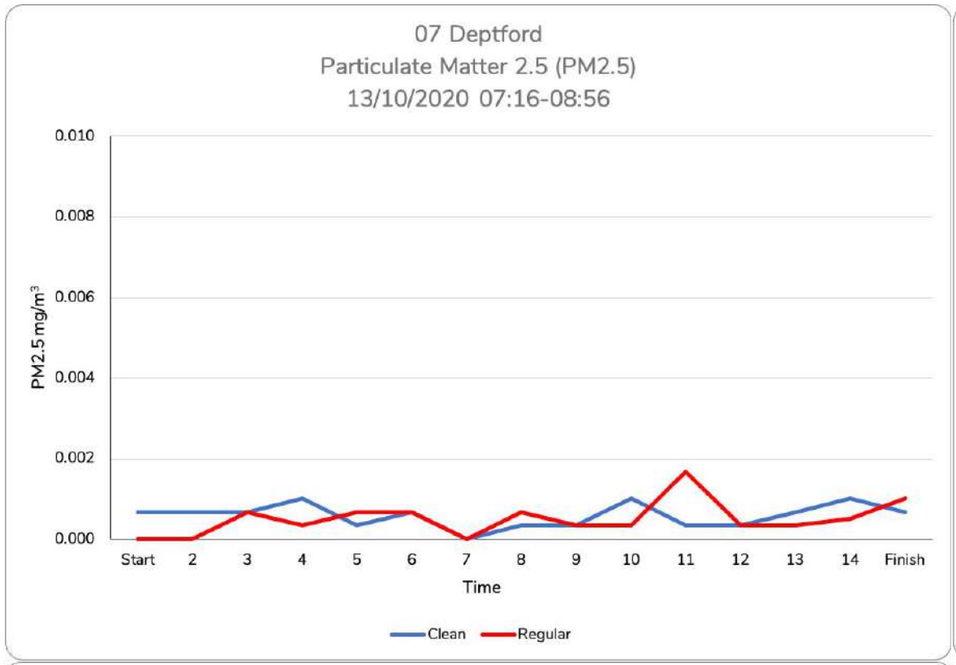
A5 Deptford, London Borough of Lewisham

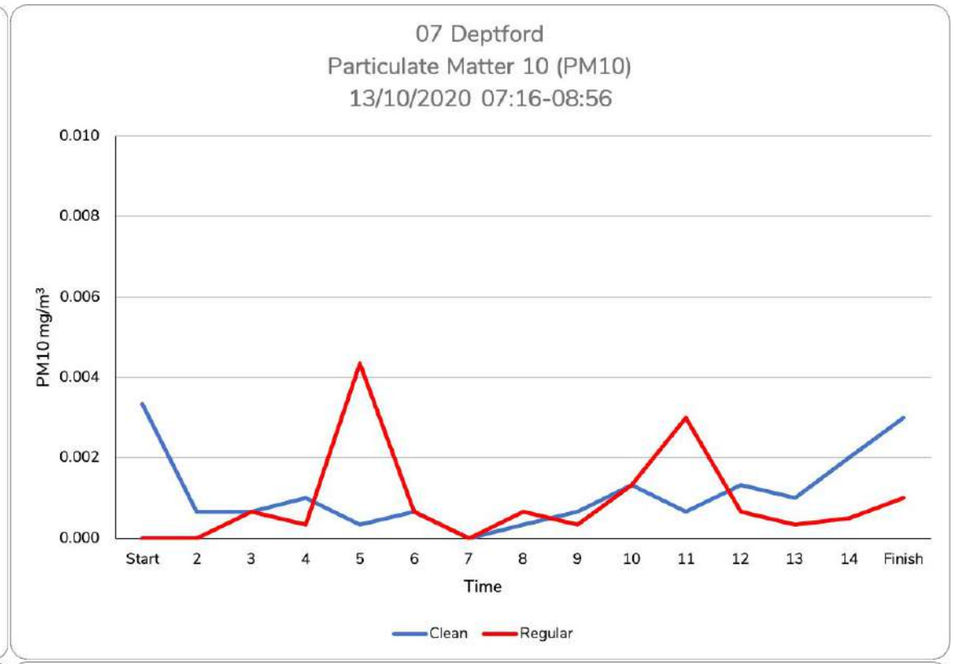
PM_{10} concentration

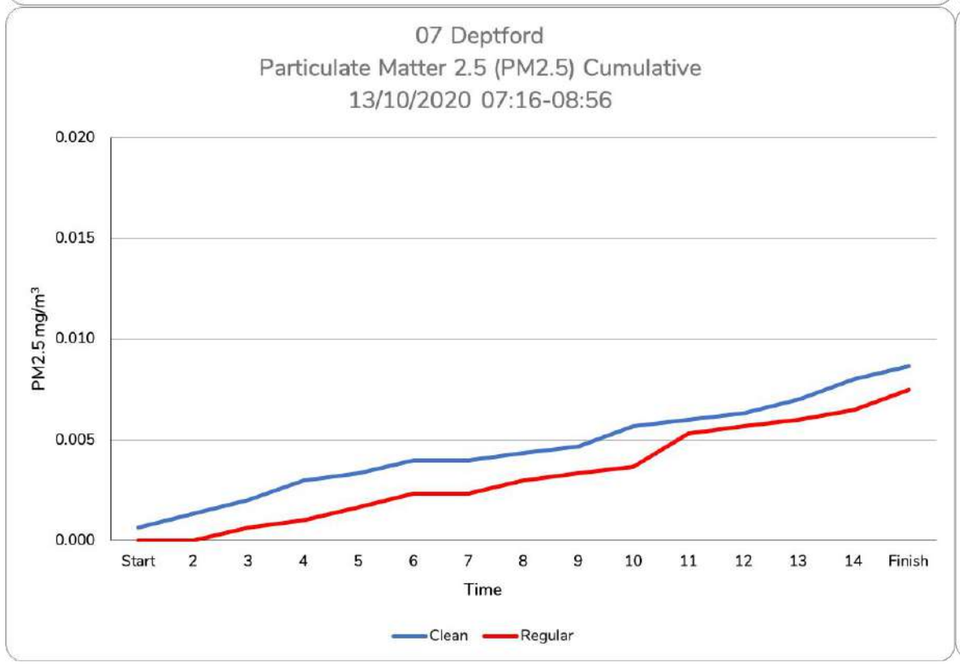


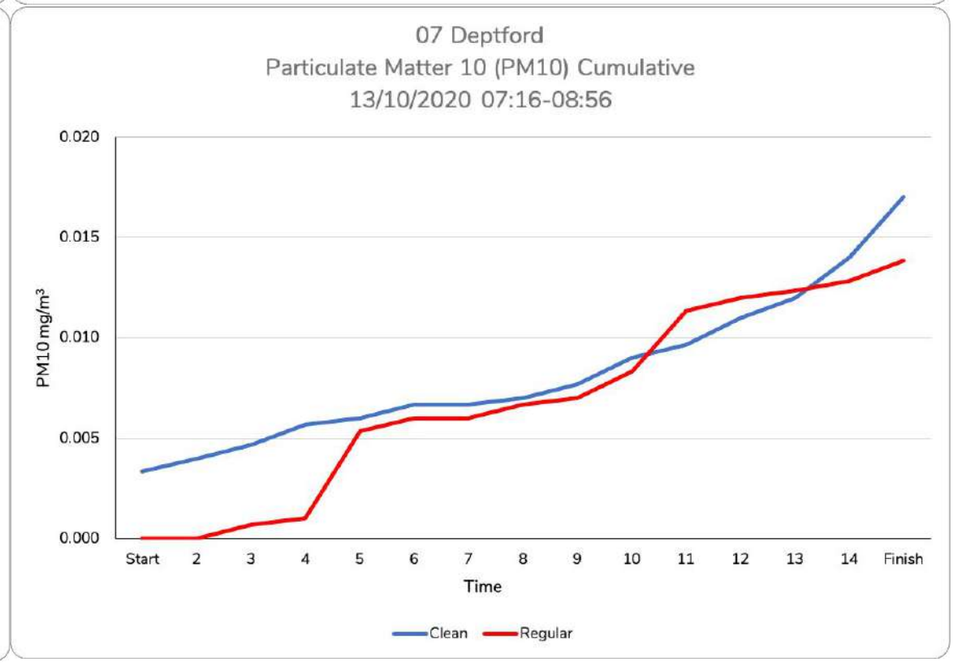
A5 Deptford, London Borough of Lewisham

Time History Graphs – Particulate Matter



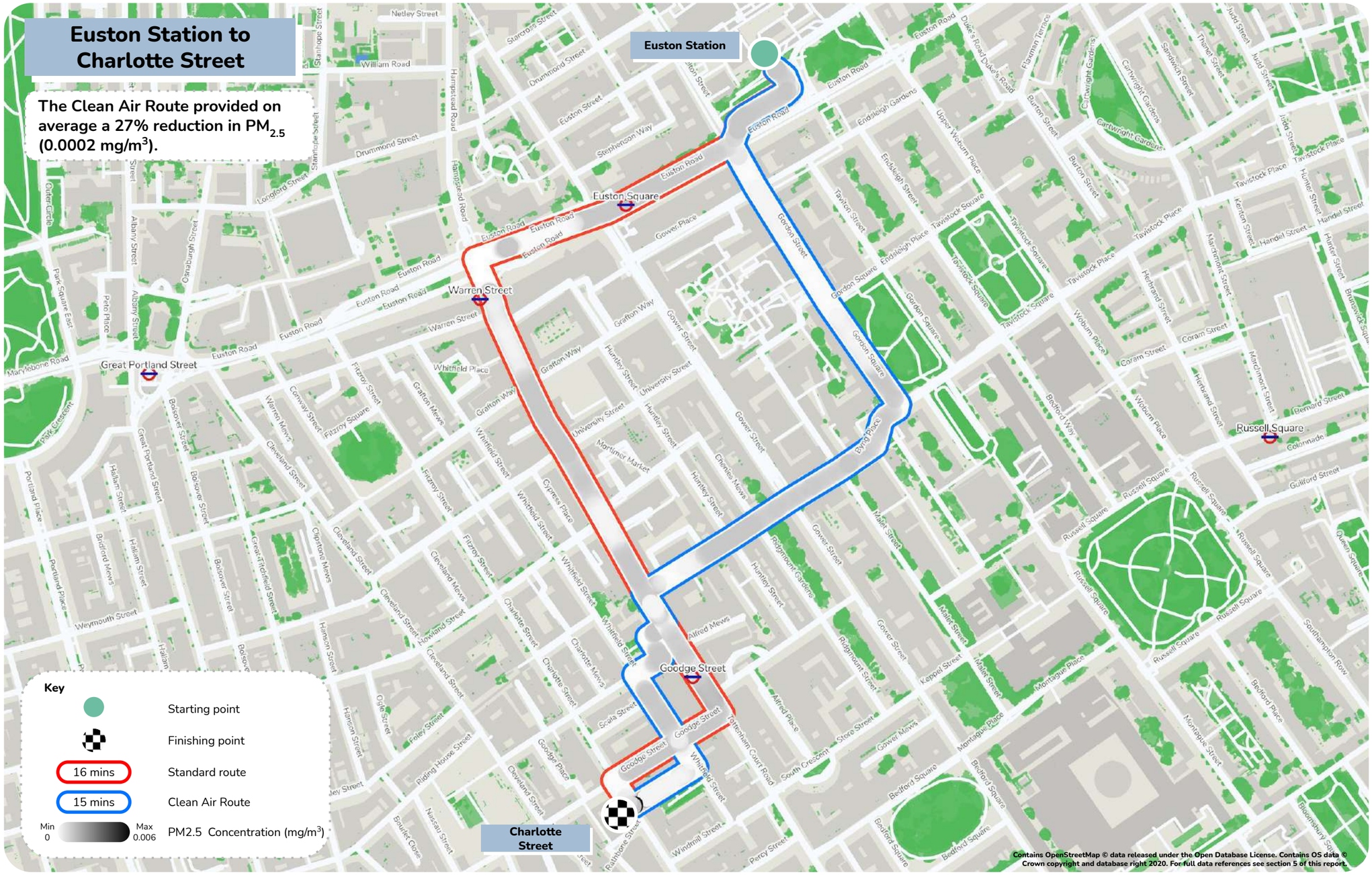






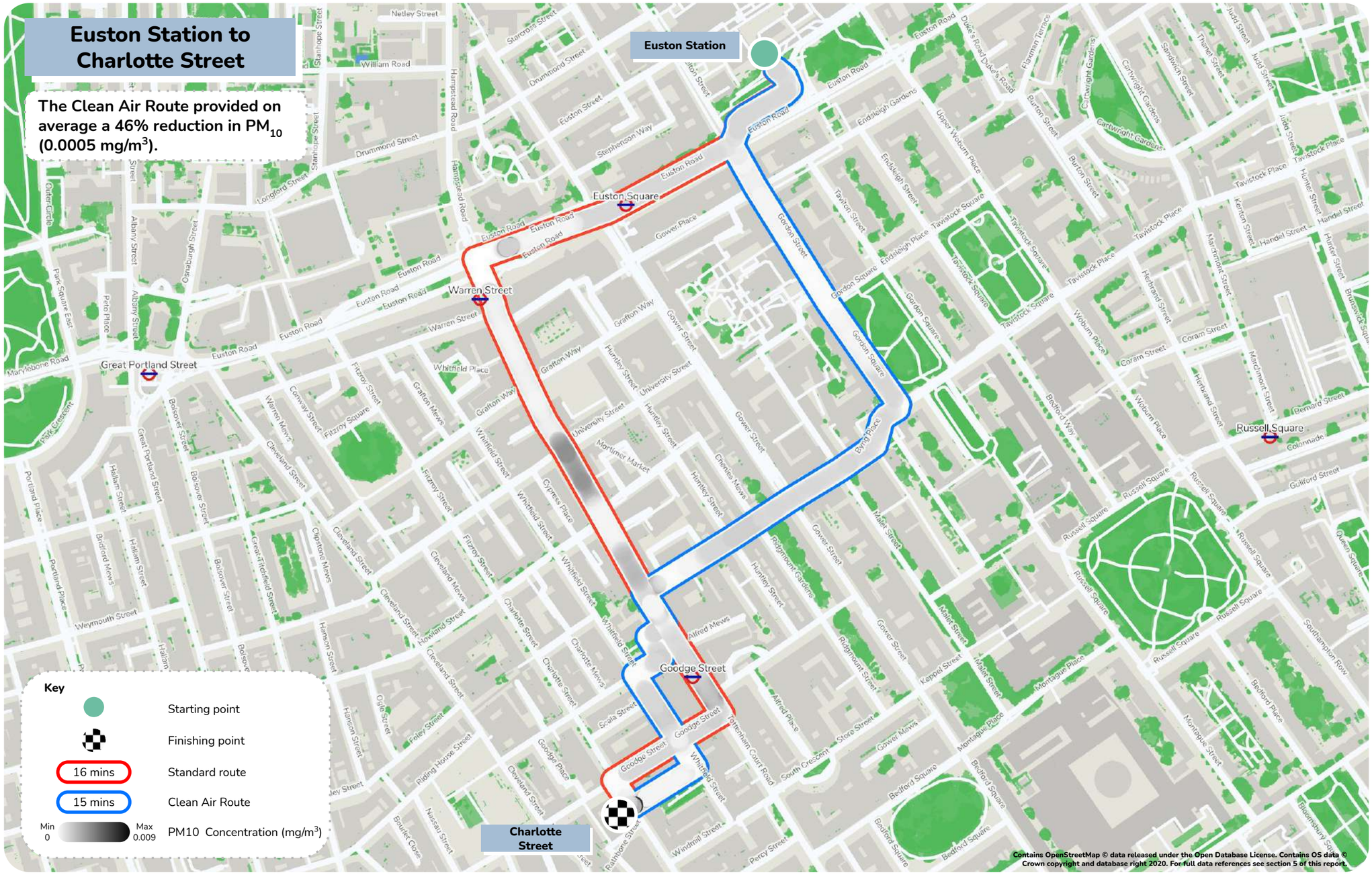
A6 Fitzrovia, Camden (Fitzrovia Partnership BID)

$PM_{2.5}$ concentration



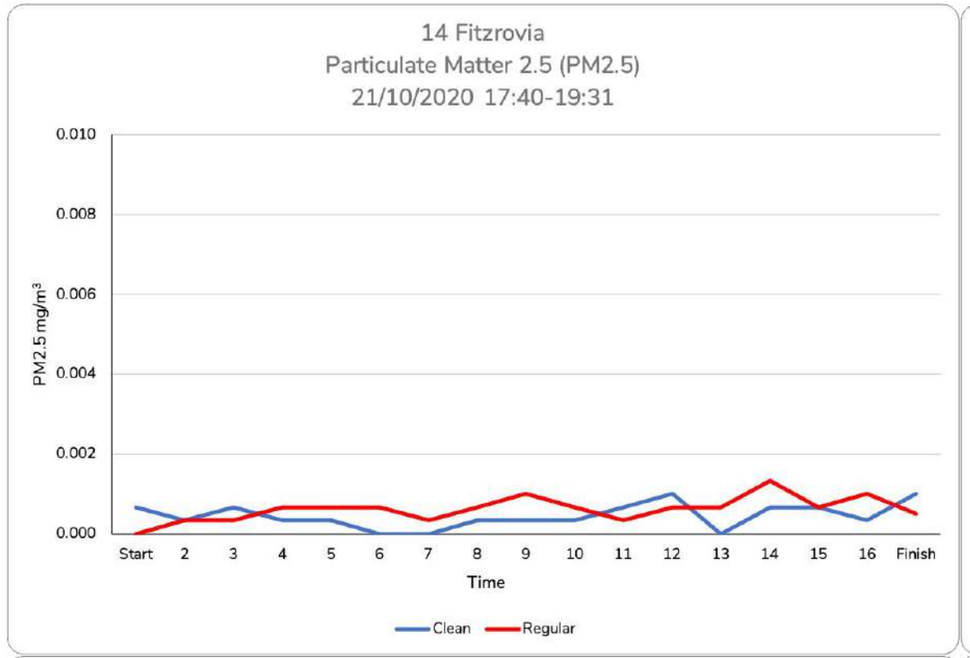
A6 Fitzrovia, Camden (Fitzrovia Partnership BID)

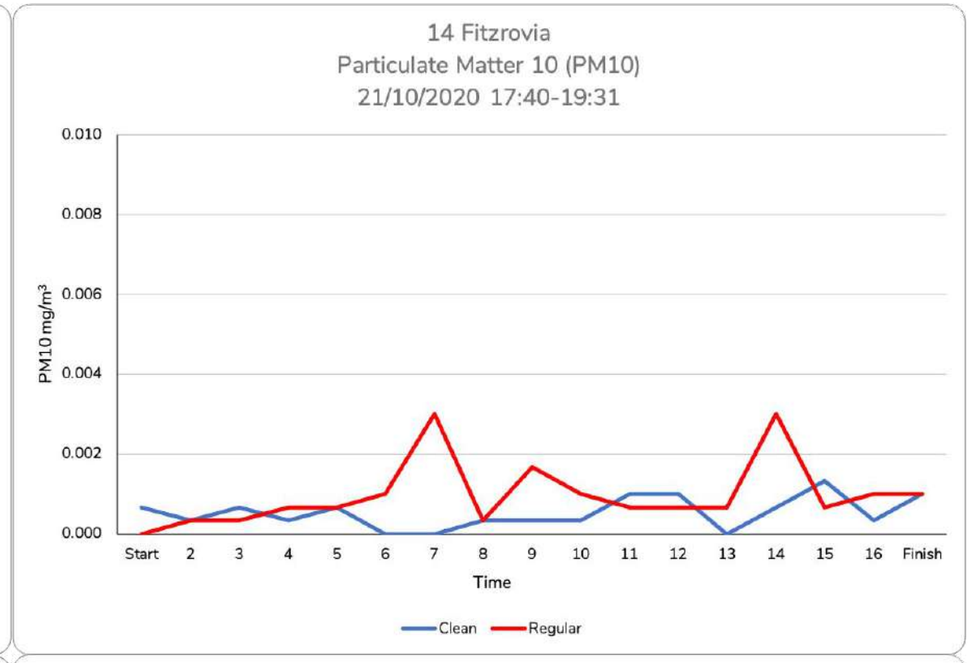
PM_{10} concentration

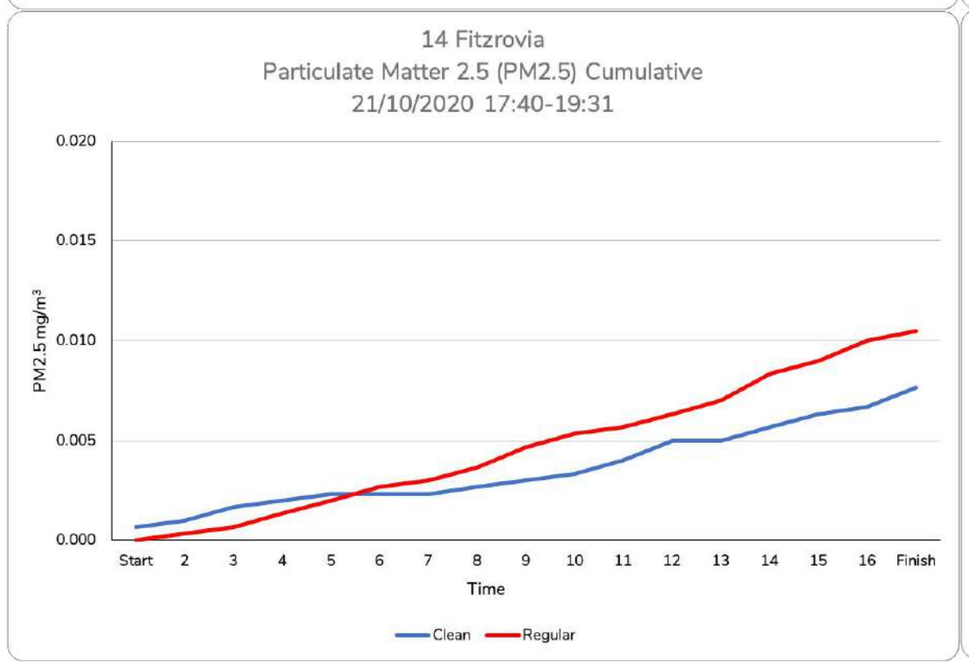


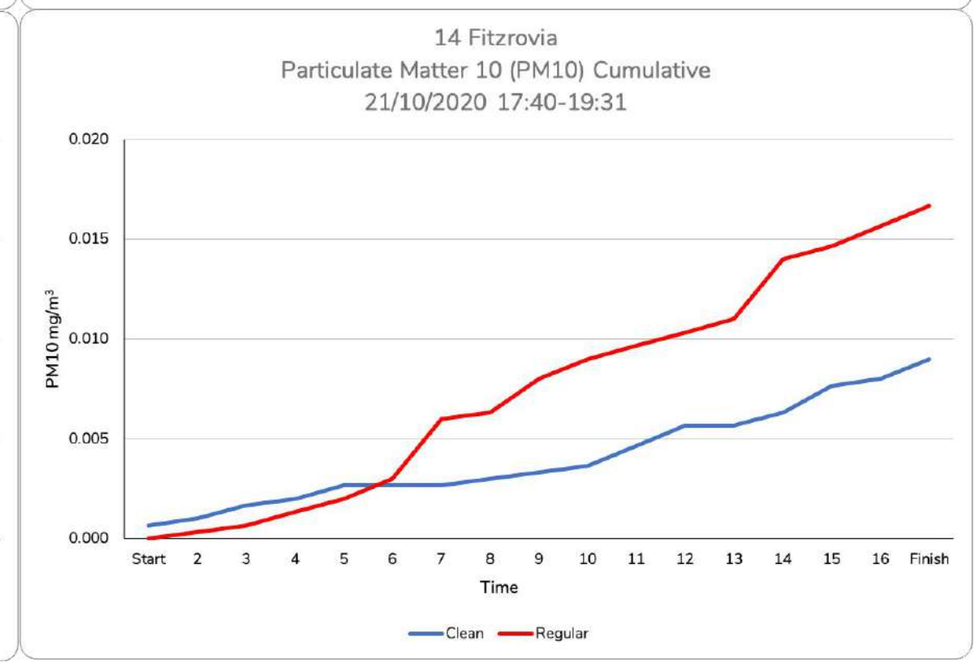
A6 Fitzrovia, Camden (Fitzrovia Partnership BID)

Time History Graphs – Particulate Matter



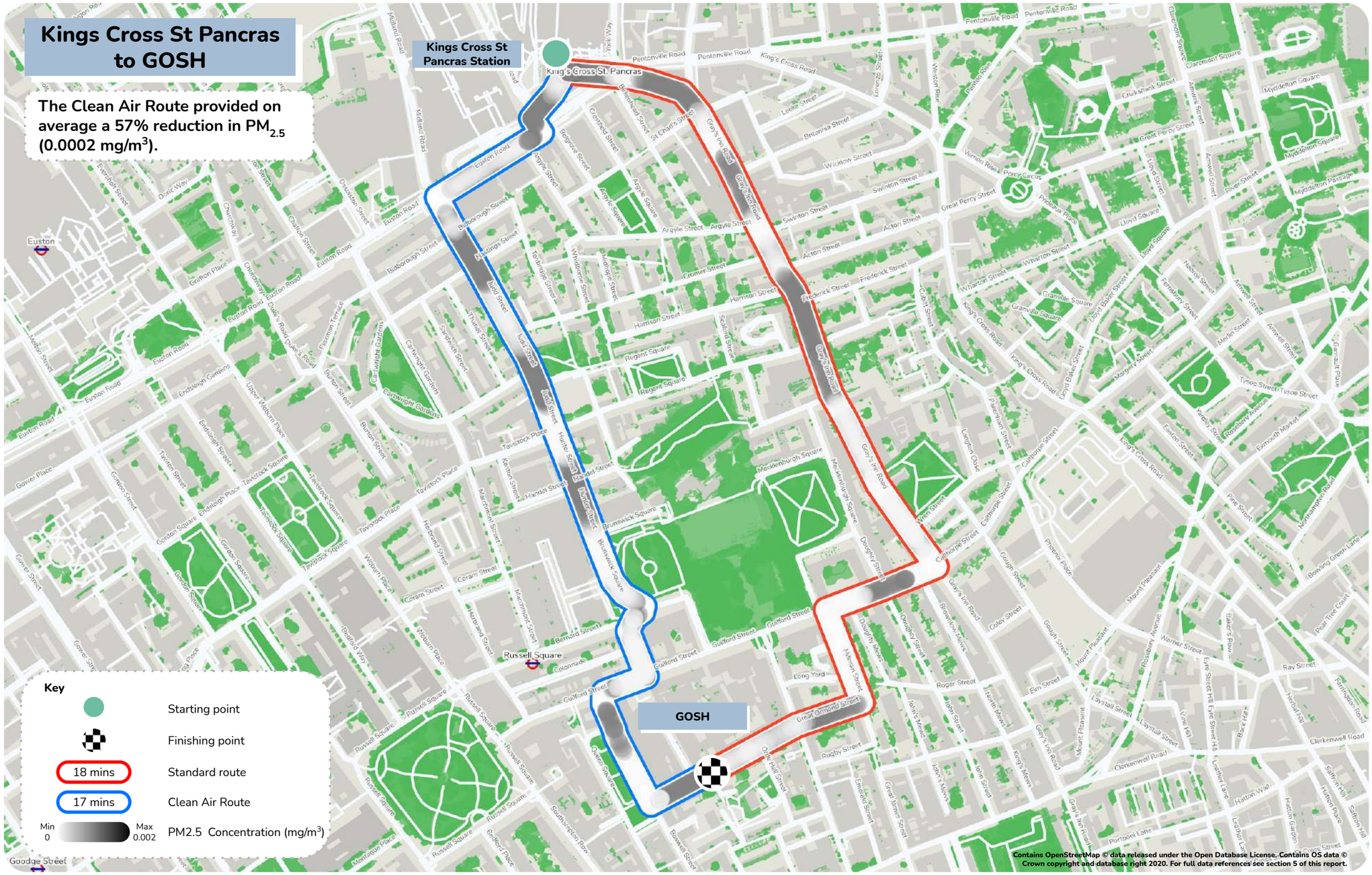






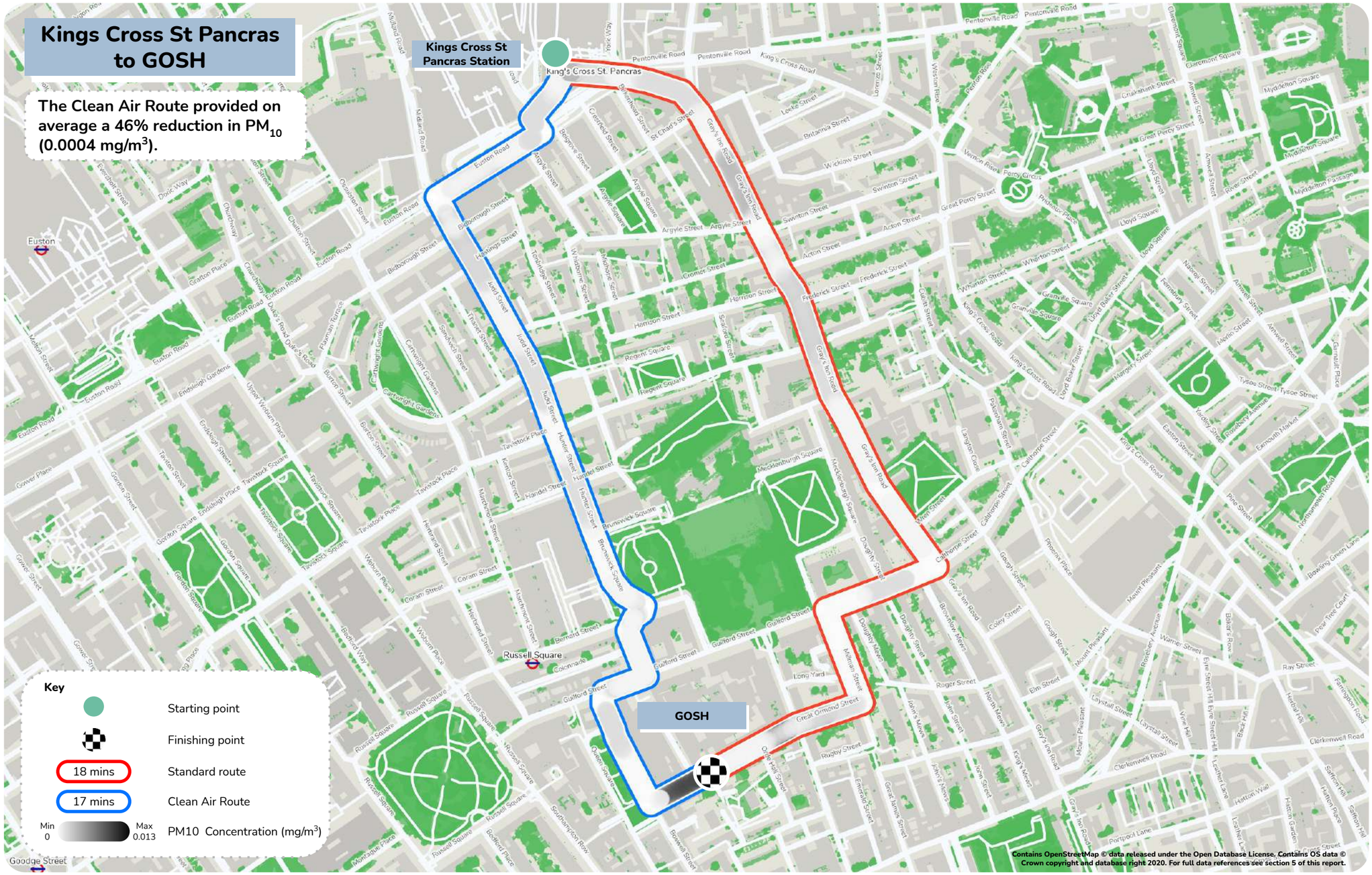
A7 Great Ormond Street Hospital, London Borough of Camden

$PM_{2.5}$ concentration



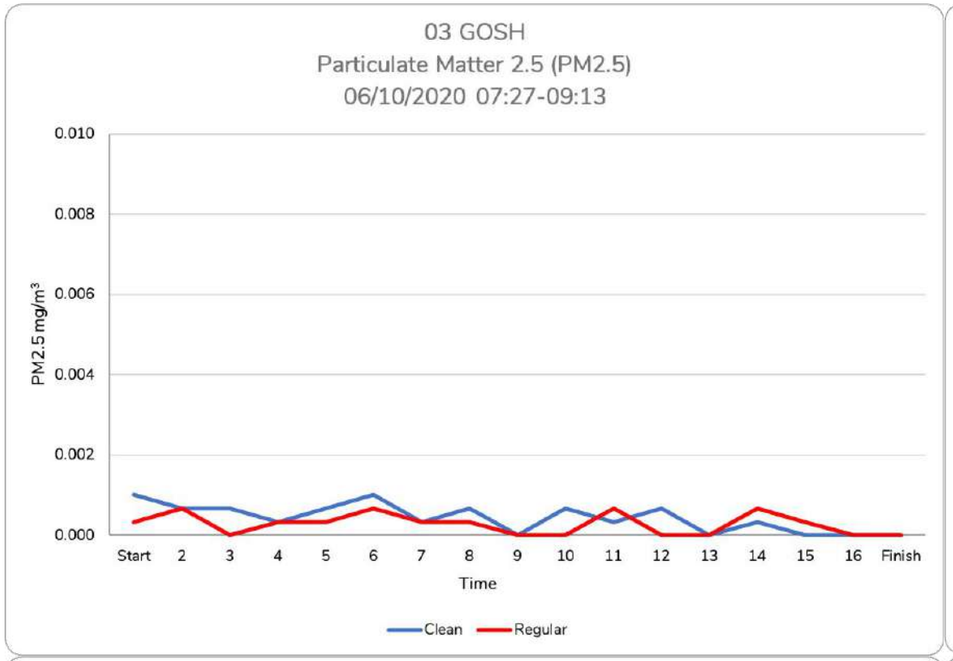
A7 Great Ormond Street Hospital, London Borough of Camden

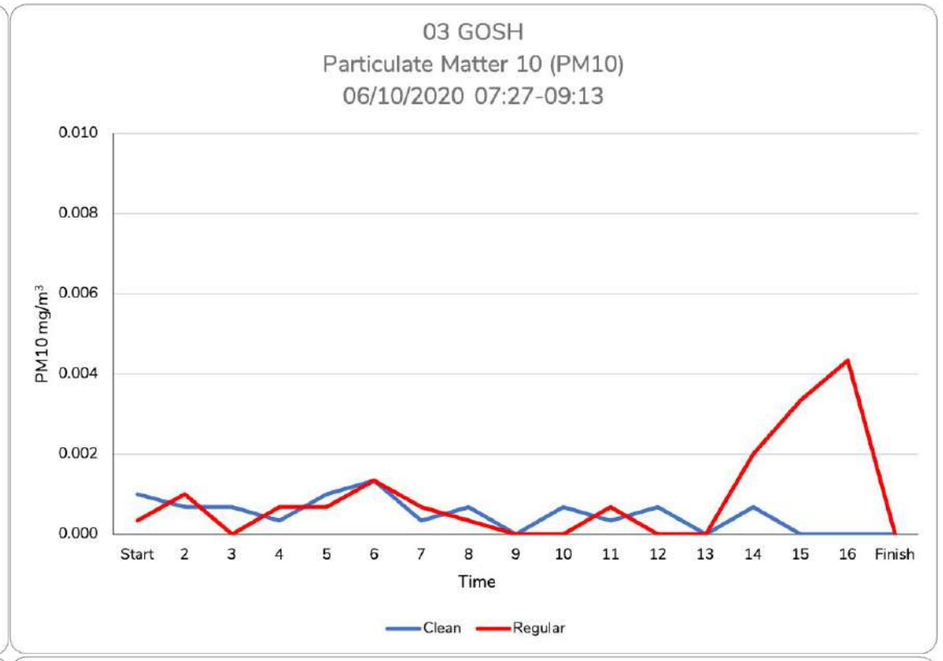
PM_{10} concentration

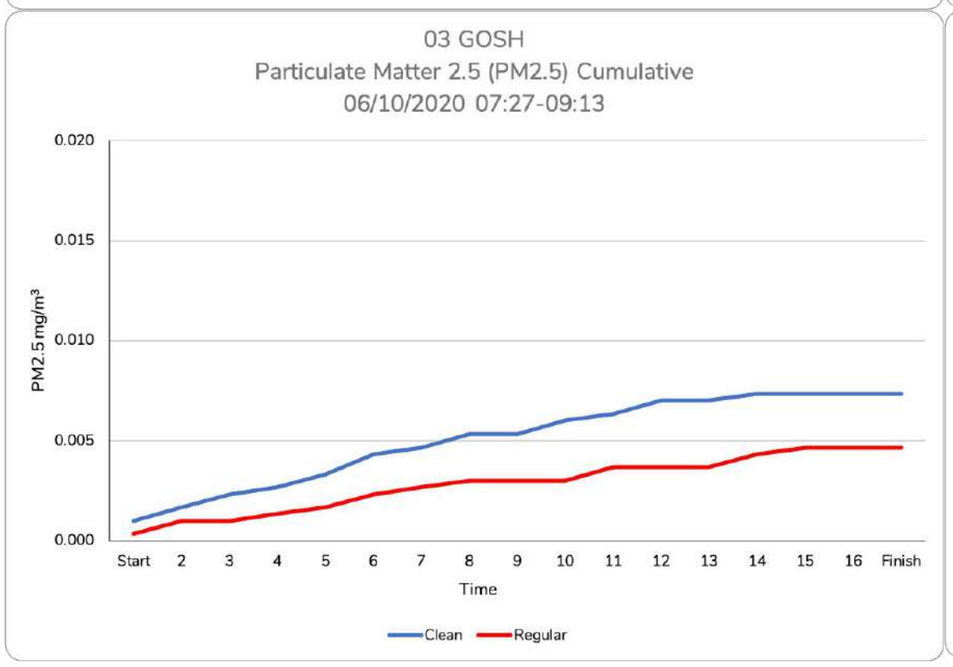


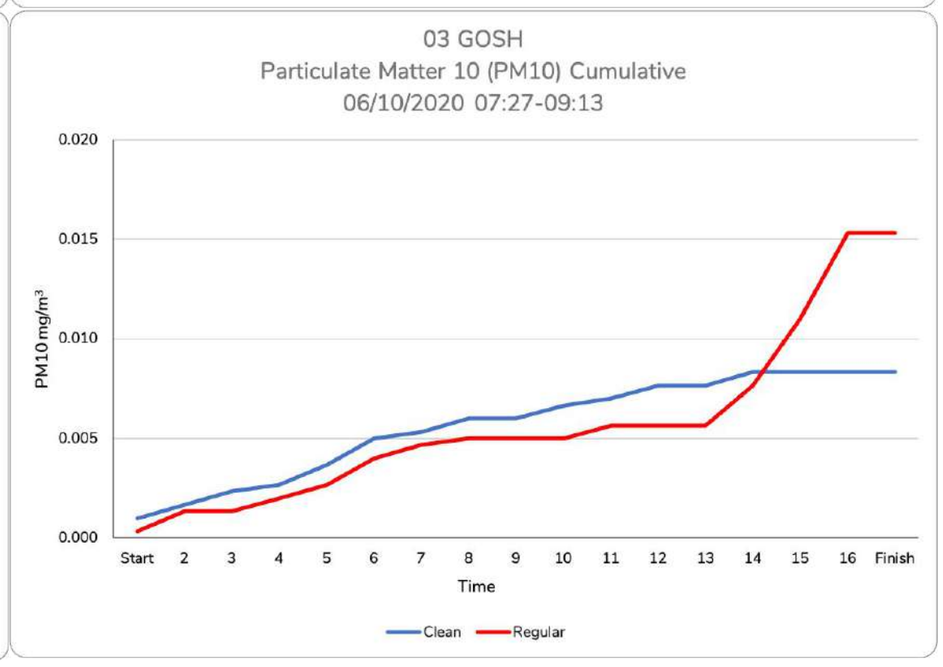
A7 Great Ormond Street Hospital, London Borough of Camden

Time History Graphs – Particulate Matter



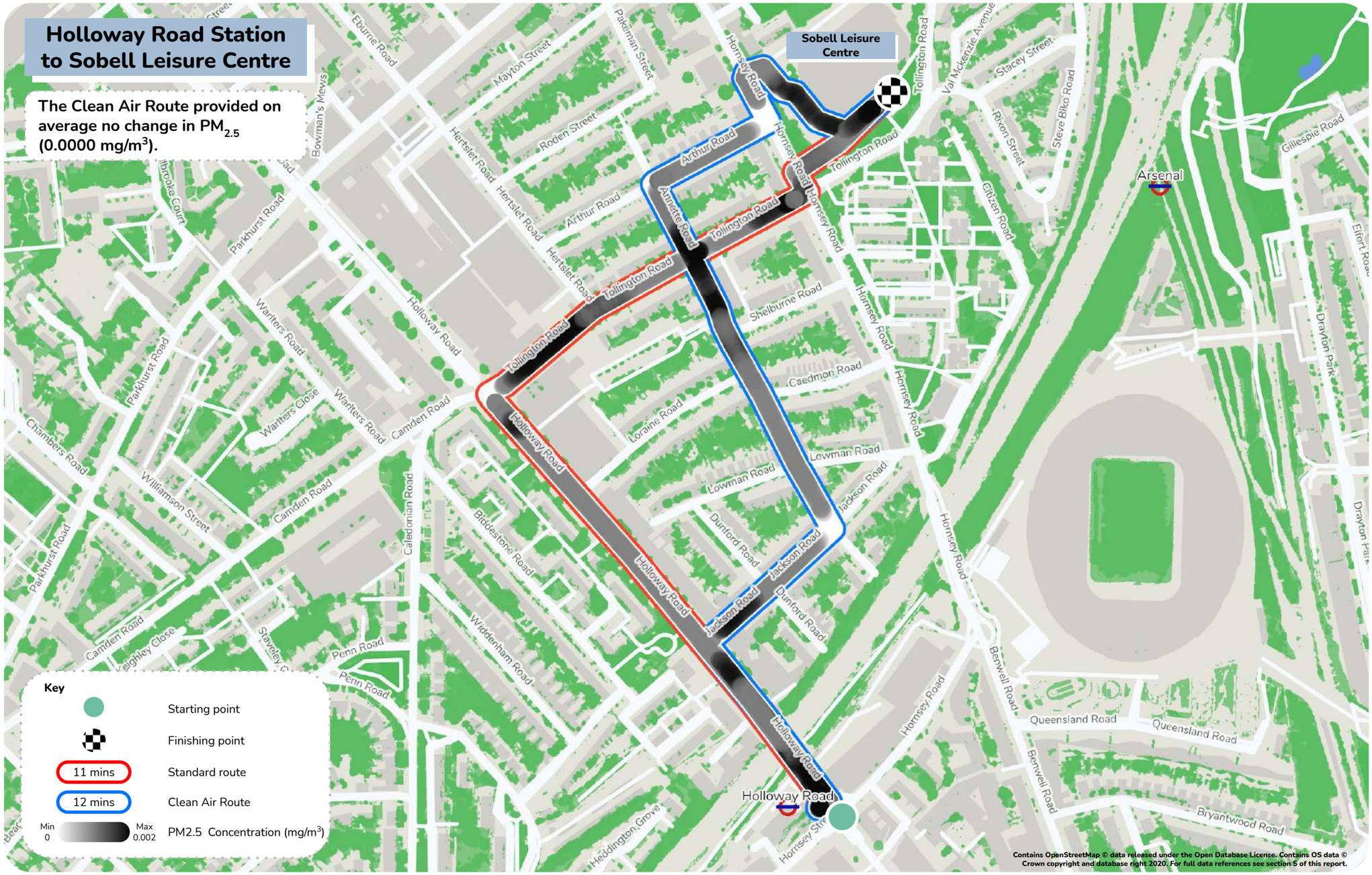






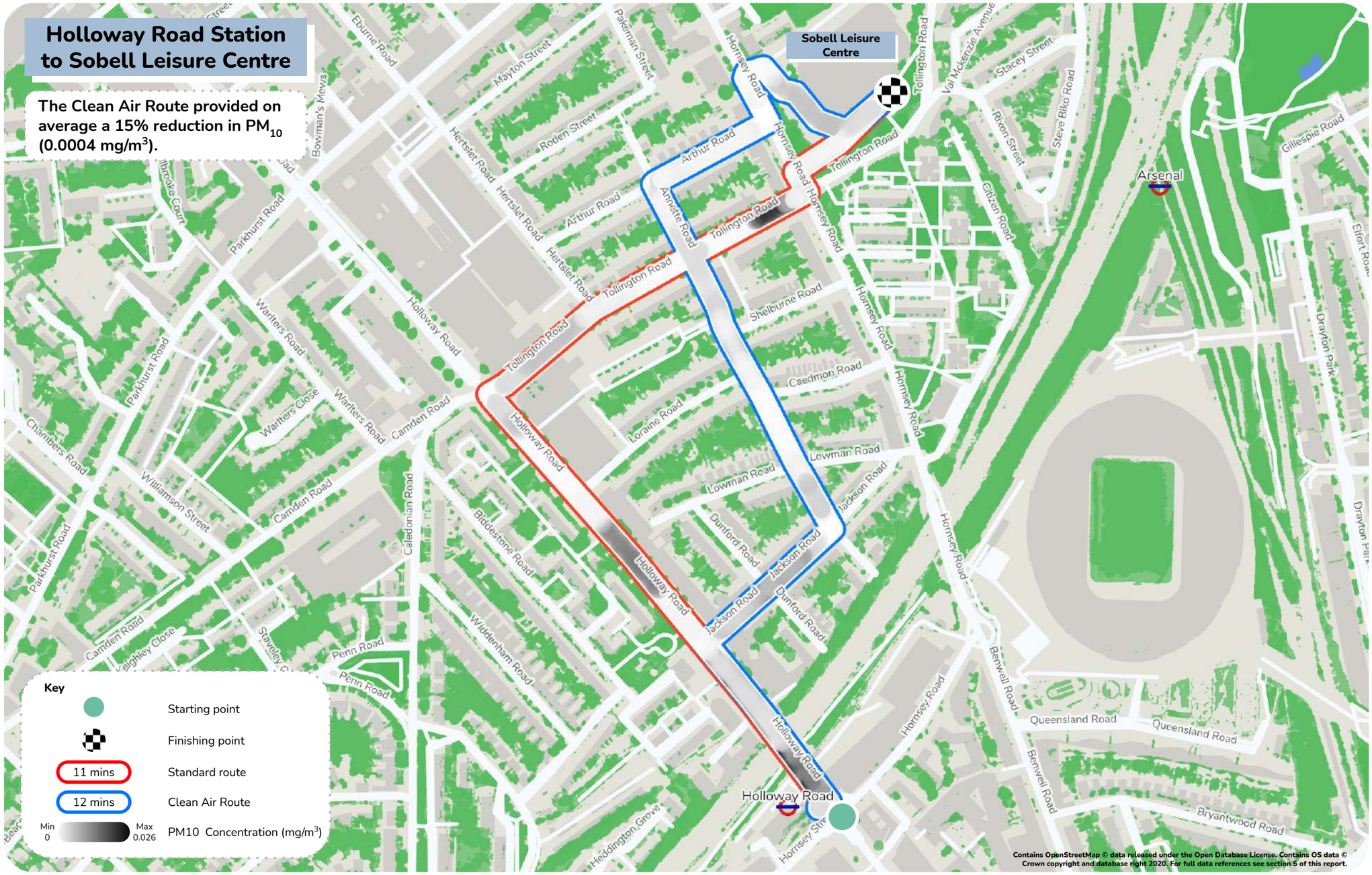
A8 Holloway Road, London Borough of Islington

$PM_{2.5}$ concentration



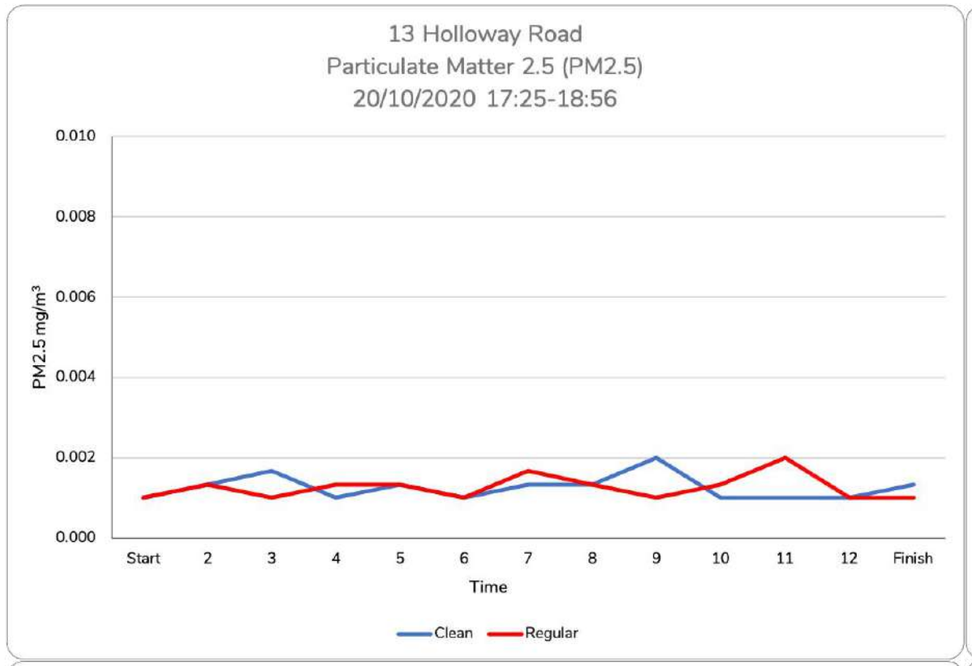
A8 Holloway Road, London Borough of Islington

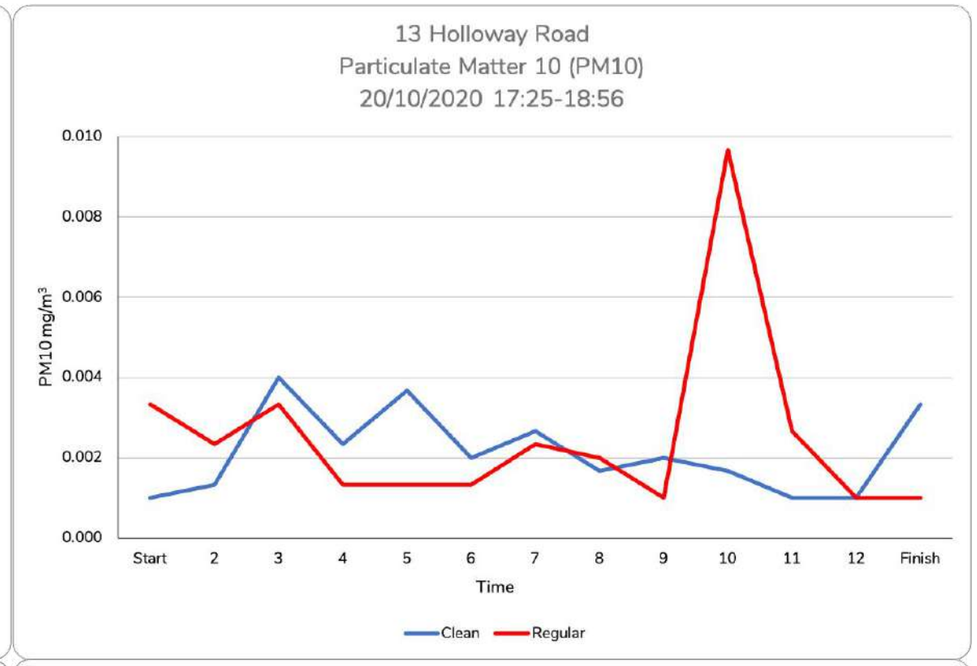
PM_{10} concentration

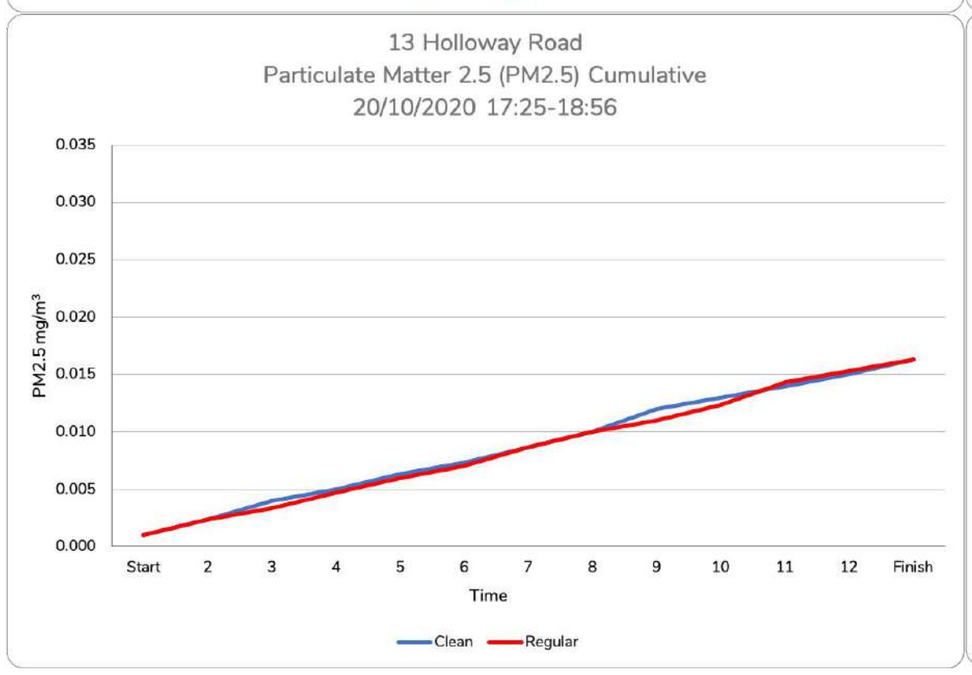


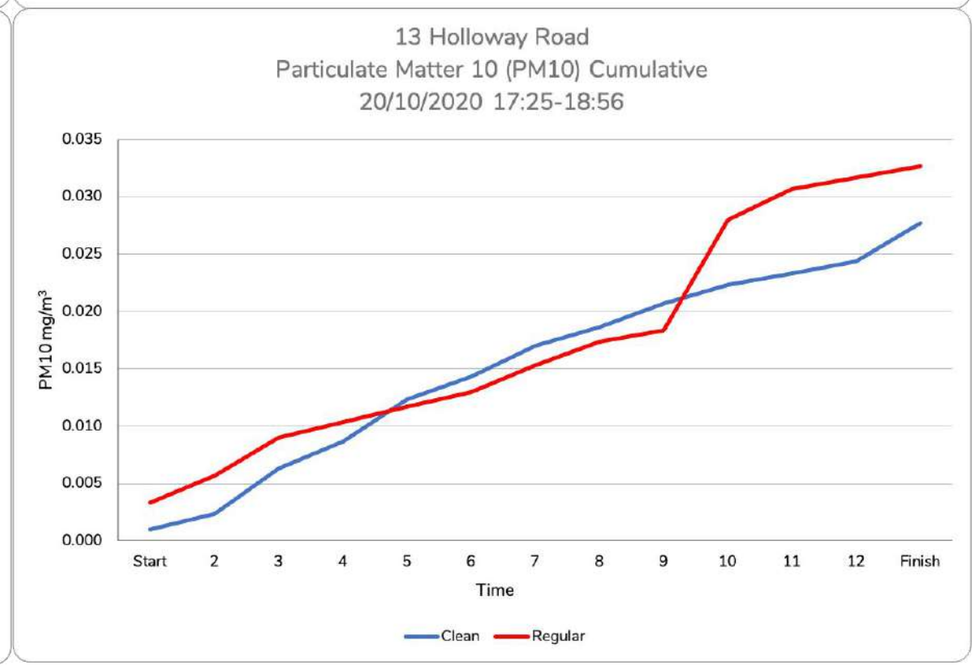
A8 Holloway Road, London Borough of Islington

Time History Graphs – Particulate Matter



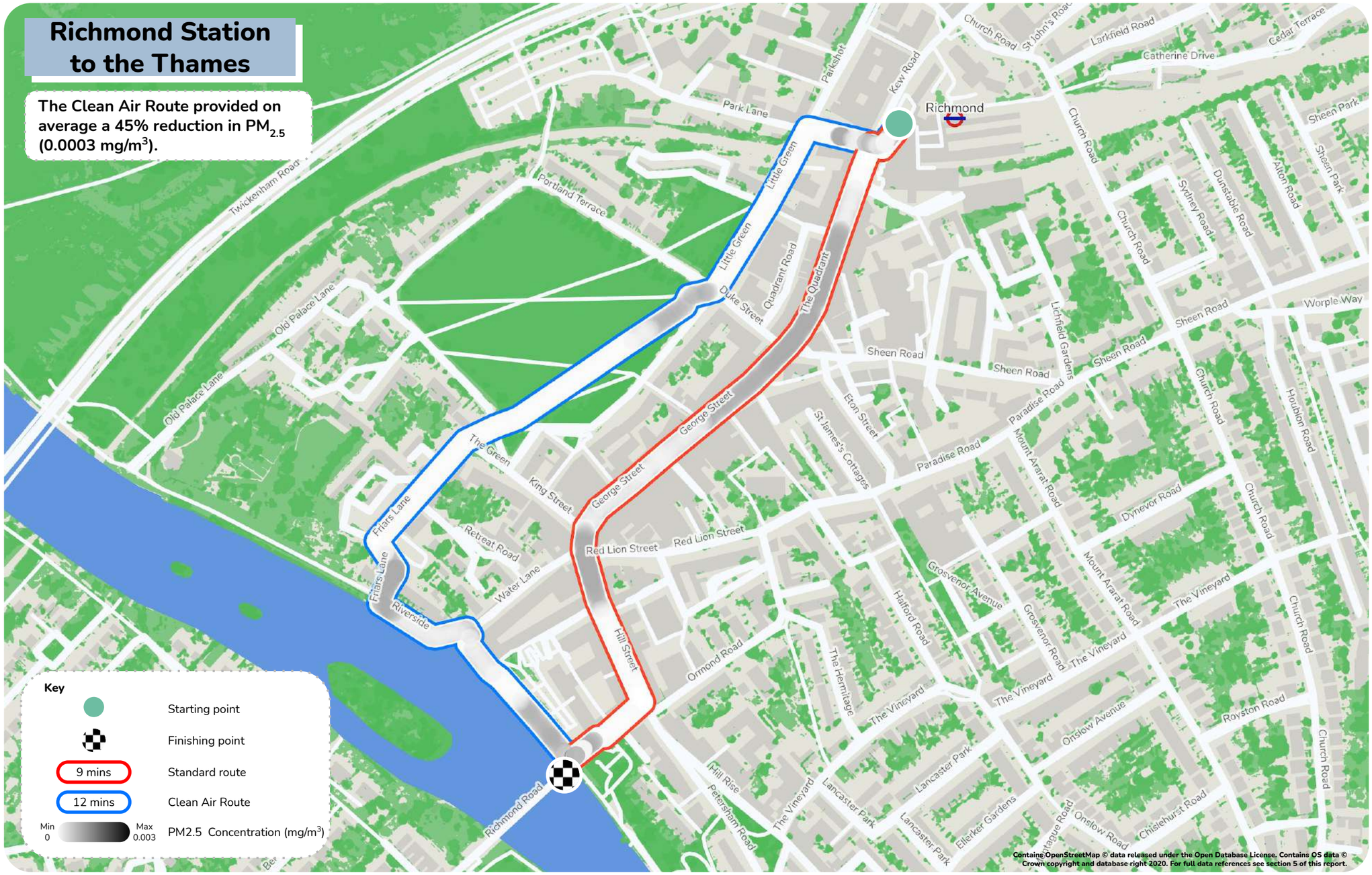






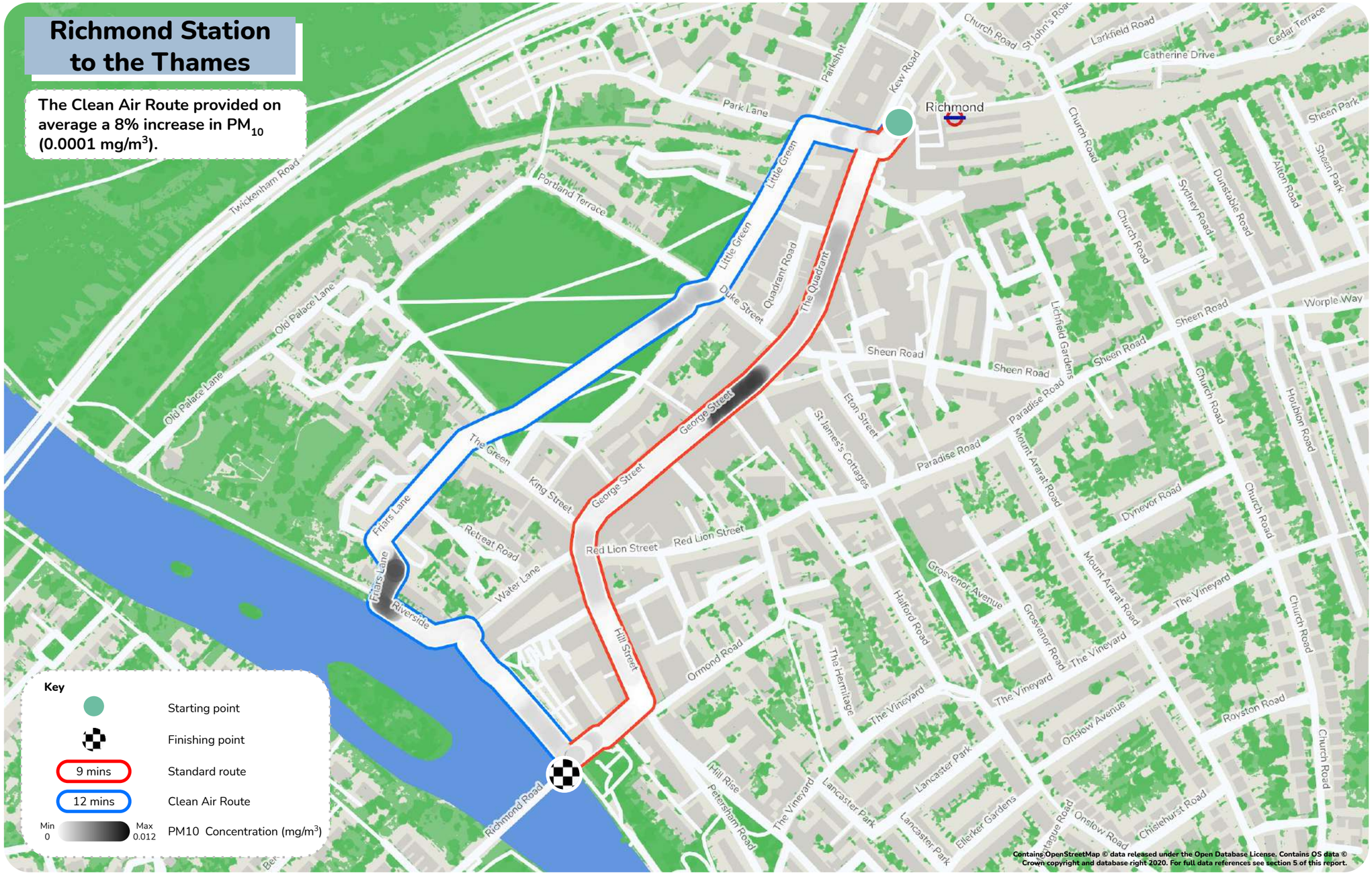
A9 Richmond, London Borough of Richmond upon Thames

$PM_{2.5}$ concentration



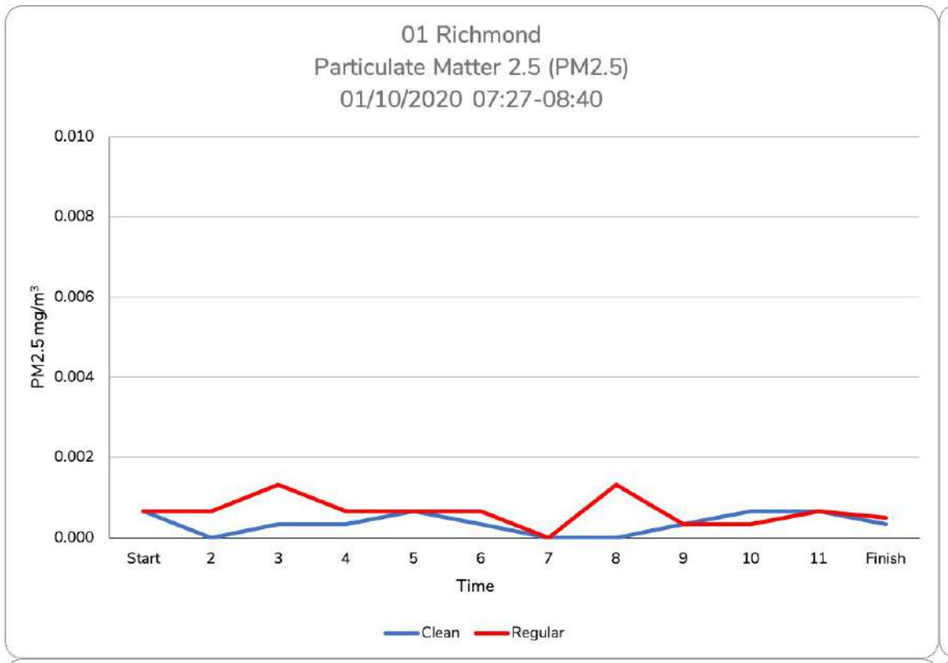
A9 Richmond, London Borough of Richmond upon Thames

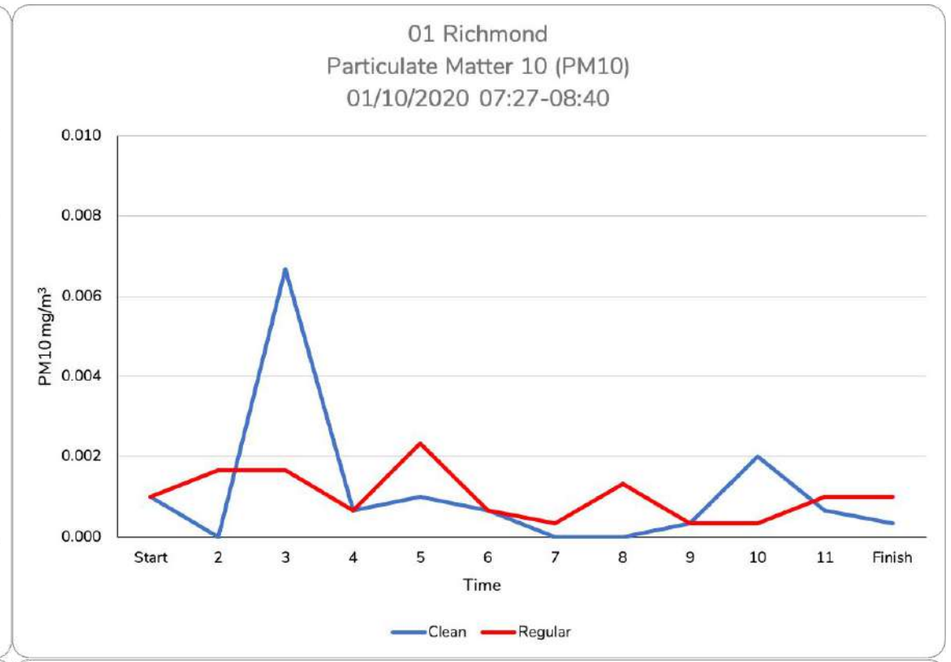
PM_{10} concentration

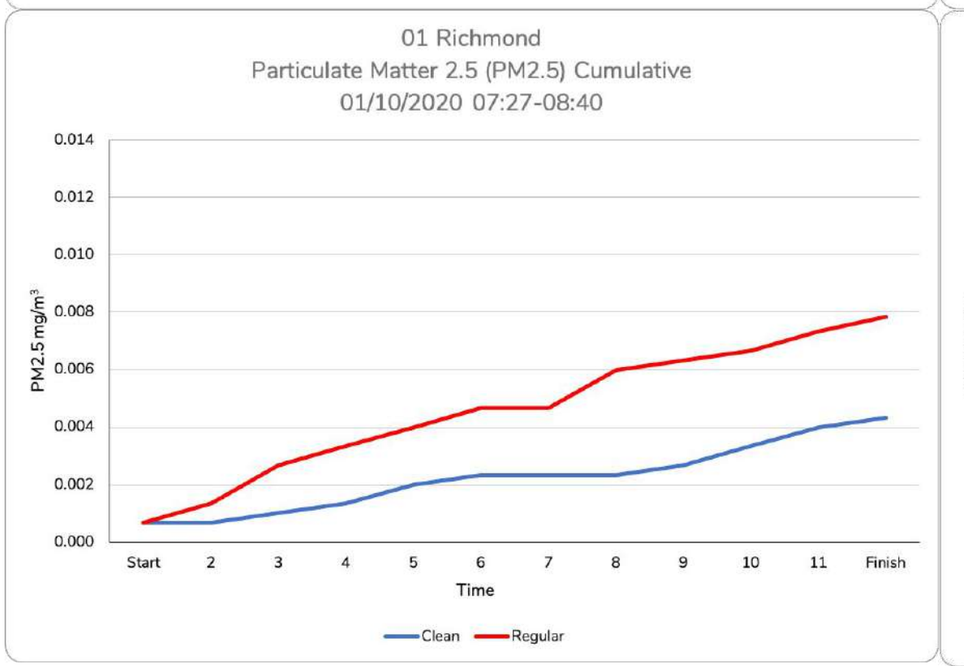


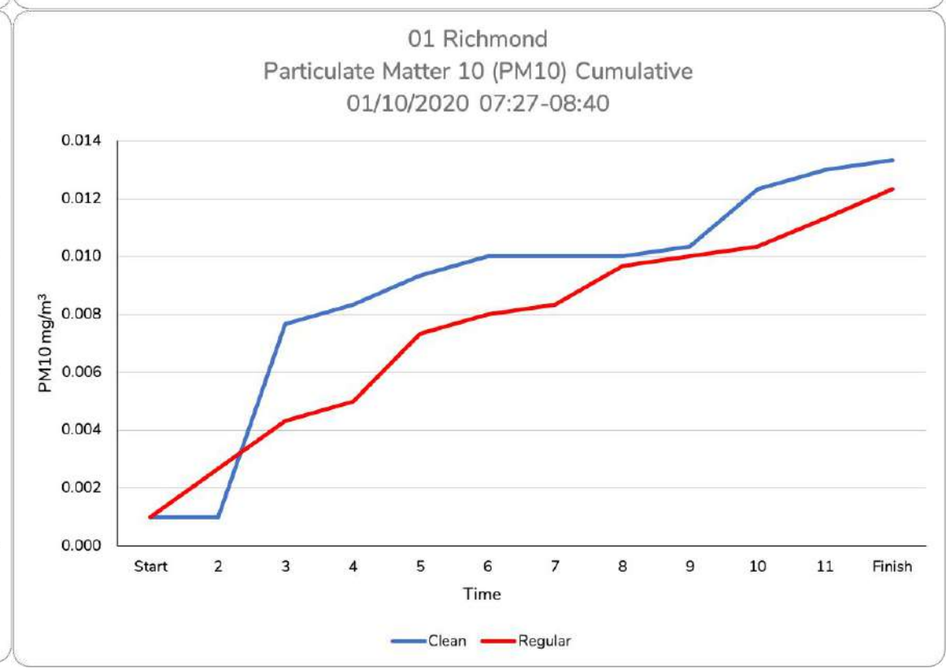
A9 Richmond, London Borough of Richmond upon Thames

Time History Graphs – Particulate Matter



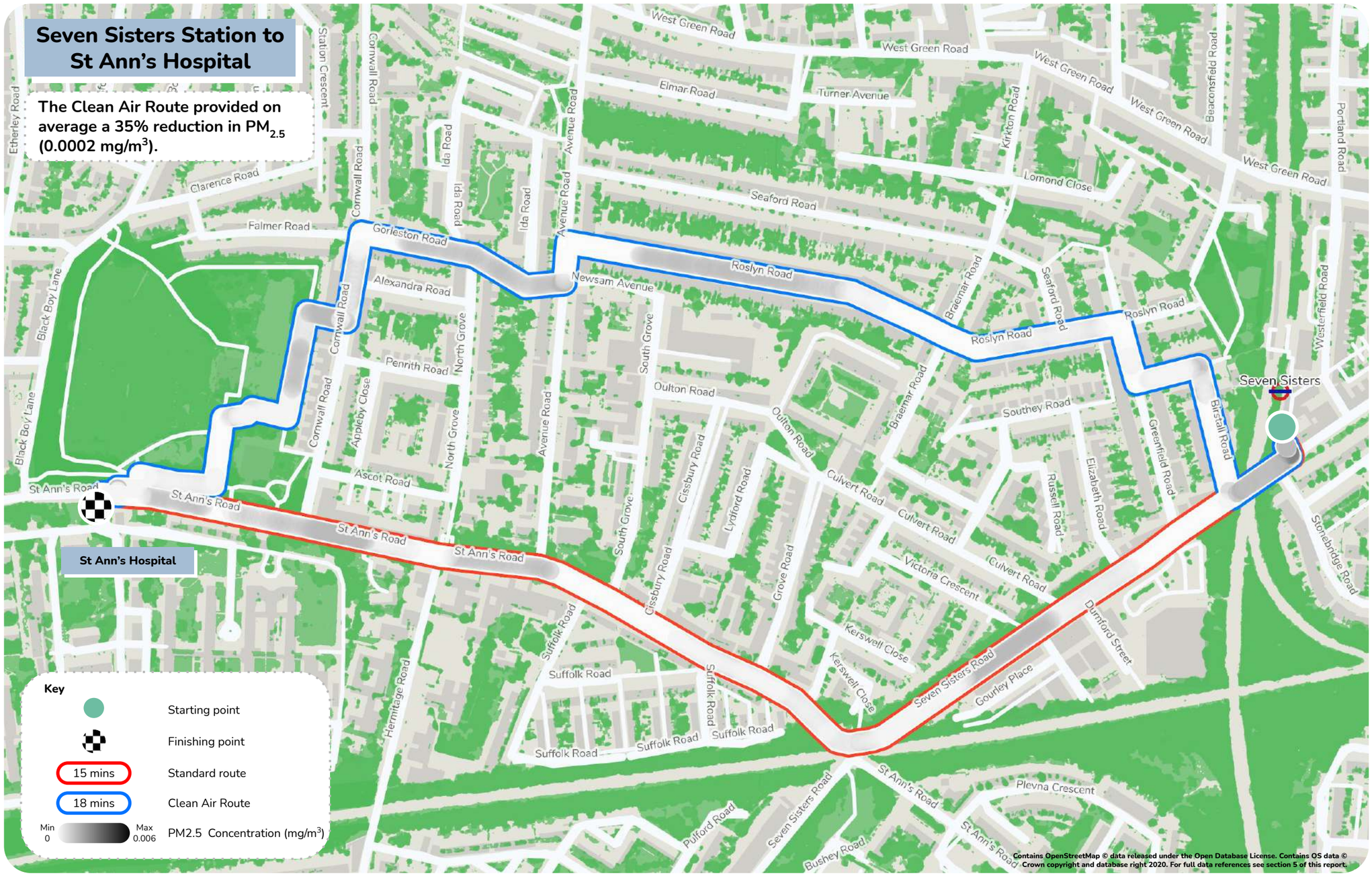






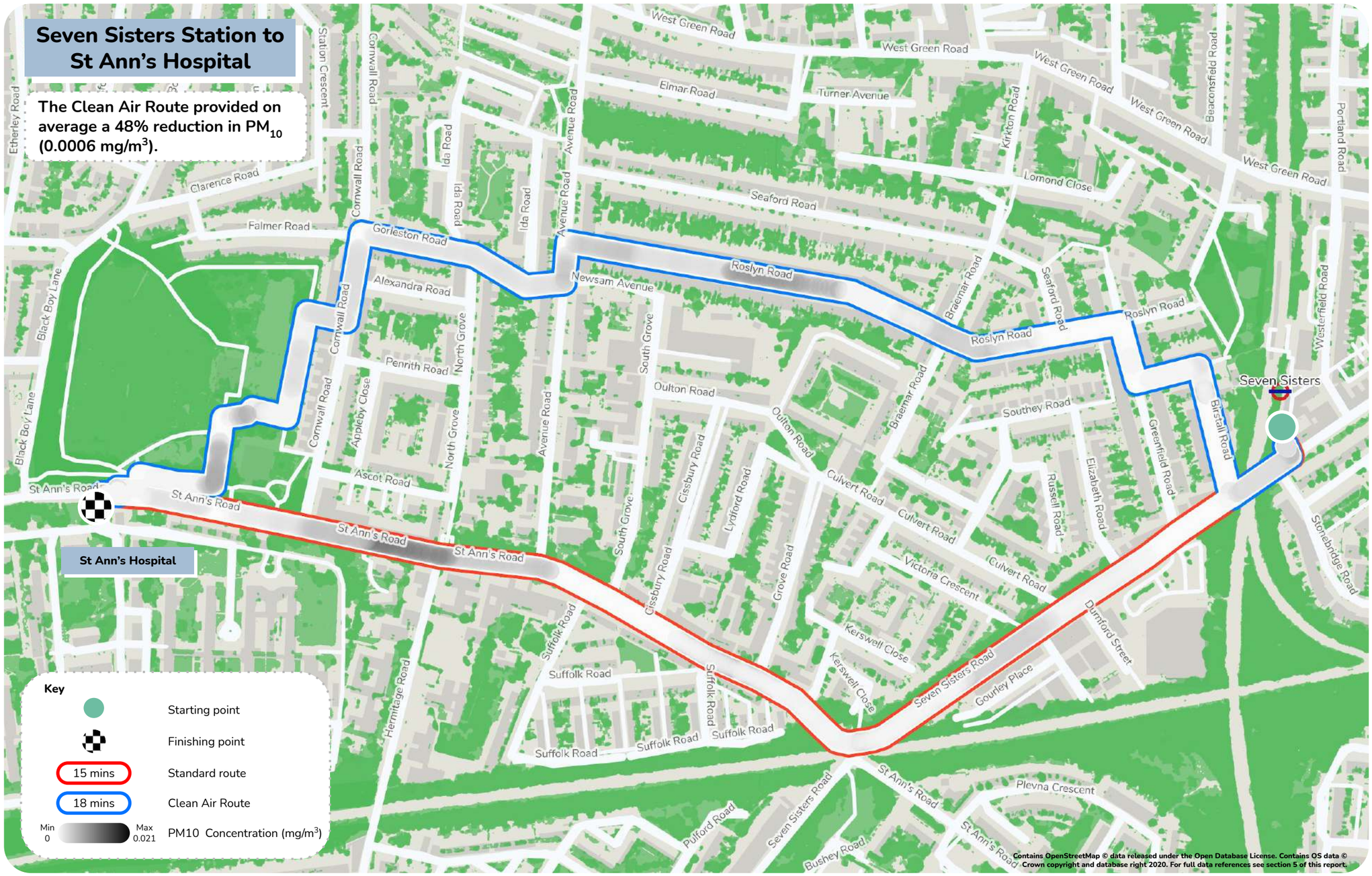
A10 Seven Sisters, London Borough of Haringey

$PM_{2.5}$ concentration



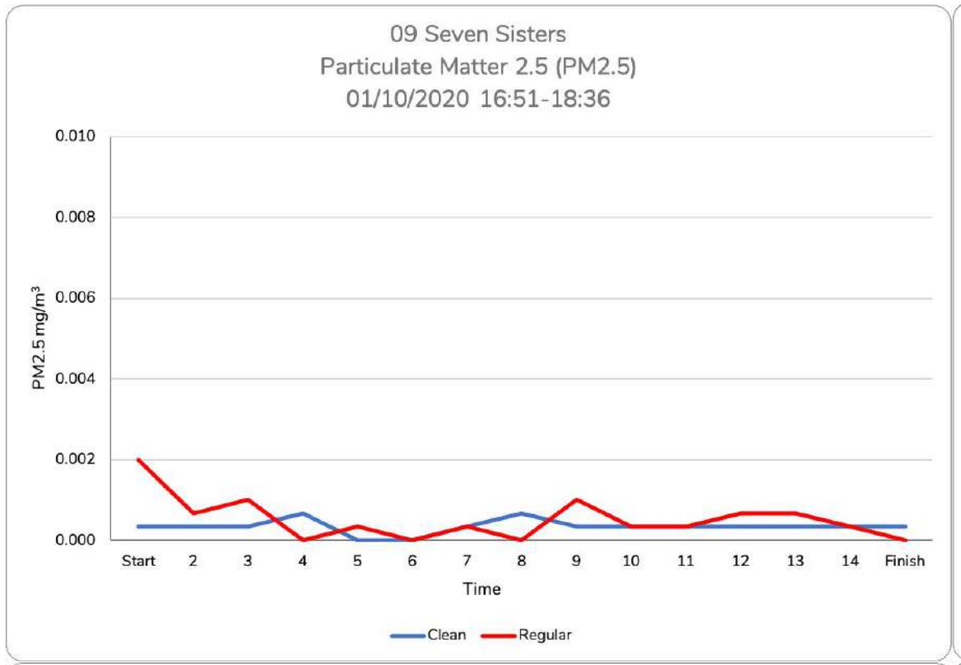
A10 Seven Sisters, London Borough of Haringey

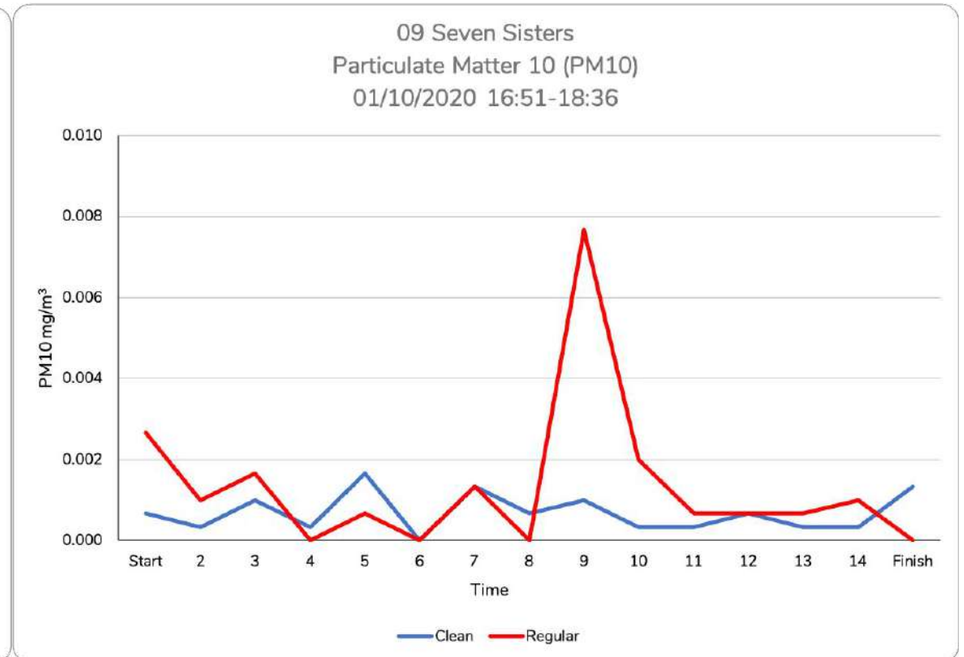
PM_{10} concentration

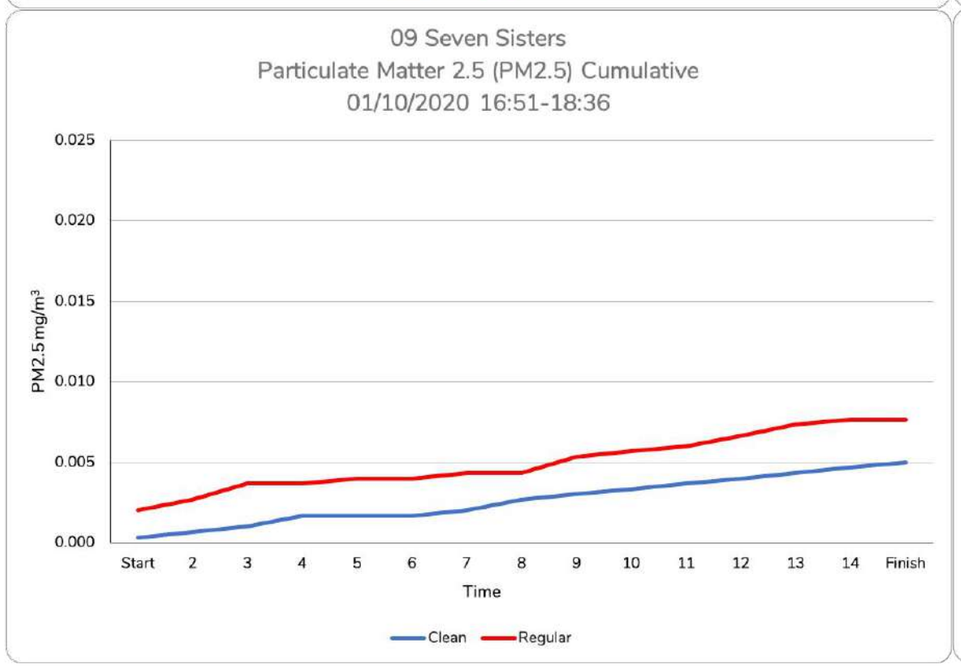


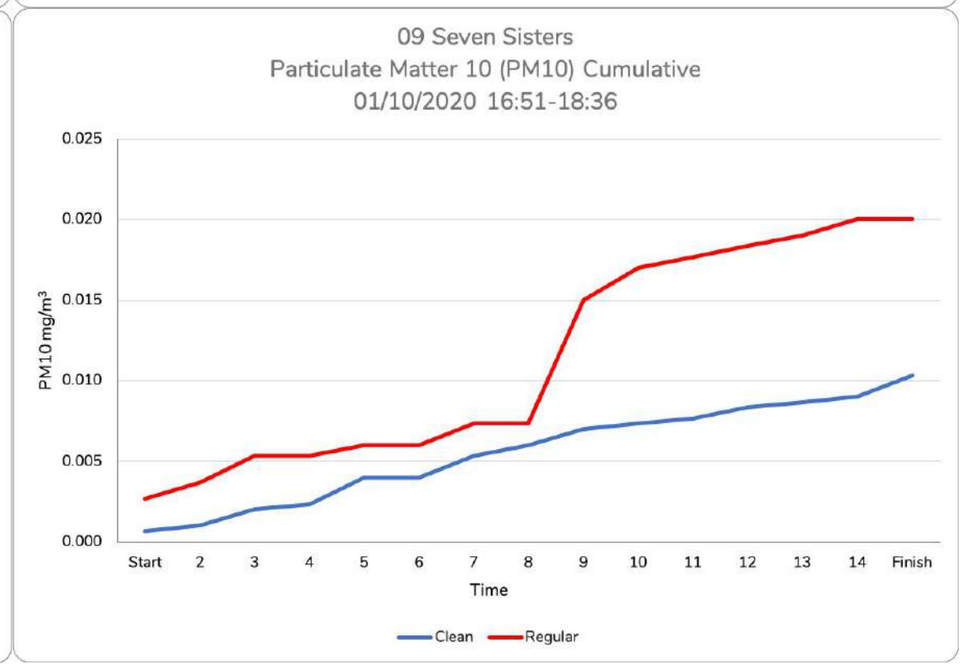
A10 Seven Sisters, London Borough of Haringey

Time History Graphs – Particulate Matter



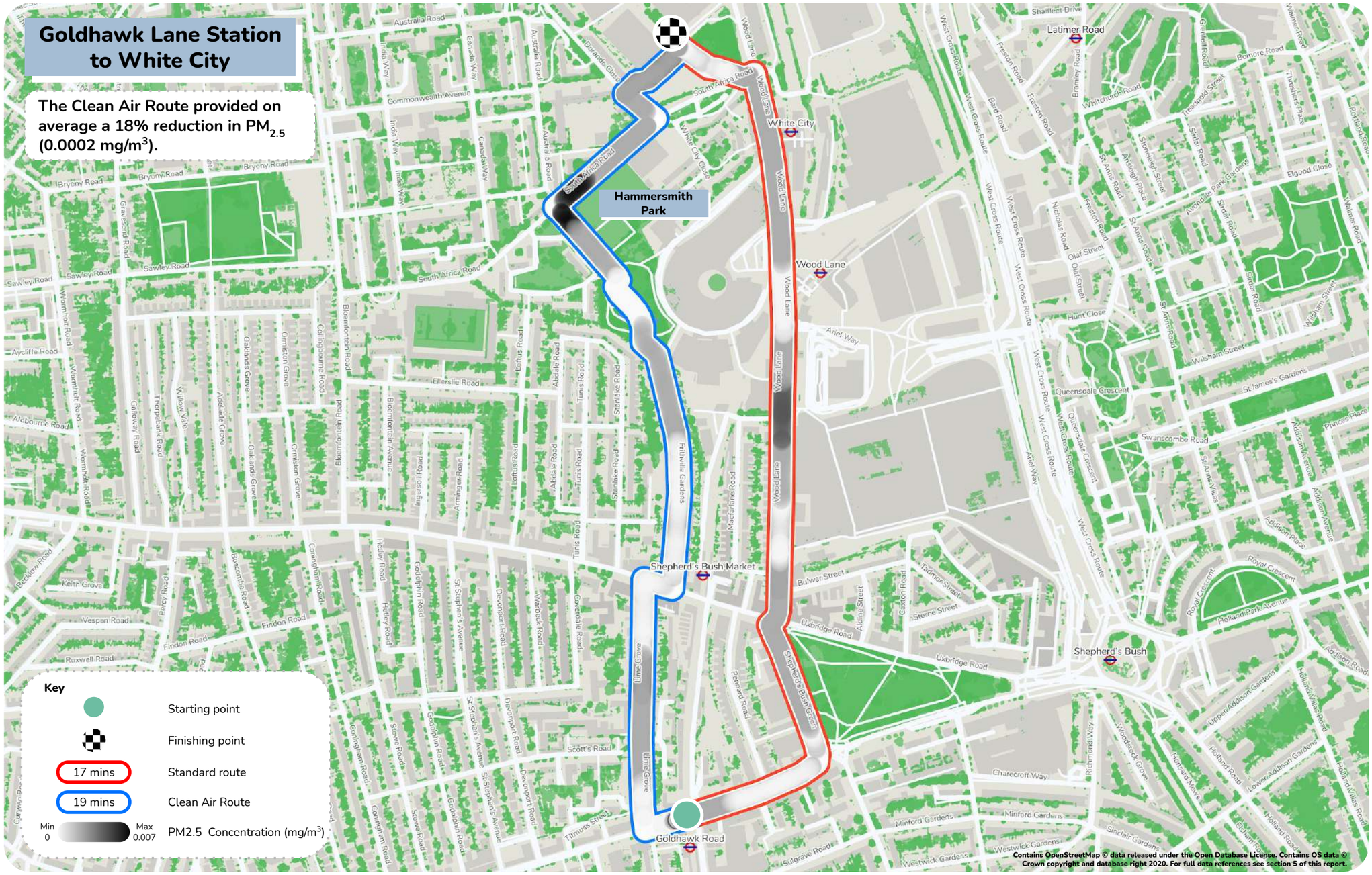






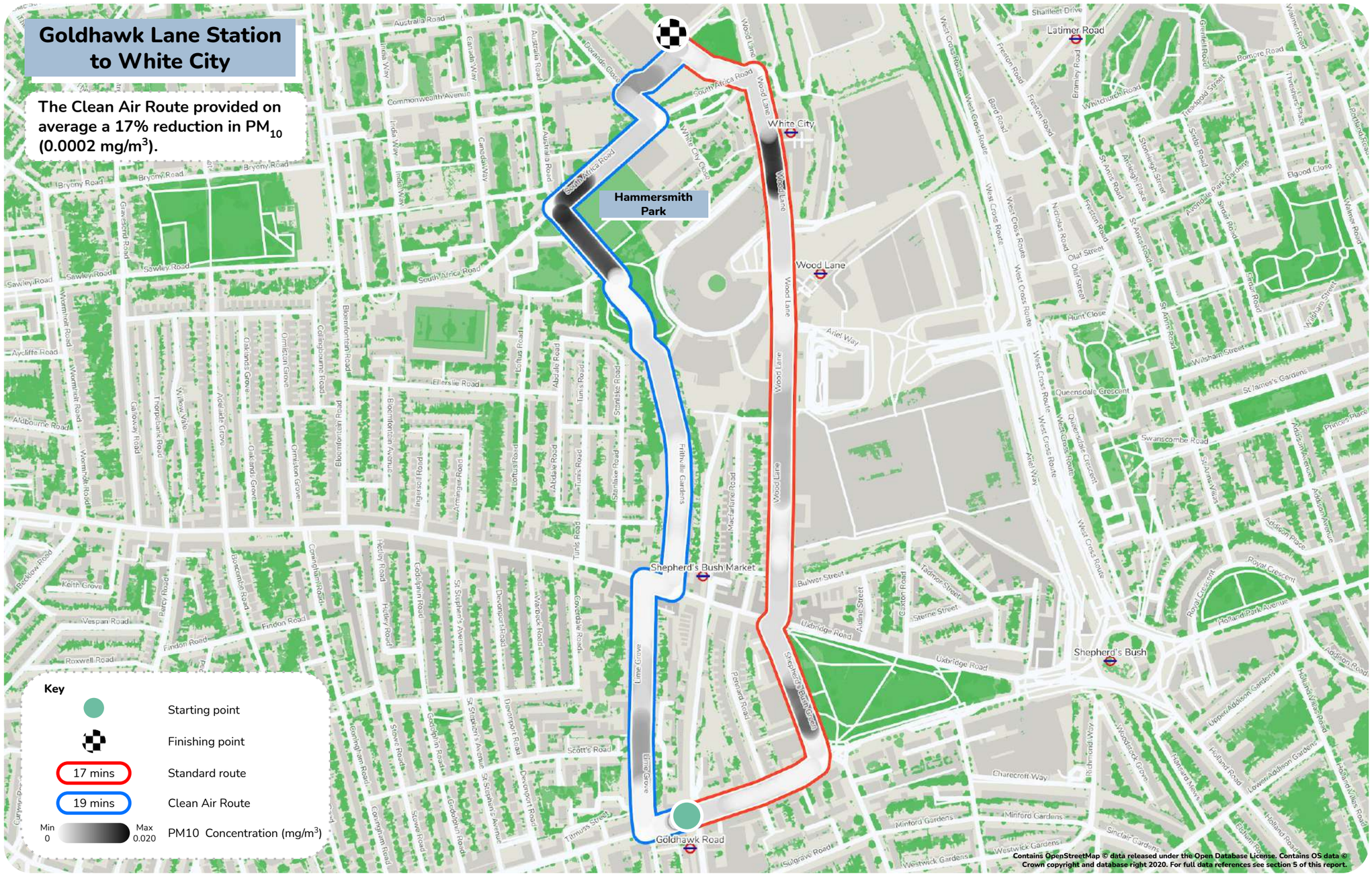
A11 Shepherd's Bush, London Borough of Hammersmith & Fulham

$PM_{2.5}$ concentration



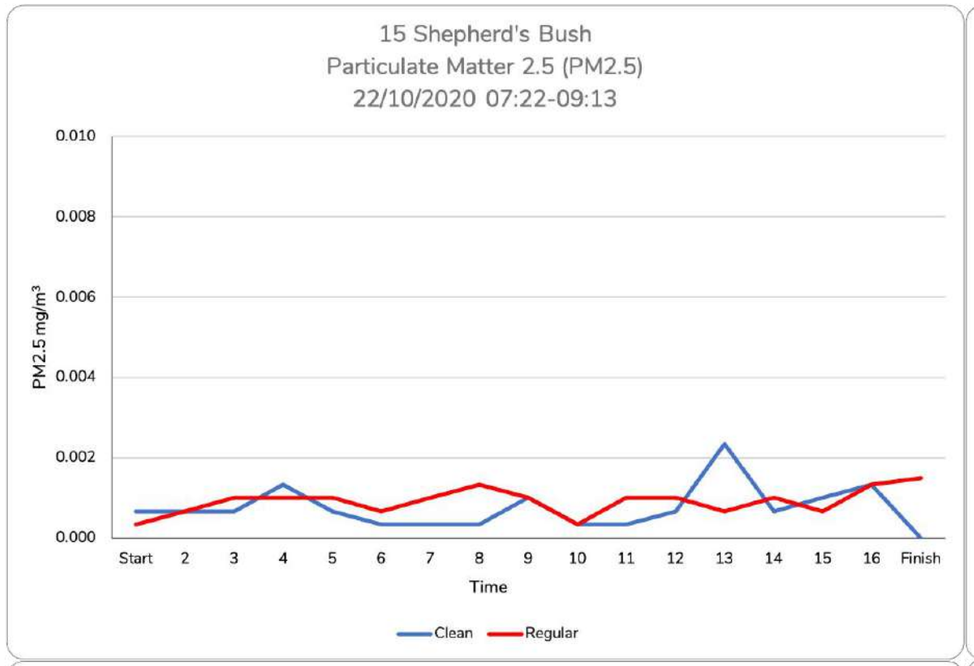
A11 Shepherd's Bush, London Borough of Hammersmith & Fulham

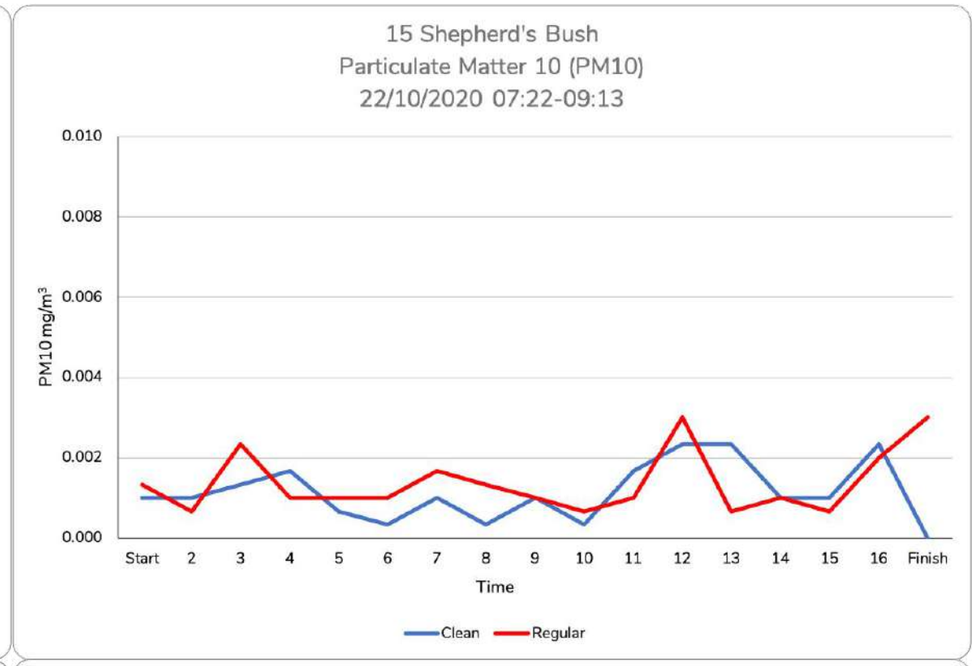
PM_{10} concentration

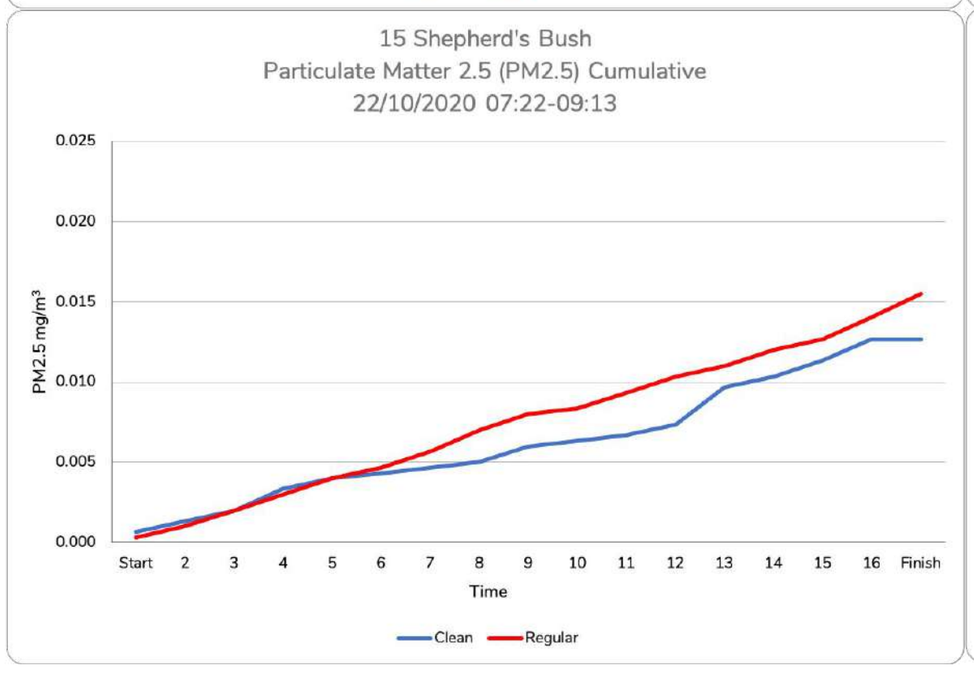


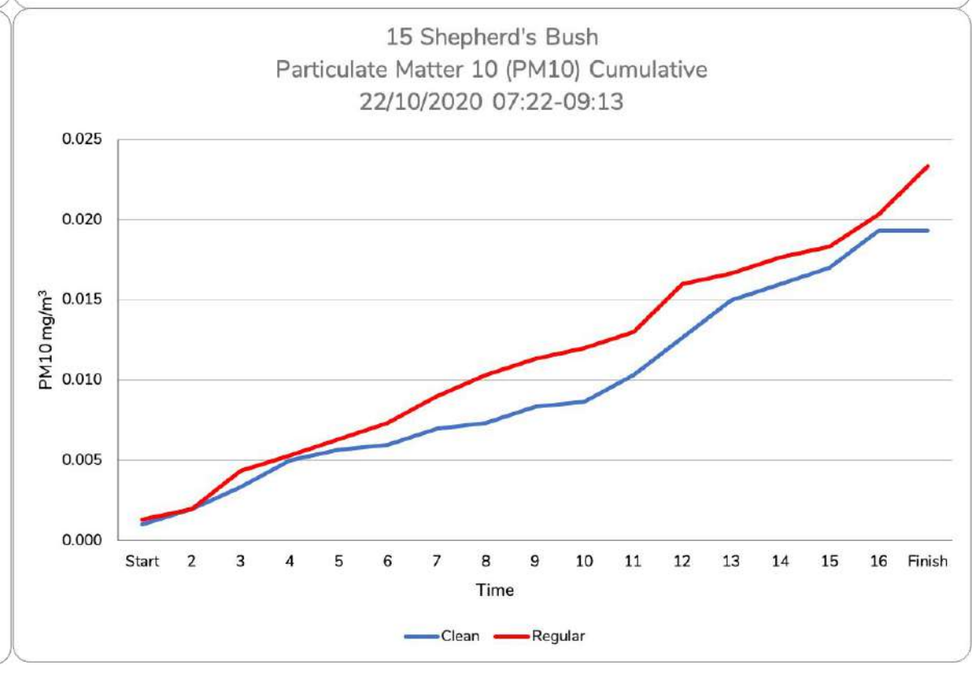
A11 Shepherd's Bush, London Borough of Hammersmith & Fulham

Time History Graphs – Particulate Matter



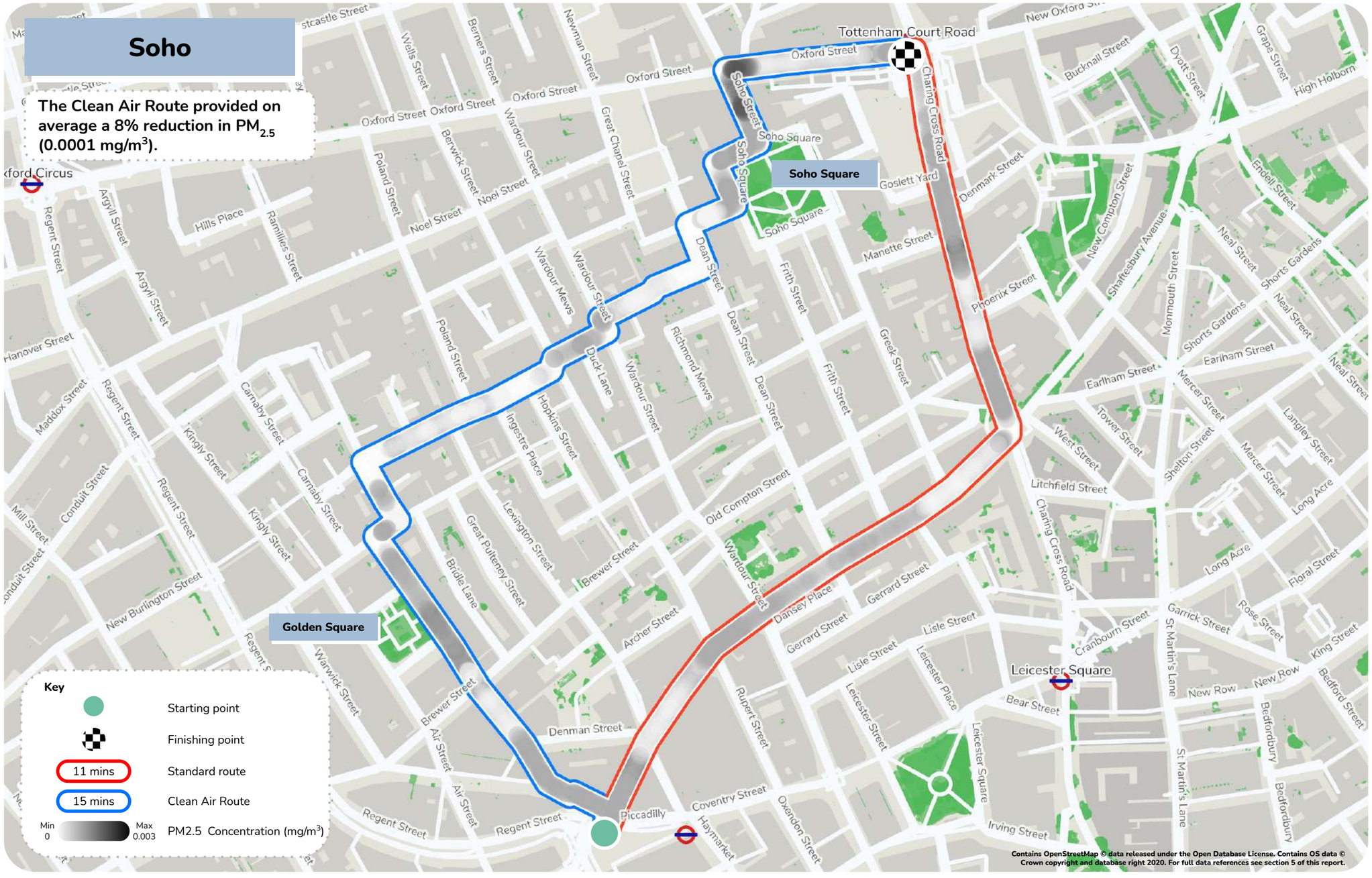






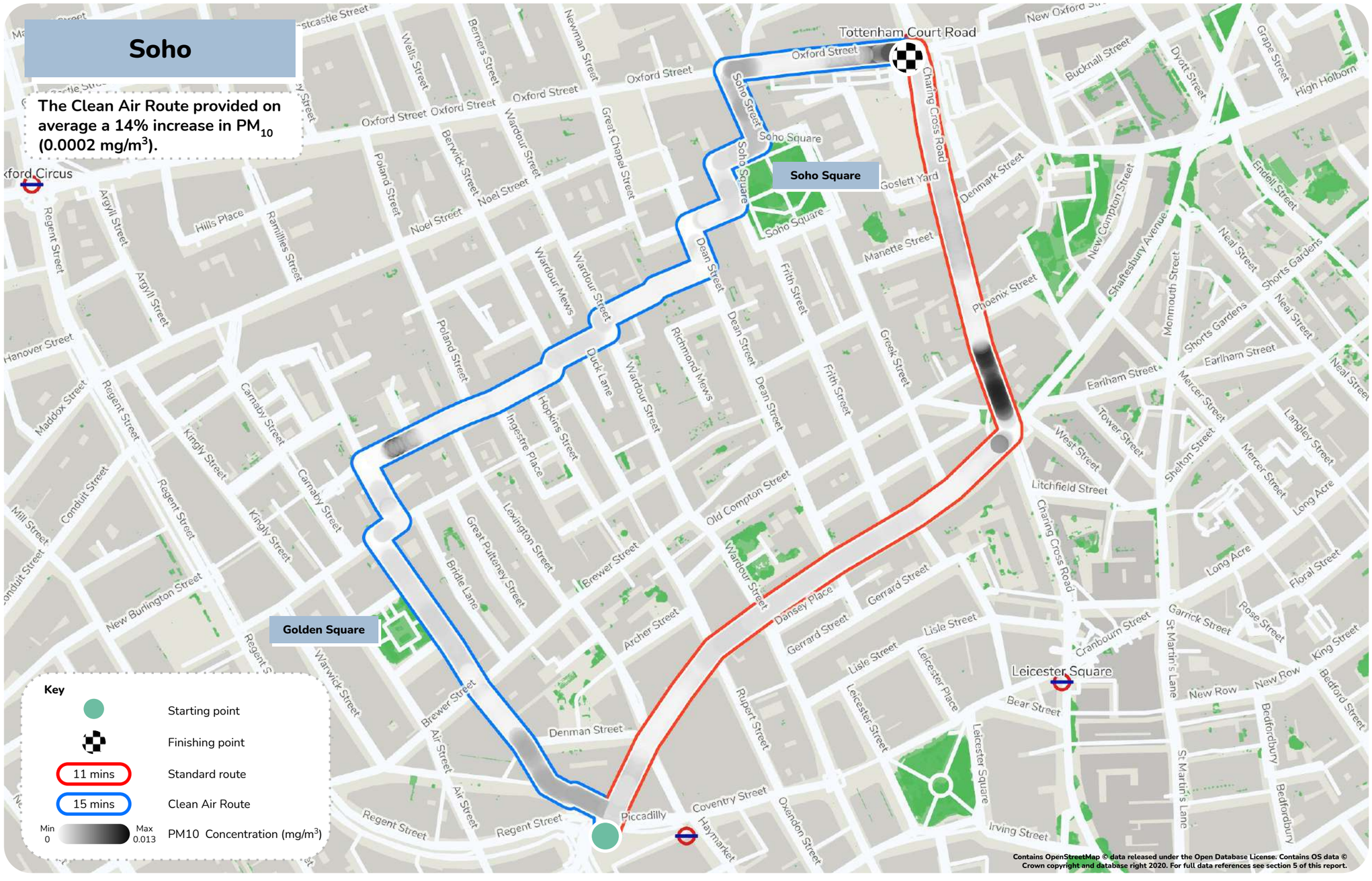
A12 Soho, City of Westminster

$PM_{2.5}$ concentration



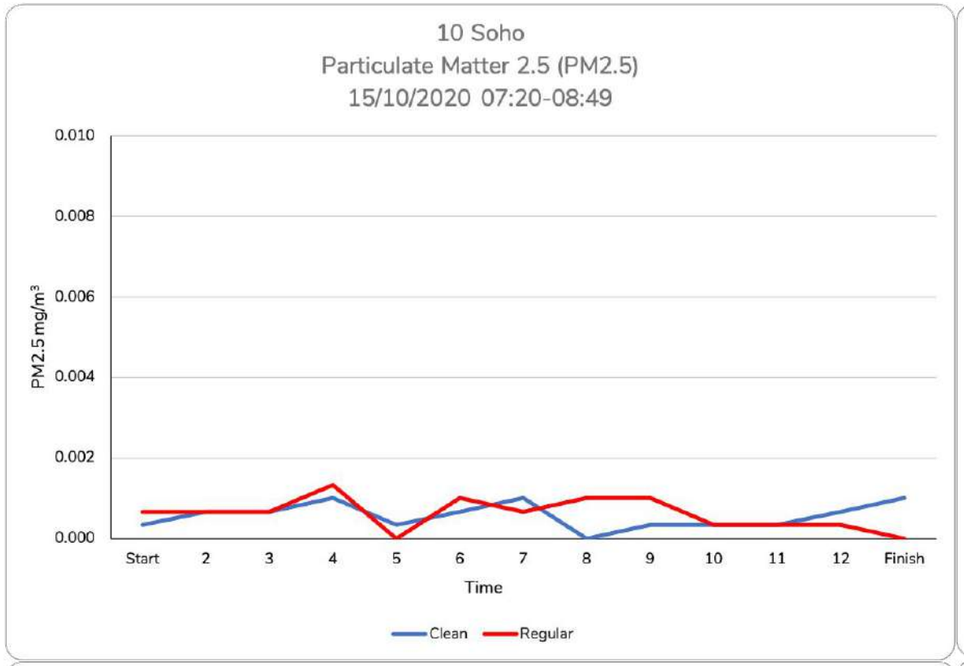
A12 Soho, City of Westminster

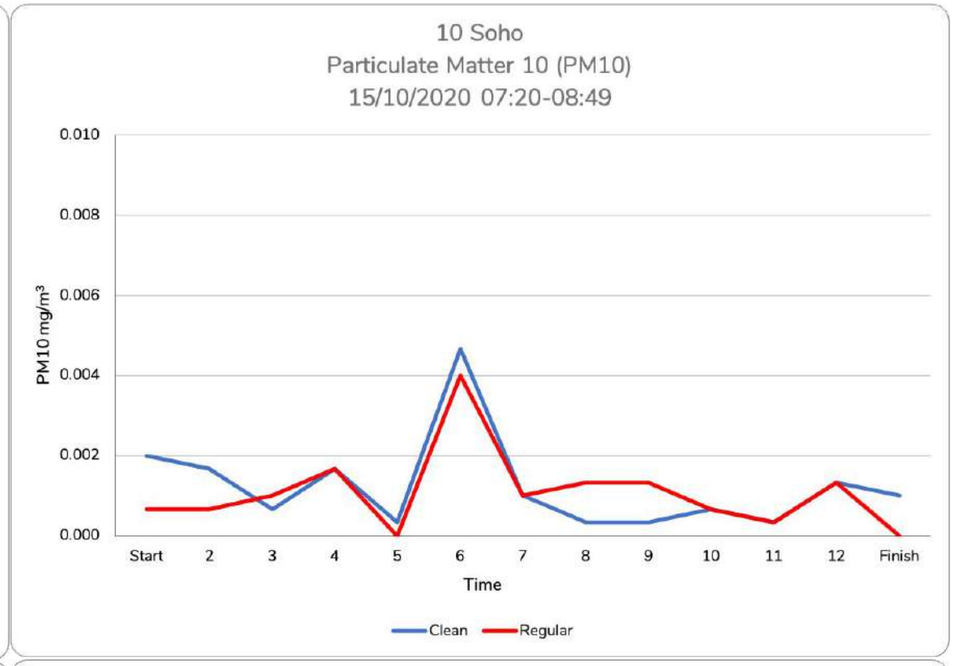
PM_{10} concentration

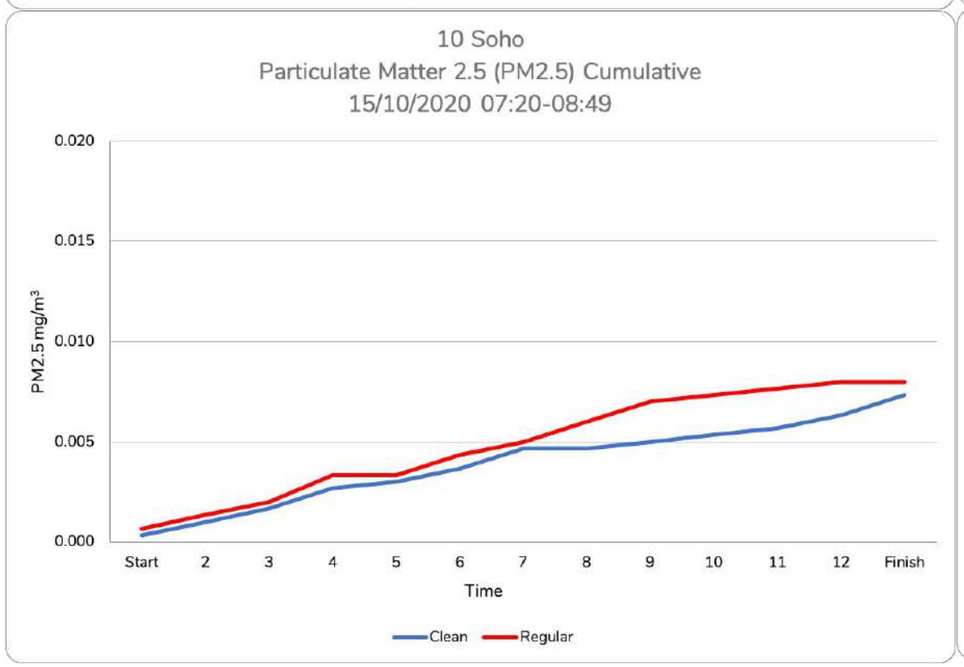


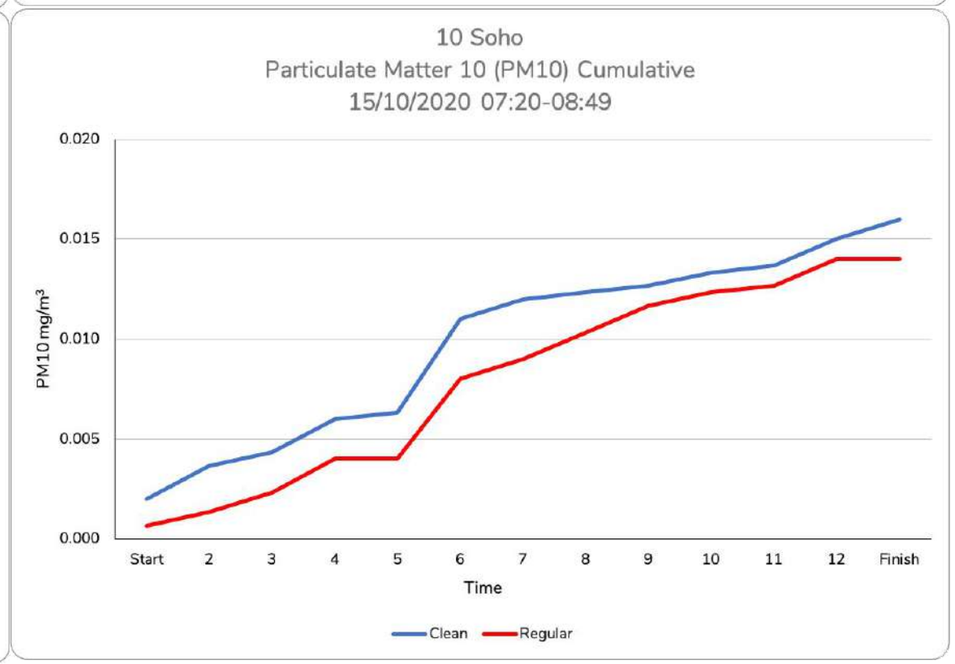
A12 Soho, City of Westminster

Time History Graphs – Particulate Matter









A13 South Bank (South Bank BID)

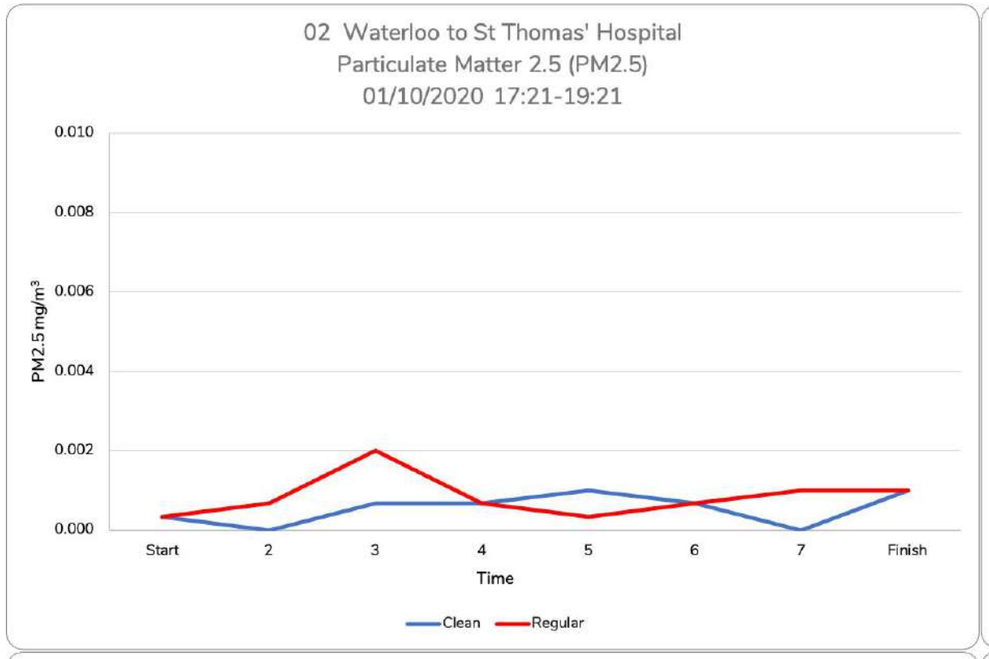
$PM_{2.5}$ concentration

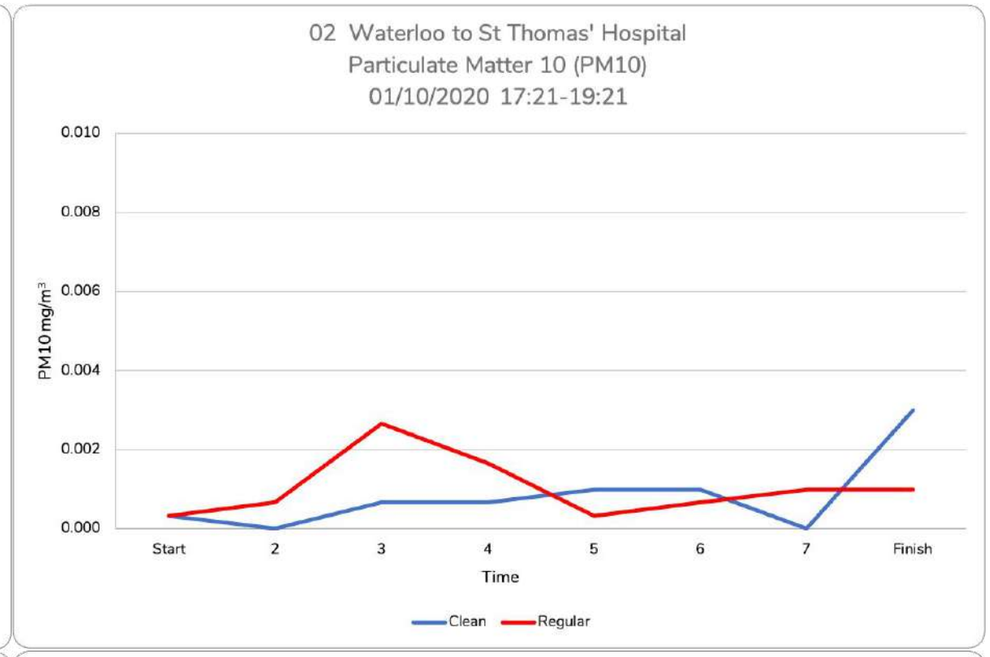
A13 South Bank (South Bank BID)

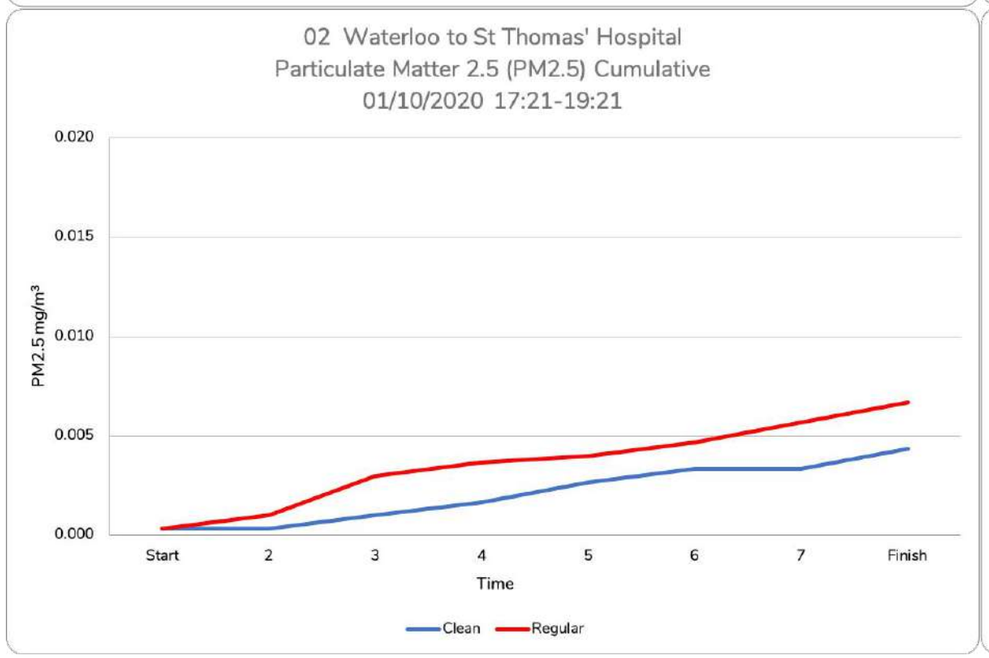
PM_{10} concentration

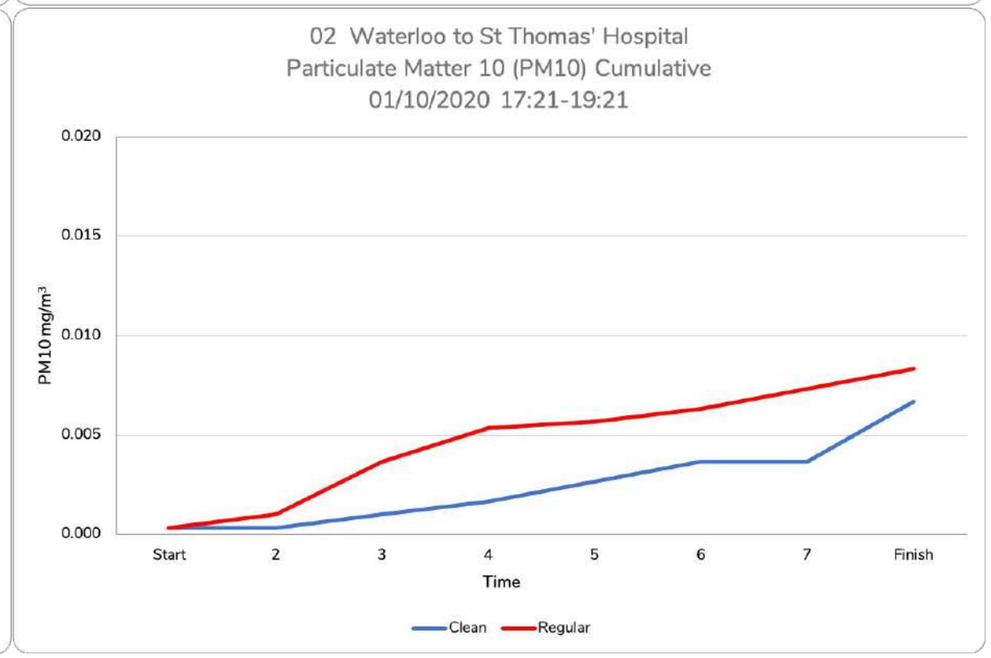
A13 South Bank – Waterloo to St Thomas' Hospital

Time History Graphs – Particulate Matter



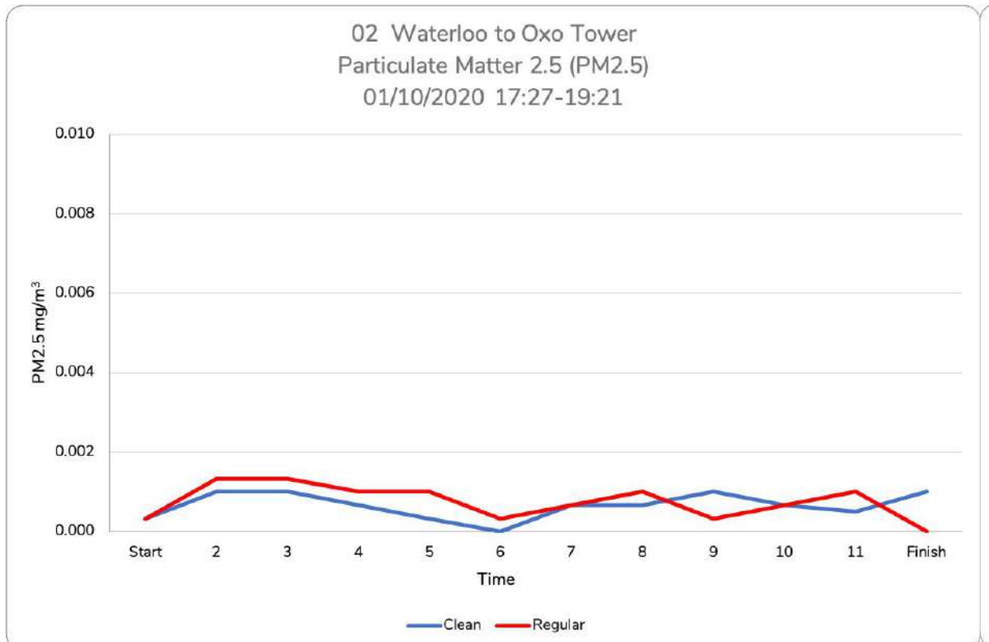


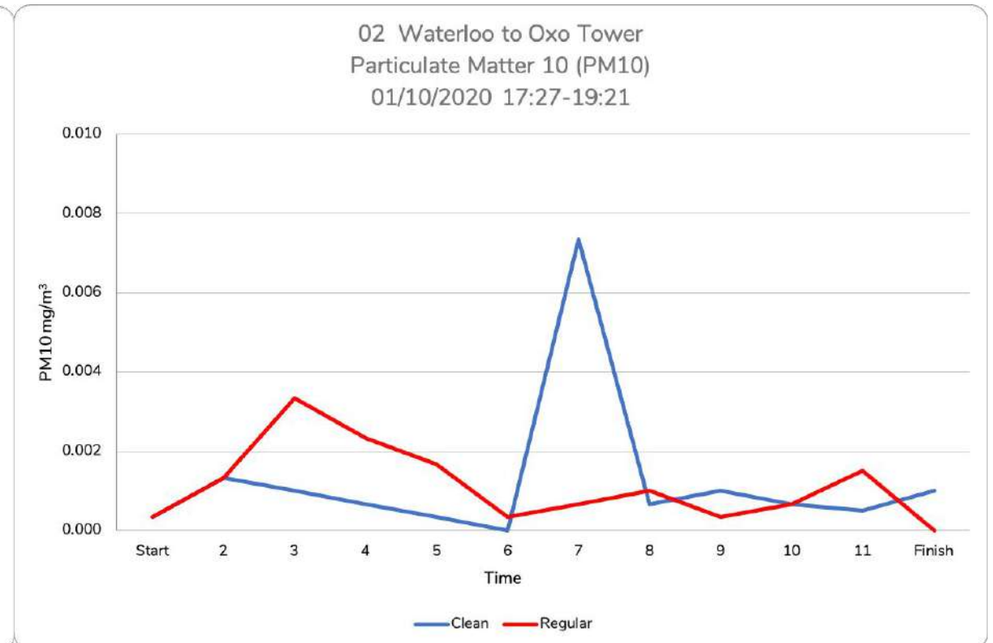


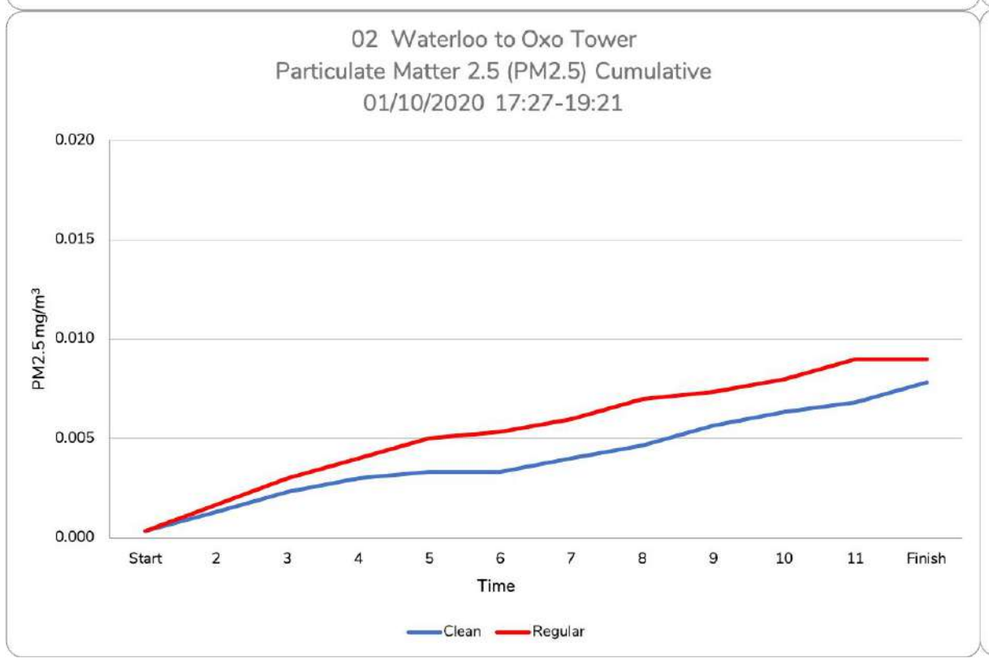


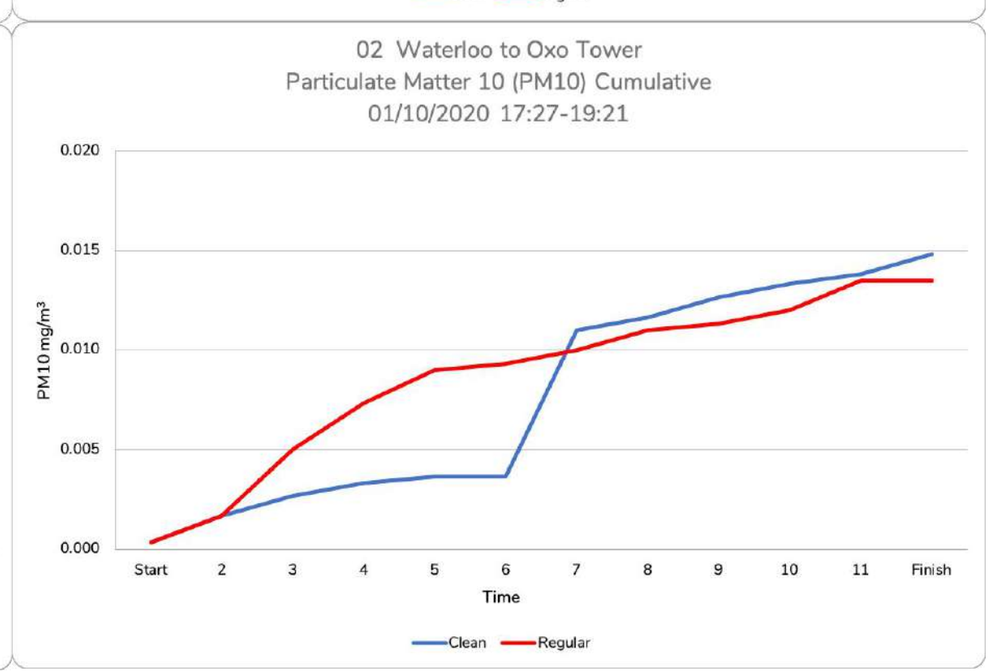
A13 South Bank – Waterloo to OXO Tower

Time History Graphs – Particulate Matter









A14 Tooting, London Borough of Wandsworth

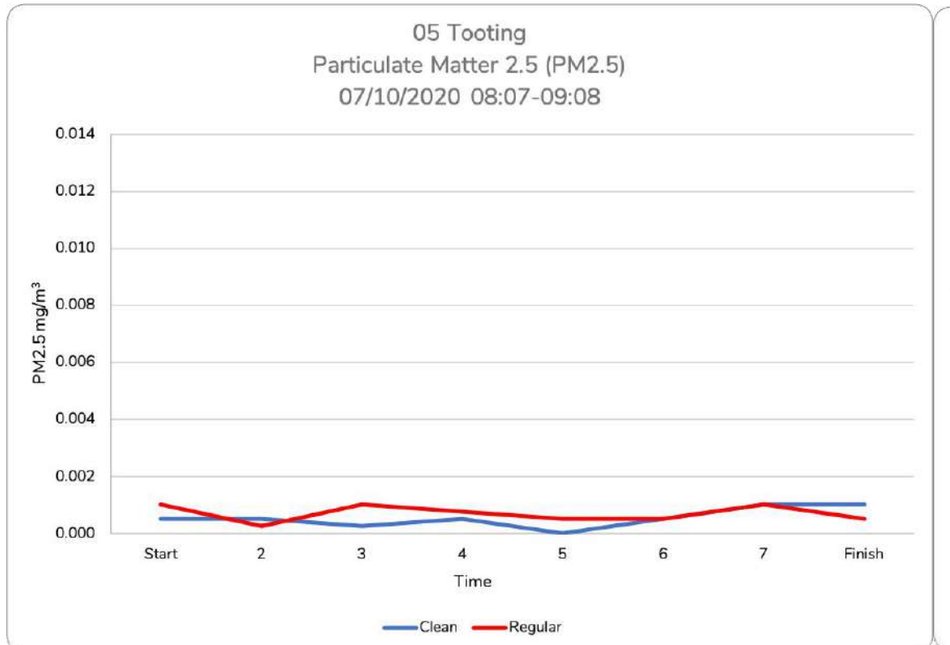
$PM_{2.5}$ concentration

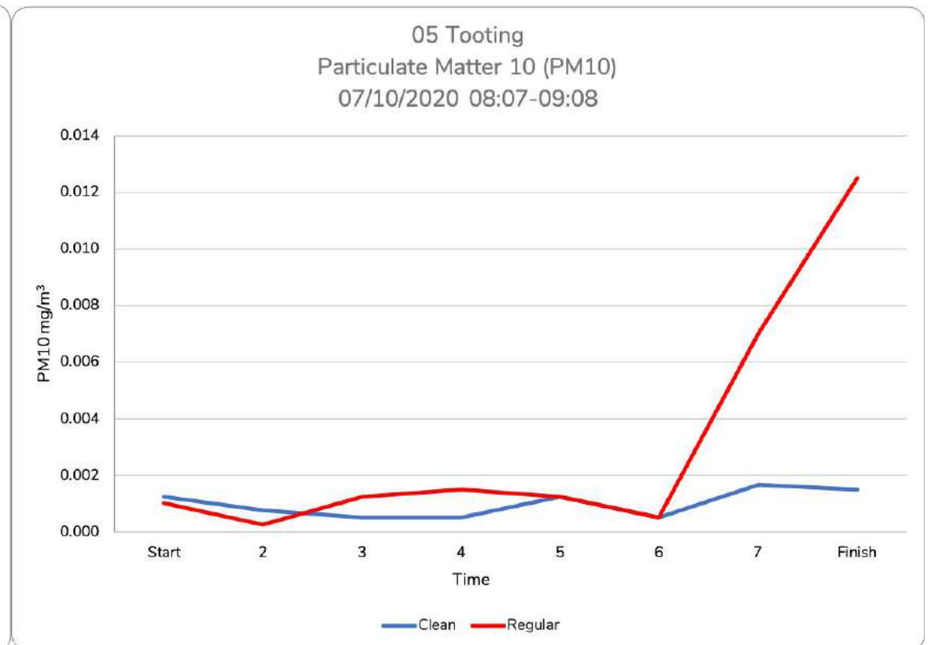
A14 Tooting, London Borough of Wandsworth

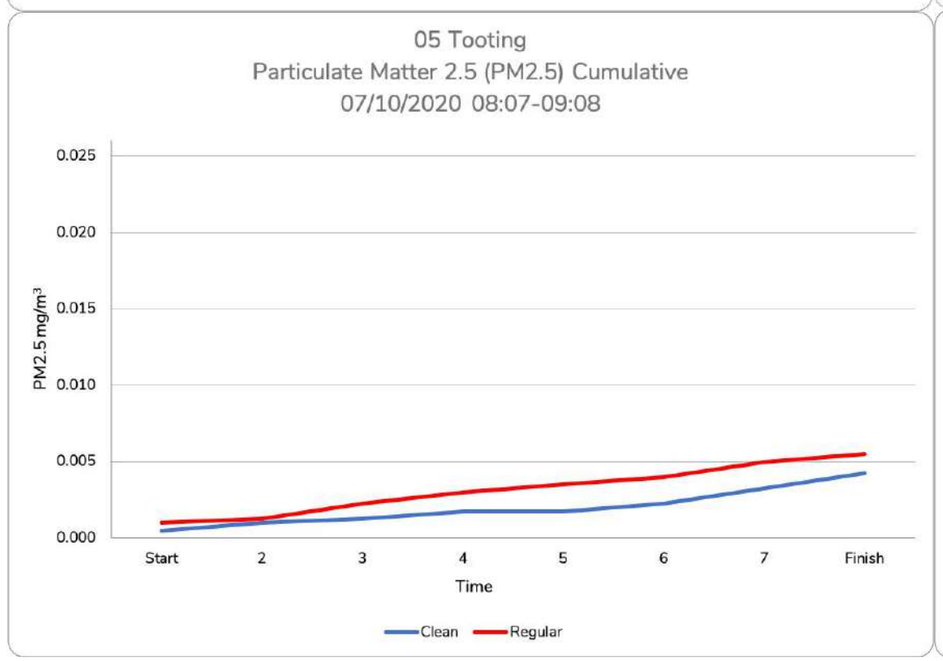
PM_{10} concentration

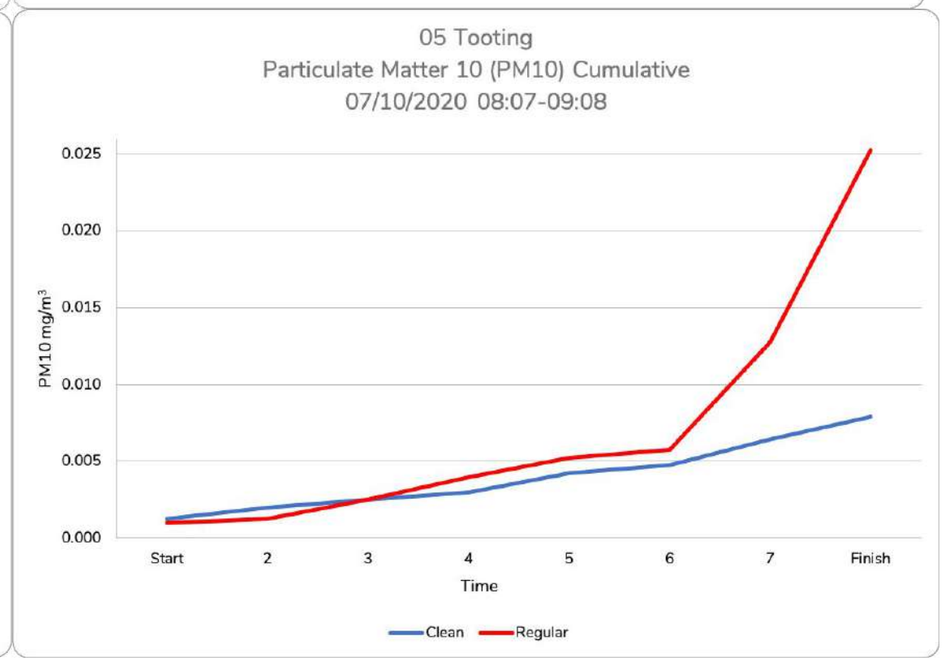
A14 Tooting, London Borough of Wandsworth

Time History Graphs – Particulate Matter



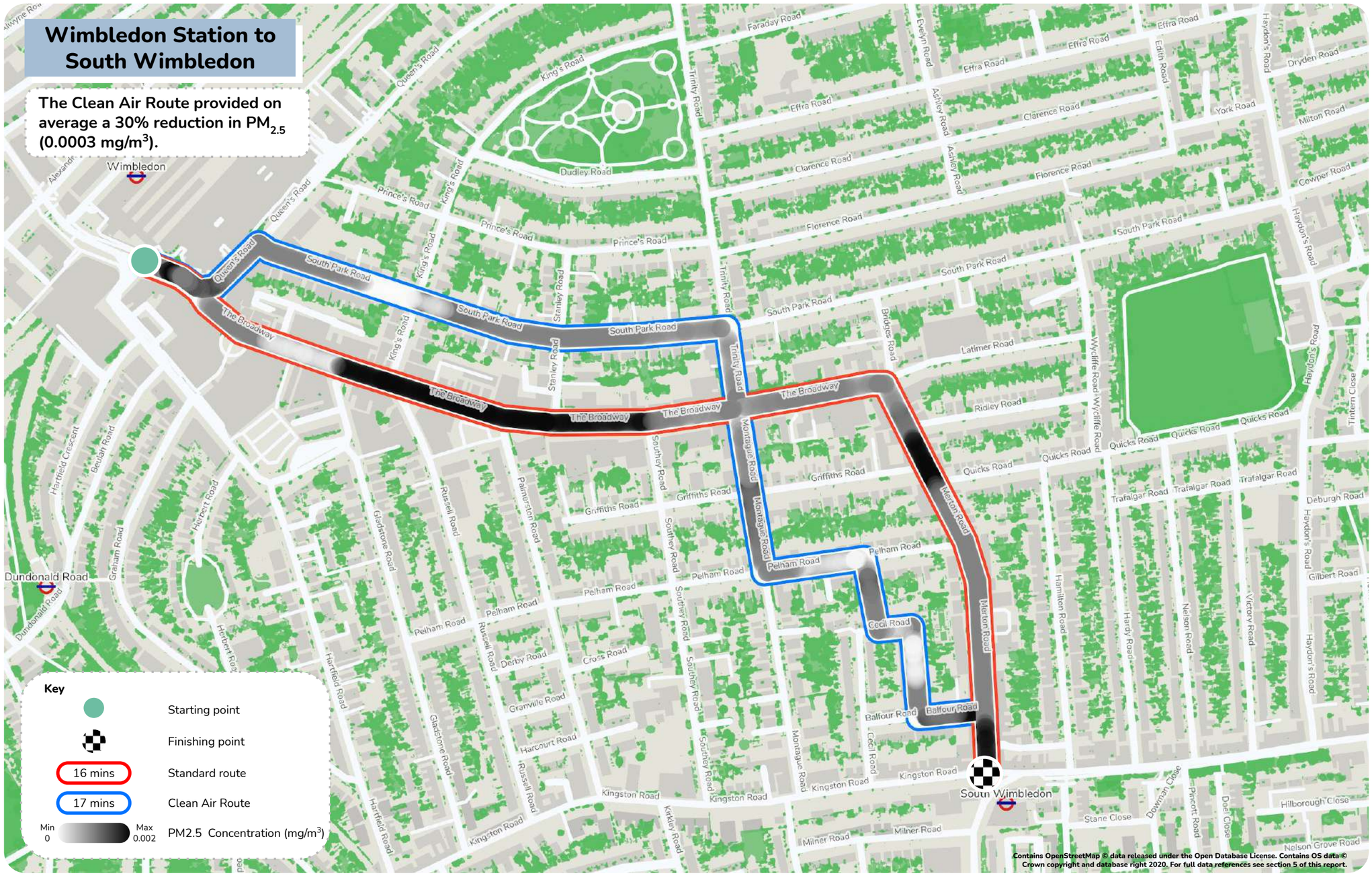






A15 Wimbledon, London Borough of Merton

$PM_{2.5}$ concentration



A15 Wimbledon, London Borough of Merton

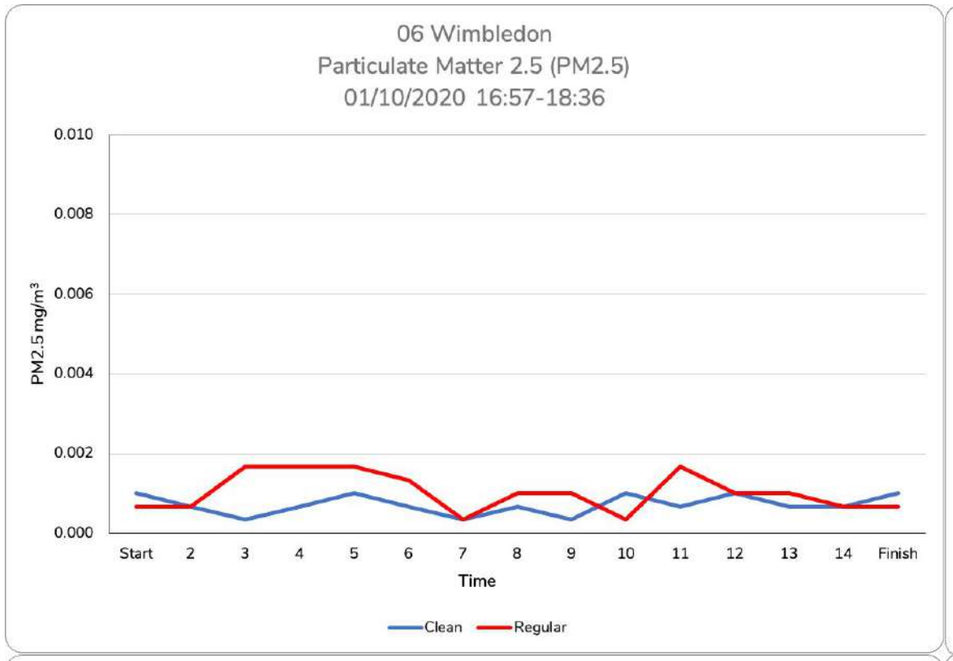
PM_{10} concentration

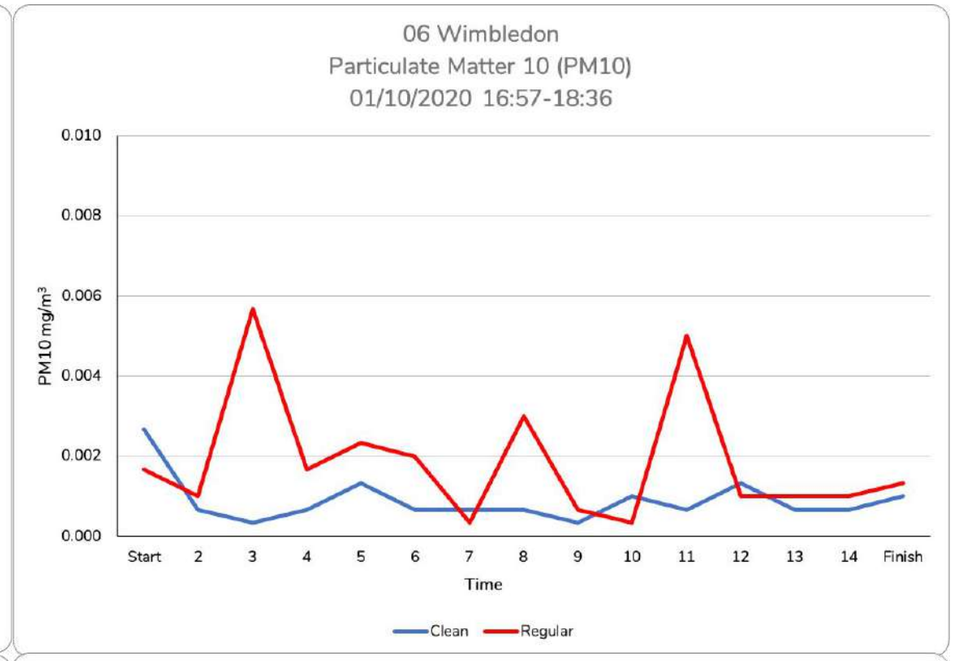
Wimbledon Station to South Wimbledon

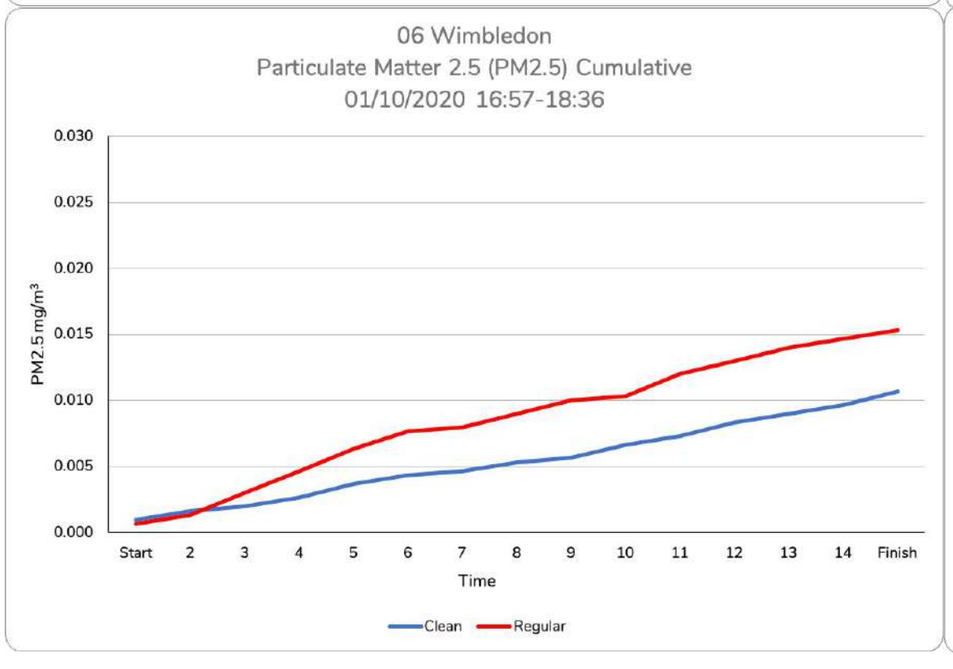
The Clean Air Route provided on average a 52% reduction in PM_{10} (0.0010 mg/m^3).

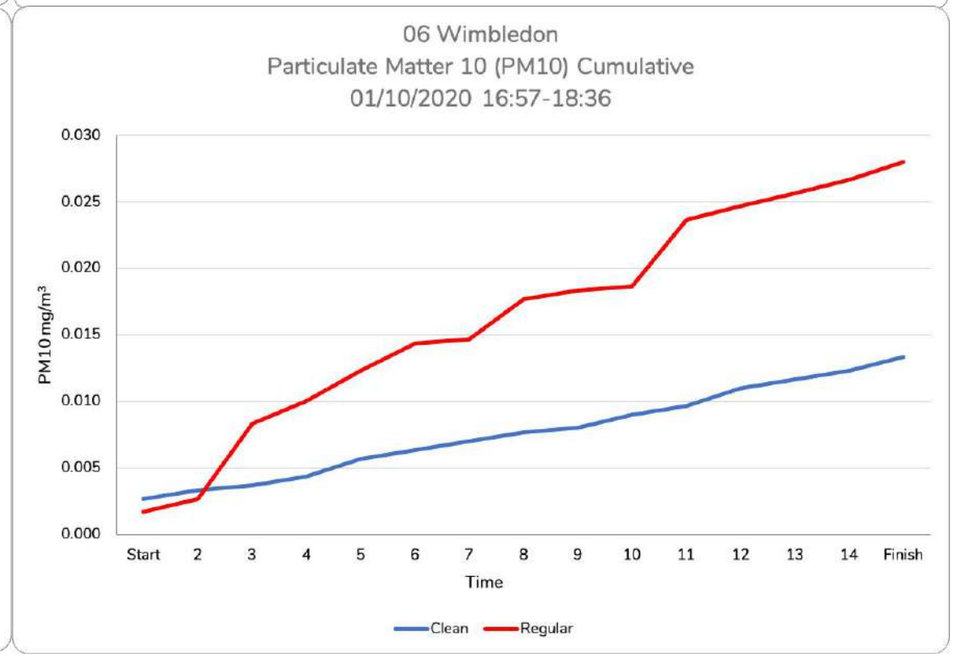
A15 Wimbledon, London Borough of Merton

Time History Graphs – Particulate Matter









This report was delivered as part of the Clean Air Villages 3 (CAV3), funded by the Defra Air Quality Grant. If you would like any further information about anything included within this report, please get in touch:

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CROSS RIVER PARTNERSHIP

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