Basildon Air Quality Management Plan

2022 Annual Monitoring Report

December 2023

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Contents

Executive Summary

This report has been produced by Essex Highways for and on behalf of Essex County Council and Basildon Council. It provides the latest air quality monitoring data recorded to assess the impact of the schemes implemented as part of the Basildon Air Quality Management Plan, following and in accordance with the Government publication of the UK Plan for tackling roadside Nitrogen Dioxide (NO_2) concentrations.

Diffusion tube monitoring across Basildon indicates that there are six hotspot locations where the annual mean NO_2 Limit Value of 40 μg/m^3 has been exceeded. The highest monitored value in 2022 was 58.4 μg/m^3, located adjacent to the eastbound A127 carriageway to the east of the Fortune of War junction. The hotspots with the most monitored values greater than 40 μg/m^3 in 2022 were Hotspot 2 (the area adjacent to the eastbound carriageway of the A127 east of the Fortune of War junction), and Hotspot 5 (East Mayne between the A127 and Paycocke Road).

A downward trend in monitored concentrations is broadly observed since 2018, although this is confounded by the temporary drop in vehicle movements (and therefore pollutant emissions) associated with the Covid-19 lockdowns.

Analysis has been undertaken utilising all available monitoring data, including air quality and traffic sensors owned by Essex County Council. The high volume of traffic is the primary cause of poor air quality at these locations. However, there are also secondary factors which exacerbate the existing situation resulting in exceedances of the Limit Value. Analysis has indicated the following secondary factors have a particular influence: the proportion of older vehicles in the fleet not reducing as quickly as expected, vehicle acceleration (e.g. from junctions), canyon effects preventing pollutant dispersion, gradients (engines work harder going uphill, and produce more emissions), and potentially vegetation (which may be preventing pollutant dispersion).

Trend analysis to estimate the year by which all of the monitoring in each of the hotspots would naturally (i.e., without the implementation of additional measures) reduce to below 40 μg/m^3 was undertaken. Hotspot 2 had the latest years, with a range of between 2029 and 2036. Similarly, Hotspot 5 had a range of between 2027 and 2036.

Basildon Council also undertake NO_2 diffusion tube monitoring to meet their Local Air Quality Management (LAQM) requirements. In 2022, all Basildon Council monitoring results were well below the Air Quality Objective of 40 μg/m^3

and consequently there are no Air Quality Management Areas (AQMAs) designated. Note that LAQM only applies where there are sensitive receptors with long term exposure (e.g. residential dwellings, hospitals, schools), which is different criteria to that applied to monitoring that is compared against the Limit Value, hence no AQMAs have been designated as a result of monitoring undertaken by Essex Highways. The Basildon Council page of the EssexAir website (https://essexair.org.uk/local-authorities/basildon) provides additional information about Local Air Quality Management within Basildon.

Air quality will gradually improve over time and the latest data shows a general reduction in nitrogen dioxide concentrations. However, based on the latest results it is evident that further measures will now need to be considered to further improve air quality in these localised hotspots.

1 Introduction

This report has been produced by Essex Highways for and on behalf of Essex County Council (ECC) and Basildon Council (BC). It provides the latest air quality monitoring data recorded to assess the impact of the schemes implemented as part of the Basildon Air Quality Management Plan, following and in accordance with the Government publication of the UK Plan for tackling roadside Nitrogen Dioxide (NO_2) concentrations (“The Plan”). The schemes implemented as part of this project are the 50 mph speed management on the A127 between the Fortune of War junction and Pound Lane, and the removal of the walkway on the central reservation on East Mayne.

2 Methodology

2.1 Diffusion Tube Monitoring

2.1.1 Results Processing

Table A1 in Appendix A presents the results of Essex Highways monitoring (recorded between February 2018 to December 2022). Table B1 in Appendix B shows the results of the available Basildon BC monitoring (2018-2022). Figures of all monitoring locations are presented in Appendix C, which corresponds with the results presented in Table A1 and Table B1.

The Essex Highways data (Table A1) represent annual mean NO_2 concentrations. Where a site has less than 9 months of monitoring data (75% data capture) results have been derived using annualisation factors (i.e. a methodology which uses factors derived by comparing short-term monitoring periods with annual monitoring periods). Background data used to annualise the short-term results were obtained from four continuous analysers located at London Bexley, Rochester Stoke, Southend-On-Sea and Thurrock. All of these sites form part of the Automatic and Urban Rural Network (AURN). The annualisation approach was undertaken in accordance with LAQM Technical Guidance (TG22)[1]. The bias correction[2] has been undertaken using the latest version of the National Bias Correction Spreadsheet (March 2023). A factor of 0.76 was applied to all Essex Highways 2022 monitored concentrations i.e. previous versions of the Correction Spreadsheet were used for the 2018, 2019, 2020 and 2021 monitoring results. The results are appended in each case to a monitoring site ID, which can be cross referenced with the Figures in Appendix C. In each case, the numbers of months of data captured in each year have been provided in Table A1.

Note that there are uncertainties associated with the annualisation approach, owing to the variations in pollutant concentrations both spatially and temporally. The more months with monitoring data per site, the more confidence can be assumed in the monitoring results at that site. It is not possible to annualise less than three months of monitoring data (as per TG22[1]), which is indicated by “Insufficient Data” in Table A1. No sites that were still being actively monitored at the end of 2022 had less than three months of data.

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[1] Defra, 2022. Local Air Quality Management Technical Guidance (TG22).
[2] Diffusion tubes have inherent error which is somewhat corrected via mass comparisons with real time analysers the results from which produce bias correction factors each year.

Currently, several monitoring sites are showing exceedances of the NO_2 annual mean Limit Value (40 μg/m^3).

2.1.2 Trend Analysis & Year of Success Calculations

The calculation of anticipated natural success years[3] has been undertaken for specific locations with higher concentrations. The diffusion tube monitoring survey has been ongoing since February 2018 so it is possible to use the trend at these monitoring sites to provide an indication of the year that each monitoring site's recorded annual mean NO_2 concentrations would reduce to below 40 μg/m^3. As there is a lot of uncertainty around this, three methods have been followed to provide an indication of a range of success years. The calculated trends / slopes were then used to project the monitoring forwards. The three methods followed were:

1) Using the total monitored annual mean NO_2 concentrations to calculate the trend.
2) Using the road NO_2 only to calculate the trend (i.e. subtracting the background concentration from the total values)
3) Using the trend calculated at the background site (O_83) and applying that trend to the relevant monitoring sites.

Examples of the above three methods are provided in Table 2-1 below for site O_67, for which data is available for all five years (2018-2022).

Table 2-1 Examples Of Methods Used To Calculate The Slope In The Trend Analysis

Method	Description	Example Annual Mean NO_2 Concentrations Used To Calculate The Slope (μg/m^3) 2018	2019	2020	2021	2022	Calculated Slope
1	O_67 total monitored NO_2 concentration	76.8	61.2	54.7	56.3	51.8	-2.66
2	O_67 monitoring road NO_2 concentration (total minus background)	59.8	44.7	39.7	42.3	39.3	-1.36
3	Background site (O_83) slope	17.0	16.5	15.0	14.0	12.5	-1.30

[3] "Success Year" refers to the year that a monitoring site, or all the monitoring in a given area (depending on the context) is anticipated to be below 40 μg/m^3 and therefore not exceed the Limit Value.

Additional detail is provided in Appendix D.

2.1.3 Changes to the Survey

During 2022, a number of air quality monitoring sites have been added and others discontinued. Discontinuing sites can occur as a result of land access changes which prevent safe access, or because the tubes are persistently removed / vandalised (i.e. low data capture). The following sites were removed during 2022:

- N_68 – discontinued in September 2022 due to health and safety concerns (the column inspection hatch was open and had exposed wiring) and the monitored concentrations in 2021 were below 30 $\mu g/m^3$;
- V_66 – discontinued in October 2022 as the site was overgrown (leading to poor data capture) and the monitored concentrations in 2021 were below 30 $\mu g/m^3$.

The site Co-Lo was added to the survey in September 2022. This is a triplicate site co-located with the new Continuous Monitoring Station (CMS) adjacent to the eastbound carriageway of the A127 approximately 520 m east of the Fortune of War junction. The CMS commissioning process was completed earlier this year, with data available from 31st July 2023.

Furthermore, a review of all active monitoring sites was undertaken at the start of 2023, with sites recommended to be removed or retained based on the monitored concentrations, the trend, or where there are other sufficient justifications. The active monitoring sites have been categorised into five groups, as detailed below:

<u>Sites Removed From Survey</u>

1) Sites where the monitored annual mean NO_2 concentrations have been below 30.4 $\mu g/m^3$ for a least 3 years and indicate a clear downward trajectory.
2) Sites where the monitored annual mean NO_2 concentrations have been below 30.4 $\mu g/m^3$ for a least 3 years and are at a very low risk of exceedance, despite there being no clear downward trajectory.
3) Other sites that Essex Highways propose to remove. These sites do not fit the criteria above, but Essex Highways believes that there is sufficient justification for removing these sites. Induvial justifications for each site have been provided.

Sites Retained

4) Sites that match the criteria to be removed, but Essex Highways are proposing to retain. Individual justifications for each site have been provided.
5) Sites to be retained.

The full list of sites that fall into each of these groups is detailed in Appendix E. Following feedback from the Joint Air Quality Unit (JAQU)[4] on the above, the changes were approved on 18/04/2023. The comments received from JAQU are also provided in Appendix E. The total number of active monitoring sites following this review is 96.

2.1.4 AQSR Reportable Site Criteria

With regards to reviewing whether the Limit Value has been achieved, only sites that are deemed as 'reportable' are considered. Non-reportable monitoring sites are those that do not meet the Air Quality Standards and Regulations (AQSR) criteria. Reportable monitoring sites should be:

- Greater than 25 m from major junctions;
- Greater than 0.5 m from an obstruction;
- Representative of 100 m of road length;
- Between 1.5 and 4.0 m in height;
- Positioned away from other emission sources (e.g. building vents);
- Inlet free in an arc of at least 270 degrees;
- At least 11 months of data capture.

JAQU split monitoring locations into 3 categories: Primary, Secondary and Tertiary. Primary sites meet all of the above criteria and are therefore always reportable. Secondary sites are generally non-reportable but for that year only, as they meet all location-based criteria, but have less than 11 months data. Tertiary sites are generally non-reportable across all monitoring years because they do not meet one or more of the location-based criteria. JAQU guidance[5] states that "*Where a primary is available, it will be used. Only where a primary is unavailable will a secondary with > 25% data capture be considered, and only where both of these are unavailable, a tertiary may be used.*" Data collected at

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[4] JAQU is a UK Government organisation comprising staff from Defra and the Department for Transport who are responsible for delivering the Government's commitments to achieve compliance with the Limit Value across the country. The results of the monitoring survey are provided to JAQU, who then report to the Secretary of State.
[5] Joint Air Quality Unit, October 2023. Exiting The NO_2 Programme – Technical Evidence Guidance

Secondary and Tertiary sites can still be useful in analysis, and may also be used when reviewing success against the Limit Value, depending on the availability of primary sites. In this report, it is considered that the primary sites are sufficient, and so the secondary and tertiary sites have not been included when determining success.

Table A2 in Appendix A provides all the siting information for each of the active monitoring sites, and the AQSR category that they fall into.

2.2 Air Quality and Traffic Sensor Monitoring

In addition to the diffusion tubes, a network of Aeroqual AQS1 air quality sensors and VivaCity traffic sensors are in operation at locations relevant to the AQMP in Basildon. Information about the sensor locations are presented in Table 2-2 and Table 2-3, and also in Figure 2-1.

Table 2-2 AQS1 Sensor Locations

ID	Location	Type	X	Y	Height (m)
AQ1	East Mayne North Bound	Roadside	573191	190911	4.0
AQ2	East Mayne North Bound	Roadside	573196	190841	4.0
AQ3	East Mayne North Bound	Roadside	573192	190990	4.0
AQ4	East Mayne South Bound	Roadside	573221	190916	4.0
AQ5	East Mayne South Bound	Roadside	573223	190974	4.0
AQ6	East Mayne South Bound	Roadside	573230	190813	4.0
AQ BG	Havalon Close	Background	571666	189394	4.0

Table 2-3 VivaCity Sensor Locations

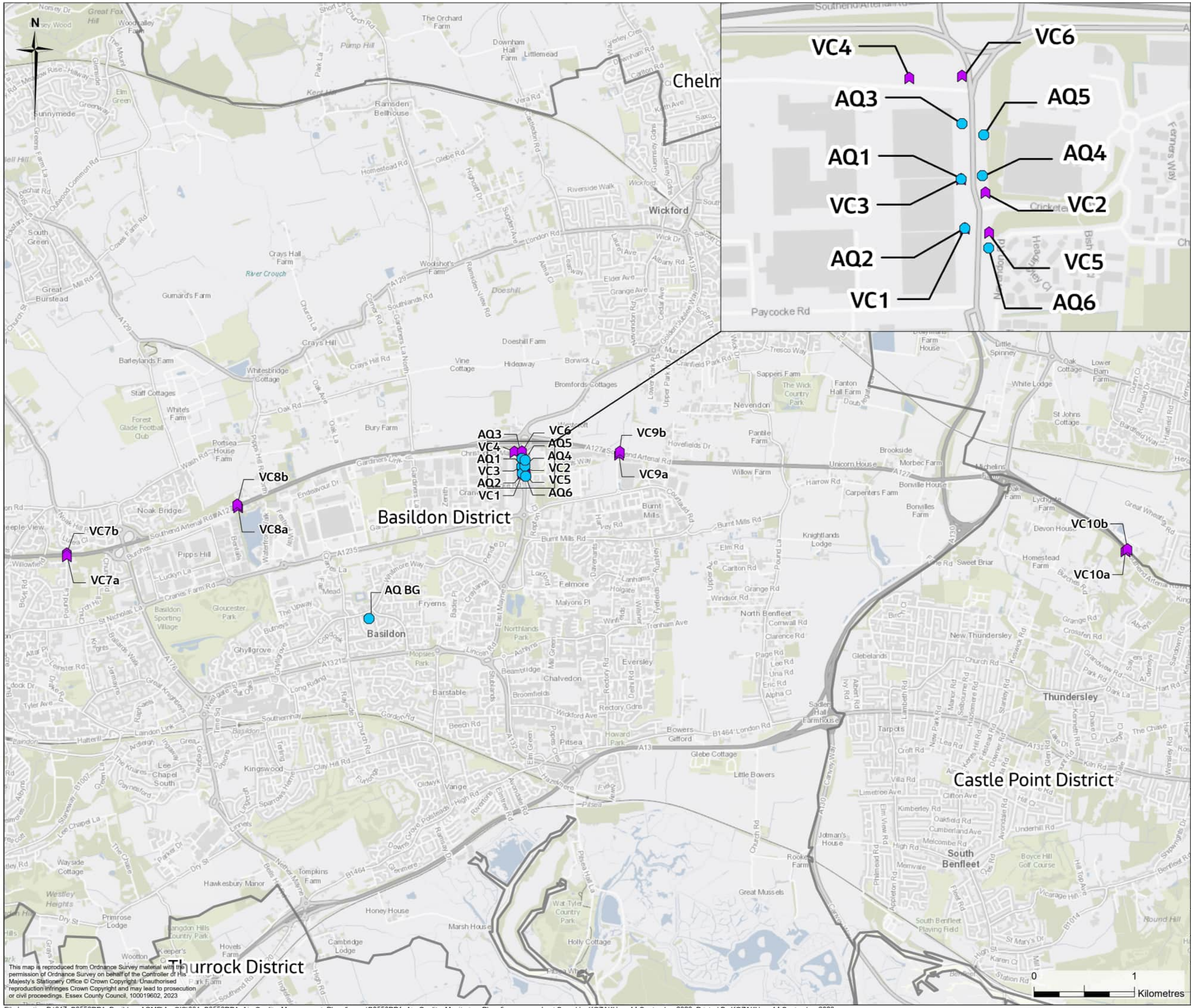
ID	Location	Flow Direction	X (BNG)	Y (BNG)
East Mayne				
VC1	East Mayne between Paycocke Road and Cricketers Way	North bound	573196	190841
VC2	East Mayne between Cricketers Way and Christopher Martin Road	South sound	573225	190892
VC3	East Mayne between Cricketers Way and Christopher Martin Road	North bound	573191	190911
VC4	Christopher Martin Road	Two-way	573117	191055

ID	Location	Flow Direction	X (BNG)	Y (BNG)
VC5	East Mayne between Paycocke Road and Cricketers Way	South bound	573231	190835
VC6	East Mayne between Christopher Martin Road and the A127	North bound	573192	191058
A127				
VC7	A127 between the Fortune of War Junction and Upper Mayne	Two-way	568654	190030
VC8	A127 between Upper Mayne and East Mayne	Two-way	570357	190517
VC9	A127 between East Mayne and the Fairglen junction	Two-way	574163	191043
VC10	A127 between the Fairglen junction and Rayleigh Weir	Two-way	579216	190076

It is also possible to approximate a two-way flow for sections of East Mayne where there are sensors on each side of the road, similar to sensors VC7-VC10. Sensors that can be paired to give a representative two-way flow are detailed in Table 2-4.

Table 2-4 VivaCity Sensor Locations

Sensors	Road Section
VC3+VC2	East Mayne 2way btw. Cricketers Way & Christopher Martin Road
VC1+VC5	East Mayne 2way btw. between Paycocke Road & Christopher Martin Road



Notes
1. Do not scale

Legend
- District Boundaries
- AQS1 Sensor
- VivaCity Sensor

Rev	Date	Description of revision	Drawn	Checked	Review'd	Approv'd
0	09/23	FINAL	HK	WD	KT	DH

DRAWING STATUS
FOR INFORMATION

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SCHEME TITLE
BASILDON AQMP

DRAWING TITLE
FIGURE 2-1: AQS1 & VIVACITY SENSOR LOCATIONS

DESIGNED	DRAWN	CHECKED	REVIEWED	APPROVED
HK	HK	DW	KT	DH
DATE SEP23	DATE SEP23	DATE SEP23	DATE SEP23	DATE SEP23

DRAWING UNITS U.N.O.
DIMENSIONS IN MILLIMETRES
LEVELS IN METRES

SCALE AT A3 (420x297 mm)
1:35,000

REV.
0

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Essex County Council

2.2.1 Analysis of Sensor Data – East Mayne

The AQS1 and VivaCity sensors both provide data to a very high temporal resolution. At their highest resolutions the AQS1 can provide data every minute, and the VivaCity sensors can provide data every fifteen minutes. This allows for much greater depth of analysis on East Mayne where both types of sensors are located. As part of this analysis polar plots and partial dependency plots have been produced, in addition to statistical analysis presented later in this report.

Polar plots combine high resolution air quality monitoring data (in this case hourly average NO_2 concentrations) and hourly meteorological data (wind speed and direction) to show the different levels of pollutant concentrations that can occur under varying meteorological conditions. These can help to identify which pollution sources can have the greatest impact on pollutant concentrations at the monitoring site, thus allowing bespoke mitigation to be developed.

Partial dependency plots are more detailed and can use a much wider range of data types to determine which of the data sources have the greatest influence on pollutant concentrations. The more representative and relevant data that can be included, the better the outputs will be. The outputs are presented as a plot for each variable against the monitored NO_2 concentration. Each plot has a percentage associated with it, which indicates the level of influence each variable has on the pollutant concentrations. The higher the percentage, the greater the influence. Percentages below approximately 5% are considered to have a negligible level of influence. In addition to the hourly mean NO_2 concentrations[6] from the AQS1 units, the data used for the partial dependency plots on East Mayne include:

- Meteorological data from Southend Airport
  - Wind direction
  - Wind speed
  - Temperature
  - Relative humidity
- Hourly traffic data from the VivaCity sensors including:
  - 1 way traffic flows to determine the individual influence of the different sides of the road

[6] The NO_2 concentrations have had the background contribution removed, so the plots indicate the influence of these factors on roadside NO_2 only

  - Different vehicle types (cars, light goods vehicles (LGV), buses, and ordinary goods vehicle (OGV) 1 and 2 which correspond to rigid and articulated heavy goods vehicles (HGV) respectively)
- Time and day
- Hourly Ozone (O_3) concentrations from local monitoring sites

The VivaCity sensors also monitor speed, occupancy and dwell times, of which the latter two are an indication of the level of queuing. However, these factors have not been found to have good correlation with the hourly NO_2 concentrations and have therefore not been included in the analysis. Essex Highways have spoken to VivaCity about finding a metric to represent acceleration, which can have a large impact on pollutant concentrations, but this currently isn't available.

The partial dependency plot and polar plot outputs are presented in Appendix F. Detailed instructions for using the 'deweather' R package are available online[7] and further detailed information about the process is provided in Carslaw and Taylor's paper 'Analysis of Air Pollution at a Mixed Source Location Using Boosted Regression Trees'[8].

2.2.2 ANPR Survey

Automatic number plate recognition (ANPR) surveys have been previously undertaken in October 2018, 2020, 2021 and 2022. For the past three years, the survey has taken place over one week covering both directions at the following locations:

- A127 – the cameras are placed east of East Mayne / A127 junction and the on / off slips
- East Mayne – the cameras are placed between the A127 / East Mayne junction and the East Mayne / Christopher Martin Road junction.

The data provided by the Department for Transport (DfT) has been processed using the most up to date version of the 'Central Evaluation Lookup Tables'[9]. The data will be presented graphically and compared against previous years,

[7] https://github.com/davidcarslaw/deweather
[8] Carslaw & Taylor (2009). Analysis of Air Pollution Data at a Mixed Source Location Using Boosted Regression Trees, Atmospheric Environment. Vol. 43, pp. 3563–3570. Available online at: https://www.sciencedirect.com/science/article/abs/pii/S1352231009003069
[9] Provided by JAQU on 19/06/2023

Emission Factor Toolkit (EFT) [10] defaults, and the fleets used in the modelling work submitted as part of the East Mayne FBC.

2.3 Fortune of War Modelling Assessment

Part of the A127 Major Road Networks (MRN) scheme proposals are to 'straighten out' the Fortune of War (FoW) junction. Currently vehicles have to decelerate on the approach to the junction, then accelerate up to 50 mph once out of the junction. Acceleration events cause higher pollutant (particularly NO_x) emissions from vehicles, which are likely responsible for the particularly high concentrations recorded by diffusion tubes immediately to the east of the FoW junction, on the north side of the road. It is considered that 'straightening out' the junction would temper the acceleration event, thereby reducing the key behaviour which leads to elevated NO_x emissions and consequently NO_2 concentrations at nearby monitoring sites.

A summary of the methodology is provided below, with the full methodology (including verification) provided in Appendix G.

Traffic modelling was undertaken by Essex Highways to investigate the transport related benefits of this A127 MRN Scheme. To provide further evidence to the A127 MRN business case, an air quality modelling assessment was undertaken to determine the potential impact that the scheme could have on the success year at this location. As traffic data suitable for an air quality modelling assessment was not readily available, the following data were used in the modelling process:

- Emissions data from the Institute for Transport Studies (ITS), who undertook and environmental evaluation of the 50 mph speed management measure on the A127 in 2021. Emission rates were obtained using instrumented vehicles recording driving cycle which were then applied to the PHEM [11] instantaneous emissions model.
- Average speed based emissions data used in the East Mayne FBC dispersion modelling
- Model alignment/setup used in the East Mayne FBC dispersion modelling
- Meteorological data from Southend Airport for 2021

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[10] The EFT is a tool published by Defra that "*allows users to calculate road vehicle pollutant rates*". This tool was used in the analysis work that fed into both sets of OBC and FBCs.
[11] Passenger car and Heavy duty Emission Model

- Monitoring data for sites O_5, O_75, N_38 and N_39

The study area was limited to all road links within 400 m of the above monitoring sites.

The first step of the methodology was to review the PHEM study outputs to identify a “free flow” link (i.e. where driver behaviour is unaffected by external factors like junctions and congestion that would impact the flow) who’s NO_x emissions could be used to represent driving conditions at the FoW junction with the scheme in place.

The next step was to ascertain the relationship between the NO_x emissions from the PHEM study of the “free flow” link, and all the other links. For each link a factor was produced to define this relationship. These factors were then multiplied by the average speed-based NO_x emission rate used in the initial modelling for the “free flow” link to give emission rates for all the model links. These rates reflect both the outcomes of the 2021 PHEM study and the modelling undertaken (including the local fleet).

These emission rates were used as inputs to the dispersion model[12], with outputs provided at the monitoring sites O_5, O_75, N_38 and N_39 only. These locations served as both verification sites and modelled receptors.

The study area and additional details about the methodology are provided in Appendix G.

[12] Atmospheric Dispersion Modelling System (ADMS) Roads version 5.0.1.3

3 Presentation of Results

3.1 Diffusion Tube Survey Results

The objective of the monitoring is to ascertain whether the A127 speed management and the East Mayne central reservation walkway removal schemes have successfully brought annual mean NO_2 concentrations across Basildon to below 40 µg/m^3 in the shortest possible time frame, in line with the Air Quality Standards and Regulations (AQSR). The modelled success years are presented in Table 3-1. As different approaches to the traffic modelling have been applied over the project's lifetime, all predicted success years have been presented.

Table 3-1 Modelled Success Years

Traffic Model	East Mayne	A127	Upper Mayne
Strategic Transport Model (VISUM)	2023	2020/1	2021/2
Countywide (VISUM)*	After 2022	2022	2022
Local (VISSIM)**	2022	N/A	N/A
* Without measures scenario ** Success achieved through removal of central reservation			

The following sections detail the results of the monitoring survey at key locations in 2022. Table A1 presents the bias adjusted and (where relevant) annualised monitored annual mean NO_2 concentrations for 2022 and the figures in Appendix C show them spatially. Table A2 details whether sites are Primary reportable or Secondary / Tertiary non-reportable in line with the AQSR siting criteria detailed above.

The monitoring results for reportable sites have been grouped into six locations (i.e. hotspots), as presented in Figure 3-1 and discussed further in this section, including:

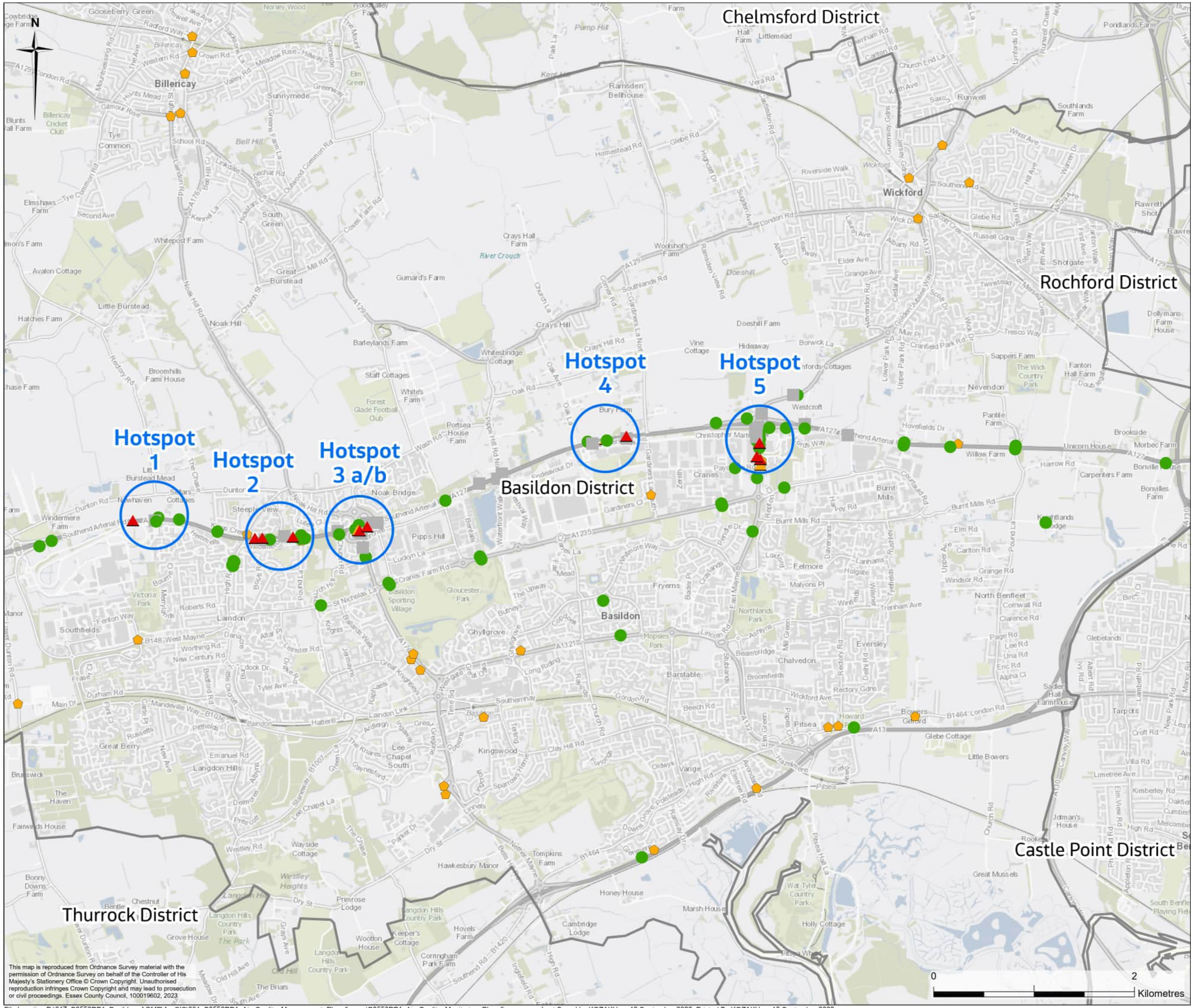
- Hotspot 1 – A127 between West Mayne and Fortune of War;
- Hotspot 2 – A127 between Fortune of War and Upper Mayne (north side of the road adjacent to the eastbound carriageway only);
- Hotspot 3a – A127 near Upper Mayne;
- Hotspot 3b – Upper Mayne below the A127;
- Hotspot 4 – A127 between Pipps Hill Road North and Gardiners Lane North; and

- Hotspot 5 – East Mayne.

Table 3-2 summarises the relevant 2022 monitored and either scenario 2020 DS1 (Strategic Transport model) or scenario 2022 DM (either the Local model for East Mayne or the Countywide model for all other locations) modelled annual mean NO_2 concentrations at each hotspot. Note that all diffusion tube monitoring locations with 2022 annual mean NO_2 concentrations greater than 40 µg/m^3 are included in Table 3-2, regardless of whether they are reportable or non-reportable. The highest monitored concentration is in hotspot 2 (58.4 µg/m^3 at N_39) and the most occurrences of concentrations above 40 µg/m^3 in a single hotspot are in hotspot 5 (five sites).

Table 3-2 Modelled vs Monitored Annual Mean NO_2 Concentrations Per Hotspot

Hotspot No.	Description	No. DT's Greater Than 40 µg/m^3 in 2022	2022 Max Monitored NO_2 Conc (µg/m^3)	Local 2020 DS1 Modelled NO_2 Conc (µg/m^3)	Local 2022 DM Modelled NO_2 Conc (µg/m^3)
1	A127 between West Mayne and the FoW	2	48.6 (N_1)	35.1 – 35.3	35.5 – 36.6
2	A127 between FoW and Upper Mayne)	4	58.4 (N_39)	37.1 – 37.5	33.5 – 33.6
3a	A127 near Upper Mayne	3	51.8 (O_67)	34.4 – 34.7	28.5 – 29.5
3b	Upper Mayne below A127	2	45.0 (N_35)	35.3 – 35.8	24.1 – 24.9
4	A127 between Pipps Hill Road North and Gardiners Lane North	2	46.3 (N_6)	29.3 – 29.6	29.1 – 29.6
5	East Mayne	5	51.3 (N_29)	32.9 – 34.1	32.2 – 37.0



Notes
1. Do not scale

Legend

District Boundaries
Local Authority Monitoring

Essex Highway Monitoring Sites

Figure

- Primary - Non-Compliant
- Secondary - Non-Compliant
- Primary or Secondary - Compliant
- Tertiary

Rev	Date	Description of revision	Drawn	Checked	Review'd	Approv'd
0	09/23	FINAL	HK	DW	KT	DH

DRAWING STATUS
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SCHEME TITLE
BASILDON AQMP

DRAWING TITLE
FIGURE 3-1: BASILDON AIR QUALITY HOTSPOT LOCATIONS

DESIGNED	DRAWN	CHECKED	REVIEWED	APPROVED
HK	HK	DW	KT	DH
DATE	DATE	DATE	DATE	DATE
SEP23	SEP23	SEP23	SEP23	SEP23

DRAWING UNITS U.N.O.
DIMENSIONS IN MILLIMETRES
LEVELS IN METRES

SCALE AT A3 (420x297 mm)
1:35,000

REV.
0

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A summary of the number of sites with recorded concentrations above 40 µg/m^3 and their AQSR classification (Primary / Secondary / Tertiary – see section 2.1.4 above) split by hotspot is provided in Table 3-3. Values are reported to JAQU to zero decimal places, so concentrations between 40.0 and 40.4 are rounded to 40 and would therefore not be classed as an exceedance, whereas values between 40.5 and 41.0 are rounded to 41 and therefore would be classed as an exceedance.

Table 3-3 Summary of Limit Value Exceedances Per Hotspot

Hotspot	Total No. Sites >40 µg/m^3 In 2022	No. Exceedance Sites Per AQSR Classification		
		Primary	Secondary	Tertiary
1	2	1	0	1
2	4	3	0	1
3a	3	1	0	2
3b	2	1	1	0
4	2	1	1	0
5	5	3	1	1

As described in Section 2.1.4, Secondary and Tertiary exceedances are generally considered non-reportable, whereas Primary exceedances are always reportable. Consequently, in 2022 there were ten reportable locations that exceeded the Limit Value. Further details are provided in the sections below, and the full detailed list with siting criteria is detailed in Table A2, Appendix A.

3.1.1 Hotspot 1

The modelling approach that applied the Strategic Transport Model indicated that success should be achieved at this location by the end of 2021 at the latest (see Table 3.2). Figure 3-2 presents the annual mean concentrations of the diffusion tube monitoring in Hotspot 1 (see Figure 3-1). The background site O_83 is included in Figure 3-2 to Figure 3-7, which has been active during the full monitoring period, with good data capture throughout. The AQSR Limit Value (40 µg/m^3) is also displayed and is represented by a horizontal dashed red line.

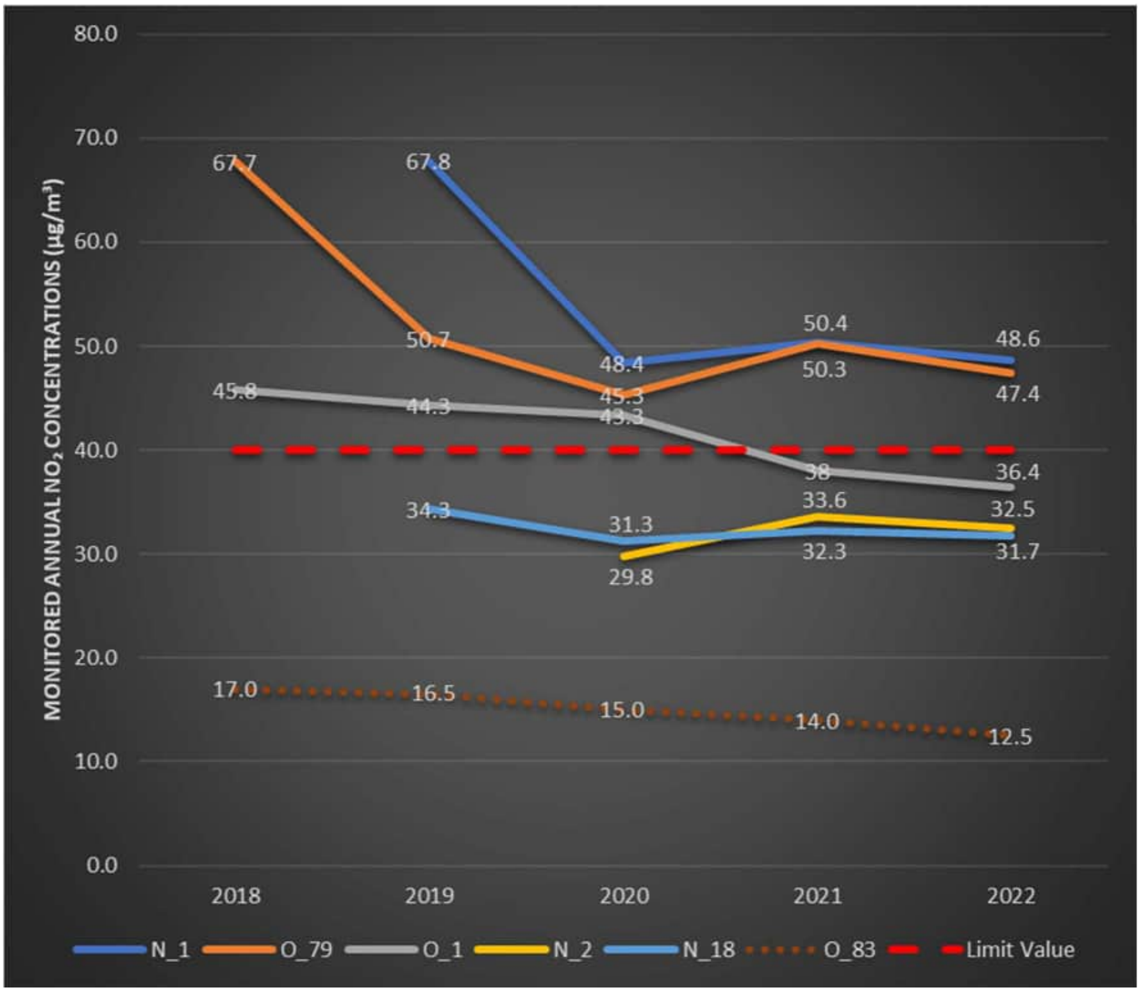


Figure 3-2: Hotspot 1 – Diffusion Tube Annual Mean NO_2 Results on the A127 Between West Mayne and the Fortune of War Junction

The monitoring data indicates that in 2022, two of the five locations in Hotspot 1 recorded concentrations greater than 40 µg/m^3, as per 2021; N_1 (48.6 µg/m^3) and O_79 (47.4 µg/m^3). All monitoring sites at this location experienced a small decrease in monitored concentrations between 2021 and 2022. N_1 and O_79 continued the overall trend of decreasing concentrations, as did site O_1 which decreased below 40 µg/m^3 in 2021 and maintained concentrations below the Limit Value in 2022.

JAQU classes exceedance site N_1 as a Primary site (reportable) and O_79 as a Tertiary site (non-reportable as the height is below 1.5 m), so in line with the AQSR siting criteria there was only one reportable exceedance in 2022. For reference, site O_1 is also a Primary site (reportable).

3.1.2 Hotspot 2

The modelling approach that applied the Strategic Transport Model indicated that success should be achieved at this location by the end of 2021 at the latest. The variation of annual mean NO_2 diffusion tube monitoring results at the hotspot adjacent to the eastbound carriageway of the A127 between the Fortune of War junction and Upper Mayne, represented by nine monitoring locations, are presented in Figure 3-3 and Table A1. Note that site Co-Lo (i.e. co-located with the new continuous monitoring station) only has data for December 2022, so the single recorded value of 30.5 $\mu g/m^3$ is not shown on the graph.

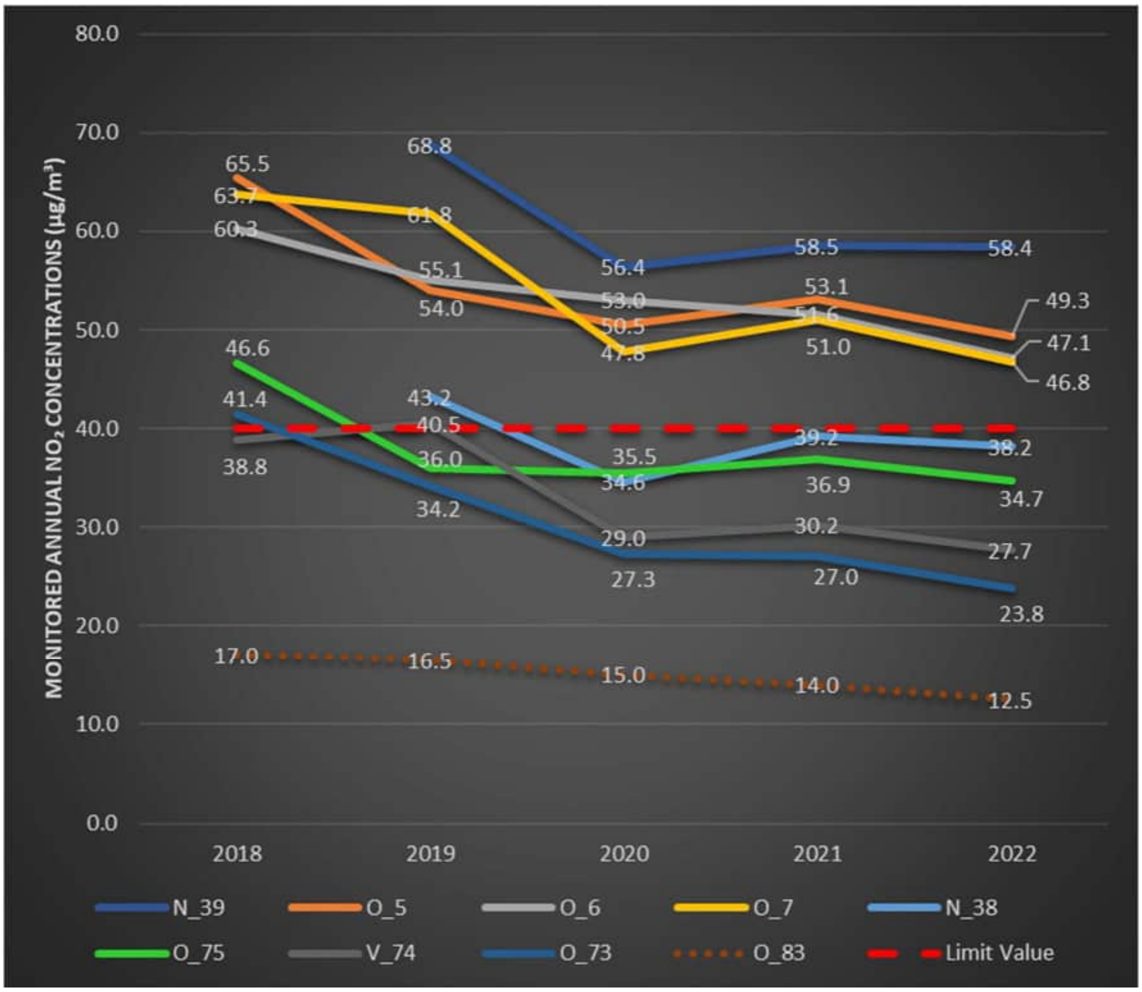


Figure 3-3: Hotspot 2 – Diffusion Tube Annual Mean NO_2 Results on the A127 Between Fortunate of War Junction and Upper Mayne (excluding the new co-location site)

In 2022 at Hotspot 2, four of the nine sites recorded concentrations greater than 40 $\mu g/m^3$; N_39 (58.4 $\mu g/m^3$), O_5 (49.3 $\mu g/m^3$), O_6 (47.1 $\mu g/m^3$) and O_7 (46.8 $\mu g/m^3$). Site N_39 recorded the highest annual mean NO_2 concentration across the active monitoring sites in 2022, and the concentrations remained relatively consistent between 2020 and 2022. This is unusual, as most locations experienced a dip in concentrations due to the reduced traffic flows associated with the Covid-19 lockdowns. All other sites experienced small decreases in concentrations, although no new sites were brought below 40 µg/m^3.

JAQU classes exceedance sites N_39, O_5 and O_7 as Primary sites (reportable) and O_6 as a Tertiary site (non-reportable as the height is below 1.5 m), so in line with the AQSR siting criteria there were three reportable exceedances in 2022.

3.1.3 Hotspot 3a

The modelling approach that applied the Strategic Transport Model indicated that success should be achieved at this location by the end of 2021 at the latest. The variation of annual mean NO_2 diffusion tube monitoring results at the hotspot on the A127 near Upper Mayne, represented by eight monitoring locations, are presented in Figure 3-4 and Table A1.

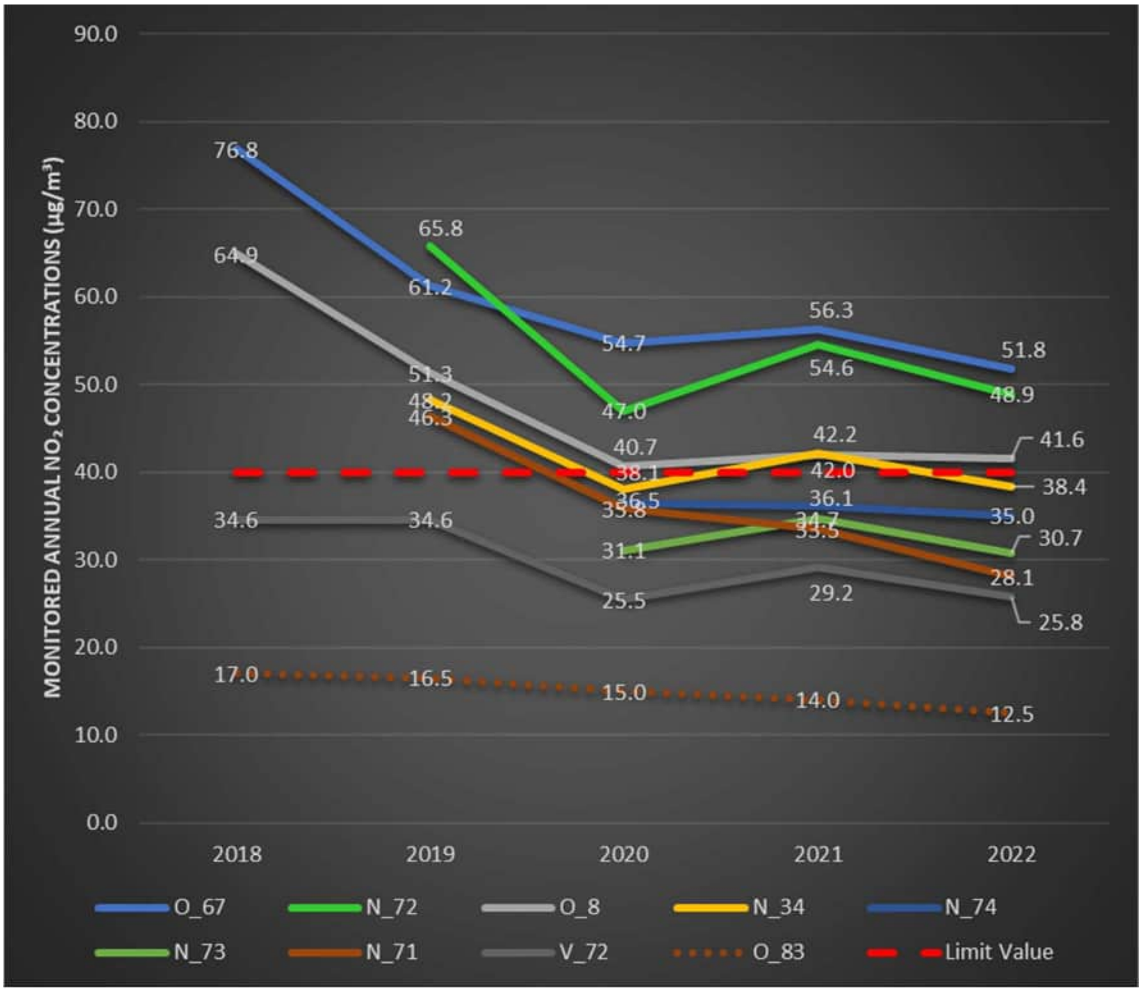


Figure 3-4: Hotspot 3a – Diffusion Tube Annual Mean NO_2 Results on the A127 Near Upper Mayne

At hotspot 3a, three of the eight sites recorded concentrations greater than 40 µg/m^3 in 2022; O_67 (51.8 µg/m^3), N_72 (48.9 µg/m^3) and O_8 (41.6 µg/m^3). This is an improvement on 2021 when four sites monitored greater than 40 µg/m^3, as site N_34 decreased from 42.2 µg/m^3 to 38.4 µg/m^3. All sites here decreased slightly between 2021 and 2022, with the exception of site O_8, which remained consistent.

JAQU classes exceedance site N_72 as a Primary site (reportable), whereas sites O_67 and O_8 are classed as Tertiary sites (non-reportable as the height is below 1.5 m), so in line with the AQSR siting criteria there was one reportable exceedance in 2022.

3.1.4 Hotspot 3b

The Air quality modelling undertaken based on the Strategic Traffic Model indicated that success should be achieved at this location by the end of 2022 at the latest. The variation of annual mean NO_2 diffusion tube monitoring results at the hotspot on Upper Mayne (below the A127), represented by five monitoring locations, are presented in Figure 3-5 and Table A1.

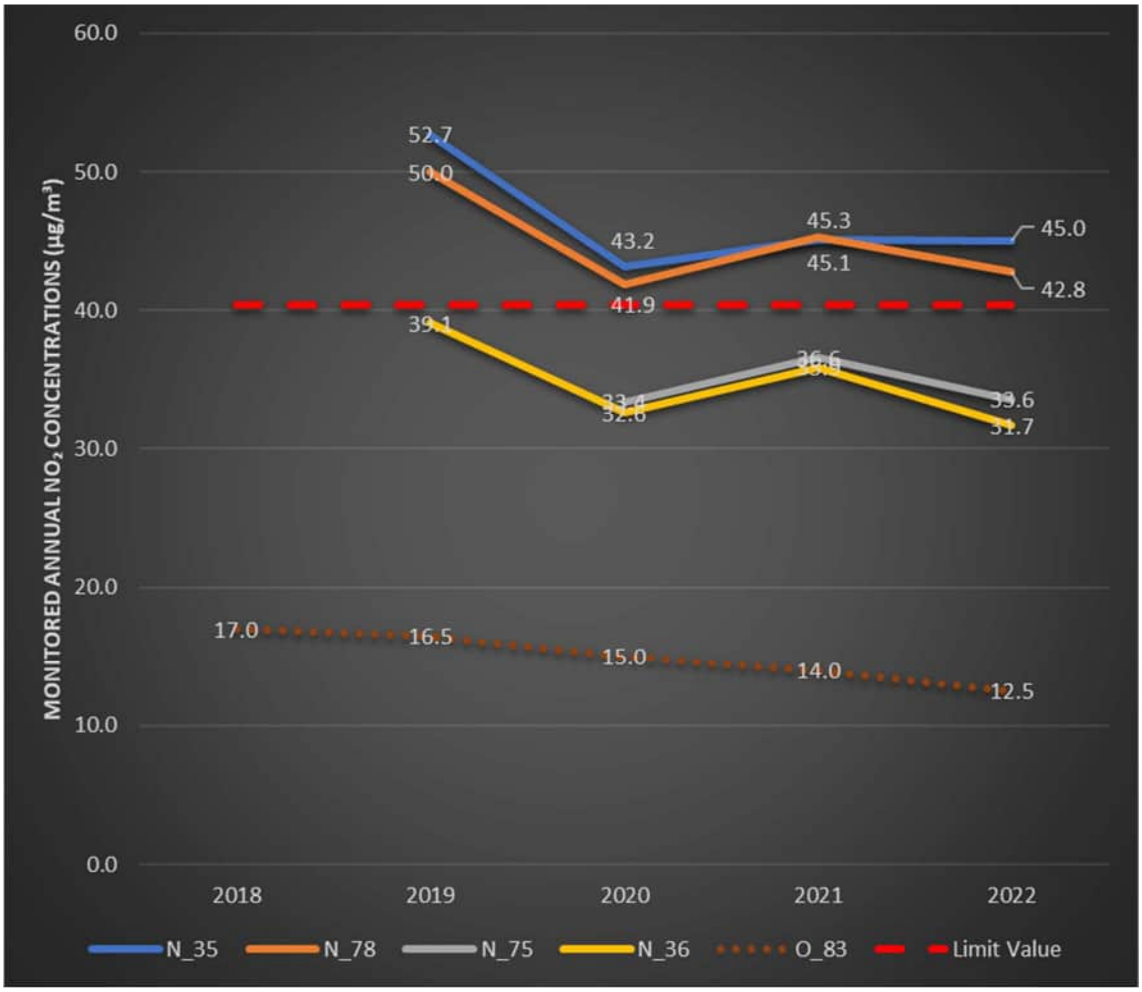


Figure 3-5: Hotspot 3b – Diffusion Tube Annual Mean NO_2 Results on Upper Mayne Below the A127

In 2022 at hotspot 3b, two of the five sites recorded concentrations greater than 40 µg/m^3; N_35 (45.0 µg/m^3) and N_78 (42.8 µg/m^3). Site N_35 stayed relatively consistent with recent years' values, whereas other sites experienced small decreases in concentrations. No new sites were brought below 40 µg/m^3.

JAQU classes exceedance site N_35 as a Primary site (reportable) whereas site N_78 is classed as a Secondary site (non-reportable for 2022 as there was less than 11 months' data capture). In line with the AQSR siting criteria there was just one reportable exceedance in 2022.

3.1.5 Hotspot 4

The modelling approach that applied the Strategic Transport Model indicated that success should be achieved at this location by the end of 2021 at the latest.

The variation of annual mean NO_2 diffusion tube monitoring results at the hotspot on the A127 between Pipps Hill Road North and Gardiners Lane North, represented by six monitoring locations, are presented in Figure 3-6 and Table A1.

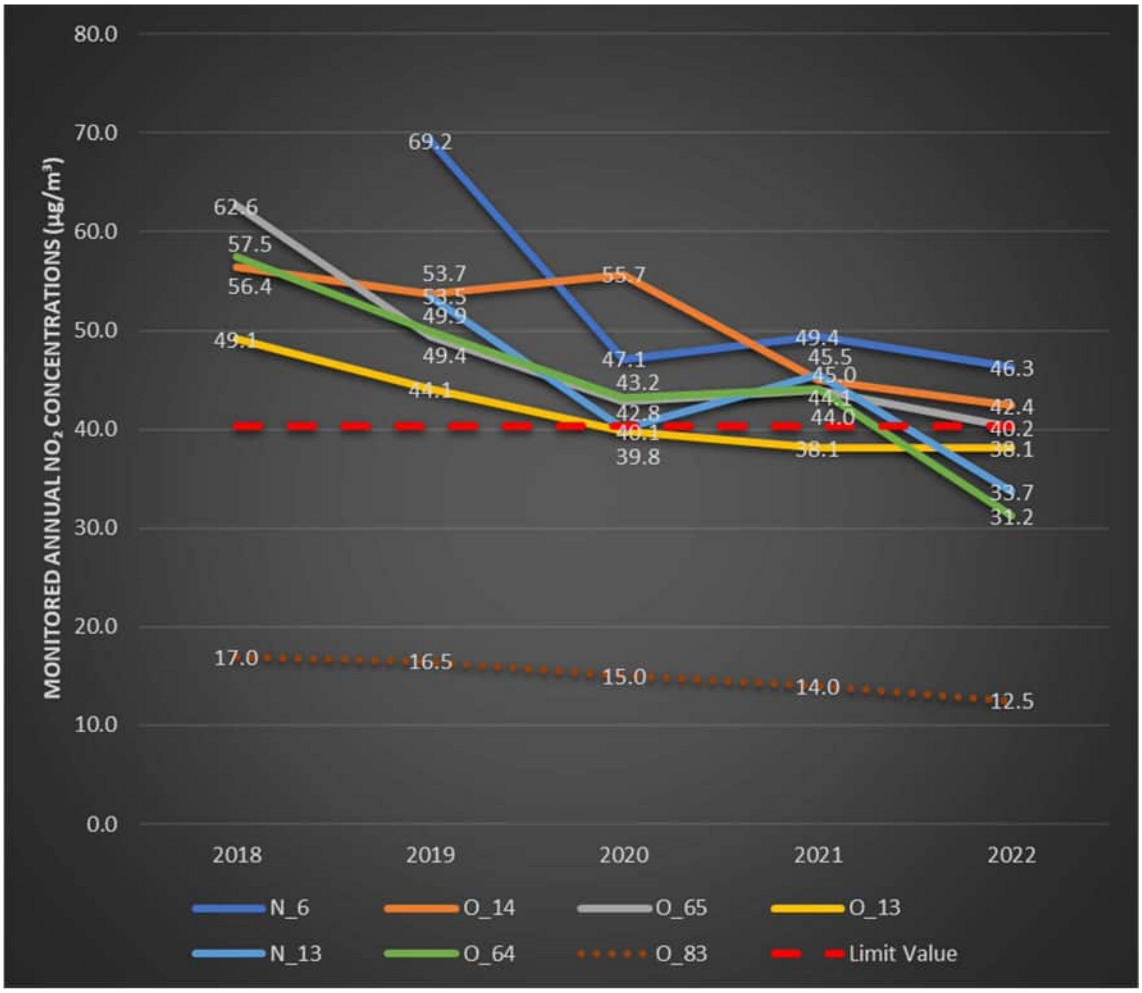


Figure 3-6: Hotspot 4 – Diffusion Tube Annual Mean NO_2 Results on the A127 Between Pipps Hill Road North and Gardiners Lane North

In 2022 at hotspot 4, two of the six sites recorded concentrations greater than 40 µg/m^3; N_6 (46.3 µg/m^3) and O_14 (42.4 µg/m^3). Whilst all sites recorded a decrease in concentrations between 2021 and 2022, sites N_13 and O_64 both recorded large decreases in concentrations of 11.8 µg/m^3 and 12.9 µg/m^3 respectively, bringing them both well below 40 µg/m^3.

JAQU classes exceedance site O_14 as a Primary site (reportable), whereas site N_6 is classed as a Secondary site (non-reportable for 2022 as there was less than 11 months' data capture). In line with the AQSR siting criteria there was just one reportable exceedance in 2022.

Note that site O_65 technically does not exceed 40 µg/m^3 owing to the way that the values are reported to Defra.

3.1.6 Hotspot 5

The modelling approach that applied the Strategic Transport Model indicated that success should be achieved at this location by the end of 2023 at the latest. Following submission of the OBC in October 2019, further modelling was undertaken using the Countywide Traffic Model, then in more detail in the vicinity of East Mayne using VISSIM. VISSIM based pollution dispersion modelling indicated that with the removal of the central reservation receptor, success would be achieved by the end of 2022 at this location.

The variation of annual mean NO_2 diffusion tube monitoring results at the hotspot on East Mayne, represented by 14 monitoring locations (including Basildon Council's site NVR12), are presented in Figure 3-7 to Figure 3-9 and Table A1. Owing to the number of monitoring sites on East Mayne, the sites have been grouped by location and split across three graphs to present the information clearer. Monitoring on East Mayne started in 2019, unlike other locations where monitoring began in 2018.

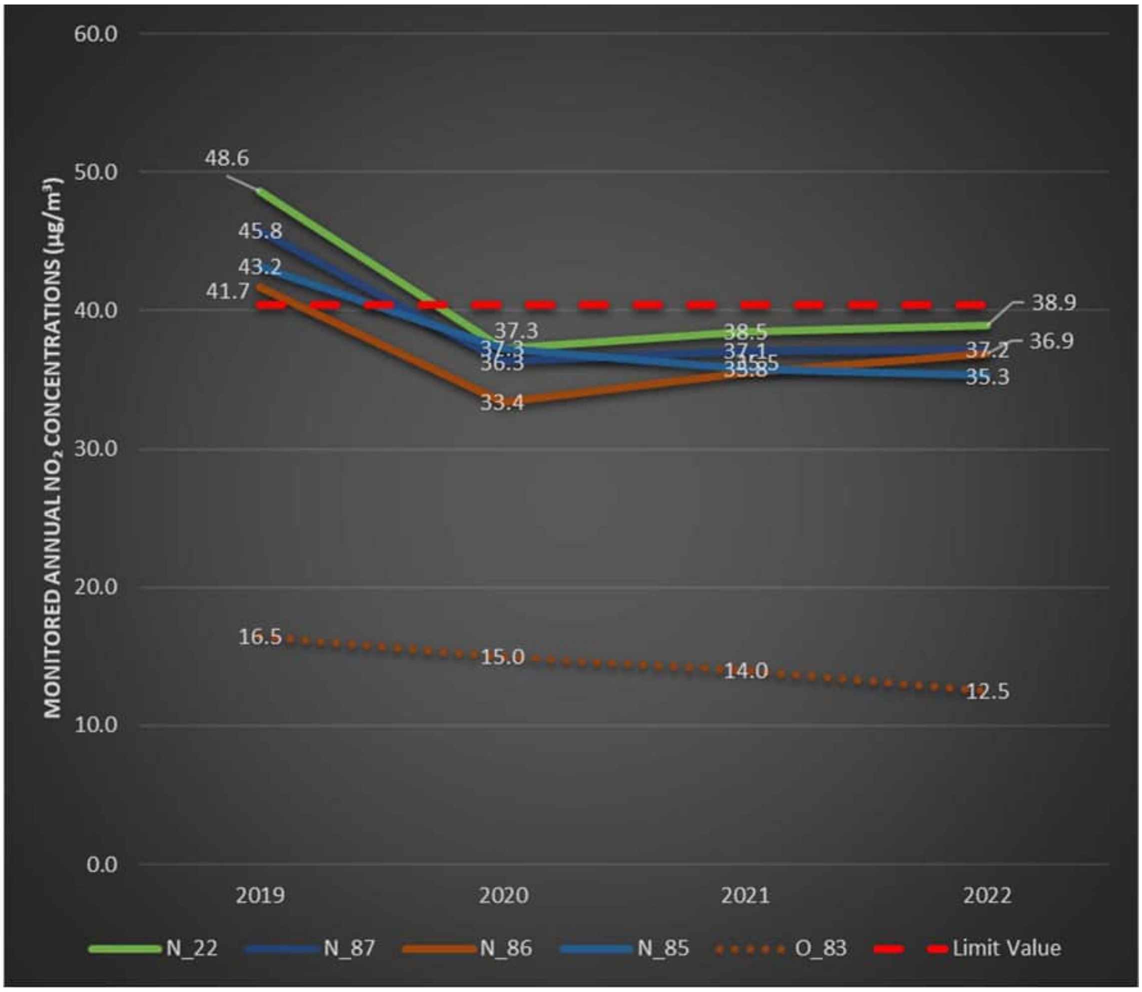


Figure 3-7: Hotspot 5 – Diffusion Tube Annual Mean NO_2 Results on East Mayne On The West Side Of East Mayne, North Of Cricketers Way

On the western side of East Mayne north of Cricketers Way at hotspot 5, none of the four sites recorded concentrations greater than 40 µg/m^3 in 2022. The recorded concentrations at these locations are broadly similar to the 2021 concentrations.

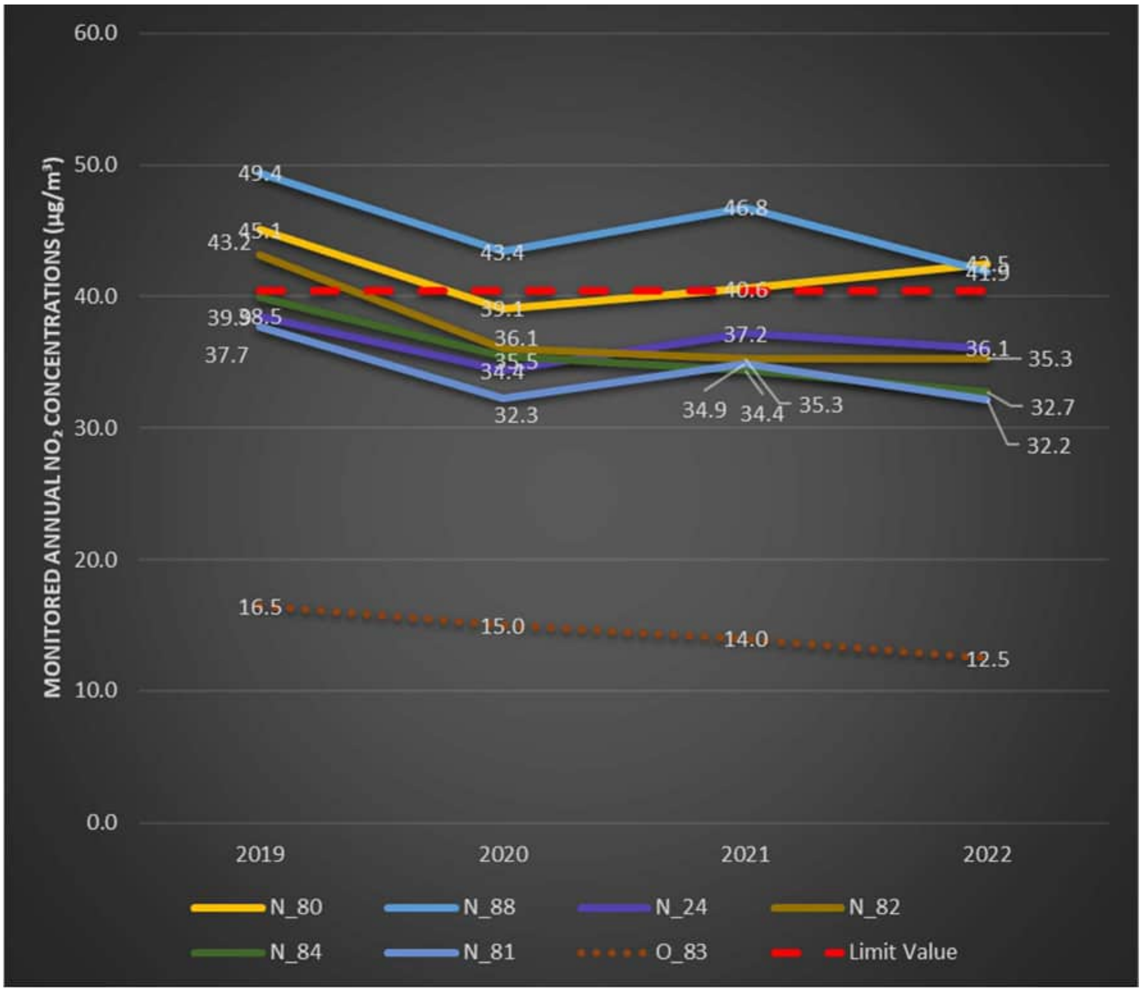


Figure 3-8: Hotspot 5 – Diffusion Tube Annual Mean NO_2 Results on East Mayne On The East Side Of East Mayne, North Of Cricketers Way

On the eastern side of East Mayne north of Cricketers Way at hotspot 5, two of the six sites recorded concentrations greater than 40 µg/m^3 in 2022; N_80 (42.5 µg/m^3) and N_88 (41.9 µg/m^3). Most sites recorded a small decrease or minimal change between 2021 and 2022. Site N_80 on the other hand has steadily increased since 2020 and is now recording the highest concentrations of this group (but not the highest of hotspot 5).

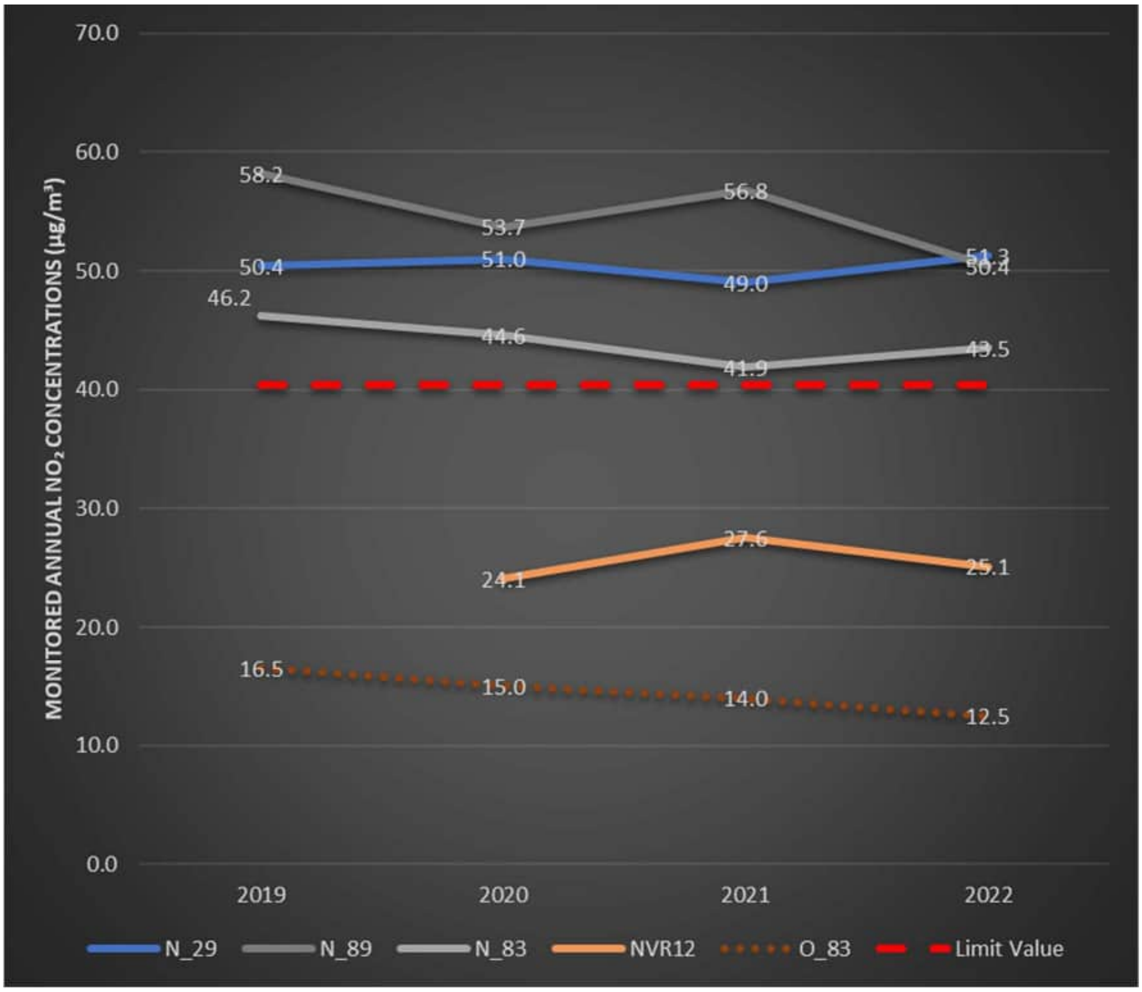


Figure 3-9: Hotspot 5 – Diffusion Tube Annual Mean NO_2 Results on East Mayne South Of Cricketers Way (Both Sides Of The East Mayne)

On East Mayne south of Cricketers Way at hotspot 5, three of the four sites recorded concentrations greater than 40 µg/m^3 in 2022; N_29 (51.3 µg/m^3), N_89 (50.4 µg/m^3) and N_83 (43.5 µg/m^3). Both N_29 and N_83 recorded small increases in NO_2 concentrations in 2022, which resulted in N_29 overtaking N_89 as having the highest recorded concentration at this hotspot. Site N_89 recorded a decrease in concentrations of 6.4 µg/m^3 between 2022 and 2021, although the recorded concentration was still above 50 µg/m^3.

JAQU classes exceedance sites N_89 (50.4 µg/m^3), N_83 (43.5 µg/m^3) and N_88 (41.9 µg/m^3) as Primary sites (reportable). However, site N_29 is classed as a Secondary site (non-reportable for 2022 as there was less than 11 months' data capture) and N_80 is classed as a Tertiary site (non-reportable as the site is within 25 m of a major junction). In line with the AQSR siting criteria there were three reportable exceedances in 2022.

3.2 East Mayne Sensor Results

3.2.1 AQS1 Sensors

The seven AQS1 sensors were installed on East Mayne (six sensors) and Havalon Close (one sensor) on the 24th and 25th January 2022. The exception to this was AQ6, which had power supply issues (and no data captured) in its original location and so was moved to its current location on 4th October 2022.

AQ1 to AQ6 are roadside monitors, whereas AQ BG is an urban background monitoring location. The AQS1 units are at a hight of approximately four meters to avoid vandalism, whereas the diffusion tubes on the same columns are at approximately two meters height. Consequently, slightly different monitored concentrations are to be expected.

Table 3-4 summarises the recorded data for each site, and Table 3-5 compares the AQS1 data to the 2022 diffusion tube monitoring data where available.

Table 3-4 Summary of AQS1 Monitored NO_2 Data

Sensor	Installation Date	Days Active	Period Data Capture *	Annual Data Capture	Annual Mean ($\mu g/m^3$) **	Max Hourly Mean ($\mu g/m^3$)
AQ1	25/01/2022	160	47.6%	44.3%	<u>38.0</u>	147.6
AQ2	25/01/2022	340	100.0%	93.2%	48.5	198.6
AQ3	25/01/2022	340	100.0%	93.2%	34.0	155.8
AQ4	24/01/2022	169	49.5%	46.3%	<u>28.8</u>	126.3
AQ5	24/01/2022	255	74.9%	70.0%	<u>31.1</u>	146.5
AQ6	04/10/2022	88	100.0%	24.2%	<u>30.1</u>	131.0
AQ BG	24/01/2022	341	100.0%	93.5%	15.7	97.8

* Period data capture is from the installation date to 31/12/2022

** Underlined values have been annualised due to having annual data capture below 75%

As indicated above the data capture varies across the sensors, which is due to issues with the power supply to the columns. AQ2, AQ3 and AQBG all had 100% data capture for the period that they were installed, as did AQ6 albeit for a much shorter period owing to the relocation. AQ1 and AQ4, suffered from power supply issues, which also affected AQ5, but to a lesser extent.

The only AQS1 unit that recorded an annual mean NO_2 concentration above 40 $\mu g/m^3$ was AQ2, which is co-located with diffusion tube N_89. Up until 2022, this diffusion tube recorded the highest monitored concentrations on East Mayne. The monitored value of 48.5 µg/m³ even at a height of four meters is notable, and reinforces that annual mean NO_2 concentrations at this location specifically are very high.

The other locations recorded much lower values, which don't necessarily align with the diffusion tube monitoring results, as presented in Table 3-5 below. This discrepancy could be an indication of the canyon effect caused by the warehouse, which will be explored further in this report.

Table 3-5 AQS1 Data Compared With Diffusion Tube (DT) Data At Corresponding Locations

Sensor	DT On Same Column As AQS1	AQS1 Annual Mean (µg/m³) *	DT Annual Mean (µg/m³) *	Difference (µg/m³)	Difference (%)
AQ1 *	N/A	38.0	N/A	N/A	N/A
AQ2	N_89	**48.5**	**50.4**	1.9	4%
AQ3	N_22	34.0	38.9	4.9	14%
AQ4	N_82	28.8	35.3	6.5	23%
AQ5	N_88	31.1	**41.9**	10.8	35%
AQ6	N_83	30.1	**43.5**	13.4	45%
AQ BG	N_96	15.7	14.9	-0.8	-5%

* **Bold** values indicate monitored concentrations greater than 40 µg/m³
** AQ1 is not located on the same lighting column as a diffusion tube

The data in Table 3-5 indicates varying levels of consistency between the AQS1 and diffusion tube results. Whilst diffusion tube monitoring is UKAS [13] accredited and the AQS1 units are not, this in itself is not an indication of good versus poor performance. Monitoring methods that use passive diffusion (such as diffusion tubes) are known to have lower accuracy than automatic analysers, (hence the need for bias adjustment – see section 2.1.1). The AQS1 units on the other hand are relatively new technology, so not as widely tested, but the suppliers (Campbell Associates) have been very impressed by their performance, even likening them to "reference" monitors.

[13] The United Kingdom Accreditation Service assesses organisations that provide certification, testing, inspection and calibration services. Diffusion tubes are sent to labs that are accredited to ISO17025

Sensors AQ2 and AQ BG recorded concentrations very close to the diffusion tube monitoring results, 1.9 µg/m^3 (4%) and 0.8 µg/m^3 (5%) away respectively. There is less alignment between the AQS1 and diffusion tube results at the other sites however. AQ3 is relatively close with a 14% difference and both values being below 40 µg/m^3. AQ5 and AQ6 are much further away from their respective diffusion tube values at 35% and 45% over, with the diffusion tubes monitoring exceedance of Limit Value, but the AQS1 units not.

3.2.2 VivaCity Sensors

The VivaCity sensors on East Mayne, Christopher Martin Road and the A127 were installed at different times due to the availability of traffic management, and issues with power supplies. Once installed, the sensors are validated, a process that can take up to two weeks. As above, a description of each of the sensor locations is provided in Table 2-3 and in. A summary of the data capture for each sensor is provided in Table 3-6.

Table 3-6 Summary of VivaCity Sensor 2022 Data Capture

Sensor	Installation Date	Validation Date	Days With Data	Period Data Capture (%)	Annual Data Capture (%)
VC1	07/12/2021	05/01/2022	339	100.0%	92.9%
VC2	24/02/2022	10/03/2022	338	100.0%	92.6%
VC3	24/02/2022	10/03/2022	134	43.4%	36.7%
VC4	24/02/2022	15/03/2022	290	93.5%	79.5%
VC5	07/12/2021	05/01/2022	338	100.0%	92.6%
VC6	07/12/2021	05/01/2022	339	100.0%	92.9%
VC7a	10/06/2022	06/07/2022	198	100.0%	54.2%
VC7b	10/06/2022	06/07/2022	199	100.0%	54.5%
VC8a	09/06/2022	06/07/2022	199	100.0%	54.5%
VC8b	09/06/2022	06/07/2022	199	100.0%	54.5%
VC9a	11/07/2022	26/07/2022	158	100.0%	43.3%
VC9b	11/07/2022	26/07/2022	158	100.0%	43.3%
VC10a	06/06/2022	19/08/2022	145	100.0%	39.7%
VC10b	06/06/2022	19/08/2022	144	100.0%	39.5%

Table 3-7 provides the one-way data for each individual sensor, with the exception of VC4 as it covers both directions of Christopher Martin Road. Table 3-8 provides the data for pairs of sensors where the pairing is able to give a representative indication of the two-way flow for given sections of road. The values in both tables are presented as Annual Average Daily Traffic (AADT)[14].

Table 3-7 Summary of VivaCity Sensor 2022 Monitoring – One-Way Flows (AADT)

Sensor	One-Way AADT Per Vehicle Type						
	Car	LGV	Bus	Rigid HGVs	Artic. HGVs	M.bike	Total
VC1	16,061	2,791	149	456	180	102	19,738
VC2	11,413	2,161	100	305	205	104	14,289
VC3	11,694	2,073	109	285	220	77	14,459
VC4 *	3,588	375	10	32	7	17	4,028
VC5	16,549	2,938	116	408	258	127	20,396
VC6	15,367	2,668	124	437	230	121	18,947
VC7a	24,587	5,066	82	629	495	130	30,989
VC7b	22,097	4,804	78	566	469	101	28,115
VC8a	24,092	4,505	89	470	326	118	29,600
VC8b	23,739	4,650	90	494	303	117	29,392
VC9a	22,181	4,159	74	480	332	124	27,350
VC9b	22,913	3,921	74	453	288	112	27,761
VC10a	28,449	5,629	55	377	253	168	34,932
VC10b	28,681	5,263	96	354	420	168	34,982
* AADT values for VC4 are two-way data							

[14] DMRB LA105 (Highways England, 2019) defines AADT as "*A description of daily traffic characteristics for the representative average 7 day period (Monday to Friday)*"

Table 3-8 Summary of VivaCity Sensor 2022 Monitoring – Two-Way Flows (Values & Percentages)

Sensors	Vehicle Type						
	Car	LGV	Bus	Rigid HGVs	Artic. HGVs	M.bike	Total AADT
AADT Per Vehicle Type							
VC3+VC2	23,107	4,234	209	591	425	182	28,748
VC1+VC5	32,610	5,728	264	864	438	229	40,135
VC7(a+b)	46,684	9,871	159	1,195	964	231	59,104
VC8(a+b)	47,831	9,154	179	965	629	235	58,992
VC9(a+b)	45,094	8,080	148	932	621	236	55,111
VC10(a+b)	57,130	10,892	151	731	674	336	69,914
Percentage of Total AADT							
VC3+VC2	80.2%	14.9%	0.7%	2.1%	1.5%	0.7%	28,748
VC1+VC5	81.3%	14.3%	0.7%	2.2%	1.1%	0.6%	40,135
VC7(a+b)	79.0%	16.7%	0.3%	2.0%	1.6%	0.4%	59,104
VC8(a+b)	81.1%	15.5%	0.3%	1.6%	1.1%	0.4%	58,992
VC9(a+b)	81.8%	14.7%	0.3%	1.7%	1.1%	0.4%	55,111
VC10(a+b)	81.7%	15.6%	0.2%	1.0%	1.0%	0.5%	69,914

There is a notable difference in total AADT between the sensors to the north and south of Cricketers Way, particularly on the southbound carriageway (VC2 and VC5 respectively). At VC5 south of Cricketers Way, the total AADT is over 6,000 AADT higher than that measured at VC2, likely due to the presence of the large Sainsburys on Cricketers Way. Both sites were installed at the same time and have had good data capture, so the time periods they represent are comparable.

The data captured by VC1 and VC3 would make a good comparison, but unfortunately VC3 has had particularly poor data capture in 2022 (134 days compared to VC1's 339 days) due to power supply issues, so it is not possible to establish if the differences are as a result of the data capture or differences between these two locations.

The tables above indicate that cars are by far the most common vehicle type on the network, as is to be expected. Both the East Mayne sensors (VC1 to VC6) and the A127 sensors (VC7 to VC10) recorded low numbers of buses (which also includes coaches).

Some of the VivaCity sensors also monitor pedestrian and cyclist trips, depending on whether a pedestrian walkway is visible to the sensor. This information is provided in AADT format in Table 3-9.

Table 3-9 Summary of VivaCity Sensor 2022 Monitoring – Pedestrians & Cyclists

Sensor	Pedestrian (One-Way AADT)	Cyclists (One-Way AADT)
VC4	158	17
VC5	60	33
VC6	8	5
VC7a	23	20
VC7b	5	4
VC8a	7	12
VC8b	7	8
VC9a	5	9
VC9b	22	18
VC10a	19	10
VC10b	2	11

VC4 on Christopher Martin Road recorded the greatest average number of pedestrian movements per day with 158.

Monitoring sites VC7 to VC10 on the A127 have very low amounts of pedestrians and cyclists, with site VC9b recording the highest total of 40 pedestrians and cyclists.

3.3 A127 & East Mayne ANPR Survey Results

The results of the 2022 ANPR survey are presented in Figure 3-10 below. Overall, as with previous years the 2022 ANPR fleet appears to have lower numbers of Euro 6 vehicles than the 2022 modelled fleet and the 2022 EFT default fleets. This is likely one of the main causes of differences between the monitored and modelled annual mean NO_2 concentrations across Basildon.

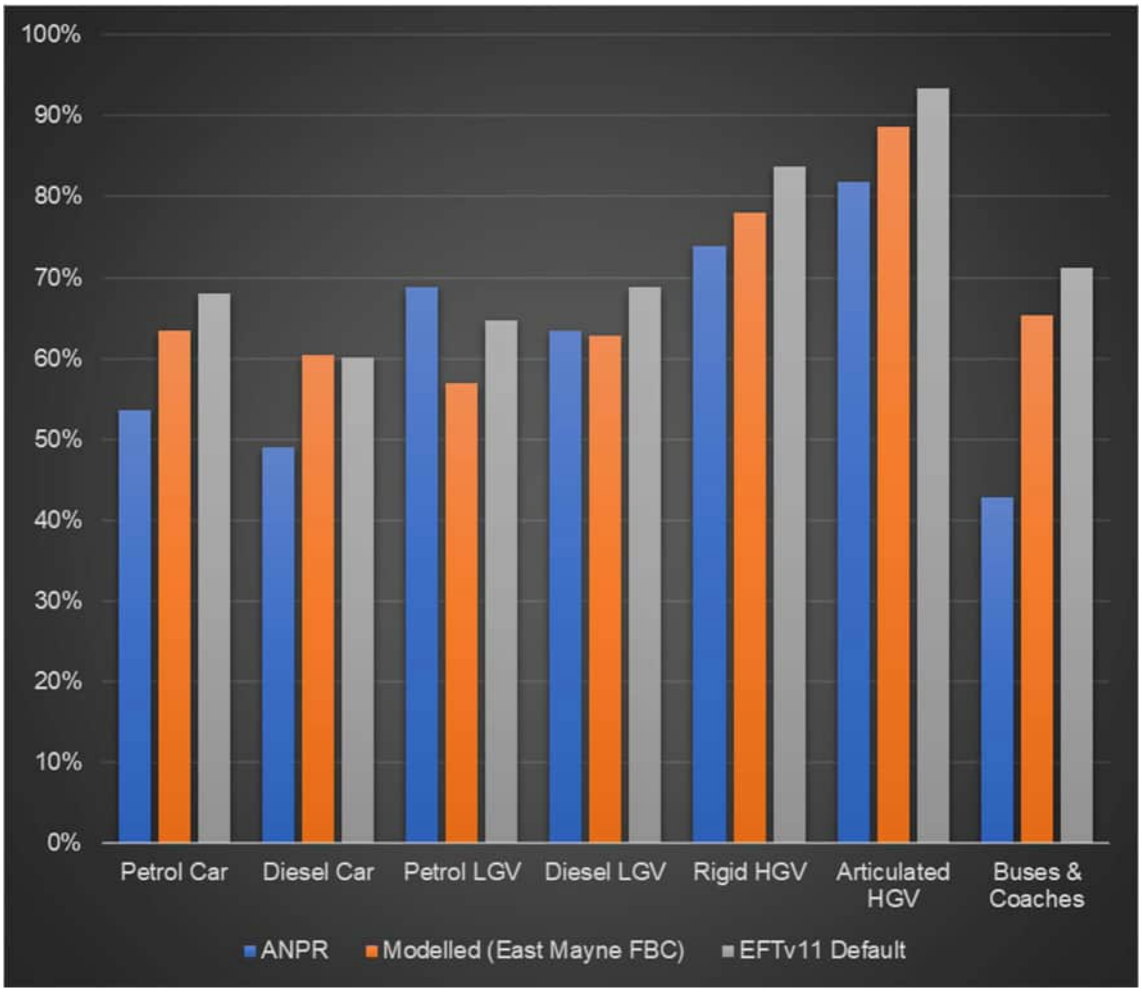


Figure 3-10: Percentage of the Fleet That Is Euro 6 / VI – Comparison of 2022 ANPR with 2022 Modelled Fleet and 2022 EFT v11 Default Fleet

The most prevalent difference is with diesel cars, which make up a large proportion of the vehicle fleet at these locations (cars themselves are approximately 80%). In the 2022 ANPR less than half (49%) of diesel cars were Euro 6, compared to 60% of diesel cars in the modelled fleet and EFT default fleet. This specifically is likely one of the main reasons for the discrepancy between the 2022 modelled and monitored fleets. There are also notably fewer Euro 6 petrol cars in the ANPR, compared with the modelled and EFT fleets, although petrol cars have less of an influence on air quality than diesel cars.

Similarly, in the 2022 ANPR results, the number of Euro VI rigid and articulated HGVs are lower than the modelled fleet (4% and 7% lower respectively), and much lower than the EFT default fleet (10% and 11% lower respectively). For buses too, there are much fewer Euro VI's in the ANPR results than the modelled and EFT default fleets, although they make up a much smaller portion of the overall fleet. It's worth noting that source apportionment has been previously reported to understand the contribution of emission from different vehicle categories to the total road contribution.

3.4 Fortune of War Junction Modelling Results

The results of the Fortune of War junction modelling assessment are presented in Table 3-10 below:

Table 3-10 Summary of AQS1 Monitored NO_2 Data

Receptor	2022 Monitored NO_2 (µg/m^3)	2022 DM Modelled NO_2 (µg/m^3)	2022 DS Modelled NO_2 (µg/m^3)	Difference (DS-DM) (µg/m^3)	Change As % Of Road NO_2 (%) *
O_5	49.3	51.2	37.7	-13.4	-37%
O_75	34.7	36.5	35.4	-1.2	-5%
N_38	38.2	36.4	35.7	-0.7	-3%
N_39	58.4	56.9	41.0	-15.9	-35%
* Road NO_2 was calculated as the total NO_2 concentration minus the background value. In this case the 2022 NO_2 concentration of 12.5 µg/m^3 was used, which was monitored at the background site O_83					

The results show that 'straightening out' the Fortune of War significantly reduces annual mean NO_2 concentrations at the receptors on the northern side of the road (O_5 and N_39) where the high emission acceleration event is replaced with free-flowing traffic. In this 2022 scenario, concentrations at N_39 (the monitoring site with the highest NO_2 concentrations across Basildon) are reduced from the modelled value of 56.9 µg/m^3 in the DM scenario to 41.0 µg/m^3 in the DS scenario. Whilst this concentration does still exceed the Limit Value, this will likely decrease to below 40 µg/m^3 within a couple of years due to 'natural' improvements to the vehicle fleet.

On the south side of the road, there are much smaller improvements in NO_2 concentrations at this location. This is due to the low emission deceleration event approaching the junction being replaced with free flowing traffic, which has higher emissions associated. This small improvement indicates that the benefit of removing the acceleration event outweighs any negative impacts associated with removing the deceleration event.

It should be noted that this is a hypothetical scenario whereby the scheme was in place for the whole of 2022. In reality the scheme is unlikely to be able to be delivered before 2026, but the values in Table 3-10 provide an indication of the sort of improvements in annual mean NO_2 concentrations that can be expected at these specific monitoring sites. In addition, the test does not account for traffic responding to other traffic calming aspects incorporated into new design.

4 Discussion Of Results

The Analysis & Discussions section has been split into 3 parts based on the data available and techniques used:

- Section 4.1 Trend Analysis & Update To Natural Success Years will provide an update on the anticipated success years associated with each hotspot location. This will be based on trend analysis of available diffusion tube data.
- Section 4.2 East Mayne details the outcomes of the analysis using data from the AQS1 sensors, VivaCity sensors, diffusion tube monitoring and other data sources
- Section 4.3 Fortune of War details the outcomes of the modelling assessment including the potential impact that it would have on success years
- Section 4.4 Other Monitoring Locations on the A127 will detail the outcomes of analysis on the A127 itself, excluding the Fortune of War location, which will already have been covered.

4.1 Trend Analysis & Update To Natural Success Years

The assessment works undertaken as part of both the Speed Management OBC / FBC and East Mayne OBC / FBC included calculation of potential success years across Basildon. As presented in Table 3-1, a range of success years were calculated based on the different traffic models and areas. The success year based on the modelling that was calculated to be furthest in the future was 2023. This used traffic data from the Strategic Transport Model and resulted in East Mayne being the latest anticipated location to achieve success across Basildon.

As presented in the sections above, success was not achieved in 2022, and the magnitude of the exceedances indicates that success is very unlikely to be achieved in 2023 either. Consequently, it is necessary to establish when NO_2 concentrations are anticipated to naturally drop below 40 μg/m^3. The outcomes of the trend analysis undertaken are presented in Table 4-1. The trend units are μg/m^3 hence, the larger the number the greater reduction in NO_2 is predicted year on year for any given monitoring site according to the trend being applied. As discussed in Section 2.1.2, trends were calculated three separate ways for monitoring sites in each hotspot and then used to extrapolate the monitored concentrations forwards to give anticipated success years. Note that only Primary (reportable) sites were used in this analysis.

Table 4-1 Summary of Trend Analysis & Projected Success Years

Hotspot	Site Used To Calculate Trend	1) Total Monitored NO_2		2) Road NO_2		3) Trend from Background Site O_83	
		Trend	Succ. Year	Trend	Succ. Year	Trend	Succ. Year
1	N_1	-5.6	2024	-4.3	2024	-1.3	2029
2	N_39	-2.9	2029	-1.6	2034	-1.3	2036
3a	N_72	-4.3	2024	-3.0	2025	-1.3	2029
3b	N_35	-2.1	2025	-0.8	2028	-1.3	2026
4	O_14	-4.5	2023	-3.2	2023	-1.3	2024
5 *	N_89	-2.0	2027	-0.7	2036	-1.3	2030
5 *	N_29	0.1	N/A - Slope is Positive	1.4	N/A - Slope is Positive	-1.3	2031

* Two sites are provided for hotspot 5. As of 2022, N_29 is the site driving success at this hotspot, but as the trend is positive using two of the methods, it is not possible to extrapolate a success year for this monitoring site. N_89 has been included to provide an indication of when concentrations may reduce to below 40 µg/m³ at hotspot 5.

The key takeaway from Table 4-1 is that without intervention, annual mean NO_2 concentrations at monitoring locations across Basildon will naturally reduce to below 40 µg/m³ between 2029 and 2036, if the anticipated trends persist.

Currently site N_39 (near the FoW junction) is anticipated to be the last monitoring site across Basildon that will reduce to below 40 µg/m³, due to having the highest recorded annual mean NO_2 concentration (58.4 µg/m³). However, the analysis indicates a downward trend of between 1.6 µg/m³ and 2.9 µg/m³ per year at this location, which are both greater year on year improvements than projected at both N_29 and N_89 on East Mayne. It is possible that N_29 will supersede site N_39 as the site(s) driving Basildon's success. Consequently, these two locations (adjacent to the eastbound carriageway of the A127 east of the Fortune of War junction, and East Mayne) should remain the focus of any works to improve annual mean NO_2 concentrations across Basildon.

It should be noted that the trend analysis presented does not account for changes in policy such as the ban on the sale of new petrol and diesel only engined vehicles in 2035, which would likely bring the success year forwards.

Furthermore, the trend analysis is complicated by 2020 and 2021 recorded concentrations being heavily impacted by the reduced traffic flows associated with COVID-19 lockdowns. As more monitoring data is captured and the trend analysis updated, the projections will likely become more reliable. However, for now there is an unknown level of uncertainty associated with the projected success years.

4.2 East Mayne

The analysis of the East Mayne monitoring has used inputs from all the data sources detailed in the sections above where possible. In relation to the partial dependency plots, where the calculated influence is under 5%, these variables are considered to have a negligible impact on NO_2 concentrations compared to other variables. These are not shown in the sections below but will be provided in Appendix F.

To avoid repetition due to similarities in the analysis of the different sites, a summary of the analysis of the East Mayne data that was undertaken is presented below, and will discuss the findings at specific sites, as well as some general commentary. Findings at the following sites will be discussed in more detail:

- AQ2 – this is the same location as diffusion tube N_89 and represented the worst case locations on the west side of the road, adjacent to the north bound carriageway between Paycocke Road and Cricketers Way;
- AQ6 – located on the same column as N_83, but is in a similar location to N_29 and is considered to be representative of monitoring on the east side of East Mayne, adjacent to the south bound carriageway between Cricketers Way and Paycocke Road; and
- AQ5 – located on the same column as diffusion tube N_88 and considered representative of the south bound carriageway between the A127 and Cricketers Way.

The remaining AQS1 monitoring locations have not been discussed in detail as the diffusion tubes that the sensors are co-located with all recorded annual mean NO_2 concentrations below 40 $\mu g/m^3$. However, the partial dependency plots and polar plots produced for each are presented in Appendix F.

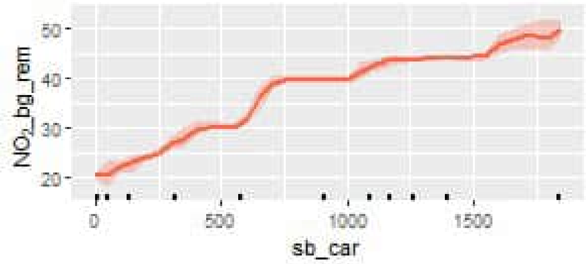
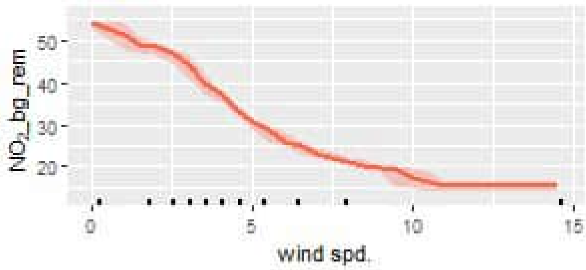
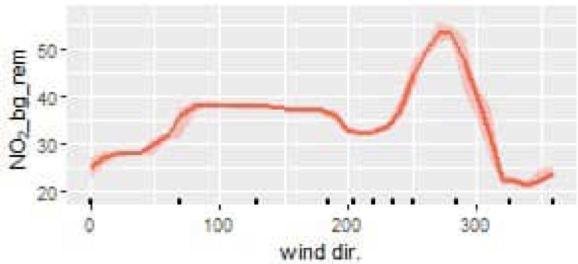
Figure 4-1 presents the polar plots for all sensors in the context of East Mayne.

Figure 4-1 Polar Plot for All AQS1 Sensors on East Mayne

4.2.1 AQ2

Diffusion tube N_89 has recorded annual mean NO_2 concentrations above 40 µg/m^3 consistently since monitoring began at this location in 2019. Consequently, it is important to understand what causes the elevated concentrations at this location in particular, which the VivaCity and AQS1 sensors have helped to achieve. Table 4-2 presents the partial dependency plots that have used hourly inputs from AQ2 (on the same column as N_89), traffic data from VC1 (north bound traffic) and VC5 (south bound traffic) and local meteorological data. AQ2's polar plot is show in Figure 4-2.

Table 4-2 Partial Dependency Plots – AQ2

Variable	Influence	Plot
South Bound Car Flow	28.8%	
Wind Speed	21.2%	
Wind Direction	20.7%	

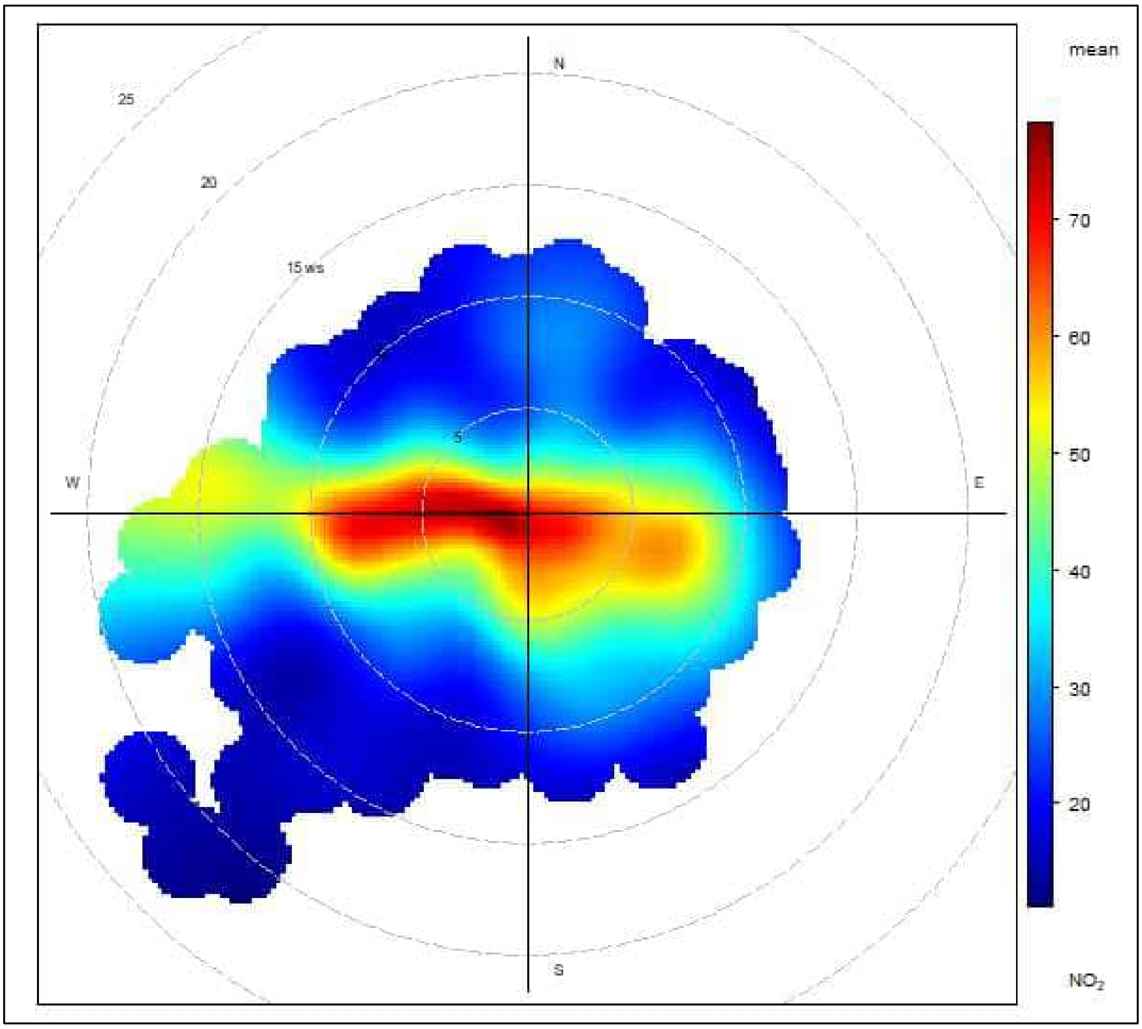


Figure 4-2 Polar Plot for AQ2. The plot shows the intensity of NO_2 at the monitoring site for a given wind speed and direction.

The variable with the greatest influence at AQ2 is the southbound car flow. As previously detailed in Table 3-7, the recorded AADT on the southbound link is approximately 20,347, compared to 19,748 in the northbound direction. The southbound traffic is likely to be accelerating harshly away from the junction with Cricketer's Way, whereas the northbound traffic at this location is far more likely to be decelerating on the approach to the junction. Acceleration events produce higher NO_x emissions than deceleration, events resulting in higher NO_2 concentrations at local receptors. This is further evidenced by the polar plot shown in Figure 4-2 where there is large contribution of NO_2 coming from the east of the site although the NO_X contribution from this direction should in theory be low if we were to assume that the contribution is from the north bound decelerating traffic.

Table 4-2 and Figure 4-2 indicate that concentrations of NO_2 increase when the wind is between 80 (from the east) and 280 degrees (from the west). When this is triangulated with the polar plots of other monitors (AQ4 and AQ6 – see Appendix F), the source appears to be strongly correlated to the short stretch of road between AQ4 and AQ6, where harsh acceleration events are likely to occur.

The plots in Table 4-2 also indicate that both wind speed and direction are particularly influential with regards to NO_2 concentrations. It indicates that on average NO_2 concentrations are greatest when the wind speeds are low, owing to the reduced pollutant dispersion. Table 4-2 also indicates that the greatest concentrations generally occur when the wind is from approximately 275 degrees (i.e. the west). This is further evidenced in the polar plot in Figure 4-2, which indicates that the high concentrations occur with westerly winds of between 0 and 10 m/s. Similarly, easterly winds also result in elevated NO_2 concentrations, although to a lesser extent.

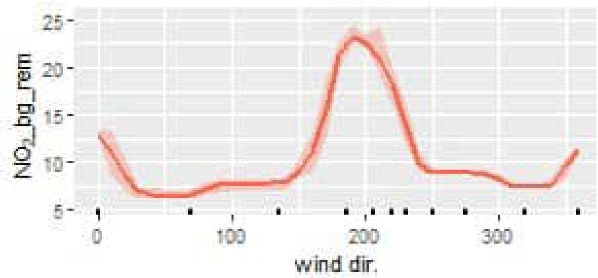
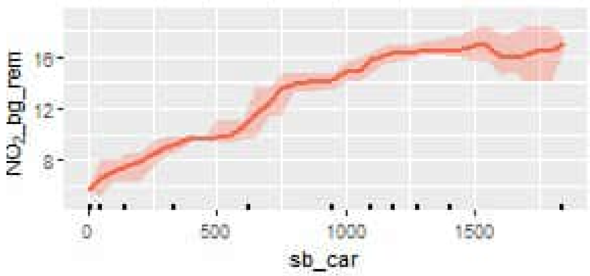
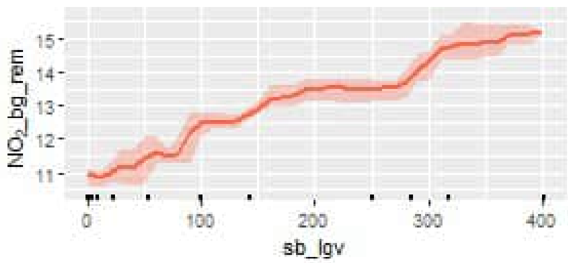
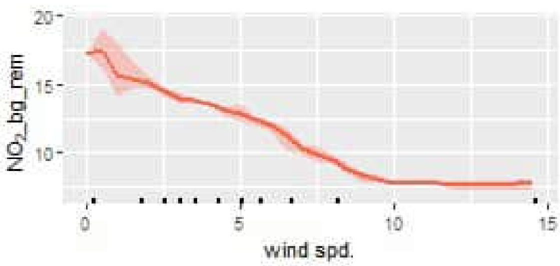
The factors detailed above indicate that a canyon effect is very important at this location. Under normal dispersion characteristics it would likely be the emission source closest to the monitor (i.e. the northbound traffic) that would have the greatest influence on northbound NO_2 concentrations. That the wind speed and direction are almost as influential is further evidence of the impact of the canyon at this location. The westerly winds are being impeded by the large warehouses to the west of East Mayne, with the warehouses causing an element of "recirculation", which is a key characteristic of the canyon effect. These circumstances reduce dispersion at this location and as a result increase monitored pollutant concentrations. Furthermore, the warehouses may be preventing pollutant dispersion when easterly winds occur, thus further increasing NO_2 concentrations at AQ2.

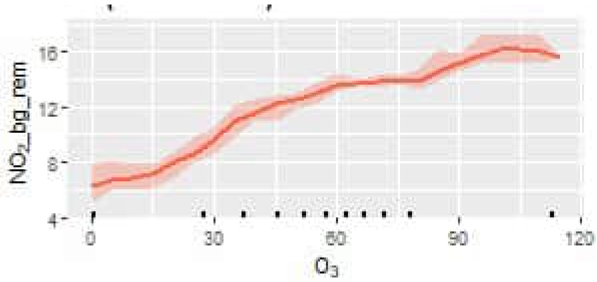
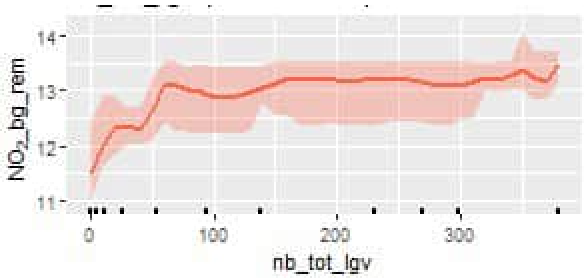
It should be noted that road speed at this location is also found not to be of great importance in the variation of air quality concentrations, which suggests that the average speed metric is not the best variable to provide an indication on traffic conditions.

4.2.2 AQ6

AQ6 is located on the same column as diffusion tube N_83, which has recorded annual mean NO_2 concentrations greater than 40 µg/m^3 since it's installation in 2019. Diffusion tube N_29 is located approximate 58 m to the south in a similar location. This site recorded the highest annual mean NO_2 concentration on East Mayne in 2022, overtaking site N_89. Given the proximity, conclusions drawn from the analysis of data at site AQ6 are considered representative of and applicable to N_29. Table 4-3 resents the partial dependency plots that have used hourly inputs from AQ6, VC1 (north bound traffic), VC5 (south bound traffic) and local meteorological data. AQ6's polar plot is also show in Figure 4-3.

Table 4-3 Partial Dependency Plots – AQ6

Variable	Influence	Plot
Wind Direction	31.0%	
South Bound Car Flow	23.9%	
South Bound LGVs	6.9%	
Wind Speed	6.2%	

Variable	Influence	Plot
Ozone Concentration	5.6%	
North Bound LGV Flow	5.2%	

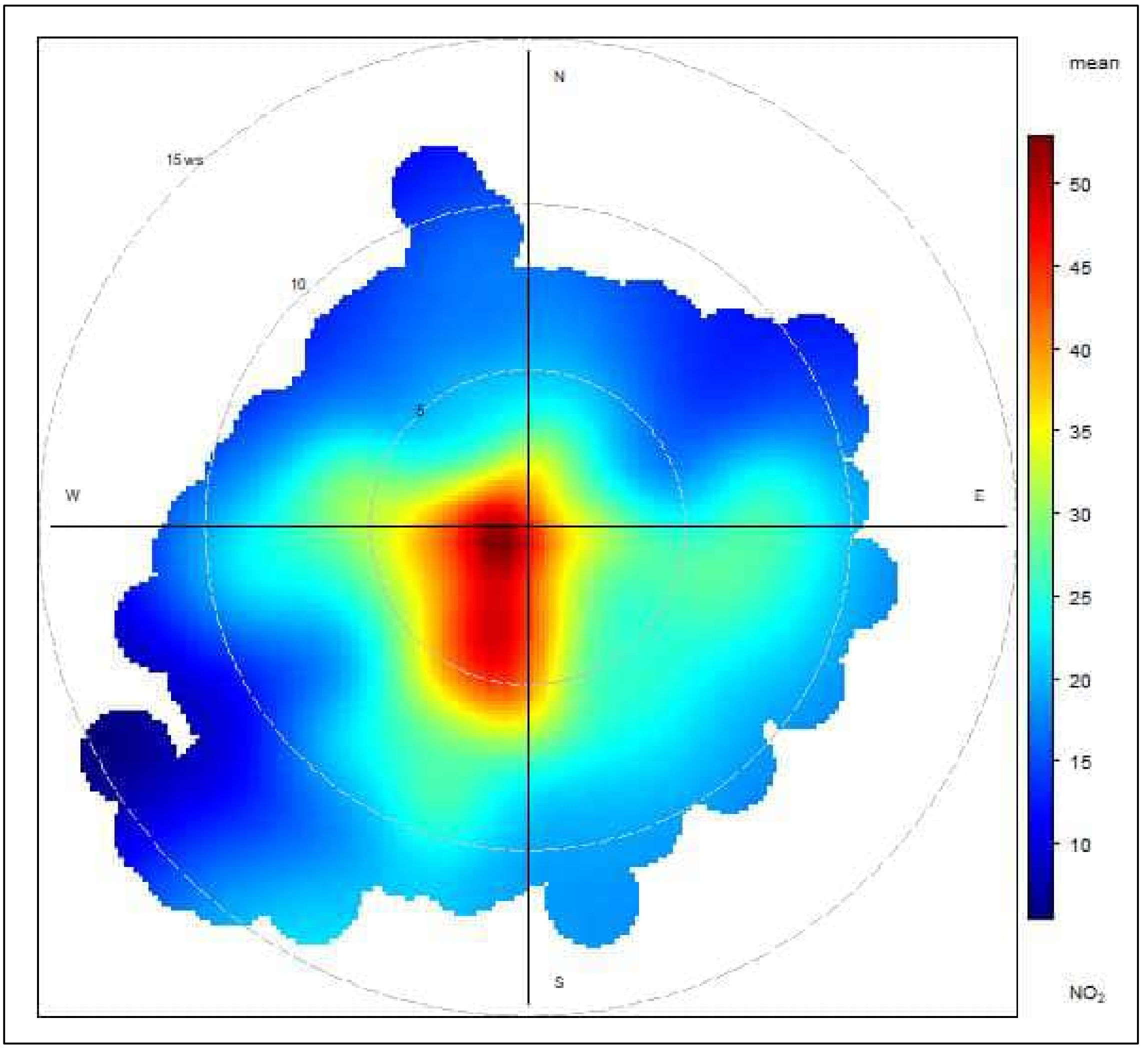


Figure 4-3 Polar Plot for AQ6

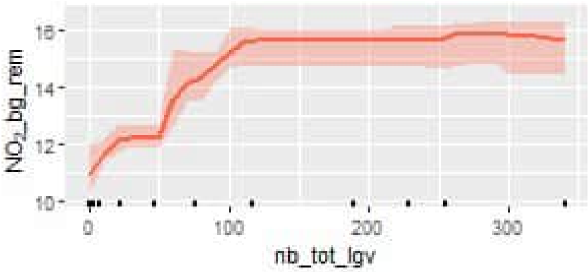
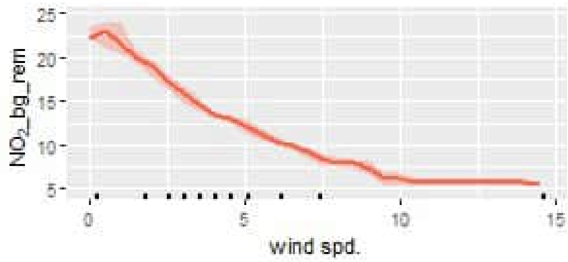
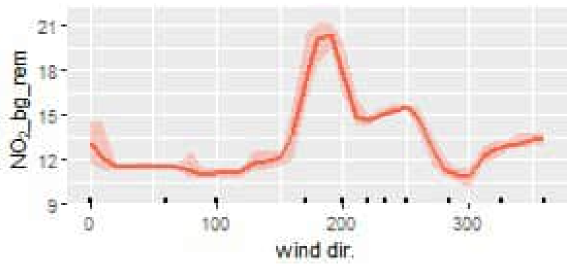
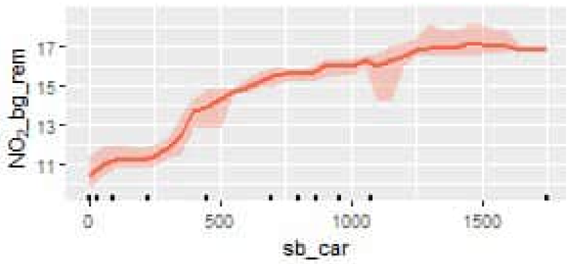
The variability in NO_2 concentrations at this location are dominated by wind direction (31.0%) and southbound car flow (23.9%). The polar plot and partial dependency plots clearly demonstrate the relationship between these, with a notable contribution coming from approximately 200 degrees (south southwest), which correlates with the acceleration event immediately to the south of Cricketers Way.

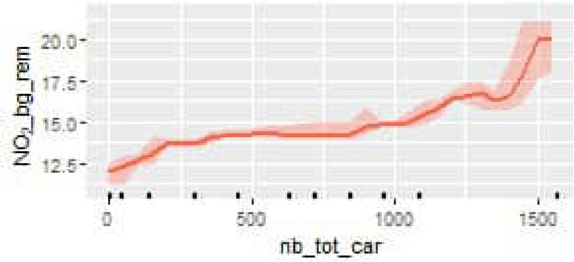
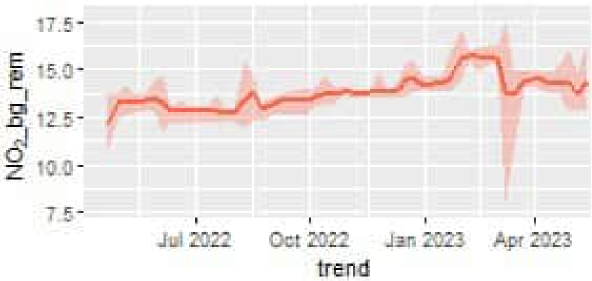
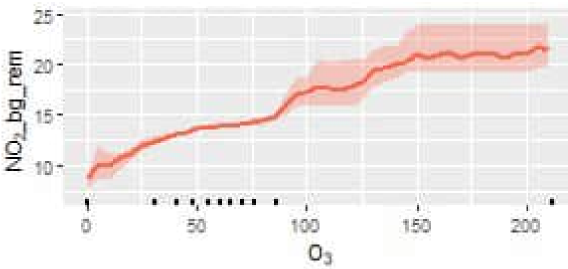
In addition to the acceleration away from Cricketers Way, diffusion tube N_29 is likely also being affected by traffic accelerating away from Paycocke Road. Given its proximity to the Paycocke Road junction (~40 m) compared to AQ6's proximity (~80 m) it is likely that this would be having a greater impact on NO_2 concentrations at N_29 than AQ6 / N_83.

4.2.3 AQ5

Diffusion tube N_88 is consistently recorded annual mean NO_2 concentrations greater than 40 µg/m^3 since monitoring began at this location in 2019. Even accounting for reduced concentrations in 2020 and 2021 to some extent, this site has shown a downward trend from 49.4 µg/m^3 in 2019 to 41.9 µg/m^3 in 2022. N_88 is co-located with the AQS1 sensor AQ5. Table 4-4 presents the partial dependency plots that have used hourly inputs from AQ5, VC3 (north bound traffic), VC2 (south bound traffic) and local meteorological data. AQ2's polar plot is shown in Figure 4-4.

Table 4-4 Partial Dependency Plots – AQ5

Variable	Influence	Plot
North Bound LGV Flow	15.8%	
Wind Speed	15.1%	
Wind Direction	12.8%	
South Bound Car	11.9%	

Variable	Influence	Plot
North Bound Car Flow	5.6%	
Trend	5.5%	
Ozone	5.1%	

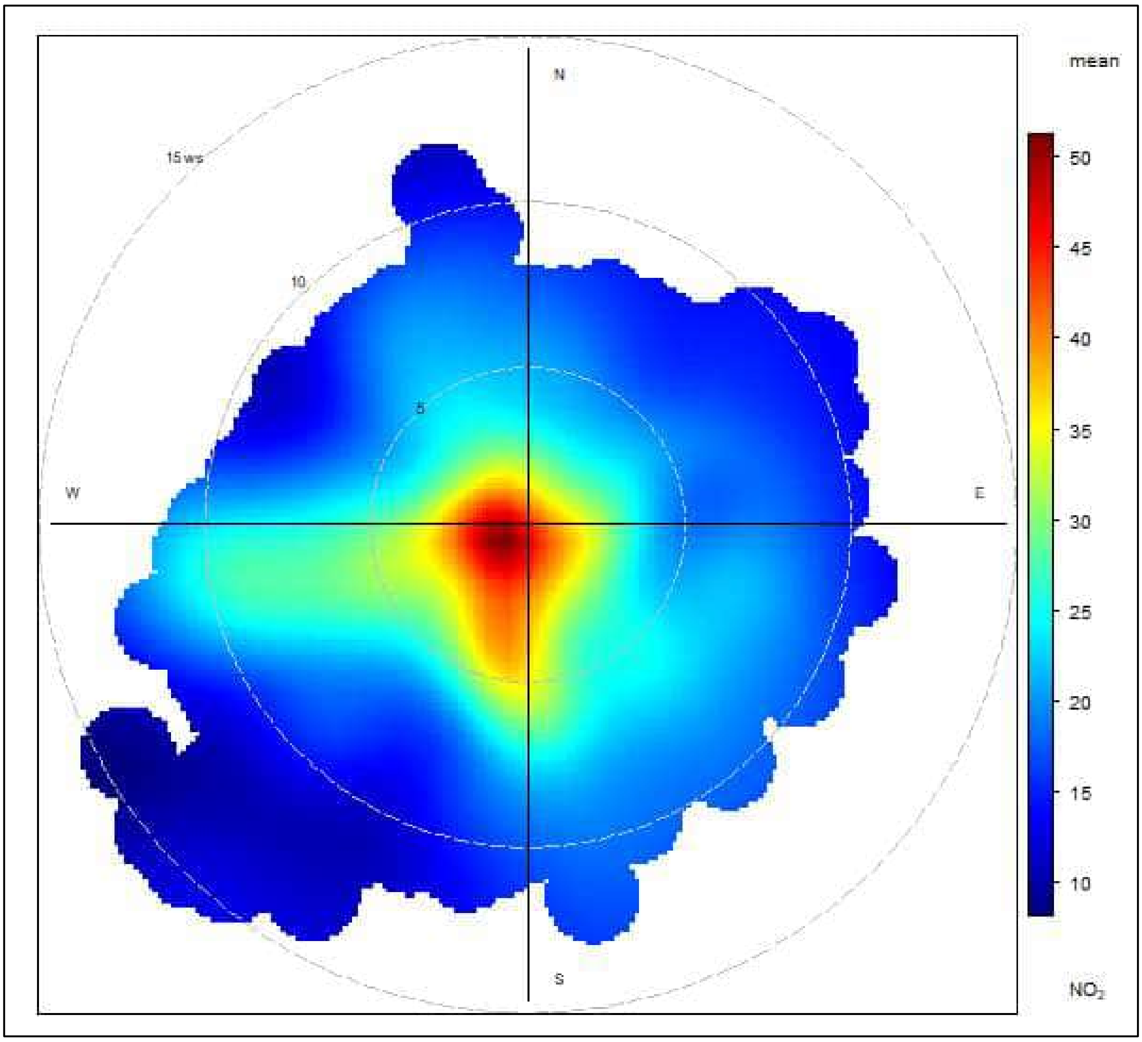


Figure 4-4 Polar Plot for AQ5

Overall, the partial dependency plot indicates that there are seven different factors with calculated influence values greater than 5%, ranging up to 15.8%. This maximum value is much lower than the maximum influence values calculated for AQ2 (28.8%) and AQ6 (31.0%). This indicates that NO_2 concentrations at sensor AQ5 are being influenced by a wider range of factors, rather than just one or two particularly dominant factors.

There are three vehicle flow related factors with notable influence at this site; the north bound LGV flow (15.8%), south bound car flow (11.9%) and north bound car flow (5.6%). Contrary to the other sites explored so far, the factor with the highest influence at AQ5 is the north bound LGV flow. The VivaCity sensor on both carriageways recorded similar car and LGV flows, so the high influence of the north bound LGV flows is of particular interest. One possible explanation for this, is the presence of queueing on the northbound carriageway. Compared to cars, LGVs are more likely to be diesel powered, less likely to have stop/start technology, and generally weigh more which puts the engine under a higher load. These factors would all likely to lead to proportionally greater NO_x emissions from LGVs compared to cars.

Contrary to the other sites explored so far, the factor with the highest influence at AQ5 is the north bound LGV flow, calculated at 15.8%. It's worth noting that shading either side of the dependency plots indicate the level of uncertainty. Wind speed will always be a key variable in terms of whether emissions reach specific receptors and so the shading around uncertainty for this parameter is consistently narrow.

4.2.4 Summary

Overall, there are a wider range of causes of elevated annual mean NO_2 concentrations than previously anticipated. The two elements causing the highest concentrations appear to be the canyon effect caused by the warehouses on the west side of East Mayne, and the road traffic acceleration events southbound caused by the Cricketer's Way junction.

4.3 Monitoring in the Vicinity of the Fortune of War Junction

Monitoring site N_39 is driving success against the Limit Value across Basildon, as it has consistently recorded the highest annual mean NO_2 concentrations since 2019. The other two primary exceedance locations in Hotspot 2 are O_5 and O_7, which recorded annual mean NO_2 concentrations of 49.3 and 46.8 $\mu g/m^3$ in 2022 respectively. Whilst not as high N_39's 58.4 $\mu g/m^3$, these are still high concentrations, which are unlikely to reduce to below the Limit Value in the near future without intervention.

A key contribution to the high annual mean NO_2 concentrations at this location is the acceleration event away from the Fortune of War Junction. Acceleration events put a greater load on the engine, resulting in significantly higher emissions than might be expected from 'free-flowing' sections of road. This is a very similar situation to the acceleration event on East Mayne just on a larger scale given the higher vehicle flows and recorded concentrations, and so similar conclusions can likely be drawn here.

The modelling assessment undertaken indicated that 'straightening out' the Fortune of War junction would significantly reduce annual mean NO_2 concentrations at local monitoring sites, in particular N_39. In the theoretical assessment scenario where the scheme was implemented in 2022, concentrations below the Limit Value were very nearly achieved. By a more realistic opening year of 2026, there would be sufficient fleet improvements so that with the scheme in place, annual mean NO_2 concentrations would likely be below the Limit Value. This seems like a viable option from a purely air quality related perspective, but additional assessments, including further detailed air quality modelling should be undertaken to confirm this, and any other benefits resulting from the scheme.

Another possibility is that the vegetation is influencing and potentially limiting dispersion at this location. This location (and a number of others along the A127) have tall, dense foliage growing at varying distances back from the monitoring locations, particularly during the spring and summer months. This vegetation could be acting similarly to the presence of a building and creating a barrier preventing the pollutants escaping the roadside, and potentially also by funnelling the pollutant concentrations further along the roadside, rather than helping them to disperse. The latter could explain the elevated concentrations at O_7, which is much further from the Fortune of War junction than N_39.

Overall, whilst the high traffic flows are the main cause of high pollutant concentrations at this location, there are clearly microclimate effects that exacerbate the situation, such as the acceleration event and presence of dense vegetation. One potential solution would be to 'straighten out' the Fortune of War junction thereby tempering the acceleration event.

4.4 Other Monitoring Locations on / near the A127

The remaining hotspot locations share a number of similarities both with each other, and with those that have already been discussed. For 2022, these hotspots each contained one primary reportable monitoring location that recorded a concentration greater than 40 $\mu g/m^3$. The hotspots and their highest recorded concentrations are provided below:

- Hotspot 1 A127 between West Mayne and Fortune of War – N_1 with 48.6 $\mu g/m^3$
- Hotspot 3a A127 near Upper Mayne – N_72 with 48.9 $\mu g/m^3$
- Hotspot 3b Upper Mayne below the A127 – N_35 with 45.0 $\mu g/m^3$
- Hotspot 4 A127 between Pipps Hill Road North and Gardiners Lane North – 42.4 $\mu g/m^3$

Of these, hotspot 3a recorded the highest 2022 NO_2 concentration, at site N_72 with 48.9 $\mu g/m^3$. It is located adjacent to the east bound off slip onto Upper Mayne, and interestingly the diffusion tube directly opposite on the north side of the road (site N_71) recorded a concentration of just 28.1 $\mu g/m^3$ in 2022. Since

2019, site N_71's recorded concentrations have been consistently approximately 20 μg/m^3 lower than N_72's every year, implying that the cause of the elevated concentrations on the south side of the road are localised to that side. Upon review of this location, vegetation again seems likely to be the cause of the elevated concentrations here. To the north of the road is a lot of open space allowing dispersion of pollutants. The south side of the road on the other hand has dense foliage growing high only a few meters back from the roadside. It is very likely that this limiting the dispersion at this location.

Owing to its proximity, the main source of emissions resulting in elevated concentrations (45.0 μg/m^3 at N_35) at hotspot 3b is likely traffic on the A127, potentially more so than traffic on Upper Mayne itself. However, it may be that the air quality issues here are exacerbated by the topography. Upper Mayne goes under the A127 at this location, creating a 'bowl' and being more sheltered from the wind, thus reducing dispersion. Acceleration away from the roundabouts at either end of this section of Upper Mayne likely also contribute to the elevated concentrations. Site N_78 is located opposite site N_35 on the other side of the road, and records similar NO_2 concentrations each year. These sites are both close to the A127 and further down the slope (i.e. more sheltered), both of which would lead to elevated recorded concentrations. Site N_36 on the other hand is located close towards the southern roundabout, so is both further from the A127 and less in the 'bowl' than the other two sites. Consequently, this site's recorded concentrations have been below 40 μg/m^3 since 2019.

With Hotspot 1, again it is clear that high volumes of traffic are clearly the main source of emissions. At this location, it appears that emissions are being exacerbated by the presence of an uphill gradient in the east bound direction. From west to east, monitoring sites N_1, O_1 and N_2 are all located on the north side of the road at intervals of ~200 m then ~250 m. Their 2022 monitored concentrations were 48.6, 36.4 and 32.5 μg/m^3 respectively. Review of LIDAR data indicates that there is approximately a 2.1% gradient adjacent to site N_1, whereas the gradients adjacent to O_1 and N_2 are approximately -0.2% and -0.4% (i.e. downhill eastbound). For this volume of traffic, a 2.1% gradient could have a notable effect on engine load and NO_x emissions, potentially explaining the elevated concentration at site N_1.

Hotspot 4 is another location where concentrations are notably higher on the north side of the road at site O_14 (42.4 μg/m^3 in 2022) compared to O_64 (31.2 μg/m^3), which is directly opposite on the south side of the road. One reason for this could be placement, as O_64 is located approximately 7.5 m back from the main carriageway, owing to the presence of the on slip at this location. With the business park set behind it however, the area around O_64 is generally more open, allowing for better dispersion. On the north side of the road, behind site O_14 there is relatively dense vegetation, which may be limiting dispersion and potentially funnelling emissions along the roadside.

5 Summary

Essex Highways have been undertaking diffusion tube monitoring across Basildon since 2018. Since then, additional air quality and traffic sensors have been installed to aid in the monitoring and evaluation of the success of both the speed management scheme on the A127, and the removal of the central reservation pedestrian walkway on East Mayne.

Monitoring in 2022 indicated that there are six hotspot locations where annual mean NO_2 concentrations were greater than 40 µg/m^3. These are summarised in Table 5-1, alongside what are considered to be the key issues for each site, in addition to high volumes of traffic.

Table 5-1 Summary of Air Quality Hotspots & Assessment Findings

Hotspot	Location	Highest Primary Reportable Monitored NO_2 Conc. And Site ID (µg/m^3)	Key Causes of Elevated Concentrations	Anticipated Success Year Range
1	A127	48.6 (N_1)	Gradient	2024-2029
2	A127	58.4 (N_39)	Acceleration event Vegetation?	2029-2036
3a	A127	48.9 (N_72)	Vegetation?	2024-2029
3b	Upper Mayne	45.0 (N_35)	Topography ('bowl') Acceleration events	2025-2028
4	A127	42.4 (O_14)	Vegetation?	2027-2036
5	East Mayne	50.4 (N_89)	Canyon effect (warehouses) Acceleration events	2027-2036

In 2022, there were ten primary reportable monitored exceedances of the Limit Value.

Trend analysis was undertaken to provide an update to previously calculated 'success years' undertaken as part of the FBC. Depending on the methodology, it is anticipated that all monitoring across Basildon would be below 40 µg/m^3 by between 2029 and 2036.

Detailed air quality modelling was undertaken in the vicinity of the Fortune of War junction to establish if the proposed scheme to 'straighten out' this section of road could improve air quality in this area. The modelling indicated improvement in annual mean NO_2 concentrations at key monitoring locations (e.g. N_39). The analysis suggested that NO_2 annual mean concentrations could reduce to below 40 μg/m^3 in the first full opening year of the scheme.

Appendix A: Essex Highways Monitoring Results 2018-2022

Table A1: Essex Highways 2018, to 2022 Annual Mean NO_2 Results (Bias Adjusted and Annualised Where Required)

"D" = Monitoring site was decommissioned in that year before sufficient monitoring was undertaken to allow annualisation (see section 2.2). Where a number is presented in brackets, this is the annualised concentration (only available with 3 or more months of data)

"NM" = Monitoring site was decommissioned in a previous year

"LDC" = Less than 3 months' worth of data for that year so annualisation couldn't be undertaken

Site ID	Coordinates (BNG – X, Y)	Local Authority	2018 Annual Mean NO_2 Conc. (µg/m³)	2018 Months With Monitoring Data	2019 Annual Mean NO_2 Conc. (µg/m³)	2019 Months With Monitoring Data	2020 Annual Mean NO_2 Conc. (µg/m³)	2020 Months With Monitoring Data	2021 Annual Mean NO_2 Conc. (µg/m³)	2021 Months With Monitoring Data	2022 Annual Mean NO_2 Conc. (µg/m³)	2022 Months With Monitoring Data
O_1	567230, 190222	Basildon	45.8	10	44.3	7	43.3	7	38.0	12	36.4	12
O_2	567820, 190082	Basildon	40.7	10	35.5	7	34.6	7	30.7	12	31.7	12
O_3	568210, 190254	Basildon	27.6	10	23.4	7	22.5	6	D	1	NM	0
O_4	568212, 190241	Basildon	24.2	9	24.4	7	23.6	6	D	0	NM	0
O_5	568193, 190026	Basildon	65.5	10	54.0	7	50.5	6	53.1	11	49.3	11
O_6	568487, 190037	Basildon	60.3	9	55.1	7	53.0	6	51.6	12	47.1	12
O_7	568572, 190039	Basildon	63.7	9	61.8	6	47.8	7	51.0	12	46.8	12
O_8	569018, 190087	Basildon	64.9	10	51.3	7	40.7	7	42.0	12	41.6	10
V_9	568665, 190338	Basildon	23.5	10	22.1	7	19.6	6	D	1	NM	0
V_10	568673, 190359	Basildon	32.2	10	33.3	10	26.6	7	D	1	NM	0
O_11	569381, 190192	Basildon	D (48.0)	8	NM	0	NM	0	NM	0	NM	0
V_12	570656, 190661	Basildon	31.4	10	35.2	9	26.0	7	22.8	12	22.0	12
O_13	571512, 190978	Basildon	49.1	10	44.1	7	39.8	6	38.1	12	38.1	12
O_14	571896, 191043	Basildon	56.4	10	53.7	7	55.7	6	45.0	12	42.4	12
V_15	573676, 191153	Basildon	39.8	10	42.3	10	30.1	12	27.4	12	26.4	12
O_16	574668, 190971	Basildon	35.8	10	35.0	7	33.5	7	29.7	12	28.9	12
V_17	575778, 190938	Basildon	32.6	9	34.4	10	26.3	7	23.0	11	22.7	11
O_18	577262, 190794	Basildon	D (42.7)	9	NM	0	NM	0	NM	0	NM	0
V_19_FG3	577845, 190842	Rochford	35.9	10	39.2	10	31.3	7	28.0	12	27.6	12
O_20	578410, 191869	Rochford	39.5	10	33.6	7	27.0	3	D	1	NM	0
O_21	579157, 190170	Castle Point	56.9	7	34.3	3	46.2	5	D	1	NM	0
O_22	579692, 189737	Rochford	80.3	9	75.5	6	73.2	6	D	1	NM	0
O_23	579791, 189732	Rochford	62.0	10	51.9	7	49.9	7	D	1	NM	0

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O_24	580098, 189709	Rochford	33.0	10	32.1	7	29.5	7	D	1	NM	0
O_25	580197, 189757	Rochford	31.9	10	29.2	6	27.5	7	D	1	NM	0
O_26	580215, 189746	Rochford	33.1	10	28.7	5	27.5	4	D	1	NM	0
O_27	580157, 190020	Rochford	35.6	9	29.9	5	31.4	5	D	1	NM	0
O_28	580169, 190030	Rochford	22.7	10	19.3	4	20.2	3	D	1	NM	0
O_29	580140, 189680	Castle Point	45.5	10	38.0	6	34.9	7	D	1	NM	0
O_30	580209, 189672	Rochford	49.3	10	42.6	7	45.0	7	D	1	NM	0
O_31	580285, 189684	Rochford	46.5	8	36.6	5	30.4	5	D	1	NM	0
O_32	580361, 189675	Rochford	37.4	10	33.3	6	31.5	7	D	1	NM	0
O_33	580687, 189626	Rochford	43.1	10	35.3	7	36.8	6	D	1	NM	0
O_34	580825, 189608	Rochford	42.6	10	38.5	7	35.0	7	D	1	NM	0
V_35	581783, 189339	Rochford	30.4	9	27.7	10	21.6	5	D	1	NM	0
O_36	582037, 189231	Rochford	33.0	10	30.8	7	28.8	7	D	0	NM	0
O_37	582588, 189028	Southend-on-Sea	30.9	10	29.3	6	30.5	6	D	1	NM	0
O_38	582665, 189535	Rochford	30.0	10	27.7	3	22.5	6	D	1	NM	0
O_39	582645, 189533	Rochford	25.3	7	26.0	5	24.1	7	D	1	NM	0
O_40	584270, 188270	Southend-on-Sea	28.0	10	26.6	5	28.3	5	D	0	NM	0
O_41	584224, 188243	Southend-on-Sea	31.8	10	28.0	7	23.4	6	D	1	NM	0
O_42	583265, 188244	Southend-on-Sea	23.6	10	24.1	7	22.4	7	D	1	NM	0
O_43	583256, 188248	Southend-on-Sea	27.6	10	25.5	7	22.2	6	D	1	NM	0
O_44	582599, 188993	Southend-on-Sea	38.9	10	31.0	7	28.6	6	D	1	NM	0
O_45	582010, 189195	Castle Point	35.2	7	26.3	3	21.9	7	D	1	NM	0
V_46	581777, 189295	Rochford	33.4	4	36.8	10	28.9	7	D	1	NM	0
O_47	580675, 189599	Rochford	45.1	9	37.4	7	29.7	7	D	0	NM	0
O_48	580601, 189605	Rochford	35.7	10	32.1	7	28.2	7	D	1	NM	0
O_49	580355, 189633	Rochford	29.3	10	26.4	6	24.0	7	D	1	NM	0
O_50	580276, 189642	Rochford	31.7	9	29.0	7	25.9	7	D	1	NM	0
O_51	580142, 189612	Castle Point	35.1	9	31.2	6	25.7	6	D	1	NM	0
O_52	580156, 189594	Castle Point	43.3	10	36.6	7	37.9	6	D	1	NM	0
O_53	580045, 189409	Castle Point	29.1	10	26.4	6	23.0	6	D	1	NM	0

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O_54	580061, 189401	Castle Point	41.9	9	35.2	6	35.2	5	D	1	NM	0
O_55	580097, 189663	Castle Point	51.5	10	42.4	7	NM	2	D	0	NM	0
O_56	579835, 189696	Castle Point	49.5	10	42.5	7	43.5	4	D	1	NM	0
O_57	579655, 189712	Castle Point	68.7	10	53.6	7	57.4	7	D	1	NM	0
O_58	579276, 189974	Castle Point	40.3	10	33.6	7	31.4	7	D	1	NM	0
O_59	577832, 190794	Basildon	43.1	10	35.1	7	27.9	6	34.9	12	32.7	12
V_60_FG2	577273, 190765	Basildon	44.2	10	35.4	7	31.6	7	33.8	11	33.3	12
V_61	575772, 190904	Basildon	34.8	9	33.2	10	23.4	7	24.8	12	23.8	11
O_62	574661, 190942	Basildon	39.7	10	35.1	7	27.9	5	29.2	12	27.8	12
O_63	573676, 191111	Basildon	38.5	10	31.9	7	24.7	12	25.3	12	26.0	12
O_64	571899, 191011	Basildon	57.5	10	49.9	7	43.2	5	44.1	10	(31.2)	8
O_65	571558, 190961	Basildon	62.6	10	49.4	7	42.8	7	44.0	11	40.2	12
V_66	570612, 190610	Basildon	38.5	10	36.6	10	27.5	7	26.1	12	D 26.9	11
O_67	569414, 190171	Basildon	76.8	10	61.2	6	54.7	7	56.3	12	51.8	12
O_68	569297, 189830	Basildon	42.9	9	37.2	7	32.0	7	35.6	12	36.4	11
O_69	569322, 189838	Basildon	55.4	10	46.7	7	43.4	6	38.4	4	NM	0
O_70	568699, 189319	Basildon	27.9	10	27.8	7	25.4	6	D	1	NM	0
O_71	568701, 189304	Basildon	26.8	6	25.1	3	19.9	5	D	1	NM	0
V_72	569033, 190055	Basildon	34.6	10	34.6	9	25.5	7	29.2	12	25.8	12
O_73	568691, 190015	Basildon	41.4	10	34.2	7	27.3	7	27.0	10	23.8	12
V_74	568643, 190013	Basildon	38.8	8	40.5	10	29.0	7	30.2	12	27.7	11
O_75	568292, 190001	Basildon	46.6	10	36.0	7	35.5	7	36.9	12	34.7	11
O_76	567975, 189740	Basildon	LDC	2	LDC	2	29.0	6	29.6	11	28.1	10
O_77	567968, 189747	Basildon	34.7	8	31.4	6	29.0	6	29.8	9	(28.4)	8
O_78	567801, 190059	Basildon	67.9	10	51.9	7	LDC	2	D	0	NM	0
O_79	567195, 190192	Basildon	67.7	10	50.7	7	45.3	7	50.3	12	47.4	12
O_80	568325, 190002	Basildon	41.9	7	35.2	7	30.7	5	D	2	NM	0
O_81	580770, 187129	Castle Point	25.1	8	23.9	4	18.8	6	D	1	NM	0
O_82	568971, 189675	Basildon	16.1	9	18.1	7	15.5	7	D	1	NM	0
O_83	576076, 190172	Basildon	17.0	10	16.5	7	15.0	7	14.0	12	12.5	12

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O_84	582242, 188380	Castle Point	13.5	10	13.4	6	10.3	6	D	1	NM	0
N_1	566976, 190203	Basildon	NM	0	67.8	3	48.4	7	50.4	11	48.6	11
N_2	567438, 190203	Basildon	NM	0	LDC	2	29.8	6	33.6	11	32.5	11
N_3	568280, 190333	Basildon	NM	0	24.0	3	23.1	7	D	1	NM	0
N_4	568161, 190157	Basildon	NM	0	28.8	3	20.0	6	D	1	NM	0
N_6	571686, 191012	Basildon	NM	0	69.2	3	47.1	7	49.4	12	(46.3)	8
N_7	579512, 189770	Castle Point	NM	0	59.8	3	52.6	7	D	1	NM	0
N_8	579802, 189734	Rochford	NM	0	58.8	3	45.5	6	D	1	NM	0
N_9	580191, 189948	Rochford	NM	0	LDC	1	35.6	4	D	0	NM	0
N_11	582689, 188937	Southend-on-Sea	NM	0	28.6	3	23.0	7	D	1	NM	0
N_12	579138, 190150	Castle Point	NM	0	LDC	2	26.1	7	D	1	NM	0
N_13	571703, 190990	Basildon	NM	0	53.5	3	40.1	7	45.5	12	33.7	10
N_14	569299, 189825	Basildon	NM	0	37.0	3	30.8	7	32.8	12	31.2	9
N_16	567988, 189780	Basildon	NM	0	LDC	1	28.5	5	28.2	11	30.3	9
N_17	567980, 189788	Basildon	NM	0	30.7	3	27.9	6	27.6	9	25.6	10
N_18	567209, 190184	Basildon	NM	0	34.3	3	31.3	6	32.3	11	31.7	10
N_19	566020, 189949	Basildon	NM	0	NM	0	NM	0	NM	0	NM	0
N_20	568978, 189662	Basildon	NM	0	LDC	2	15.4	6	D	1	NM	0
N_21	576079, 190173	Basildon	NM	0	16.8	3	14.8	7	13.3	11	12.6	11
N_22	573192, 190990	Basildon	NM	0	48.6	3	37.3	11	38.5	12	38.9	12
N_23	573178, 190082	Basildon	NM	0	53.3	3	47.2	9	42.3	4	NM	0
N_24	573224, 190943	Basildon	NM	0	38.5	3	34.4	12	37.2	12	36.1	10
N_25	573604, 191443	Basildon	NM	0	LDC	2	29.5	9	24.6	11	25.4	11
N_26	572851, 190339	Basildon	NM	0	LDC	2	27.2	12	30.5	12	29.6	12
N_27	572843, 190363	Basildon	NM	0	LDC	1	25.8	11	25.7	11	26.4	12
N_28	573470, 190521	Basildon	NM	0	LDC	2	25.3	7	23.7	11	25.7	12
N_29	573231, 190755	Basildon	NM	0	50.4	3	51.0	11	49.0	11	51.3	9
N_30	573199, 190617	Basildon	NM	0	43.6	3	32.4	12	36.5	12	35.3	12
N_31	572979, 190716	Basildon	NM	0	31.8	3	25.1	12	25.5	11	22.0	12
N_32	569540, 189551	Basildon	NM	0	37.8	3	32.7	7	34.4	12	33.8	12

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N_33	569525, 189571	Basildon	NM	0	LDC	2	31.4	7	32.1	12	31.4	12
N_34	569257, 190123	Basildon	NM	0	48.2	3	38.1	7	42.2	12	38.4	11
N_35	569237, 190101	Basildon	NM	0	52.7	3	43.2	6	45.1	8	45.0	12
N_36	569225, 190079	Basildon	NM	0	39.1	3	32.6	7	35.9	11	31.7	12
N_37	568639, 190077	Basildon	NM	0	LDC	2	28.6	6	D	1	NM	0
N_38	568342, 190003	Basildon	NM	0	43.2	3	34.6	7	39.2	12	38.2	12
N_39	568266, 190028	Basildon	NM	0	68.8	3	56.4	7	58.5	12	58.4	12
N_40	575126, 190927	Basildon	NM	0	36.0	3	30.3	7	34.7	11	30.6	12
N_41	574104, 191044	Basildon	NM	0	35.4	3	27.1	12	30.0	12	27.3	12
N_42	578847, 190370	Castle Point	NM	0	56.5	3	44.1	6	38.3	5	NM	0
N_43	578381, 191799	Rochford	NM	0	36.5	3	D	1	NM	0	NM	0
N_44	578097, 191280	Rochford	NM	0	42.0	3	41.3	7	38.5	12	37.8	12
N_45	580203, 189771	Rochford	NM	0	30.9	3	25.8	7	D	1	NM	0
N_46	574167, 188130	Basildon	NM	0	LDC	2	37.2	7	34.8	12	33.0	11
N_47	574045, 188026	Basildon	NM	0	25.7	3	24.3	7	D	1	NM	0
N_48	577285, 189956	Basildon	NM	0	LDC	0	NM	0	NM	0	NM	0
N_49	572052, 186836	Basildon	NM	0	41.4	3	37.1	6	38.6	11	36.6	12
N_50	571927, 186753	Basildon	NM	0	NM	0	NM	0	NM	0	NM	0
N_51	571644, 188995	Basildon	NM	0	LDC	1	23.2	3	D	1	NM	0
N_52	571839, 189048	Basildon	NM	0	LDC	2	24.5	5	23.3	8	(23.7)	8
N_53	565958, 189242	Basildon	NM	0	27.9	3	D (24.2)	4	NM	0	NM	0
N_54	565959, 189285	Basildon	NM	0	30.7	3	D (27.9)	5	NM	0	NM	0
N_55	568779, 189318	Basildon	NM	0	LDC	1	28.2	7	D	1	NM	0
N_56	568852, 189347	Basildon	NM	0	35.8	3	29.5	7	28.7	12	28.3	11
N_57	570453, 189806	Basildon	NM	0	35.7	3	29.4	7	28.6	10	26.6	11
N_58	570438, 189834	Basildon	NM	0	40.8	3	34.2	6	33.5	12	31.7	11
N_59	570432, 190561	Basildon	NM	0	48.9	3	37.2	7	35.7	11	33.2	11
N_60	570094, 190391	Basildon	NM	0	47.1	3	35.6	7	36.7	12	34.9	12
N_61	574032, 188723	Basildon	NM	0	29.7	3	24.9	7	D	1	NM	0
N_62	574045, 188680	Basildon	NM	0	30.1	3	28.9	3	D	1	NM	0

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N_63	573496, 188020	Basildon	NM	0	29.9	3	29.0	7	D	1	NM	0
N_64	570736, 189684	Basildon	NM	0	LDC	2	15.1	7	D	1	NM	0
N_65	573154, 190084	Basildon	NM	0	39.5	3	31.8	9	33.6	12	29.7	11
N_66	573893, 189820	Basildon	NM	0	LDC	2	17.9	6	D	1	NM	0
N_67	571820, 190705	Basildon	NM	0	25.0	3	19.8	6	D	1	NM	0
N_68	573560, 191445	Basildon	NM	0	LDC	2	25.8	9	27.9	10	D 28.2	7
N_69	565229, 189756	Basildon	NM	0	46.0	3	41.8	7	D	1	NM	0
N_70	569319, 190022	Basildon	NM	0	NM	0	30.5	3	D	1	NM	0
N_71	569301, 190168	Basildon	NM	0	46.3	3	35.8	7	33.5	11	28.1	12
N_72	569312, 190141	Basildon	NM	0	65.8	3	47.0	6	54.6	12	48.9	12
N_73	569196, 190104	Basildon	NM	0	LDC	2	31.1	4	34.7	8	30.7	12
N_74	569228, 190147	Basildon	NM	0	LDC	2	36.5	7	36.1	10	35.0	12
N_75	569256, 190064	Basildon	NM	0	LDC	2	33.4	6	36.6	12	33.6	12
N_76	569015, 190275	Basildon	NM	0	33.7	3	26.6	6	D	1	NM	0
N_77	569269, 189923	Basildon	NM	0	37.1	3	30.1	7	32.5	12	32.3	12
N_78	569220, 190106	Basildon	NM	0	50.0	3	41.9	7	45.3	11	42.8	10
N_79	573244, 191258	Basildon	NM	0	42.2	3	35.3	12	35.3	12	34.0	12
N_80	573250, 191090	Basildon	NM	0	45.1	3	39.1	9	40.6	12	42.5	12
N_81	573222, 191052	Basildon	NM	0	37.7	3	32.3	12	34.9	11	32.2	11
N_82	573221, 190916	Basildon	NM	0	43.2	3	36.1	12	35.3	12	35.3	11
N_83	573230, 190813	Basildon	NM	0	46.2	3	44.6	10	41.9	12	43.5	12
N_84	573227, 191003	Basildon	NM	0	39.9	3	35.5	12	34.4	12	32.7	10
N_85	573181, 191093	Basildon	NM	0	43.2	3	37.3	12	35.8	10	35.3	12
N_86	573192, 191058	Basildon	NM	0	41.7	3	33.4	12	35.5	11	36.9	12
N_87	573190, 191026	Basildon	NM	0	45.8	3	36.3	12	37.1	10	37.2	11
N_88	573223, 190974	Basildon	NM	0	49.4	3	43.4	12	46.8	12	41.9	11
N_89	573196, 190841	Basildon	NM	0	58.2	3	53.7	12	56.8	12	50.4	11
FG_1	578291, 190645	Castle Point	NM	0	LDC	2	21.9	7	24.7	12	24.2	12
FG_6	579708, 189691	Castle Point	NM	0	24.6	3	20.8	7	D	1	NM	0
FG_7	578150, 190699	Castle Point	NM	0	LDC	2	22.1	5	24.9	10	26.2	10

Site ID	Coordinates (BNG – X, Y)	Local Authority	2018 Annual Mean NO_2 Conc. (µg/m^3)	2018 Months With Monitoring Data	2019 Annual Mean NO_2 Conc. (µg/m^3)	2019 Months With Monitoring Data	2020 Annual Mean NO_2 Conc. (µg/m^3)	2020 Months With Monitoring Data	2021 Annual Mean NO_2 Conc. (µg/m^3)	2021 Months With Monitoring Data	2022 Annual Mean NO_2 Conc. (µg/m^3)	2022 Months With Monitoring Data
N_90	573098, 191210	Basildon	NM	0	NM	0	24.5	8	23.2	12	23.9	12
N_91	572790, 191165	Basildon	NM	0	NM	0	33.5	8	30.5	10	28.3	10
N_92	566167, 189990	Basildon	NM	0	NM	0	32.3	8	30.2	12	30.7	12
N_93	566046, 189937	Basildon	NM	0	NM	0	26.0	8	25.6	11	23.8	12
N_94	573321, 191117	Basildon	NM	0	NM	0	LDC	1	28.7	12	27.2	11
N_95	573488, 191116	Basildon	NM	0	NM	0	LDC	1	26.5	12	21.6	10
N_42b	579011, 190277	Castle Point	NM	0	NM	0	NM	0	48.3	4	41.4	12
N_96	571666, 189394	Basildon	NM	0	NM	0	NM	0	NM	0	14.9	11
Co-Lo	568654, 190045	Basildon	NM	0	NM	0	NM	0	NM	0	(30.5)	4

Table A2: The 91x Basildon Monitoring Sites Classified As Primary, Secondary or Tertiary

Primary – meets all siting criteria (see below) and has at least 11 months' data capture

Secondary – Meets all siting criteria (see below) but has less than 11 months' data capture

Tertiary – does not meet any one of the following aspects of siting criteria:

- Representative of 100 m of road length?
- Within 10 m of the kerb?
- Greater than 25 m from major junctions?
- More than 0.5 m from an obstruction?
- Inlet free in arc of at least 270 degrees?
- Positioned away from other emission sources?
- Inlet height between 1.5 m and 4.0 m from the ground?

Note that V_66 and N_68 have been excluded from this, as they were decommissioned towards the end of 2022.

Site ID	2022 Annual Mean NO_2 Concentration	Data Capture (months)	Rep. 100 m Road Length?	Kerb Distance (m)	Distance from Major Junction (m)	Distance from Obstruction (m)	Inlet free 270 degrees?	Away from emissions sources?	Inlet Height (m)	AQSR Category	Success Achieved in 2022?
O_1	36.4	12	Yes	4.8	1,080	3.8	Yes	Yes	1.52	Primary	Yes
O_2	31.7	12	Yes	4.5	245	1.0	Yes	Yes	1.50	Primary	Yes
O_5	49.3	11	Yes	5.2	87	1.17	Yes	Yes	2.25	Primary	**No**
O_6	47.1	12	Yes	3.5	381	0.67	Yes	Yes	1.20	Tertiary	Yes
O_7	46.8	12	Yes	4.3	467	1.7	Yes	Yes	1.72	Primary	**No**
O_8	41.6	10	Yes	3.9	446	0.7	Yes	Yes	1.35	Tertiary	Yes
V_12	22.0	12	Yes	10.6	0	0.0	Yes	Yes	1.80	Tertiary	Yes
O_13	38.1	12	Yes	4.8	1,229	1.0	Yes	Yes	1.60	Primary	Yes
O_14	42.4	12	Yes	3.5	842	0.65	Yes	Yes	1.70	Primary	**No**
V_15	26.4	12	Yes	2.4	24	1.5	Yes	Yes	2.25	Tertiary	Yes
O_16	28.9	12	Yes	5.0	1,022	4.0	Yes	Yes	1.85	Primary	Yes
V_17	22.7	11	Yes	8.0	2,145	25	Yes	Yes	2.10	Primary	Yes
O_59	32.7	12	Yes	2.1	85	1.0	Yes	Yes	1.70	Primary	Yes
V_60_FG2	33.3	12	Yes	3.6	475	2.0	Yes	Yes	2.30	Primary	Yes
V_61	23.8	11	Yes	7.7	1,975	23.0	Yes	Yes	1.90	Primary	Yes
O_62	27.8	12	Yes	3.9	874	1.0	Yes	Yes	1.85	Primary	Yes
O_63	26.0	12	Yes	2.4	389	2.0	Yes	Yes	1.96	Primary	Yes
O_64	31.2	8	Yes	1.9	8	5.0	Yes	Yes	1.80	Tertiary	Yes
O_65	40.2	12	Yes	3.1	345	0.4	Yes	Yes	1.85	Tertiary	Yes

Site ID	2022 Annual Mean NO_2 Concentration	Data Capture (months)	Rep. 100 m Road Length?	Kerb Distance (m)	Distance from Major Junction (m)	Distance from Obstruction (m)	Inlet free 270 degrees?	Away from emissions sources?	Inlet Height (m)	AQSR Category	Success Achieved in 2022?
O_67	51.8	12	Yes	3.1	270	2.1	Yes	Yes	1.37	Tertiary	Yes
O_68	36.4	11	Yes	0.7	145	6.7	Yes	Yes	1.97	Primary	Yes
V_72	25.8	12	Yes	3.3	205	2.0	Yes	Yes	1.90	Primary	Yes
O_73	23.8	12	Yes	3.6	310	2.0	Yes	Yes	1.70	Primary	Yes
V_74	27.7	11	Yes	2.4	566	0.8	Yes	Yes	1.95	Primary	Yes
O_75	34.7	11	Yes	4.0	198	0.2	Yes	Yes	2.05	Tertiary	Yes
O_76	28.1	10	Yes	1.6	193	8.0	Yes	Yes	2.00	Secondary	Yes
O_77	28.4	8	Yes	1.8	189	1.0	Yes	Yes	2.00	Secondary	Yes
O_79	47.4	12	Yes	3.3	1,052	0.1	Yes	Yes	1.45	Tertiary	Yes
O_83	12.5	12	Yes	4.3	1,120	1.0	Yes	Yes	1.90	Primary	Yes
N_1	48.6	11	Yes	3.5	830	2.55	Yes	Yes	2.04	Primary	**No**
N_2	32.5	11	Yes	3.2	622	N/A - fields behind	Yes	Yes	1.60	Primary	Yes
N_6	46.3	8	Yes	4.0	1,055	0.6	Yes	Yes	2.15	Secondary	Yes
N_13	33.7	10	Yes	3.0	198	2.45	Yes	Yes	1.90	Secondary	Yes
N_14	31.2	9	Yes	1.3	146	2.55	Yes	Yes	2.00	Secondary	Yes
N_16	30.3	9	Yes	3.0	143	11	Yes	Yes	2.00	Secondary	Yes
N_17	25.6	10	Yes	2.2	137	12	Yes	Yes	2.00	Secondary	Yes
N_18	31.7	10	Yes	9.6	837	4.0	Yes	Yes	2.00	Secondary	Yes
N_21	12.6	11	Yes	2.4	1,113	3.0	Yes	Yes	1.90	Primary	Yes
N_22	38.9	12	Yes	1.9	98	6.0	Yes	Yes	2.00	Primary	Yes
N_24	36.1	10	Yes	1.8	58	2.9	Yes	Yes	1.95	Secondary	Yes
N_25	25.4	11	Yes	1.9	84	1.0	Yes	Yes	1.85	Primary	Yes
N_26	29.6	12	Yes	3.0	162	2.0	Yes	Yes	2.00	Primary	Yes
N_27	26.4	12	Yes	2.3	199	30	Yes	Yes	1.96	Primary	Yes
N_28	25.7	12	Yes	3.2	234	5.0	Yes	Yes	1.85	Primary	Yes
N_29	51.3	9	Yes	2.7	28	21	Yes	Yes	2.00	Secondary	Yes
N_30	35.3	12	Yes	1.5	65	7.5	Yes	Yes	2.00	Primary	Yes
N_31	22.0	12	Yes	2.7	212	4.0	Yes	Yes	2.00	Primary	Yes
N_32	33.8	12	Yes	1.8	105	4.7	Yes	Yes	1.73	Primary	Yes
N_33	31.4	12	Yes	2.6	31	10	Yes	Yes	1.80	Primary	Yes

Site ID	2022 Annual Mean NO_2 Concentration	Data Capture (months)	Rep. 100 m Road Length?	Kerb Distance (m)	Distance from Major Junction (m)	Distance from Obstruction (m)	Inlet free 270 degrees?	Away from emissions sources?	Inlet Height (m)	AQSR Category	Success Achieved in 2022?
N_34	38.4	11	Yes	6.0	103	2.2	Yes	Yes	1.80	Primary	Yes
N_35	45.0	12	Yes	2.3	81	8.0	Yes	Yes	1.70	Primary	**No**
N_36	31.7	12	No	3.2	26	4.0	Yes	Yes	1.90	Tertiary	Yes
N_38	38.2	12	Yes	3.8	246	1.5	Yes	Yes	2.00	Primary	Yes
N_39	58.4	12	Yes	4.7	165	1.87	Yes	Yes	1.62	Primary	**No**
N_40	30.6	12	Yes	3.2	1,317	1.2	Yes	Yes	1.75	Primary	Yes
N_41	27.3	12	Yes	4.0	310	1.0	Yes	Yes	1.37	Tertiary	Yes
N_46	33.0	11	Yes	2.8	426	1.0	Yes	Yes	1.90	Primary	Yes
N_49	36.6	12	Yes	5.4	704	1.1	Yes	Yes	2.00	Primary	Yes
N_52	23.7	8	Yes	2.8	475	2.0	Yes	Yes	1.50	Secondary	Yes
N_56	28.3	11	Yes	1.7	195	15	Yes	Yes	1.80	Primary	Yes
N_57	26.6	11	Yes	1.6	150	10	Yes	Yes	1.60	Primary	Yes
N_58	31.7	11	Yes	1.6	188	6.6	Yes	Yes	2.05	Primary	Yes
N_59	33.2	11	Yes	3.4	1,038	0.4	Yes	Yes	1.90	Tertiary	Yes
N_60	34.9	12	Yes	3.9	966	1.3	Yes	Yes	2.25	Primary	Yes
N_65	29.7	11	Yes	1.8	307	9.5	Yes	Yes	2.00	Primary	Yes
N_71	28.1	12	Yes	2.8	110	8.0	Yes	Yes	1.35	Tertiary	Yes
N_72	48.9	12	Yes	3.1	161	2.0	Yes	Yes	1.90	Primary	**No**
N_73	30.7	12	Yes	7.2	220	N/A - open area	Yes	Yes	1.50	Primary	Yes
N_74	35.0	12	Yes	6.1	281	18	Yes	Yes	1.50	Primary	Yes
N_75	33.6	12	No	1.7	23	4.0	Yes	Yes	1.86	Tertiary	Yes
N_77	32.3	12	No	1.9	45	5.5	Yes	Yes	1.97	Tertiary	Yes
N_78	42.8	10	Yes	2.2	47	3.2	Yes	Yes	1.90	Secondary	Yes
N_79	34.0	12	No	2.4	5	1.3	Yes	Yes	2.10	Tertiary	Yes
N_80	42.5	12	No	2.1	39	1.9	Yes	Yes	2.00	Tertiary	Yes
N_81	32.2	11	Yes	2.3	42	0.9	Yes	Yes	2.00	Primary	Yes
N_82	35.3	11	Yes	2.1	31	6.6	Yes	Yes	2.00	Primary	Yes
N_83	43.5	12	Yes	2.9	54	0.9	Yes	Yes	1.90	Primary	**No**
N_84	32.7	10	Yes	2.8	41	1.18	Yes	Yes	1.85	Secondary	Yes
N_85	35.3	12	No	1.9	3	7.7	Yes	Yes	1.45	Tertiary	Yes
N_86	36.9	12	No	3.4	21	8.3	Yes	Yes	1.59	Tertiary	Yes

Site ID	2022 Annual Mean NO_2 Concentration	Data Capture (months)	Rep. 100 m Road Length?	Kerb Distance (m)	Distance from Major Junction (m)	Distance from Obstruction (m)	Inlet free 270 degrees?	Away from emissions sources?	Inlet Height (m)	AQSR Category	Success Achieved in 2022?
N_87	37.2	11	No	2.1	13	5.2	Yes	Yes	1.90	Tertiary	Yes
N_88	41.9	11	Yes	1.4	62	2.6	Yes	Yes	1.95	Primary	**No**
N_89	50.4	12	Yes	1.6	113	7.8	Yes	Yes	2.00	Primary	**No**
N_90	23.9	12	Yes	2.3	43	3.0	Yes	Yes	2.10	Primary	Yes
N_91	28.3	10	Yes	2.2	353	8.0	Yes	Yes	2.05	Secondary	Yes
N_92	30.7	12	Yes	4.2	327	4.0	Yes	Yes	2.10	Primary	Yes
N_93	23.8	12	Yes	2.0	173	6.0	Yes	Yes	2.05	Primary	Yes
N_94	27.2	11	Yes	2.2	38	3.0	Yes	Yes	2.16	Primary	Yes
N_95	21.6	10	Yes	2.2	194	2.0	Yes	Yes	2.17	Secondary	Yes
N_96	14.9	12	No	0.7	73	5.5	Yes	Yes	2.00	Tertiary	Yes
N_Coloc	30.5	12	Yes	8.1	520	2.0	Yes	Yes	1.50	Secondary	Yes
NVR12 *	25.1	11	Yes	0.5	55	1.0	Yes	Yes	2.00	Primary	Yes

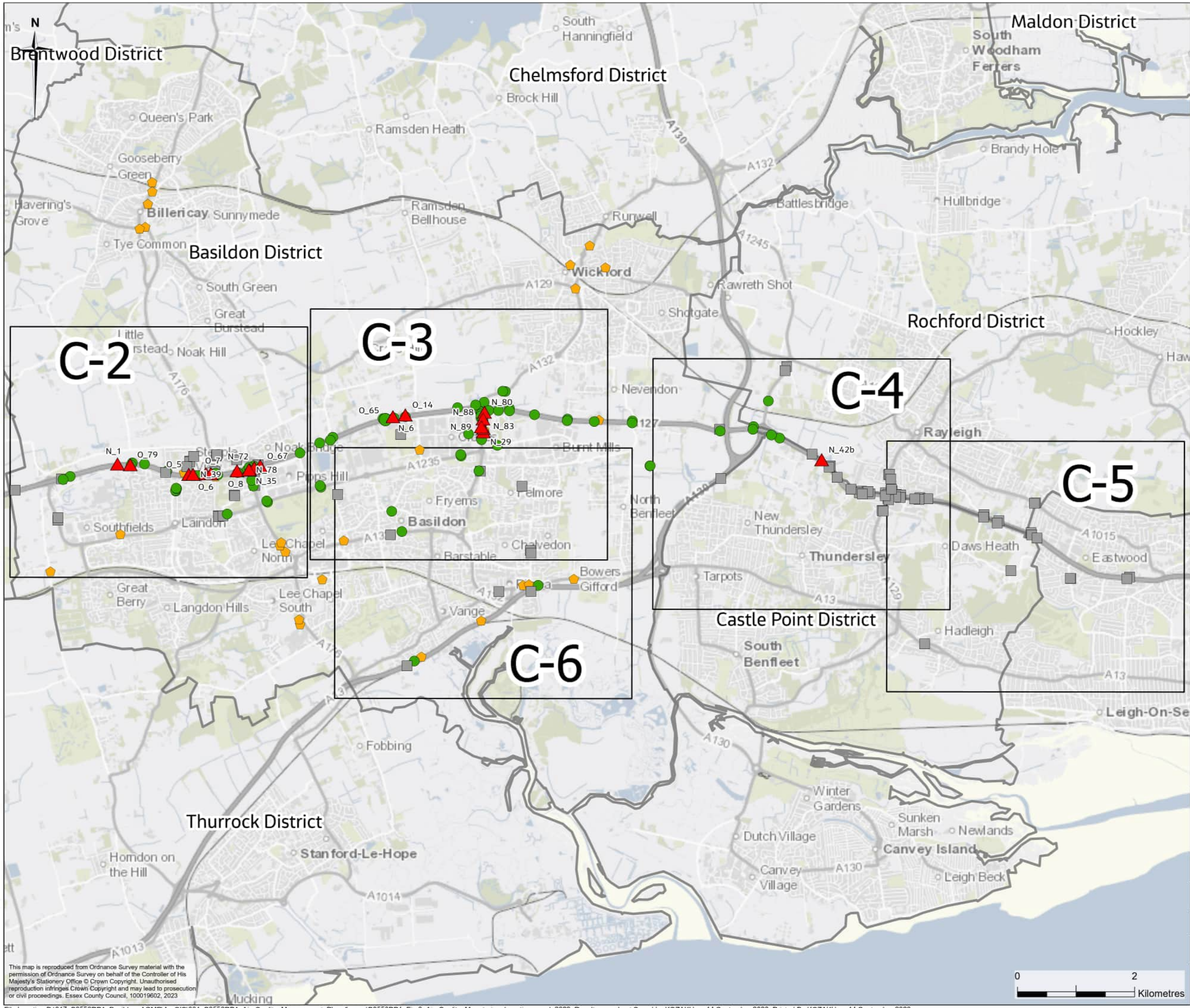
* NVR12 is a Basildon Council monitoring site on Nevendon Road, East Mayne

Appendix B: Basildon Council Monitoring Results 2018-2022

Table B1: Basildon Council 2018 to 2022 Annual Mean NO_2 Results (Bias Adjusted and Annualised Where Required)

Site ID	Coordinates (BNG – X, Y)	2018 Annual Mean NO_2 Conc. (µg/m^3)	2019 Annual Mean NO_2 Conc. (µg/m^3)	2020 Annual Mean NO_2 Conc. (µg/m^3)	2021 Annual Mean NO_2 Conc. (µg/m^3)	2022 Annual Mean NO_2 Conc. (µg/m^3)
BA001	568654, 189997	25.4	22.6	-		-
BA002	568115, 190062	22.9	23.6	-		-
BA003	575204, 190963	30.8	30.4	-		-
BA006	573194, 187531	27.2	25.3	-		-
BA007	572173, 186916	26.4	25.7	-		-
BA008	569845, 188709	24.4	22.2	-		-
BA009	569754, 188814	23.9	23.4	-		-
BA010	569774, 188870	28.1	28.8	-		-
BA016	573245, 190764	30.4	29.9	-		-
BA017	570844, 188902	27.4	24.7	-		-
BA018	565831, 188372	19.7	18.5	-		-
BA019	567026, 189010	26.1	23.5	-		-
GL1	572143, 190454	-	-	20.3	21.0	19.7
HR2	573910, 188138	-	-	35.6	39.8	35.8
HRR3	574009, 188150	-	-	36.4	38.6	36.8
LR4	574776, 188245	-	-	20.7	21.3	-
SR5	575316, 193567	-	-	24.0	23.9	24.3
RC6	574804, 193209	-	-	18.8	20.0	-
TB7	574715, 193613	-	-	29.6	31.9	31.6
NOR8	567571, 194865	-	-	23.7	27.3	26.0
CS9	567496, 194653	-	-	22.8	25.6	-
SS10	567451, 194259	-	-	27.6	30.3	29.2
SSL11	567355, 194229	-	-	21.6	22.9	20.9
NVR12	573243, 190795	-	-	24.1	27.6	25.1
RW4	567569, 195025	-	-	-	-	25.2
CE6	570475, 188238	-	-	-	-	26.1
NMH13	570096, 187468	-	-	-	-	21.6
NMR14	570079, 187552	-	-	-	-	36.3
TL9	567496, 194653	-	-	-	-	22.4

Appendix C: Air Quality Monitoring Locations and 2022 Monitoring Results Figures



Notes

1. Do not scale

Legend

District Boundaries

Local Authority Monitoring

Essex Highway Monitoring Sites

2022 Annual Mean NO_2 Concentrations

> 40 ug/m^3

<= 40 ug/m^3

No Data

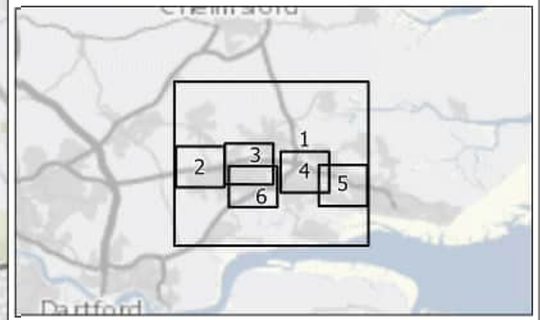


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FIGURE C-1: AIR QUALITY MONITORING LOCATIONS OVERVIEW MAP (PAGE 1 OF 6)

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HK	HK	DW	KT	DH
DATE	DATE	DATE	DATE	DATE
SEP23	SEP23	SEP23	SEP23	SEP23

DRAWING UNITS U.N.O.
DIMENSIONS IN MILLIMETRES
LEVELS IN METRES

SCALE AT A3 (420x297 mm)
1:60,000

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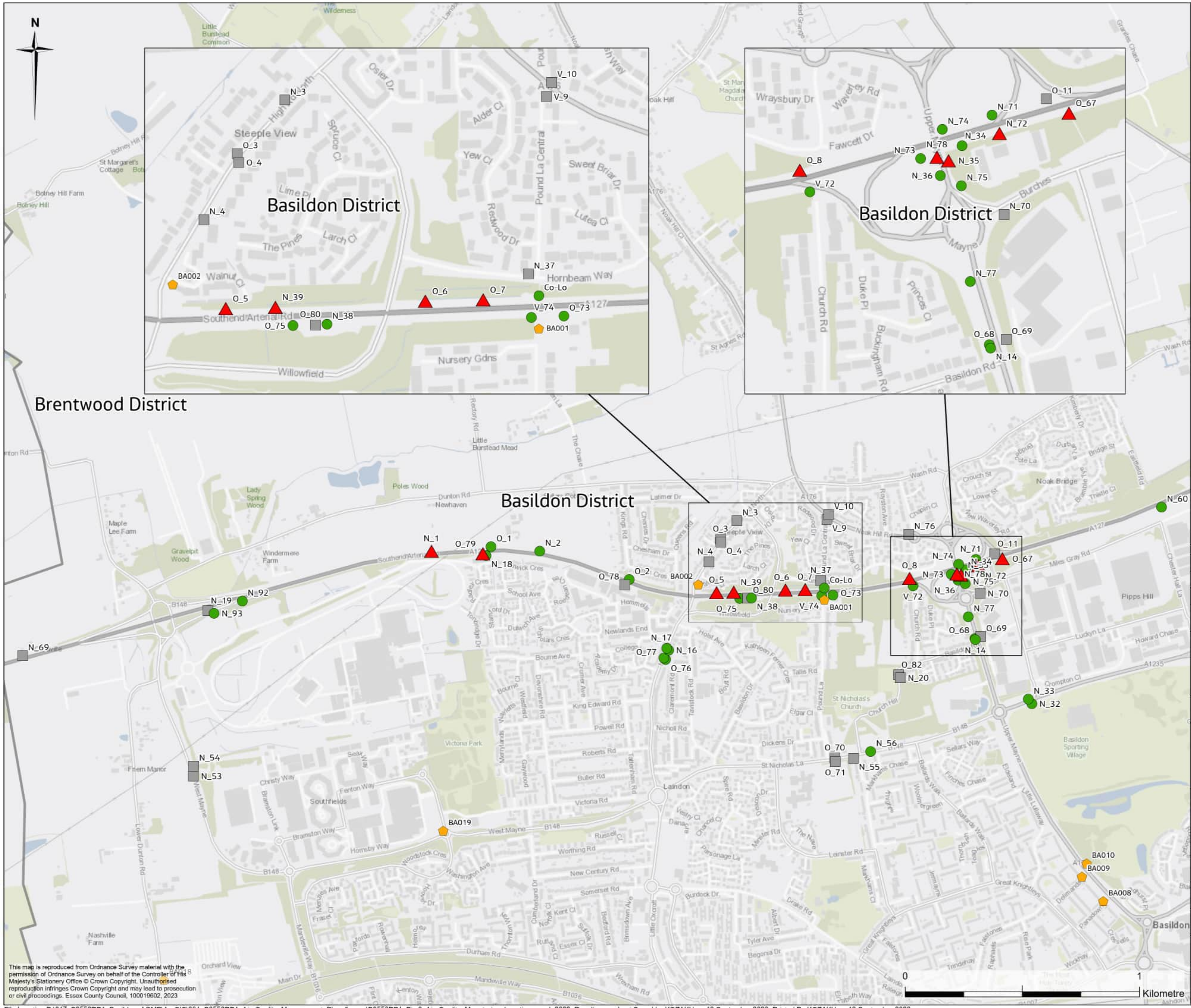

Notes
1. Do not scale

Legend

District Boundaries

Local Authority Monitoring

Essex Highway Monitoring Sites

2022 Annual Mean NO_2 Concentrations

> 40 ug/m^3

<= 40 ug/m^3

No Data

Rev.	Date	Description of revision	Drawn	Checked	Review'd	Approv'd
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FIGURE C-2: AIR QUALITY MONITORING LOCATIONS. WEST BASILDON (PAGE 2 OF 6)

DESIGNED	DRAWN	CHECKED	REVIEWED	APPROVED
HK	HK	DW	KT	DH
DATE	DATE	DATE	DATE	DATE
SEP23	SEP23	SEP23	SEP23	SEP23

DRAWING UNITS U.N.O.
DIMENSIONS IN MILLIMETRES
LEVELS IN METRES

SCALE AT A3 (420x297 mm)
1:15,000

REV.
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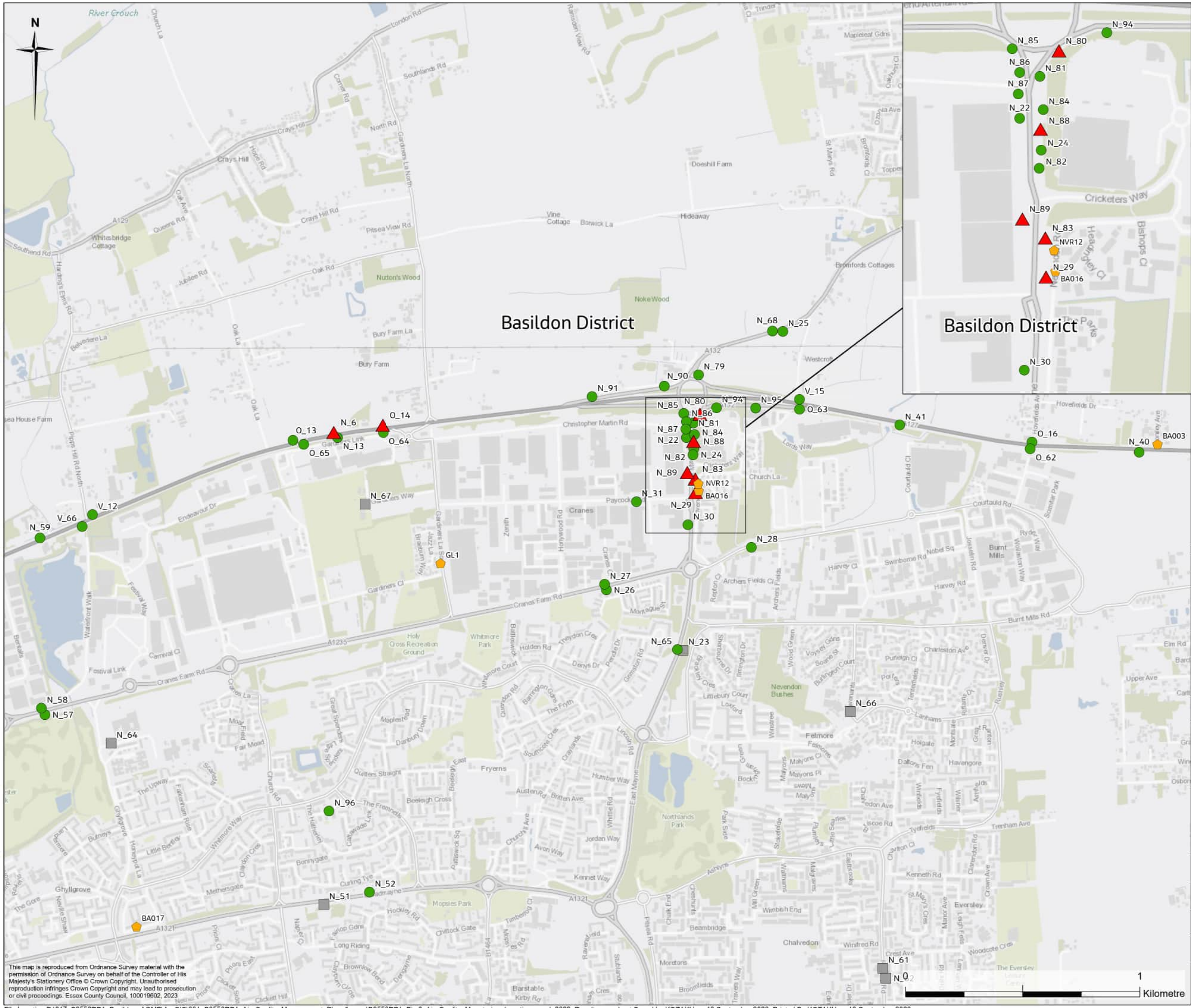


Notes
1. Do not scale

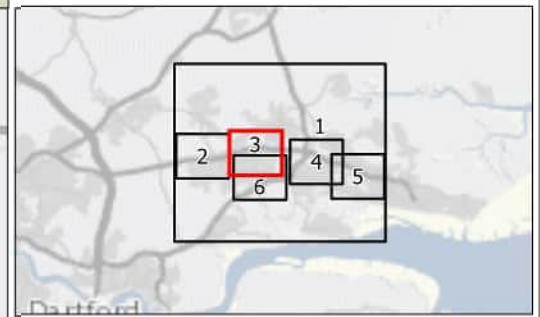
Legend

District Boundaries
Local Authority Monitoring

Essex Highway Monitoring Sites

2022 Annual Mean NO_2 Concentrations

> 40 ug/m^3
<= 40 ug/m^3
No Data



Rev	Date	Description of revision	Drawn	Checked	Review'd	Approv'd
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BASILDON AQMP

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FIGURE C-3: AIR QUALITY MONITORING LOCATIONS. EAST BASILDON (PAGE 3 OF 6)

DESIGNED	DRAWN	CHECKED	REVIEWED	APPROVED
HK	HK	DW	KT	DH
DATE	DATE	DATE	DATE	DATE
SEP23	SEP23	SEP23	SEP23	SEP23

DRAWING UNITS U.N.O.
DIMENSIONS IN MILLIMETRES
LEVELS IN METRES

SCALE AT A3 (420x297 mm)
1:15,000

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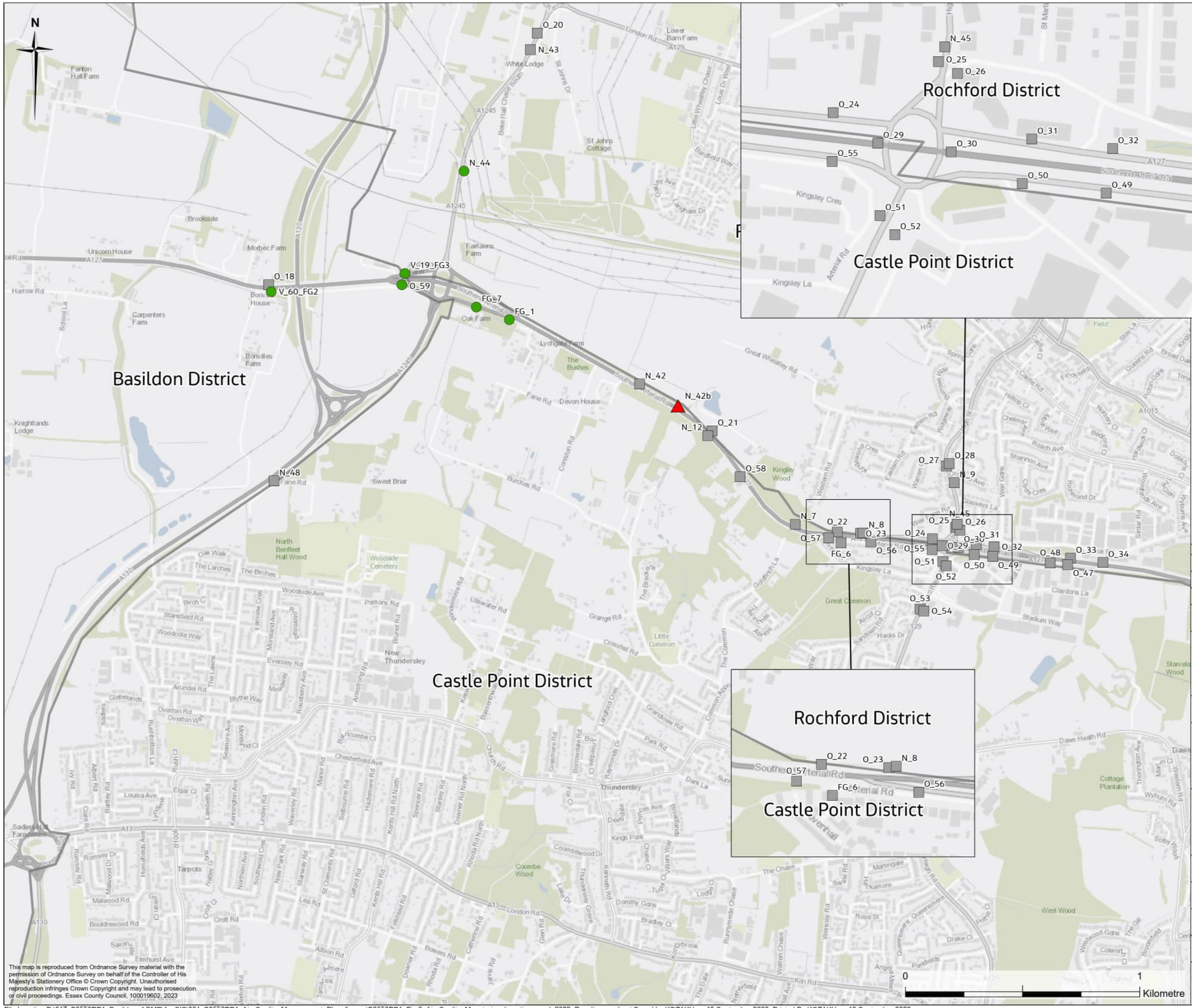
File Location P:\017_B3553RP1_Basildon_AQMP\ArcGIS\001_B3553RP1_Air_Quality_Management_Plan_figures\B3553RP1_Fig.3_Air_Quality_Monotoring_Locations_and_2022_Results.aprx Last Saved by KOZAKH on 13 September 2023 Printed By KOZAKH on 13 September 2023



Notes
1. Do not scale

Legend

District Boundaries

Local Authority Monitoring

Essex Highway Monitoring Sites

2022 Annual Mean NO_2 Concentrations

> 40 ug/m^3

<= 40 ug/m^3

No Data

Rev	Date	Description of revision	Drawn	Checked	Review'd	Approv'd
0	09/23	FINAL	HK	WD	KT	DH

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SCHEME TITLE

BASILDON AQMP

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FIGURE C-4: AIR QUALITY MONITORING LOCATIONS. FAIRGLEN AND WEST ROCHFORD (PAGE 4 OF 6)

DESIGNED	DRAWN	CHECKED	REVIEWED	APPROVED
HK	HK	DW	KT	DH
DATE	DATE	DATE	DATE	DATE
SEP23	SEP23	SEP23	SEP23	SEP23

DRAWING UNITS U.N.O.
DIMENSIONS IN MILLIMETRES
LEVELS IN METRES

SCALE AT A3 (420x297 mm)
1:15,000

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Notes

1. Do not scale

Legend

District Boundaries

Local Authority Monitoring

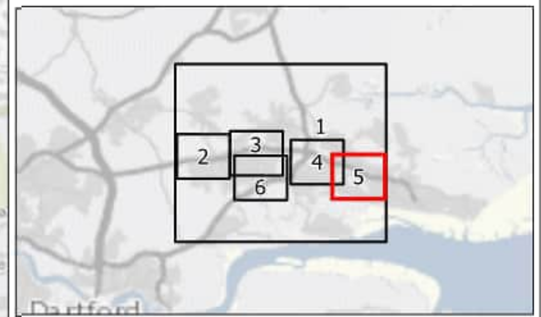
Essex Highway Monitoring Sites

2022 Annual Mean NO_2 Concentrations

> 40 ug/m³

<= 40 ug/m³

No Data



Rev.	Date	Description of revision	Drawn	Checked	Review'd	Approv'd
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BASILDON AQMP

DRAWING TITLE

FIGURE C-5: AIR QUALITY MONITORING LOCATIONS. EAST ROCHFORD (PAGE 5 OF 6)

DESIGNED	DRAWN	CHECKED	REVIEWED	APPROVED
HK	HK	DW	KT	DH
DATE	DATE	DATE	DATE	DATE
SEP23	SEP23	SEP23	SEP23	SEP23

DRAWING UNITS U.N.O.
DIMENSIONS IN MILLIMETRES
LEVELS IN METRES

SCALE AT A3 (420x297 mm)
1:15,000

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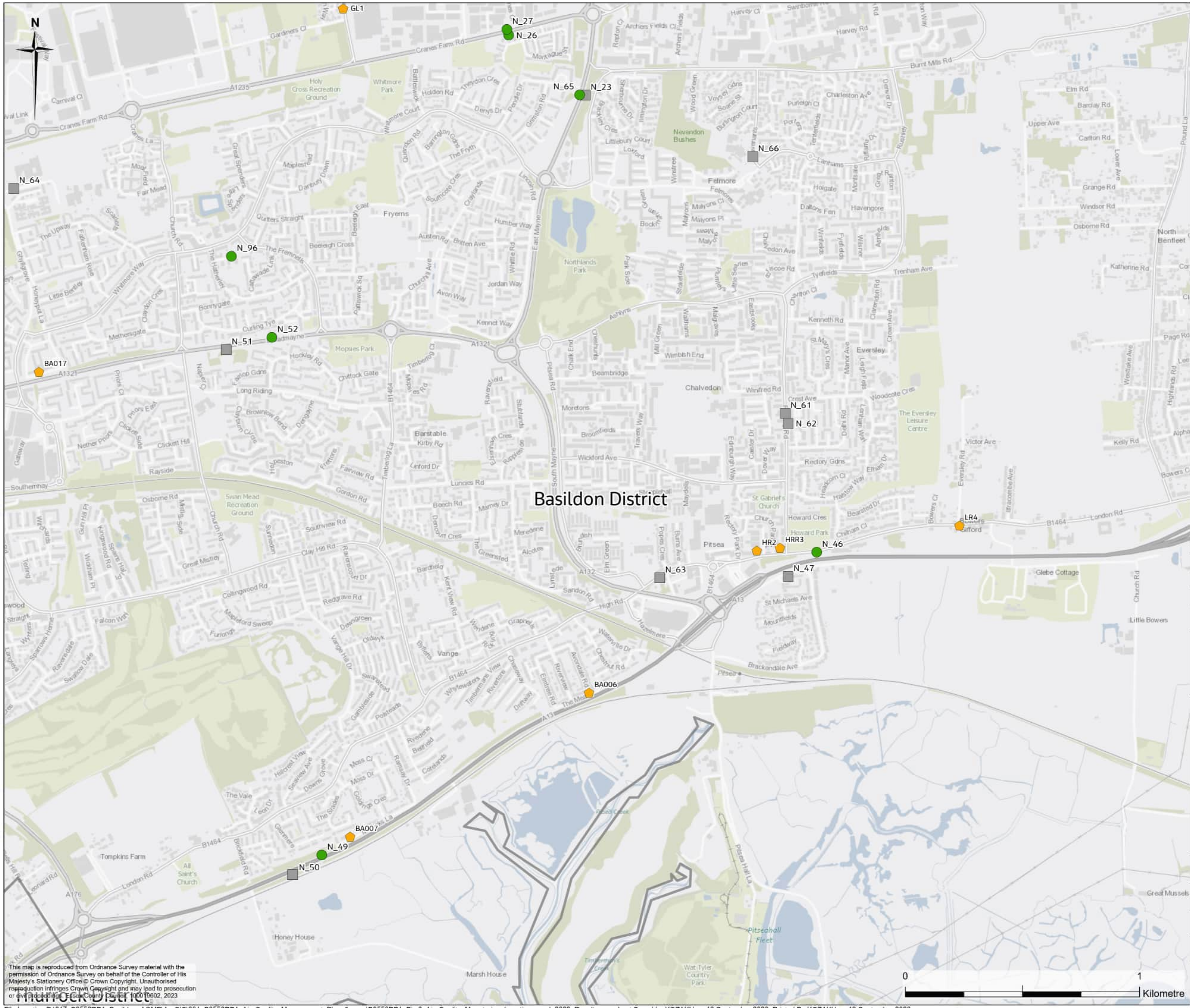


Notes
1. Do not scale

Legend

District Boundaries

Local Authority Monitoring

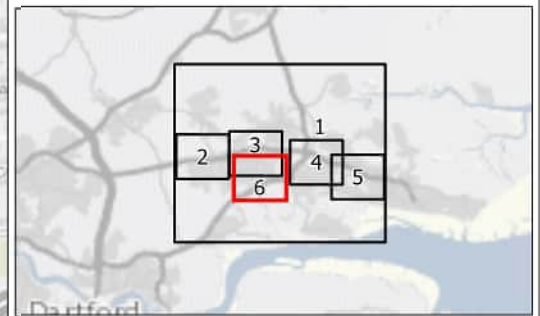
Essex Highway Monitoring Sites

2022 Annual Mean NO_2 Concentrations

> 40 ug/m³

<= 40 ug/m³

No Data



Rev.	Date	Description of revision	Drawn	Checked	Review'd	Approv'd
0	09/23	FINAL	HK	WD	KT	DH

DRAWING STATUS
FOR INFORMATION

Essex Highways

Essex Highways, Seax House, Victoria Road South, Chelmsford, CM1 1QH.
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SCHEME TITLE
BASILDON AQMP

DRAWING TITLE
FIGURE C-6: AIR QUALITY MONITORING LOCATIONS. SOUTH BASILDON (PAGE 6 OF 6)

DESIGNED	DRAWN	CHECKED	REVIEWED	APPROVED
HK	HK	DW	KT	DH
DATE	DATE	DATE	DATE	DATE
SEP23	SEP23	SEP23	SEP23	SEP23

DRAWING UNITS U.N.O.	SCALE AT A3 (420x297 mm)
DIMENSIONS IN MILLIMETRES LEVELS IN METRES	1:15,000

REV.
0

RINGWAY JACOBS — Integrated expertise
Essex County Council

File Location P:\017_B3553RP1_Basildon_AQMP\ArcGIS\001_B3553RP1_Air_Quality_Management_Plan_figures\B3553RP1_Fig.3_Air_Quality_Monotoring_Locations_and_2022_Results.aprx Last Saved by KOZAKH on 13 September 2023 Printed By KOZAKH on 13 September 2023

Appendix D: Trend Analysis Methodology

Trend analysis was undertaken for key monitoring sites across Basildon to establish an updated indication of success year for each of the hotspots. Three methods were followed to provide success years with a range of optimism. The key locations selected were the highest primary reportable location at each of the hotspot. Where a secondary non-reportable monitoring site recorded a higher concentration than the primary site, this has been included for reference, as it could influence compliance in future years if the data capture is equal to or greater than 12 months. These values are presented in the table with light grey font colouring.

For each of the three methods, the “SLOPE” function in excel was applied to the 2019-2022 monitoring data. For all sites, the slope was calculated using four years’ worth of data (2019 to 2022 inclusive), so that the method followed was consistent across all sites. Some of the values were annualised values, but no sites had any years between 2019 and 2022 that recorded less than three months’ data.

Once the slope was calculated, this value was added to the 2022 monitored concentration for each year after until concentrations reduced to below 40 $\mu g/m^3$.

The method followed is simple and contains a number of assumptions, including the following:

- Does not account for changes in policy, such as the ban on sale of new internal combustion engine vehicles from 2035;
- Consistent change between 2022 and the ‘success year’;
- Consistent improvement in the vehicle fleet and background concentrations between 2022 and the ‘success year’.

For each method two tables will be presented. The values used and the calculated slope are presented in the first table, and the projected annual mean NO_2 concentrations for each site are presented in second table. The highlighting in the table will indicate the first year that each site’s recorded annual mean NO_2 concentration reduces to below 40 $\mu g/m^3$, thus indicating compliance.

Trend Calculation Method 1

The first method is the simplest, and used the bias adjusted (and annualised where required) annual mean NO_2 concentrations from 2019 to 2022 without further processing.

Table D1 Method 1 Slope Calculation

Site ID	Hotspot	Annual Mean NO_2 Concentrations Used To Calculate The Slope (µg/m^3)				Calculated Slope
		2019	2020	2021	2022	
N_1	1	67.8	48.4	50.4	48.6	-5.56
N_39	2	68.8	56.4	58.5	58.4	-2.91
O_67	3a	61.2	54.7	56.3	51.8	-2.66
N_72	3a	65.8	47.0	54.6	48.9	-4.31
N_35	3b	52.7	43.2	45.1	45.0	-2.12
N_6	4	69.2	47.1	49.4	46.3	-6.64
O_14	4	53.7	55.7	45.0	42.4	-4.46
N_89	5	58.2	53.7	56.8	50.4	-2.03
N_29	5	50.4	51.0	49.0	51.3	0.07

Table D2 Method 1 Projection & Calculation of Updated Success Year

Site ID	Hotspot	Slope	Projected Annual Mean NO_2 Concentrations (µg/m^3) 2023	2024	2025	2026	2027	2028	2029	Calculated Success Year
N_1	1	-5.56	43.0	37.5	-	-	-	-	-	2024
N_39	2	-2.91	55.5	52.6	49.7	46.8	43.9	40.9	38.0	2029
O_67	3a	-2.66	49.1	46.5	43.8	41.2	38.5	-	-	2027
N_72	3a	-4.31	44.6	40.3	-	-	-	-	-	2024
N_35	3b	-2.12	42.9	40.8	38.6	-	-	-	-	2025
N_6	4	-6.64	39.7	-	-	-	-	-	-	2023
O_14	4	-4.46	37.9	-	-	-	-	-	-	2023
N_89	5	-2.03	48.4	46.3	44.3	42.3	40.3	-	-	2027
N_29	5	0.07	51.4	51.4	51.5	51.6	51.7	51.7	51.8	N/A - Slope is Positive

Trend Calculation Method 2

The second method uses the road contribution only to calculate the trend. This was calculated by subtracting the background concentration (site O_83 – see Table D5 in the following section) from each of the monitoring sites, and applying the SLOPE function to these values. The background values were then re-added unadjusted to give the concentrations above.

Table D3 Method 2 Slope Calculation

Site ID	Hotspot	Road Contribution Annual Mean NO_2 Concentrations Used To Calculate The Slope (µg/m^3)				Calculated Slope
		2019	2020	2021	2022	
N_1	1	51.3	33.4	36.4	36.1	-4.26
N_39	2	52.3	41.4	44.5	45.9	-1.61
O_67	3a	44.7	39.7	42.3	39.3	-1.36
N_72	3a	49.3	32.0	40.6	36.4	-3.01
N_35	3b	36.2	28.2	31.1	32.5	-0.82
N_6	4	52.7	32.1	35.4	33.8	-5.34
O_14	4	37.2	40.7	31.0	29.9	-3.16
N_89	5	41.7	38.7	42.8	37.9	-0.73
N_29	5	33.9	36.0	35.0	38.8	1.37

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Table D4 Method 2 Projection & Calculation of Updated Success Year

ID	Hotspot	Slope	Projected Annual Mean NO_2 Concentrations (µg/m³)														Calc. Succ. Year
			2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	
N_1	1	-4.26	44.3	40.1	-	-	-	-	-	-	-	-	-	-	-	-	2024
N_39	2	-1.61	56.8	55.2	53.6	52.0	50.4	48.7	47.1	45.5	43.9	42.3	40.7	39.1	-	-	2034
O_67	3a	-1.36	50.4	49.1	47.7	46.4	45.0	43.6	42.3	40.9	39.6	-	-	-	-	-	2031
N_72	3a	-3.01	45.9	42.9	39.9	-	-	-	-	-	-	-	-	-	-	-	2025
N_35	3b	-0.82	44.2	43.4	42.5	41.7	40.9	40.1	-	-	-	-	-	-	-	-	2028
N_6	4	-5.34	41.0	35.6	-	-	-	-	-	-	-	-	-	-	-	-	2024
O_14	4	-3.16	39.2	-	-	-	-	-	-	-	-	-	-	-	-	-	2023
N_89	5	-0.73	49.7	48.9	48.2	47.5	46.8	46.0	45.3	44.6	43.8	43.1	42.4	41.6	40.9	40.2	2036
N_29	5	1.37	52.7	54.0	55.4	56.8	58.2	59.5	60.9	62.3	63.6	65.0	66.4	67.7	69.1	70.5	N/A

Trend Calculation Method 3

The third method uses the SLOPE calculated for the background site (O_83) and applied to 2022 annual mean NO_2 concentrations.

Table D5 Method 3 Slope Calculation

Site ID	Hotspot	Road Contribution Annual Mean NO_2 Concentrations Used To Calculate The Slope (µg/m^3)				Calculated Slope
		2019	2020	2021	2022	
O_83	-	16.5	15.0	14.0	12.5	-1.30

Table D6 Method 3 Projection & Calculation of Updated Success Year

ID	Hotspot	Slope	Projected Annual Mean NO_2 Concentrations (µg/m^3)														Calc. Succ. Year
			2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	
N_1	1	-1.30	47.3	46.0	44.7	43.4	42.1	40.8	39.5	-	-	-	-	-	-	-	2029
N_39	2	-1.30	57.1	55.8	54.5	53.2	51.9	50.6	49.3	48.0	46.7	45.4	44.1	42.8	41.5	40.2	2036
O_67	3a	-1.30	50.5	49.2	47.9	46.6	45.3	44.0	42.7	41.4	40.1	-	-	-	-	-	2031
N_72	3a	-1.30	47.6	46.3	45.0	43.7	42.4	41.1	39.8	-	-	-	-	-	-	-	2029
N_35	3b	-1.30	43.7	42.4	41.1	39.8	-	-	-	-	-	-	-	-	-	-	2026
N_6	4	-1.30	45.0	43.7	42.4	41.1	39.8	-	-	-	-	-	-	-	-	-	2027
O_14	4	-1.30	41.1	39.8	-	-	-	-	-	-	-	-	-	-	-	-	2024
N_89	5	-1.30	49.1	47.8	46.5	45.2	43.9	42.6	41.3	-	-	-	-	-	-	-	2030
N_29	5	-1.30	50.0	48.7	47.4	46.1	44.8	43.5	42.2	40.9	-	-	-	-	-	-	2031

Appendix E: Changes to the Monitoring Survey at the Start of 2023

Survey Review Methodology

In order to reduce the number of monitoring locations from that currently deployed in 2022, the following stipulations were requested by JAQU:

- "*Provide JAQU with evidence that the DTs you plan to remove measured decreasing NO_2 concentrations over the last 4 years (2019-2022). This will serve as a proof that the NO2 reduction is not linked to low data capture due to lockdown restrictions. For sites installed after 2019: JAQU will review these sites in more detail to determine the risk of removal*; and
- *Continue reporting measurements from DTs that are not AQSR compliant if NO_2 concentrations remain above 30 $\mu g/m^3$*"

To provide sufficient justification for removing a site, in line with JAQU's request, the sites have been split into five groups:

Sites proposed to be removed:

1) Sites where the monitored annual mean NO_2 concentrations have been below 30.4 $\mu g/m^3$ for a least 3 years and indicate a clear downward trajectory.
2) Sites where the monitored annual mean NO_2 concentrations have been below 30.4 $\mu g/m^3$ for a least 3 years and are at a very low risk of exceedance, despite there being no clear downward trajectory.
3) Other sites that Essex Highways propose to remove. These sites do not fit the criteria above, but Essex Highways believes that there is sufficient justification for removing these sites. Induvial justifications for each site have been provided.

<u>Sites proposed to be retained:</u>

4) Sites that match the criteria to be removed, but Essex Highways are proposing to retain. Individual justifications for each site have been provided.
5) All other sites that do not fall into the above categories and therefore shall be retained.

Proposed Survey Changes As Agreed With JAQU

A summary of the number of sites in each group, and the action attributed to that group, are presented in Table E1 and Tables E2 to E6 below indicate the sites that are proposed to be removed or retained. These correspond with Figures C-1 to C-6 in Appendix A.

Table E1 Summary of All Groups Presented in Tables E2 to E6

Group	Action	Count *
1	Remove	18
2	Remove	4
3	Remove	5
4	Retain	1
5	Retain	64
Totals		
1-3	**Remove**	**27**
4-5	**Retain**	**65**
* The co-located triplicate location is counted as 1 site		

Table E2 Group 1 (Remove): Sites below 30.4 µg/m3 for at least 3 years and concentrations are decreasing

ID	X	Y	Annual Mean NO_2 Concentration (µg/m^3)					Slope (µg/m^3)	Justification
			2018	2019	2020	2021	2022		
V_12	570656	190661	31.4	35.2	26.0	22.8	23.2	-2.90	At least 3 years below 30.4 µg/m^3 and downward trajectory of concentrations
V_15	573676	191153	39.8	42.3	30.1	27.4	27.8	-3.89	
V_17	575778	190938	32.6	34.4	26.3	23.0	23.9	-2.90	
V_61	575772	190904	34.8	33.2	23.4	24.8	25.1	-2.78	
O_62	574661	190942	39.7	35.1	27.9	29.2	29.3	-2.66	
O_63	573676	191111	38.5	31.9	24.7	25.3	27.4	-2.88	
O_73	568691	190015	41.4	34.2	27.3	27.0	25.0	-4.01	
V_74	568643	190013	38.8	40.5	29.0	30.2	29.1	-2.97	
O_77	567968	189747	34.7	31.4	29.0	29.8	30.0	-1.11	
N_17	567980	189788	-	30.7	27.9	27.6	27.0	-1.15	
N_25	573604	191443	-	-	29.5	24.6	26.7	-1.41	
N_27	572843	190363	-	-	25.8	25.7	27.8	0.97	
N_31	572979	190716	-	31.8	25.1	25.5	23.1	-2.57	
N_41	574104	191044	-	35.4	27.1	30.0	28.7	-1.70	
N_56	568852	189347		35.8	29.5	28.7	29.8	-1.87	
N_57	570453	189806	-	35.7	29.4	28.6	26.6	-2.83	
N_93	566046	189937	-	-	26.0	25.6	25.0	-0.47	
N_95	573488	191116	-	-	24.1	26.5	22.7	-0.72	

Table E3 Group 2 (Remove): Sites below 30.4 µg/m3 for at least 3 years with a low risk of exceedance, but no clear downward trend

ID	X	Y	Annual Mean NO_2 Concentration (µg/m^3)					Slope (µg/m^3)	Justification
			2018	2019	2020	2021	2022		
O_76	567975	189740	-	-	29.0	29.6	29.6	0.27	3x years consistently below 30.4 µg/m^3. Low risk of exceedance, as concentrations between 2020 and 2022 do not show any indication of increasing to greater than 40.4 µg/m^3.
N_28	573470	190521	-	-	25.3	23.7	27.0	0.86	
N_52	571839	189048	-	-	24.5	23.3	25.0	0.23	
N_90	573098	191210	-	-	24.5	23.2	25.1	0.32	

Table E4 Group 3 (Remove): Other locations to be removed

ID	X	Y	Annual Mean NO_2 Concentration (µg/m^3)					Slope (µg/m^3)	Justification
			2018	2019	2020	2021	2022		
N_14	569299	189825	-	37.0	30.8	32.8	32.9	-1.02	This location is near (<6m away) to O_68, which has higher concentrations and a longer monitoring history. No benefit is gained from retaining N_14.
N_21	576079	190173	-	16.8	14.8	13.3	13.2	-1.22	This is a background location and is closely located to O_83, which has a longer monitoring history. No benefit is gained from retaining this site.

ID	X	Y	Annual Mean NO_2 Concentration (µg/m³)					Slope (µg/m³)	Justification
			2018	2019	2020	2021	2022		
N_91	572790	191165	-	-	33.5	30.5	29.8	-1.88	Monitoring at this location has been in the low 30s or below 30 µg/m3 for the past 3 years, with a downward trend in that period. Nearby site N_90 is proposed to be removed too and also has a low risk of exceedance.
N_92	566167	189990	-	-	32.3	30.2	32.3	0.02	Monitoring at this location has been in the low 30s µg/m3 for the past 3 years. Nearby site N_93 is proposed to be removed too and also has a low risk of exceedance.
N_96	571666	189394	-	-	-	-	15.7	-	This site was co-located with the background AQS1 sensor on Havalon Close. The AQS1 unit is being removed, so there is no benefit to retaining this location.

Table E5 Group 4 (Retain): Sites that meet the criteria to be removed, but are to be retained

ID	X	Y	Annual Mean NO_2 Concentration (µg/m³)					Slope (µg/m³)	Justification
			2018	2019	2020	2021	2022		
V_72	569033	190055	34.6	34.6	25.5	29.2	27.1	-2.04	Sited on the A127 near the FoW roundabout, which is an area of interest.

Table E6 Group 6 (Retain): Locations to retain that do not meet the criteria to be retained

ID	X	Y	Annual Mean NO_2 Concentration (µg/m^3)					Slope (µg/m^3)
			2018	2019	2020	2021	2022	
O_1	567230	190222	45.8	44.3	43.3	38.0	38.3	-2.13
O_2	567820	190082	40.7	35.5	34.6	30.7	33.3	-1.95
O_5	568193	190026	65.5	54.0	50.5	53.1	51.9	-2.81
O_6	568487	190037	60.3	55.1	53.0	51.6	49.5	-2.50
O_7	568572	190039	63.7	61.8	47.8	51.0	49.3	-3.97
O_8	569018	190087	64.9	51.3	40.7	42.0	43.8	-5.16
O_13	571512	190978	49.1	44.1	39.8	38.1	40.1	-2.39
O_14	571896	191043	56.4	53.7	55.7	45.0	44.7	-3.23
O_16	574668	190971	35.8	35.0	33.5	29.7	30.4	-1.60
V_19_FG3	577845	190842	35.9	39.2	31.3	28.0	29.0	-2.51
O_59	577832	190794	43.1	35.1	27.9	34.9	34.5	-1.75
V_60_FG2	577273	190765	44.2	35.4	31.6	33.8	35.1	-1.99
O_64	571899	191011	57.5	49.9	43.2	44.1	32.8	-5.52
O_65	571558	190961	62.6	49.4	42.8	44.0	42.3	-4.59
O_67	569414	190171	76.8	61.2	54.7	56.3	54.6	-4.93
O_68	569297	189830	42.9	37.2	32.0	35.6	38.3	-1.08
O_75	568292	190001	46.6	36.0	35.5	36.9	36.5	-1.92
O_79	567195	190192	67.7	50.7	45.3	50.3	49.9	-3.59
O_83	576076	190172	17.0	16.5	15.0	14.0	13.1	-1.02
N_1	566976	190203	-	67.8	48.4	50.4	51.2	-4.80
N_2	567438	190203	-	-	29.8	33.6	34.2	2.21
N_6	571686	191012	-	69.2	47.1	49.4	48.7	-5.93
N_13	571703	190990	-	53.5	40.1	45.5	35.5	-4.86
N_16	567988	189780	-	-	28.5	28.2	31.9	1.71

ID	X	Y	Annual Mean NO_2 Concentration (µg/m^3)					Slope (µg/m^3)
			2018	2019	2020	2021	2022	
N_18	567209	190184	-	34.3	31.3	32.3	33.4	-0.15
N_22	573192	190990	-	48.6	37.3	38.5	41.0	-2.17
N_24	573224	190943	-	38.5	34.4	37.2	38.0	0.13
N_26	572851	190339	-	-	27.2	30.5	31.2	2.00
N_29	573231	190755	-	50.4	51.0	49.0	54.0	0.86
N_30	573199	190617	-	43.6	32.4	36.5	37.1	-1.52
N_32	569540	189551	-	37.8	32.7	34.4	35.5	-0.52
N_33	569525	189571	-	-	31.4	32.1	33.0	0.80
N_34	569257	190123	-	48.2	38.1	42.2	40.4	-1.93
N_35	569237	190101	-	52.7	43.2	45.1	47.4	-1.40
N_36	569225	190079	-	39.1	32.6	35.9	33.4	-1.39
N_38	568342	190003	-	43.2	34.6	39.2	40.2	-0.47
N_39	568266	190028	-	68.8	56.4	58.5	61.4	-2.01
N_40	575126	190927	-	36.0	30.3	34.7	32.2	-0.69
N_44	578097	191280	-	42.0	41.3	38.5	39.8	-0.92
N_46	574167	188130	-	-	37.2	34.8	34.7	-1.25
N_49	572052	186836	-	41.4	37.1	38.6	38.5	-0.70
N_58	570438	189834	-	40.8	34.2	33.5	33.4	-2.28
N_59	570432	190561	-	48.9	37.2	35.7	35.0	-4.32
N_60	570094	190391	-	47.1	35.6	36.7	36.7	-2.99
N_65	573154	190084	-	39.5	31.8	33.6	31.3	-2.27
N_71	569301	190168	-	46.3	35.8	33.5	29.5	-5.25
N_72	569312	190141	-	65.8	47.0	54.6	51.5	-3.54
N_73	569196	190104	-	-	31.1	34.7	32.3	0.58
N_74	569228	190147	-	-	36.5	36.1	36.8	0.14

ID	X	Y	Annual Mean NO_2 Concentration (µg/m³)					Slope (µg/m³)
			2018	2019	2020	2021	2022	
N_75	569256	190064	-	-	33.4	36.6	35.4	0.96
N_77	569269	189923	-	37.1	30.1	32.5	34.0	-0.70
N_78	569220	190106	-	50.0	41.9	45.3	45.1	-1.15
N_79	573244	191258	-	42.2	35.3	35.3	35.8	-1.94
N_80	573250	191090	-	45.1	39.1	40.6	44.7	0.04
N_81	573222	191052	-	37.7	32.3	34.9	33.9	-0.87
N_82	573221	190916	-	43.2	36.1	35.3	37.2	-1.91
N_83	573230	190813	-	46.2	44.6	41.9	45.8	-0.38
N_84	573227	191003	-	39.9	35.5	34.4	34.4	-1.76
N_85	573181	191093	-	43.2	37.3	35.8	37.2	-1.94
N_86	573192	191058	-	41.7	33.4	35.5	38.8	-0.67
N_87	573190	191026	-	45.8	36.3	37.1	39.1	-1.92
N_88	573223	190974	-	49.4	43.4	46.8	44.1	-1.25
N_89	573196	190841	-	58.2	53.7	56.8	53.0	-1.22
N_42b	579011	190277	-	-	-	48.3	43.6	-
N_Coloc	568654	190045	-	-	-	-	32.3	-
FG_1	578291	190645	-	-	21.9	24.7	25.5	1.78
FG_7	578150	190699	-	-	22.1	24.9	27.5	2.73
N_94	573321	191117	-	-	18.1	28.7	28.6	5.26

Appendix F: Partial Dependency Plots & Polar Plots for All AQS1 Monitoring Locations

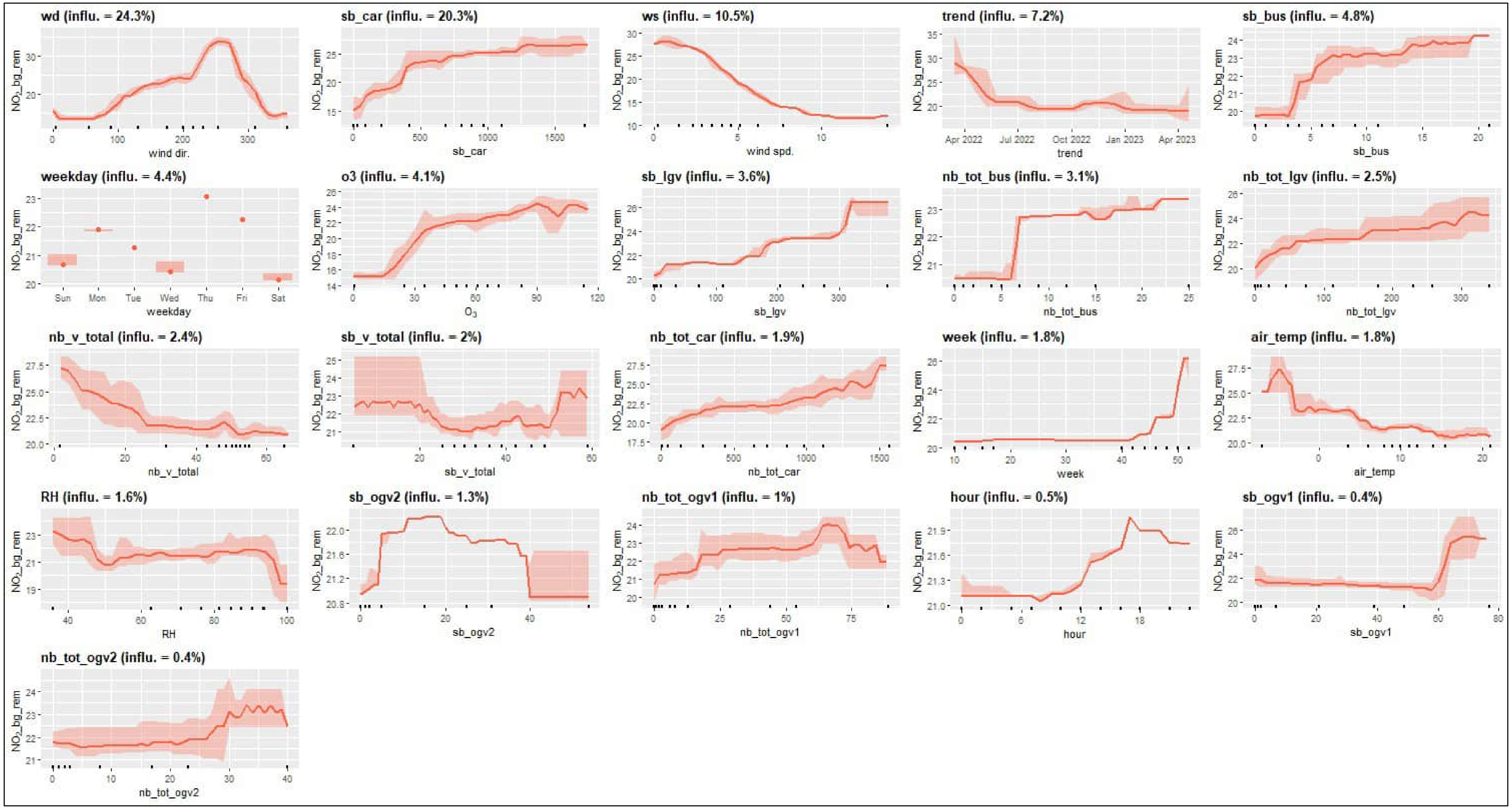

Figure F1 – AQ1 Partial Dependency Plots

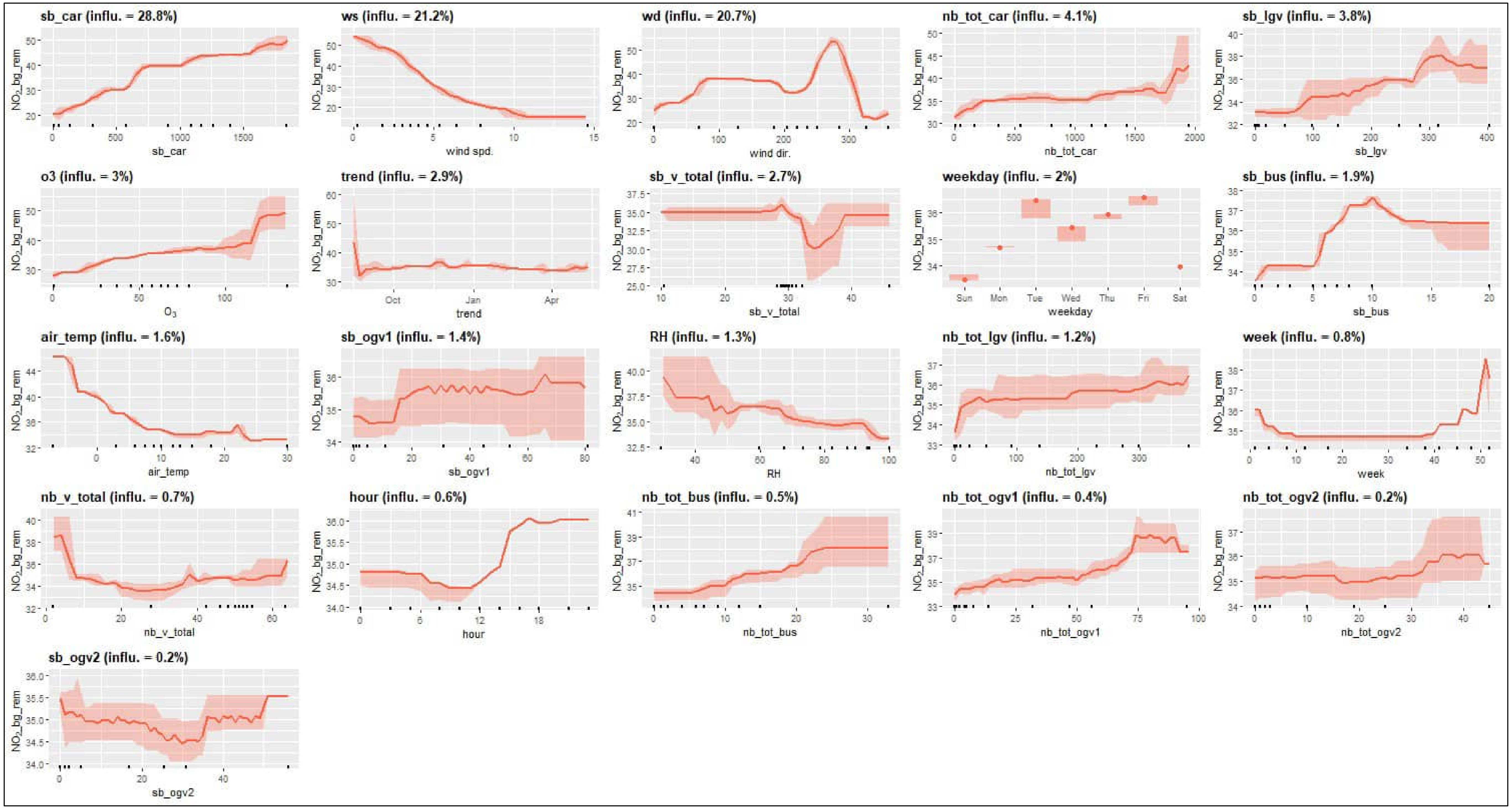

Figure F2 – AQ2 Partial Dependency Plots

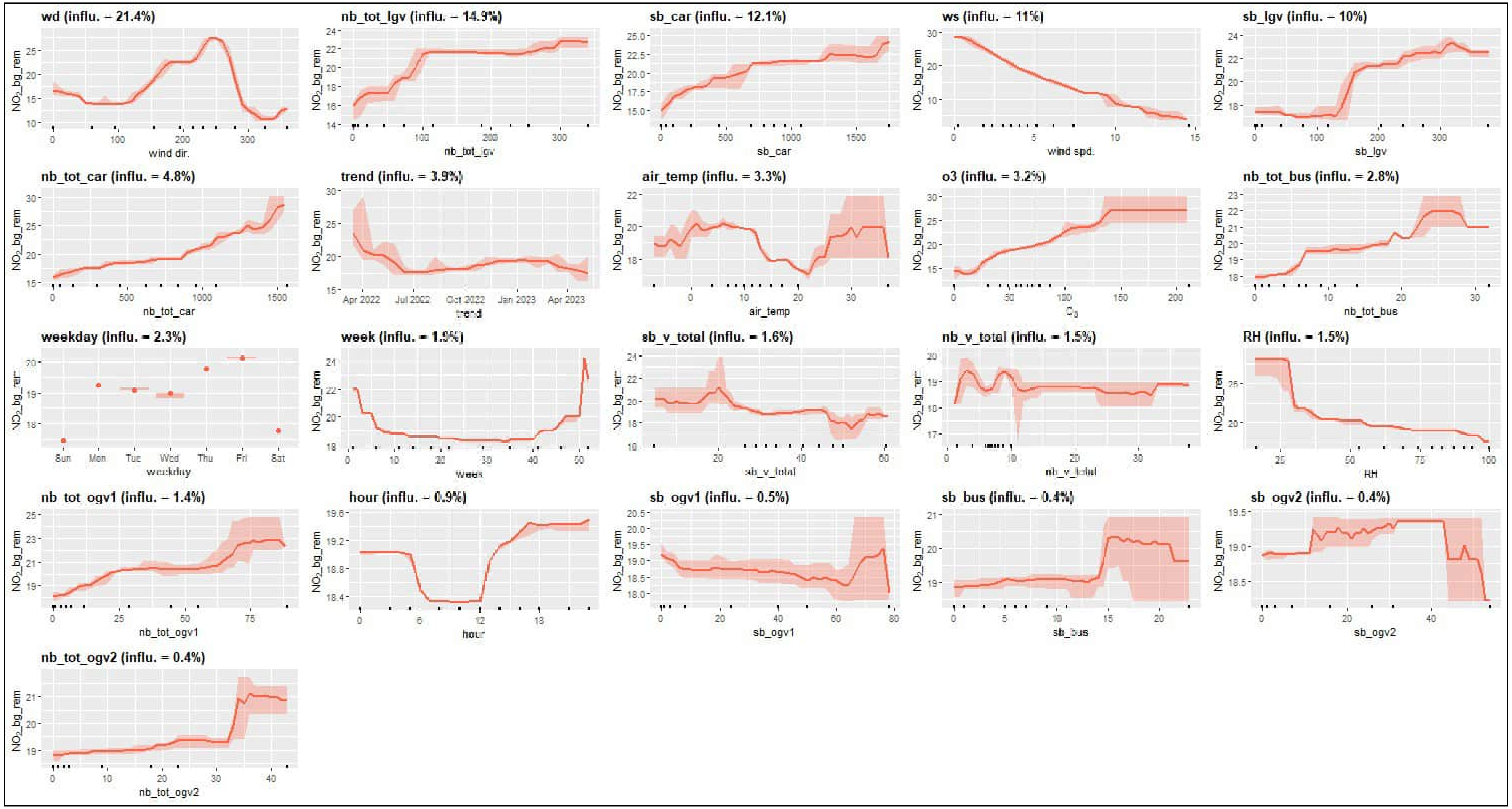

Figure F3 – AQ3 Partial Dependency Plots

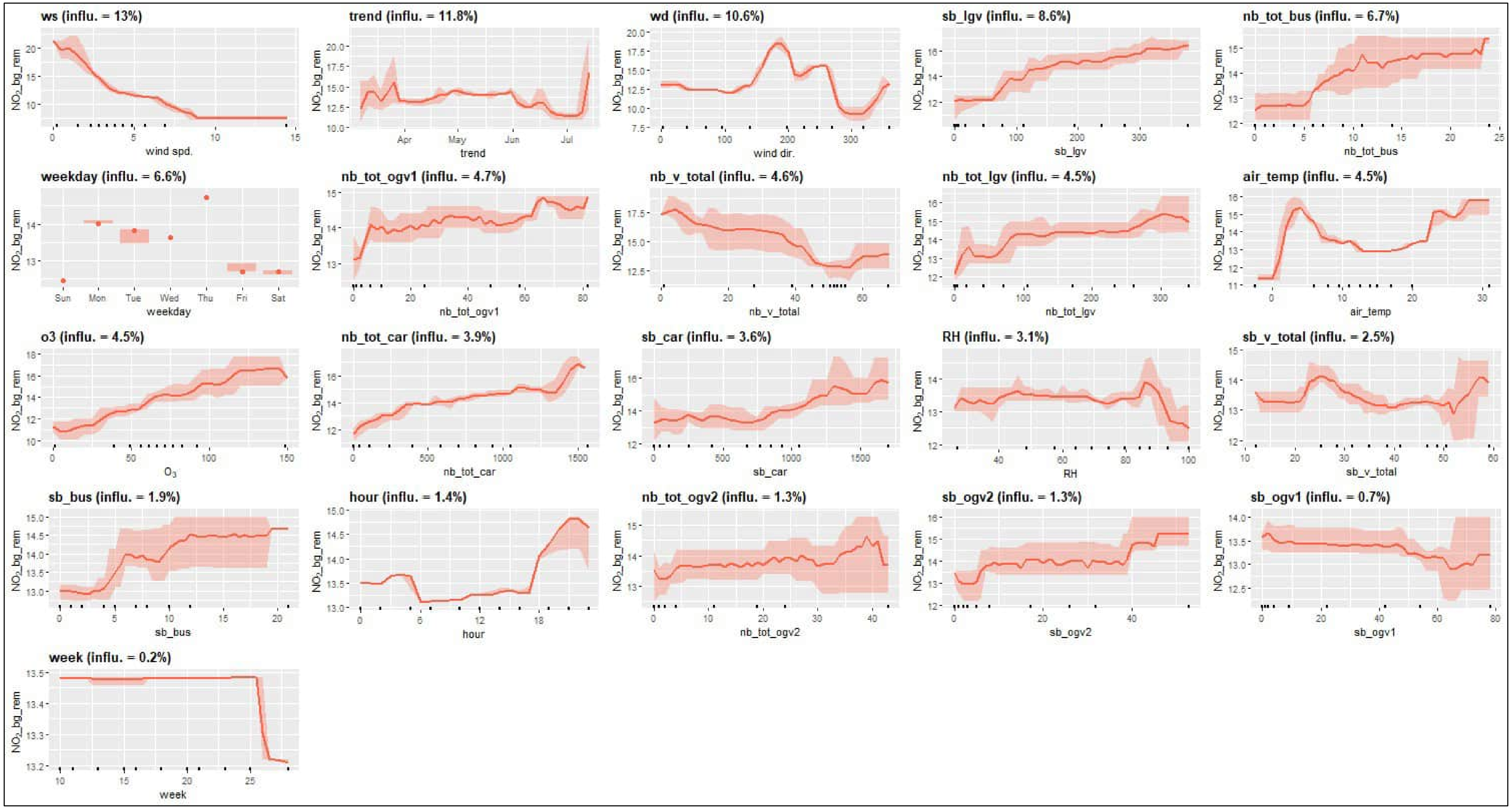

Figure F4 – AQ4 Partial Dependency Plots

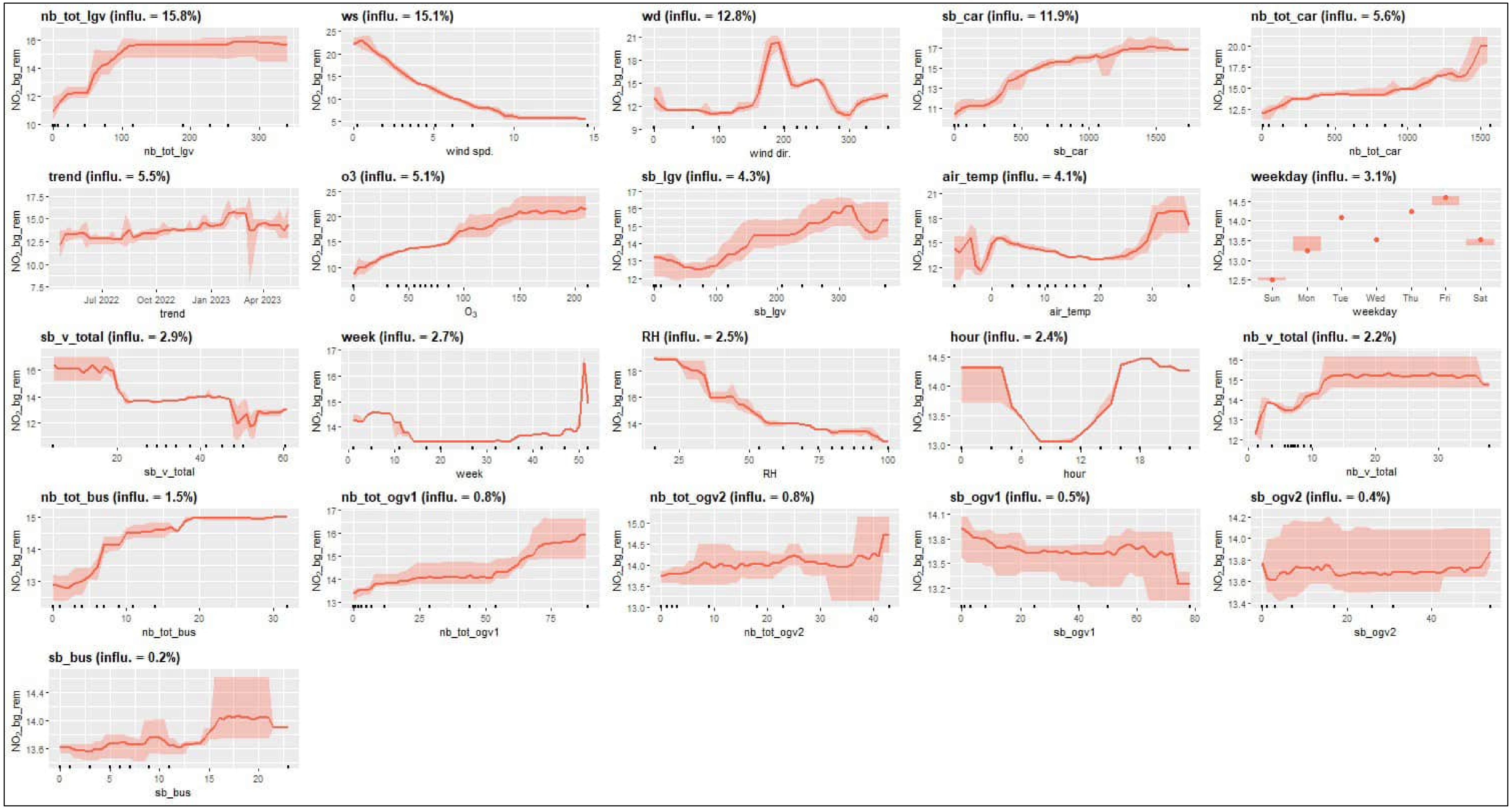

Figure F5 – AQ5 Partial Dependency Plots

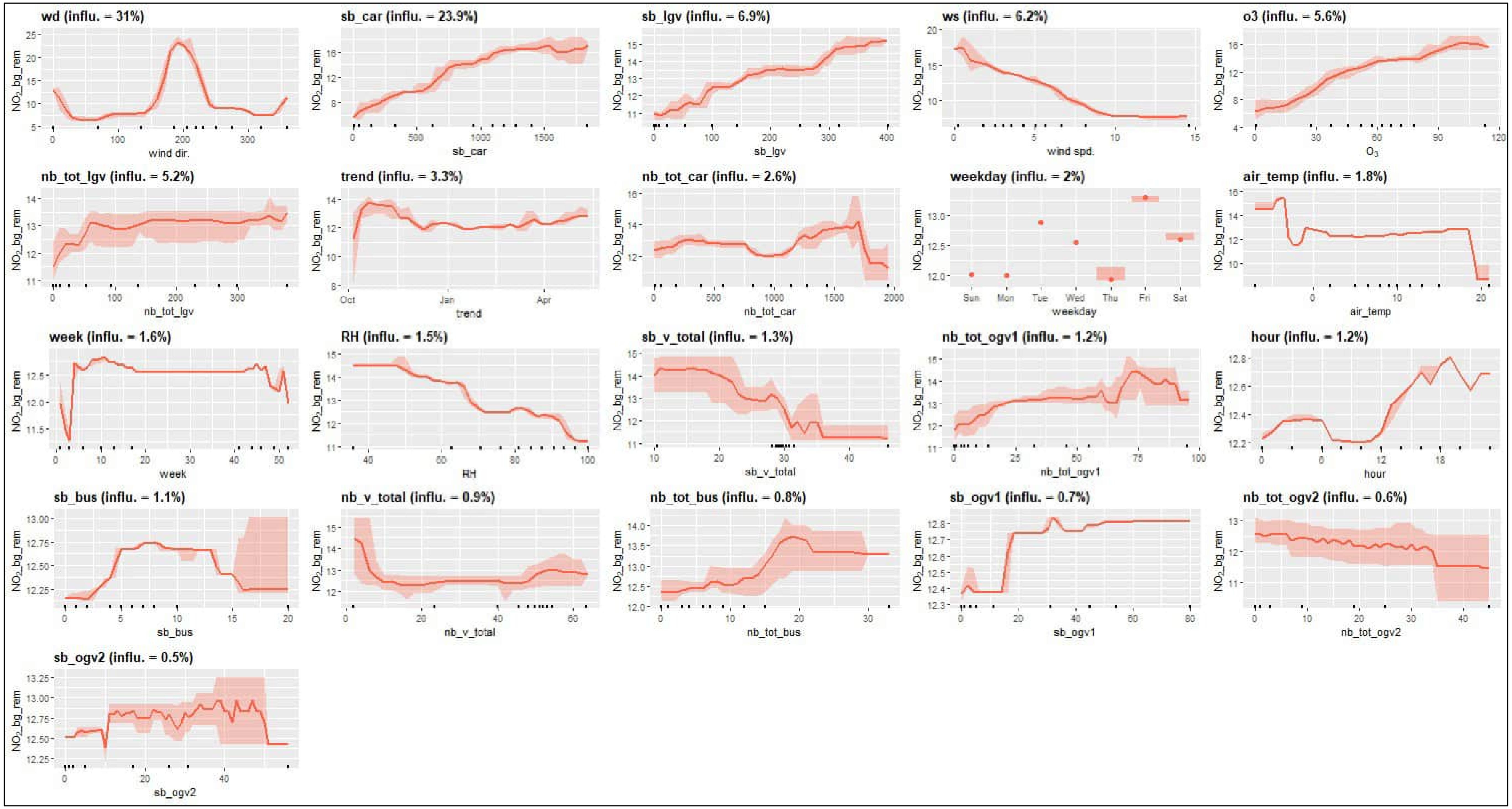

Figure F6 – AQ6 Partial Dependency Plots

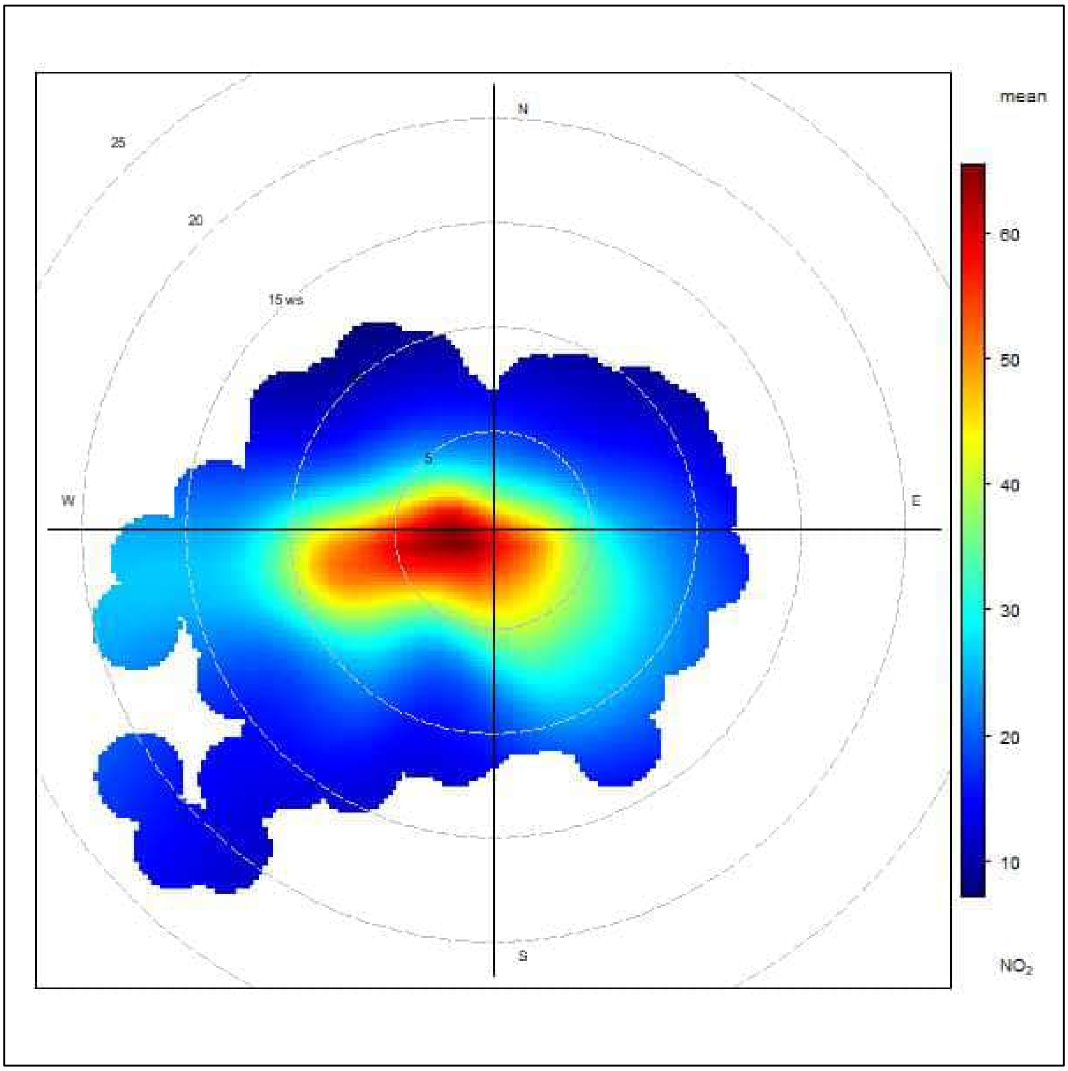

Figure F7 – AQ1 Polar Plot

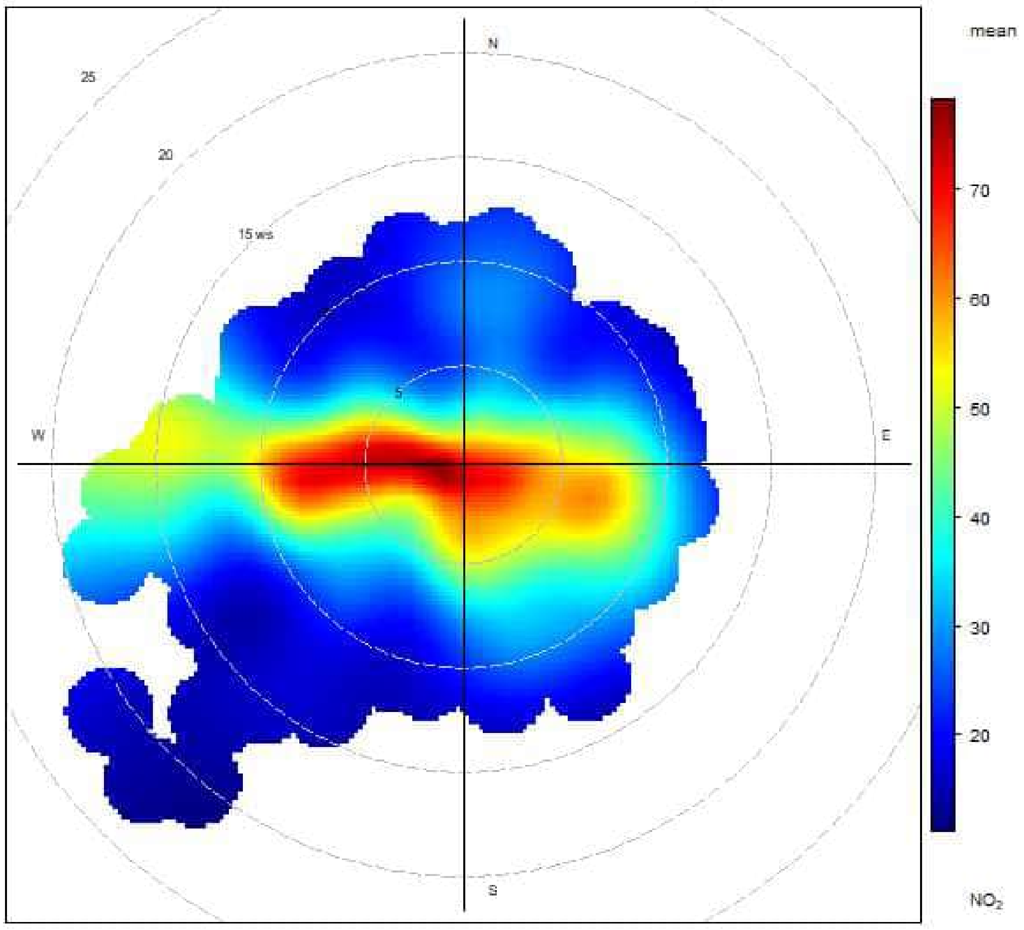

Figure F8 – AQ2 Polar Plot

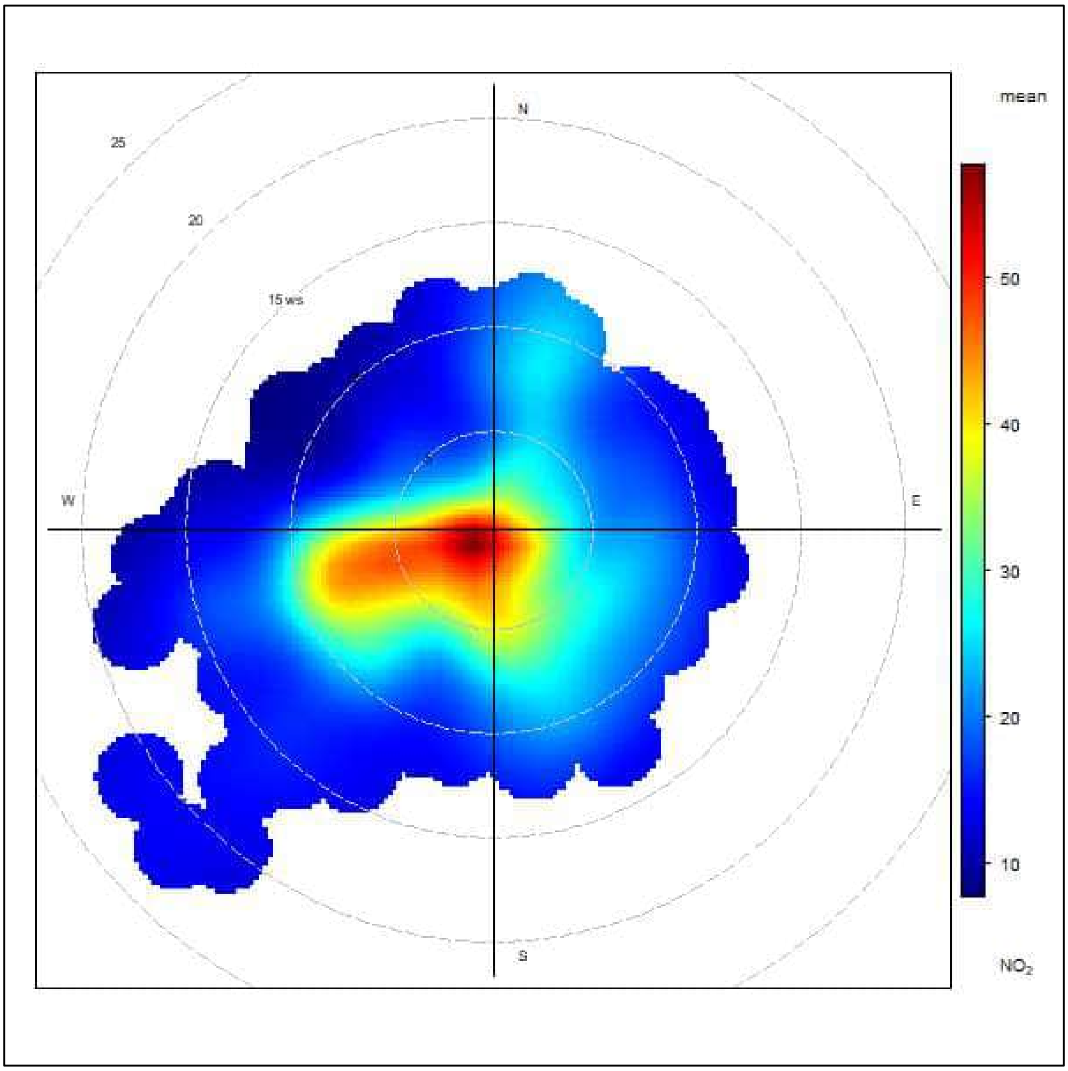

Figure F9 – AQ3 Polar Plot

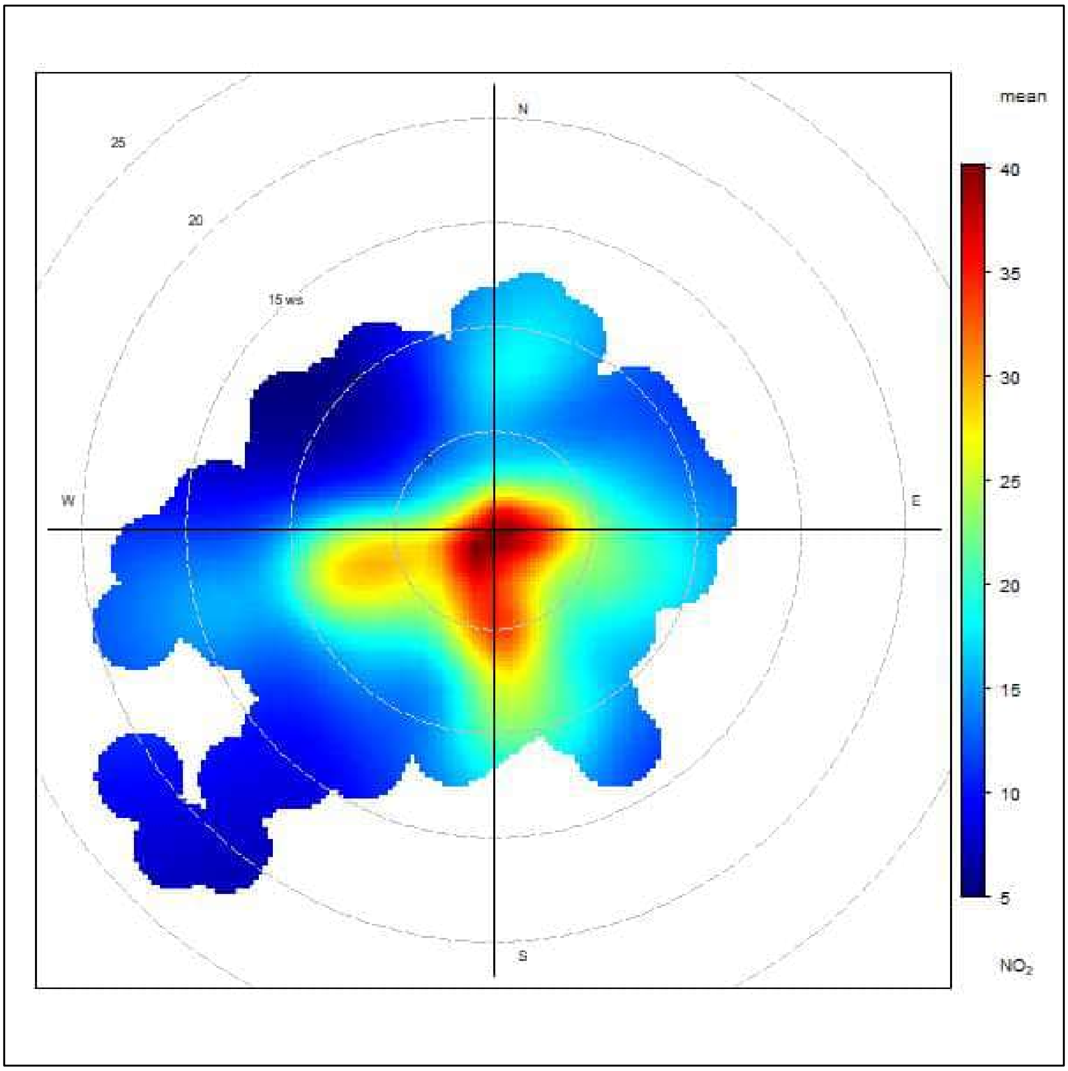

Figure F10 – AQ4 Polar Plot

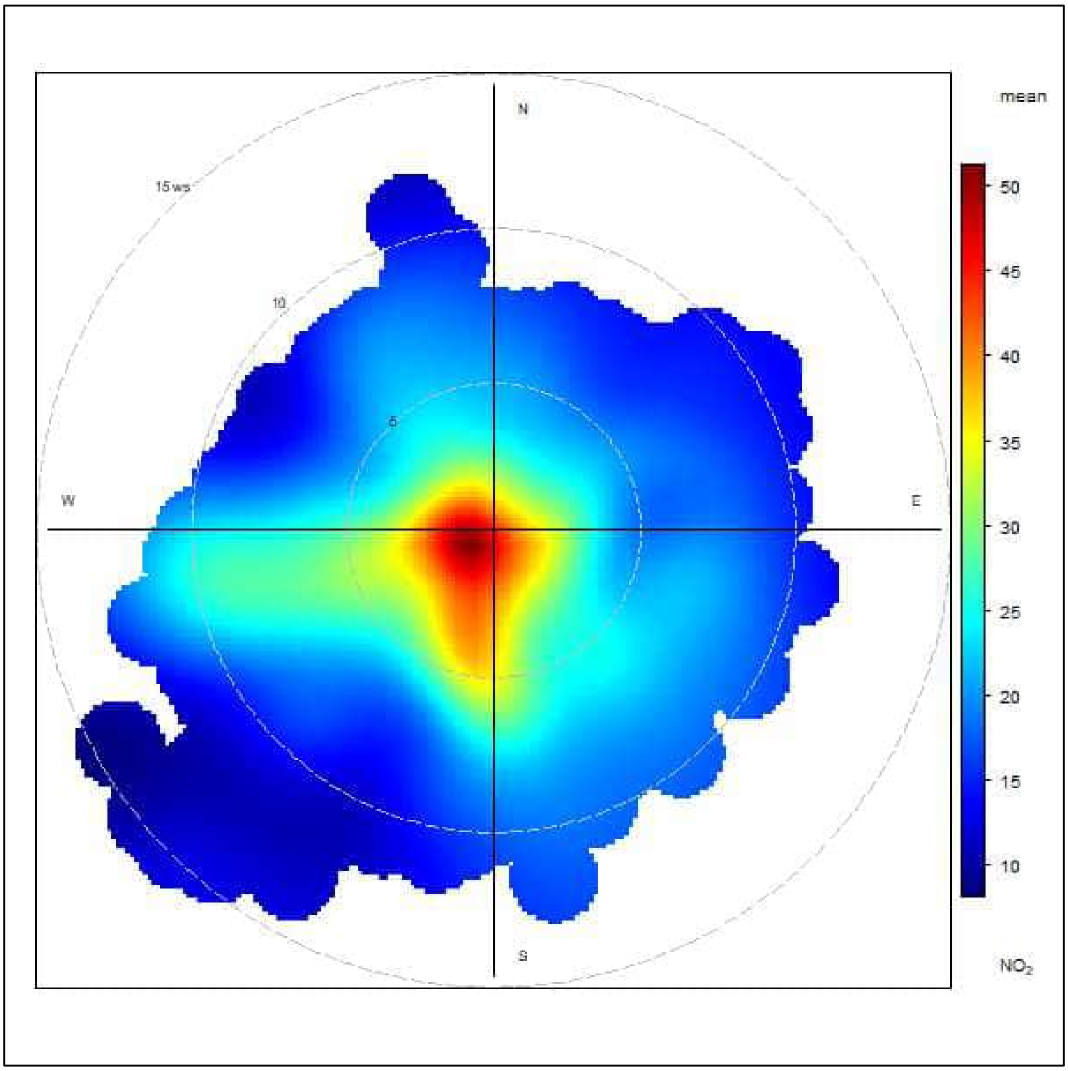

Figure F11 – AQ5 Polar Plot

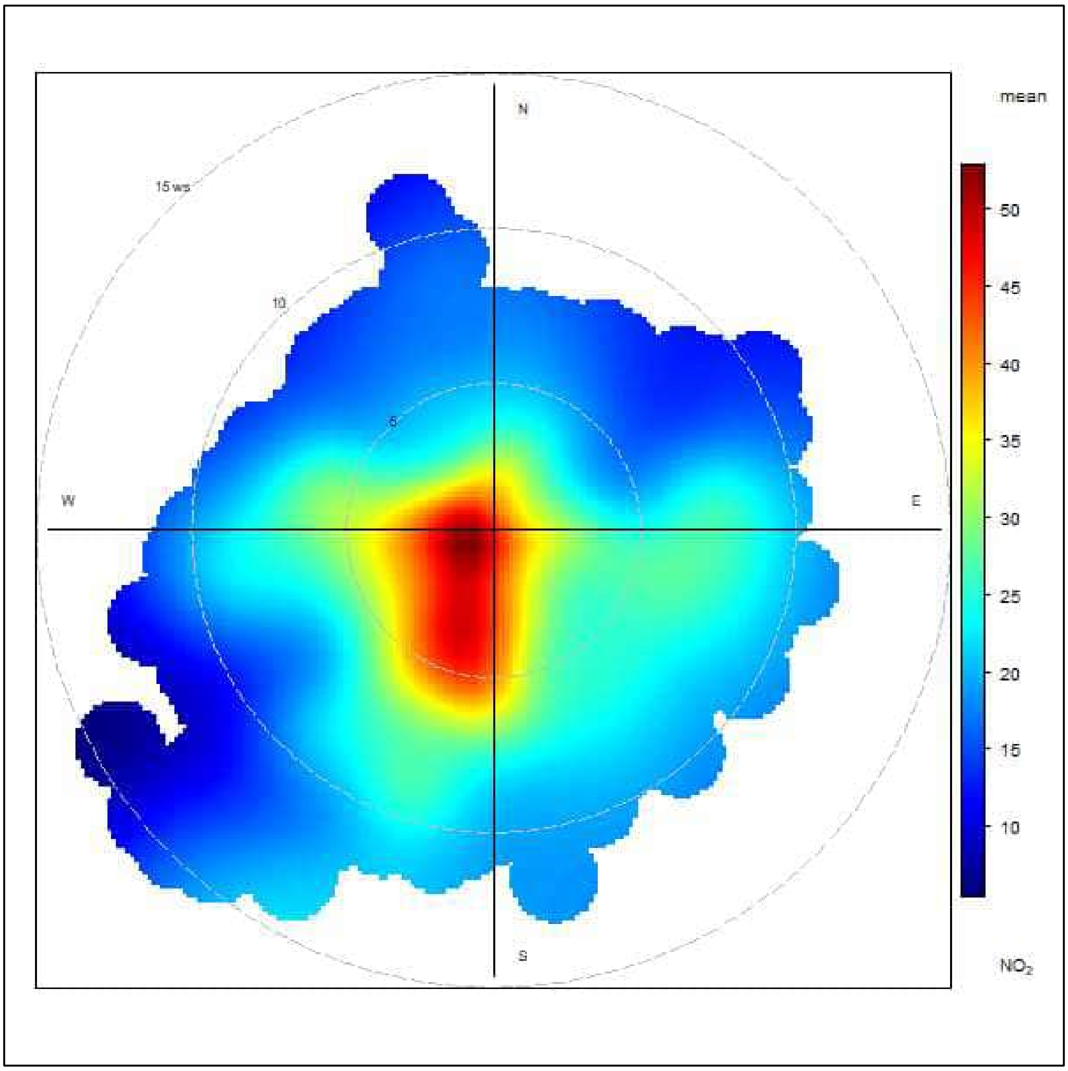

Figure F12 – AQ6 Polar Plot

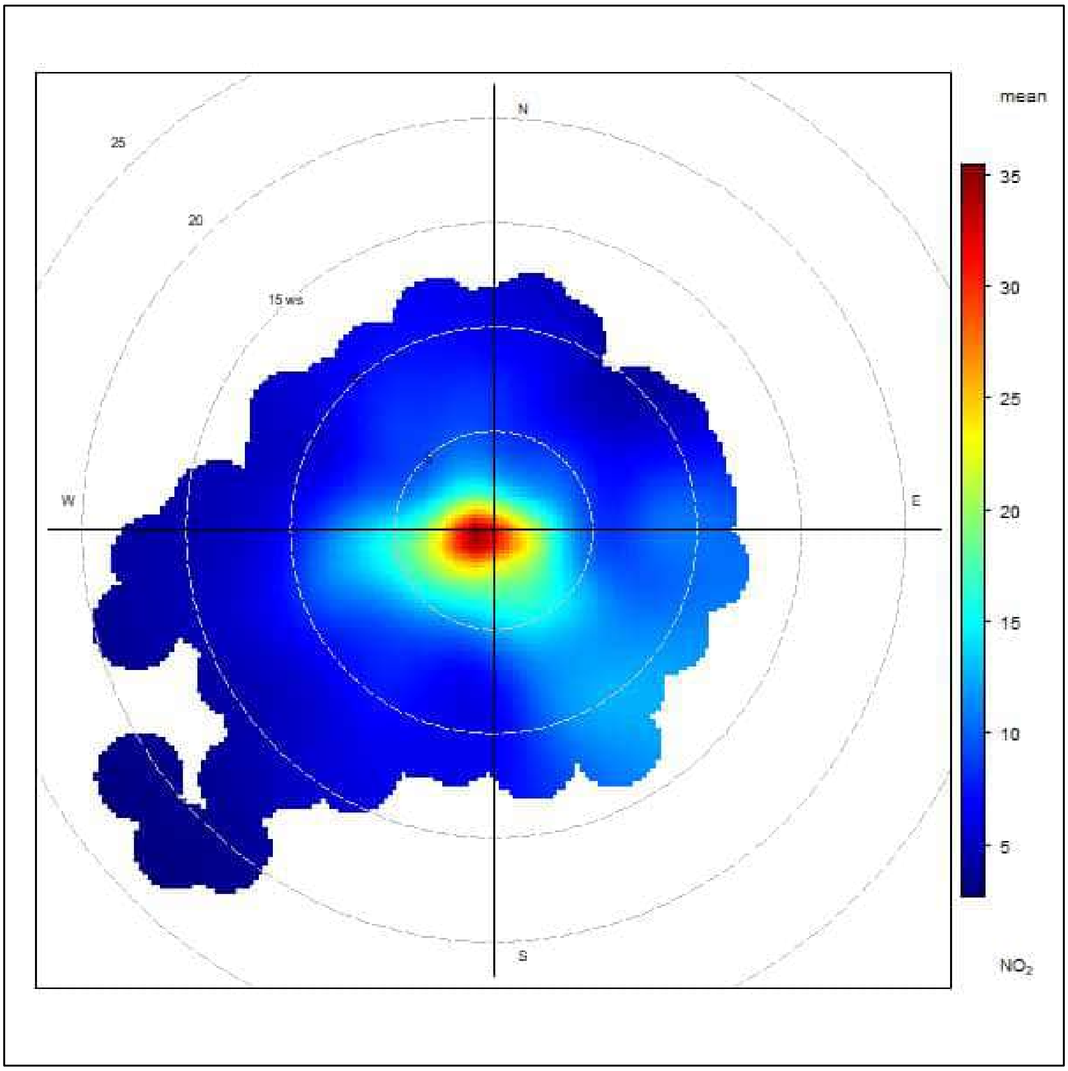

Figure F13 – AQ BG Polar Plot

Appendix G: Fortune of War Modelling Assessment Methodology

Reviewing the ITS Emissions Data

Emissions data from the Institute for Transport Studies (ITS) study of the 50 mph speed management measure were analysed to identify an appropriate free flowing steady state segment of the road network to be used as the ideal proxy link to replicate the impact of removing the chicane at the Fortune of War. The working assumption is that "straightening out" the chicane would improve traffic flow conditions to a free-flowing state, whereby speed and acceleration would be steady and constant. These conditions result in lower emissions, therefore modelling these conditions for a new scenario where the chicane is "straightened out" would enable the high-level evaluation of such an intervention. It should be noted that this would be an ideal situation. In practice, a new straightened junction would still be affected by traffic from the adjoining roads and slip ways.

The data analysed were based on drive cycle data which were applied to the PHEM instantaneous emissions model. The resulting emission points were mapped to road links using GIS to identify common characteristics of a free-flowing link in terms of speed and acceleration. The relationship between speed, acceleration and NO_x emissions is presented in Figure G1 for each link across the study.

The aim was to identify a link that demonstrates:

- a consistent speed profile
- a consistent acceleration profile with little to no acceleration or deceleration i.e. steady state
- low and consistent emissions profile
- similar gradient to the FoW study area; and
- close proximity to the FoW study area.

The link that was chosen as the ideal free flowing link based on the criteria above was 10405_10506d.

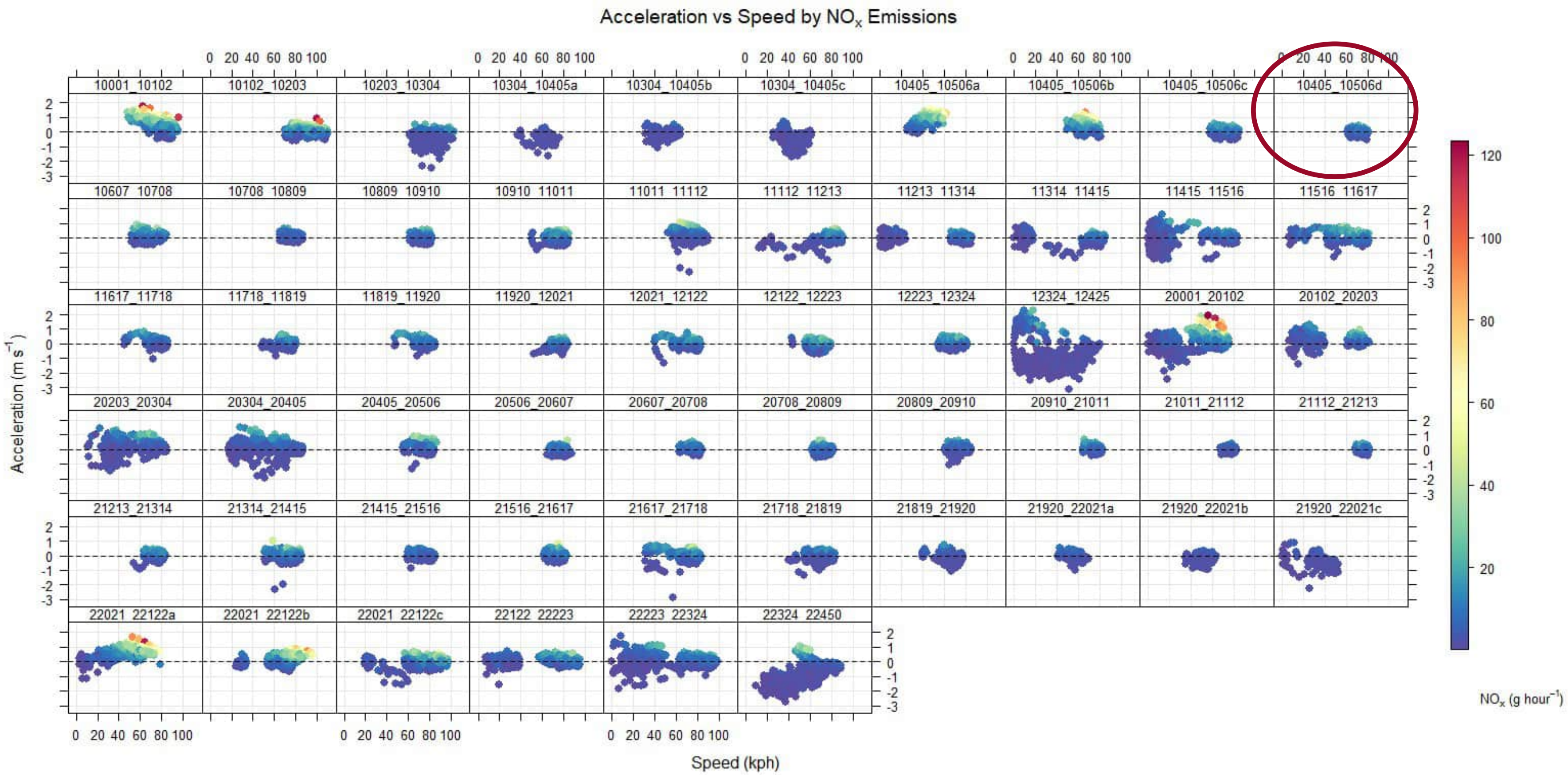

Figure G1: Relationship between vehicle Acceleration, Speed and associated NOx emissions from the ITS data plotted by link

Air Quality Dispersion Modelling Process

Model Software

The ADMS-Roads model has been developed by Cambridge Environmental Research Consultants Ltd and is a version of an atmospheric modelling system that focuses on road traffic as a source of pollutant emissions. Version 5.0 (January 2022) has been used for this study.

The pre-existing ADMS-Roads models used in the evaluation of the East Mayne Final Business (FBC) study were modified for use in this study. The emissions data within the models have been modified by factoring based on the relativity of the various comparisons made between road links using the ITS emissions data. This is described further in the following sections.

The initial emission rates used in the assessment take into account the emissions produced by light duty and heavy-duty vehicles (LDV and HDV, respectively) travelling at a certain speed along a section of road over an average day. It should be noted the assumptions made regarding factoring assume emissions from LDVs and HDVs are impacted in the same way by changing emissions from a congested/accelerating state to a free flowing one. ADMS-Roads predicts the dispersion of these emissions using appropriate historical meteorological data. The effect of meteorological conditions on dispersion is given a complex treatment within the model. The most significant factors are wind speed and direction, and the boundary layer height, which is the calculated mixed depth of the lower atmosphere.

The daily average emission rates are distributed across each hour of the day and day of the week with use of a time factoring emissions file which factors the average emission rate up or down, based on a typical traffic profile e.g. elevated emissions in the AM peak when traffic flows are typically higher. An average three day flow profile for 2021 was obtained from the DfT TRA03037 Database[15]. The difference in the profile is presented in Figure G2, where 1 is equal to the average hour across the week.

[15] Department for Transport, 2023. Road traffic statistics (TRA): TRA0307 Traffic distribution on all roads by time of day and day of the week in Great Britain. Available at: https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra#annual-daily-traffic-flow-and-distribution-tra03

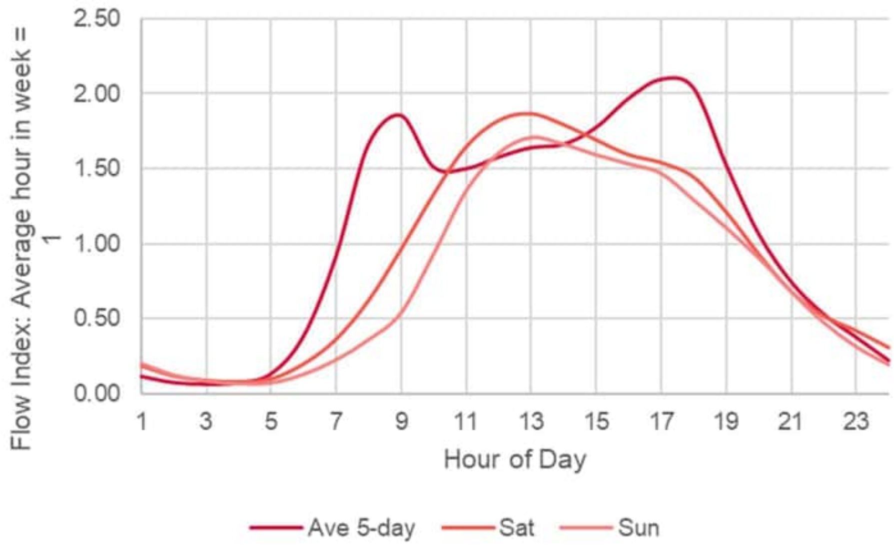

Figure G2: Traffic distribution by time of day on all roads in Great Britain, 2021

Modelled Scenarios

In order to quantify the air quality impact of the proposed scheme, the pollutant concentrations resulting from the emissions from existing road traffic on local roads have been compared to those resulting from predicted traffic emissions with the Proposed Scheme in place.

The following scenarios were modelled:

- Modelled Base/Do-minimum (2022) – current situation without Proposed Scheme; and
- Modelled Do-something (2022) – with Proposed Scheme i.e. assumed “straightened out” junction.

Background Concentrations

The background concentration used in this assessment was taken from the background diffusion tube O_83, which monitored a concentration of 12.5 µg/m^3 in 2022.

Road Parameters

The ADMS-Roads model requires lengths of road of equal width to be input into the model. Road alignment and width were determined using the OS MasterMap base mapping within ArcGIS, as per the FBC assessment.

Modelled Emissions Data

The existing East Mayne FBC dispersion models and traffic data inputs were used to produce a subset for the Fortune of War study area which consisted of an area approximately 400m from the junction.

Emission factors for 2022 in the East Mayne FBC were used for the do-minimum and do-something modelling. The emissions used in the modelling were factored once a suitable free flowing link was identified using the ITS data (see above). The assumption being that each emission rate in the existing model would be factored based on the same link's ITS emission data relationship relative to the free flowing link that would be representative of a "straightened out" do-something scenario. For the do-minimum, it was assumed the FBC modelled emission rate remained the same for the "free-flow" link (10405_10506d), and the emission rate on each other link in the model was factored based on the difference in real world ITS emission data relative to the "free-flow" link (10405_10506d). For the do-something each link in the model was modelled with the emission rate equal to the free flowing link, as the theoretical aim of the scheme would be to achieve free flowing conditions on either side of the road equal to link 10405_10506d. The modelled emission rates are shown below in Table G1. Where a link is excluded from Table G1, it was modelled as per the FBC assessment, as ITS emissions data did not exist for that link. It was assumed that NO_2 emissions were factored in the same way as NO_x emissions.

The modelled network for the Base/Do-minimum and Do-something scenarios are presented in Figure G3 and Figure G4 respectively, which show the modelled links in relation to modelled receptors, with key A127 links labelled.

Table G1 Emission Rates used in the Modelling Exercise

Link ID	FBC Modelling		ITS Data		Do-Minimum		Do-Something	
	NO_x **Emission Rate (g/km/s)**	NO_2 **Emission Rate (g/km/s)**	NO_x **Emission Rate (g/hr)**	Factor Relative to Free Flow Link	Revised NO_x **Emission Rate (g/km/s)**	Revised NO_2 **Emission Rate (g/km/s)**	Revised NO_x **Emission Rate (g/km/s)**	Revised NO_2 **Emission Rate (g/km/s)**
10304_10405a	0.1645	0.0417	2.4710	31%	0.0419	0.0108	0.1332	0.0344
10304_10405b	0.1645	0.0417	2.5021	32%	0.0424	0.0109	0.1332	0.0344
10304_10405c	0.1645	0.0417	1.9831	25%	0.0336	0.0087	0.1332	0.0344
10405_10506a	0.1579	0.0395	19.3690	246%	0.3281	0.0847	0.1332	0.0344
10405_10506b	0.1332	0.0344	19.5382	248%	0.3310	0.0855	0.1332	0.0344
10405_10506c	0.1332	0.0344	9.2508	118%	0.1567	0.0405	0.1332	0.0344
10405_10506d*	**0.1332**	**0.0344**	**7.8655**	**100%**	**0.1332**	**0.0344**	**0.1332**	**0.0344**
21819_21920	0.1372	0.0370	2.8013	36%	0.0475	0.0123	0.1332	0.0344
21920_22021a	0.1372	0.0370	4.1383	53%	0.0701	0.0181	0.1332	0.0344
21920_22021b	0.1372	0.0370	2.8360	36%	0.0480	0.0124	0.1332	0.0344
21920_22021c	0.1560	0.0406	2.1026	27%	0.0356	0.0092	0.1332	0.0344
22021_22122a	0.1723	0.0476	22.8864	291%	0.3877	0.1001	0.1332	0.0344
22021_22122b	0.1723	0.0476	21.4352	273%	0.3631	0.0938	0.1332	0.0344
22021_22122c	0.1723	0.0476	12.6107	160%	0.2136	0.0552	0.1332	0.0344

* Identified Free Flow Link

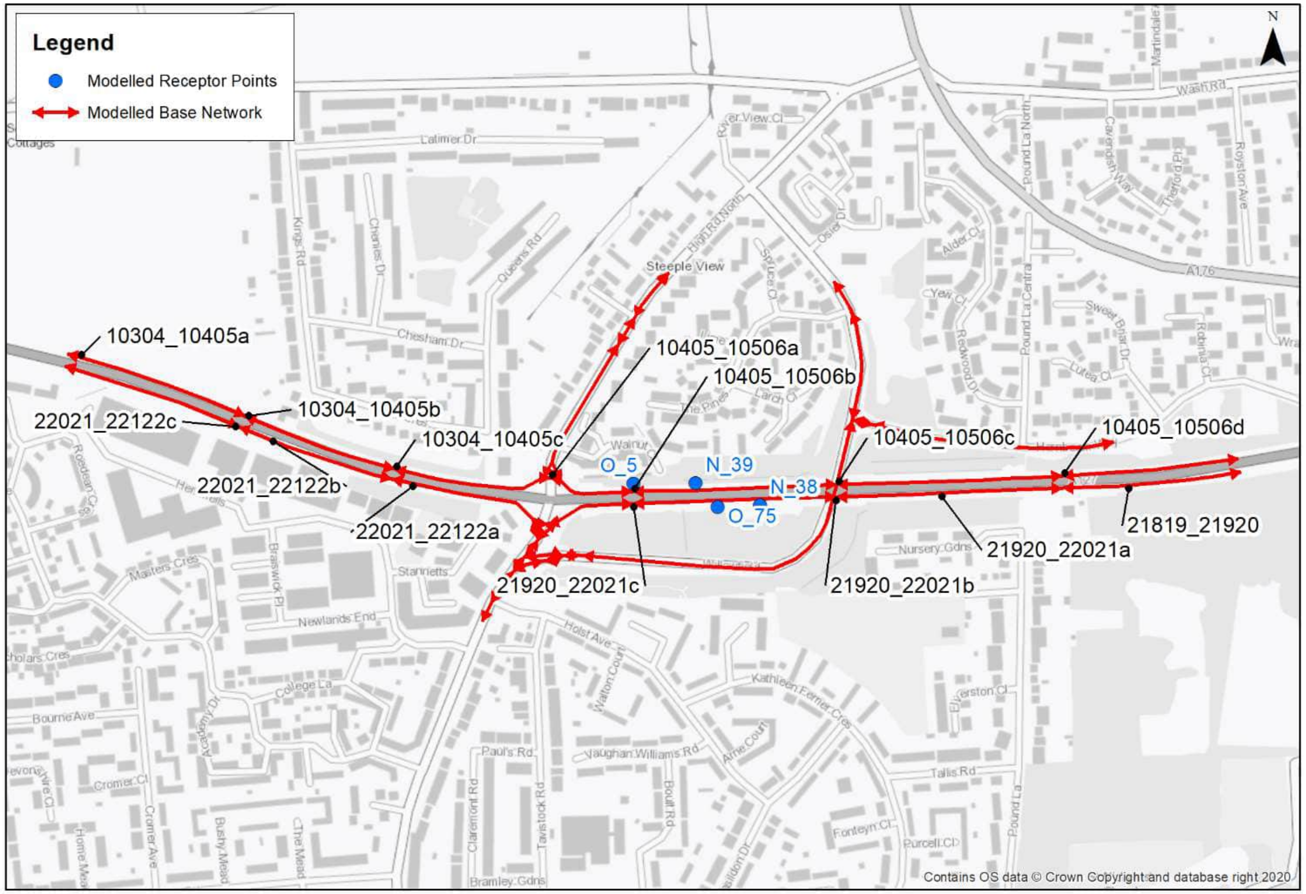

Figure G3: Modelled Base/Do-minimum Network

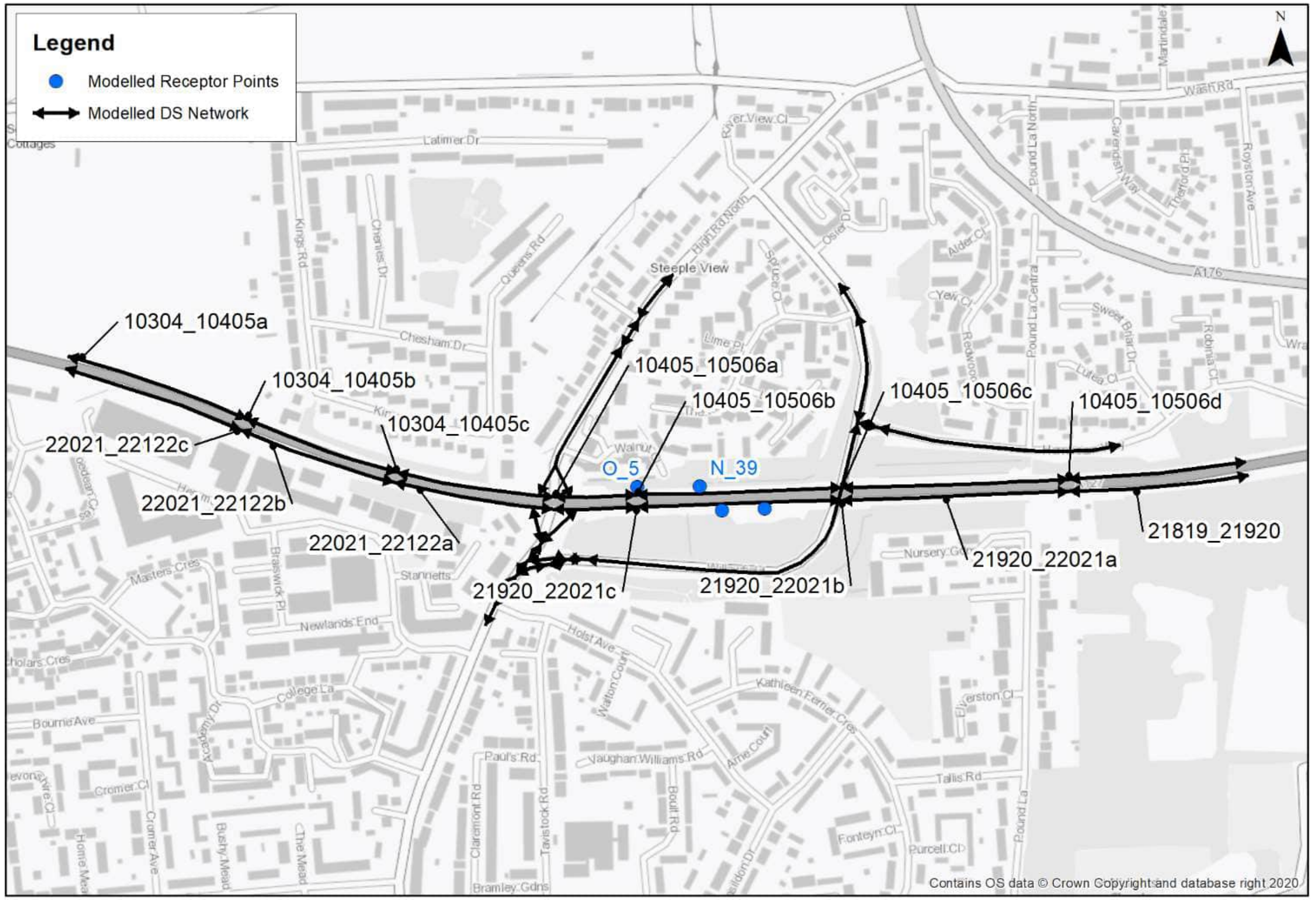

Figure G4: Modelled Do-something Network

Meteorological Data

In order to assess the impact of the Proposed Scheme upon local air quality using a dispersion model, it is important to use representative meteorological data. In simple terms, meteorology is the next most significant factor in determining ambient pollutant levels after emissions.

Meteorological data for the dispersion modelling assessment were taken from Southend Airport, which is considered to be the most representative source for the study area. The windrose for Southend Airport for 2021 is shown in Figure G5. It is noted that the modelled meteorological year (2021) does not match the year of monitoring selected for use in the verification process (2022). A brief comparison between 2021 and 2022 meteorological data showed little difference and it was determined it was more important to use the latest available monitoring data for the verification and scenario testing.

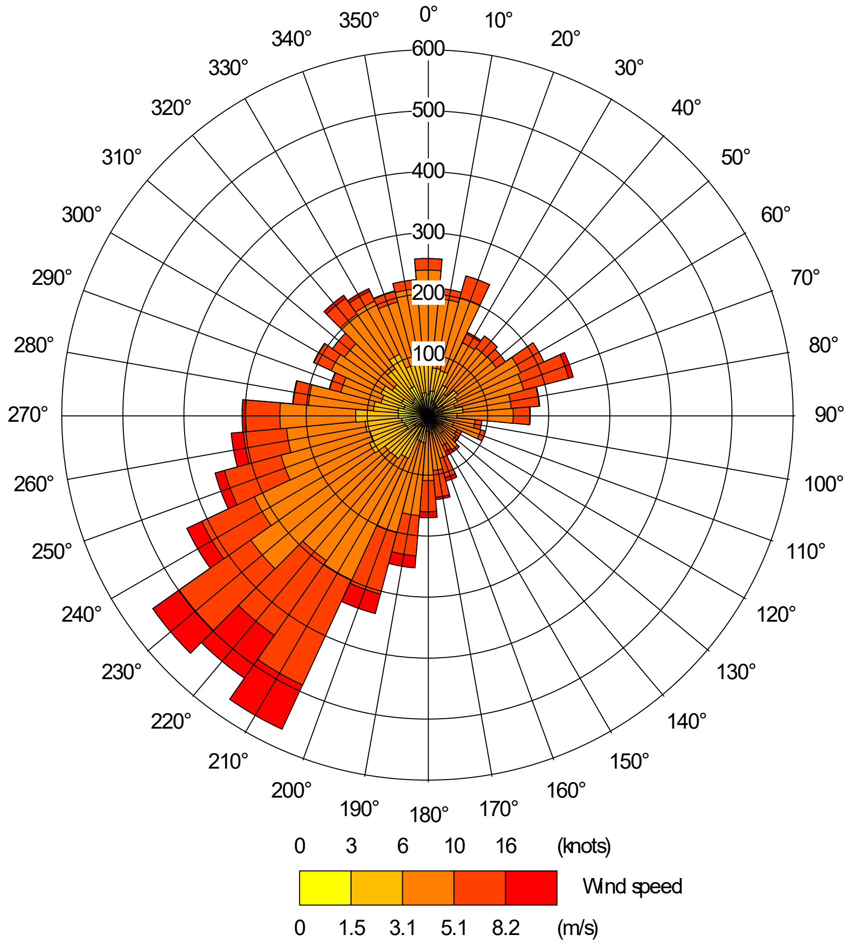

Figure G5: Southend Airport windrose 2021

Surface Roughness Length

The surface roughness length at the meteorological data site, where the wind speed measurements were taken, was set at 0.2 m, whilst for the dispersion site, it was set at 0.5 m to reflect the broadly parkland & open suburbia settings of the study area.

Monin-Obukhov Length

ADMS-Roads models use the Monin-Obukhov length as a parameter to describe the turbulent length scale which is dependent on meteorological conditions. A minimum length can be used to account for the urban heat island effect, whereby retained heat in cities causes convective turbulence, which prevents the formation of a very shallow boundary layer at night. A minimum Monin-Obukhov length of 10 m was set for the meteorological site and 30 for the dispersion site to again reflect the rural settings of the meteorological site and mixed urban/industrial setting of the air quality study area.

Modelled Receptors

The air quality monitoring sites O_5, O_75, N_38 and N_39 were modelled as receptors for the purposes of verification and evaluation of the proposed scheme.

Air Quality Model Verification and Adjustment

Introduction

The comparison of modelled atmospheric pollutant concentrations with local monitored concentrations is a process termed 'verification'. Model verification investigates the discrepancies between modelled and measured concentrations, which can arise due to the presence of inaccuracies and/or uncertainties in model input data, modelling and monitoring data assumptions. The following are examples of potential causes of such discrepancies.

- Estimates of background pollutant concentrations
- Meteorological data uncertainties
- Traffic data uncertainties
- Vehicle emission factors uncertainties

Model input parameters, such as 'roughness length'[16]

- Overall limitations of the dispersion model

Model Precision

Residual uncertainty may remain after systematic error or 'model accuracy' has been accounted for in the final predictions. Residual uncertainty may be considered synonymous with the 'precision' of the model predictions, i.e. how wide the scatter or residual variability of the predicted values compare with the monitored true value, once systematic error has been allowed for. The quantification of model precision provides an estimate of how the final predictions may deviate from true (monitored) values at the same location over the same period.

Model Performance

An evaluation of model performance has been undertaken to establish confidence in the modelled results. LAQM.TG(22) identifies a number of statistical procedures that are appropriate to evaluate model performance and assess uncertainty. The statistical parameters used in this assessment are:

- Root mean square error (RMSE)
- Fractional bias (FB)
- Correlation coefficient (CC)

A brief explanation of each statistic is provided in Table G2, and further details can be found in LAQM.TG(22) Box 7.17.

Table G2 Model Performance Statistics

Statistical Parameter	Comments	Ideal value
RMSE	RMSE is used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared. If the RMSE values are higher than 25 % of the objective being assessed, it is recommended that the model inputs and verification should be revisited in order to make improvements. For example, if the model predictions are for the annual mean NO_2 AQO of 40 µg/m^3, an RMSE of 10 µg/m^3 or	< 4.0

[16] Topographic features, buildings or vegetation increase the ground's 'surface roughness' effecting dispersion because of the enhanced mechanical turbulence generated as the air moves over the ground.

Statistical Parameter	Comments	Ideal value
	above would suggest the model parameters and model verification should be revisited. Ideally, an RMSE within 10 % of the AQO would be derived, which equates to 4 µg/m^3 for the annual mean NO_2 AQO.	
FB	FB is used to identify if the model shows a systematic tendency to over or under predict. FB values vary between + 2 and - 2 and has an ideal value of zero. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.	0.0
CC	CC is used to measure the linear relationship between predicted and observed data. A value of zero means no relationship and a value of 1 means absolute relationship. This statistic can be particularly useful when comparing a large number of model and observed data points.	1.0

These parameters estimate how the model results agree or diverge from the observations.

These calculations have been carried out prior to and after adjustment and provide information on the improvement of the model predictions as a result of the application of the verification adjustment factors.

The verification process involves a review of the modelled air pollutant concentrations against corresponding monitoring data to determine how well the air quality model has performed. Depending on the outcome it may be considered that the model has performed adequately and that there is no need to adjust any of the modelled results.

Alternatively, the model may not perform well against the monitoring data, in which case there is a need to check all the input data to ensure that it is reasonable and accurately represented by the air quality modelling process. Where all input data, such as traffic data, emissions rates and background concentrations have been checked and considered reasonable, then the modelled results may require adjustment to improve alignment with the monitoring data. This adjustment may be made either by using a single verification adjustment factor (to be applied to the modelled concentrations across the study area) or a range of different adjustment factors to account for different situations in the study area.

Verification Methodology – NO_x / NO_2

The verification method followed the process detailed in LAQM.TG(22). The first stage of verification was undertaken by comparing the modelled versus monitored contribution from road traffic sources (Road NOx). Road NOx contributions at the diffusion tube sites were calculated using the latest Defra NOx to NO_2 Calculator (v8.1), because diffusion tubes only measure total NO_2, from which Road NOx needs to be estimated having first subtracted background NO_2 concentrations.

Once the modelled Road NOx component had been adjusted with the relevant verification group, this value was used in the Defra NOx to NO_2 Calculator, and the calculated Road NO_2 component was adjusted following comparison with the monitored Road NO_2.

The calculated adjustment factors were then applied to the model outputs as follows: southern side of road – 2.02, northern side of road – 2.54. Table G3 indicates the comparison between modelled and monitored total annual mean NO_2 concentrations at each monitored site used in the verification, and Table G4 details the adjustment factors calculated.

Table G3 Monitored and Modelled NO_2 concentrations

Site	Monitored NO_2 (µg/m^3)	Verification Area	Unadjusted Modelled NO_2 (µg/m^3)	Unadjusted Percentage Difference (%)	Adjusted Modelled NO_2 (µg/m^3)	Adjusted Percentage Difference (%)
O_5	**49.3**	North	29.8	-40	**51.2**	3.8
O_75	34.7	South	25.2	-27	36.5	5.2
N_38	38.2	South	25.1	-34	36.4	-4.7
N_39	**58.4**	North	32.7	-44	**56.9**	-2.5

Table G4 Monitored and Modelled NO_x concentrations

Site	Assumed Background NO_2 (µg/m^3)	Monitored Road NOx (µg/m^3)	Unadjusted Modelled Road NO_x (µg/m^3)	Unadjusted Percentage Difference (%)	Modelled / Monitored
O_5	12.5	83.9	35.2	-58	2.39
O_75		46.4	25.2	-46	1.84
N_38		54.8	25.0	-54	2.19
N_39		110.3	41.8	-62	2.64

Verification Summary – NO_x / NO_2

A review was undertaken of the monitored vs modelled performance across the whole study area. The summary results and model performance statistics defined in LAQM.TG(22) are provided in Table G5.

Table G5 Verification summary and model performance

Parameter	No Adjustment	Adjusted
No. of monitoring sites	4	4
Road **NO_x** Adjustment Factor	1.00	South -2.02 North – 2.54
NO_2 Adjustment Factor	1.00	1.00
RMSE	18.03	1.74
FB	0.46	0.00
CC	0.99	0.98
Number within ± 10%	0	4
Number within ± 25%	0	4
Number greater than ± 25%	4	0

The statistics support the methodology adopted, and shows an improved model performance after adjustment. The model with fractional bias and correlation coefficients close to their ideal values. The RMSE is greatly improved post model adjustment and well below the ideal value of 4.00 (10% of the air quality objective).