Chichester District Council Air Quality Action Plan Review - 2020

Report 1: Baseline modelling update (2020)

January 2021

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1. Introduction

1.1 Chichester District Council (CDC) commissioned Phlorum Ltd to undertake a review of air quality across their district and to assess key areas of concern for air quality. The review will contribute towards the development of a new Air Quality Action Plan (AQAP) for CDC.

1.2 The key priority of an AQAP is to deliver compliance with the Air Quality Standards (AQS) within any Air Quality Management Area (AQMA), but also to improve air quality across the district.

Baseline modelling update (2020) – revision 7

1.3 This report (Report 1 v7) provides an update to the baseline air quality modelling and source apportionment study following the provision of updated bus data as provided by Stagecoach Ltd (June 2020).

1.4 The updated Stagecoach data identified significant differences in the ratio of Euro class buses operating in the district from those identified in the Department for Environment, Food and Rural Affairs (Defra) Emissions Factor Toolkit (EFT). This data is significant as the Euro class determines the type of emissions control system that a vehicle has fitted and the higher the Euro class number (i.e. VI/6), the cleaner the vehicle and the lower the emissions.

1.5 The EFT provides different ratios of vehicle Euro (emissions) classes dependent on the location of the assessment. In the case of the modelling for Chichester and Midhurst, the EFT area used in previous assessment was set to the standard England (not London) basic split option in Chichester and the Rural (not London) detailed split (option 1) for Midhurst.

1.6 Analysis of the Stagecoach data identified the following difference in ratios of buses operating in the key areas of concern from those set out in the EFT. Tables 1.1 and 1.2 provide the ratios or percentages of buses operating in these areas by Euro class.

Table 1.1: Bus Euro class ratios in Orchard St., St Pancras and Stockbridge AQMAs.

Euro Class	EFT ratio	Orchard Street, Chichester		St Pancras, Chichester		Stockbridge A27	
		Ratio	EFT Diff	Ratio	EFT Diff	Ratio	EFT Diff
II	**1%**	0.0%	**-1.0%**	0.0%	**-1.0%**	0.0%	**-1.0%**
III	**6%**	5.5%	**-0.5%**	0.0%	**-6.0%**	5.3%	**-0.7%**
IV	**5%**	55.5%	**50.5%**	56.7%	**51.7%**	38.5%	**33.5%**
V	**21%**	33.9%	**12.9%**	36.7%	**15.7%**	52.4%	**31.4%**
VI	**67%**	5.2%	**-61.8%**	6.7%	**-60.3%**	3.7%	**-63.3%**

1.7 The updated bus data shown in Table 1.1 shows significant differences to the Defra EFT Euro class ratios for buses within Chichester AQMAs.

1.8 The updated data shows similar ratios for Euro II and III buses. However, thereafter, the EFT significantly underestimates the ratio of Euro IV buses (EFT at 5%) by a range of 51.7% to 33.4% and the Euro V buses (at 21%) by a range of 31.4% to 12.9%.

1.9 The EFT overestimates the ratio of Euro VI buses (at 67%) significantly by between 60.3% to 63.3%.

Table 1.2: Bus Euro class ratios operating in Midhurst.

Euro Class	EFT ratio	Rumbolds Hill, Midhurst	
		Ratio	EFT Diff
II	**2%**	0.0%	**-2.0%**
III	**10%**	5.7%	**-4.3%**
IV	**9%**	19.2%	**10.2%**
V	**29%**	64.4%	**35.4%**
VI	**50%**	10.7%	**-39.3%**

1.10 The updated bus data shown in Table 1.2 shows significant differences in the Euro class ratios between Stagecoach data and the Defra EFT ratios for buses in Midhurst .

1.11 The updated data shows similar ratios for Euro II and III buses. However, thereafter, the EFT significantly underestimates the ratio of Euro IV buses (EFT at 9%) by 10.2% and Euro V buses (at 29%) by 35.4%.

1.12 The EFT overestimates the ratio of Euro VI buses (at 50%) significantly by 39.3%.

Summary of adjustments to EFT

1.13 A revision of the Euro class ratios for buses have been applied in the EFT for all model domains (Chichester and Midhurst). The adjusted Euro class ratios in Tables 1.1 and 1.2 have been applied to 2018 and 2020 modelling runs, with revised Euro class ratios applied for 2025. The 2025 projections reflect likely reductions in Euro II and III buses being replaced with newer Euro class VI buses.

1.14 The baseline modelling assessment and source apportionment presented in this report (Report1 v7) has been revised to reflect these updated ratios of bus Euro classes. Other parameters remained the same.

2. Assessment methodology

2.1 The review of Chichester AQMAs includes a series of modelling assessments and reports to determine current and future air quality concentrations in key locations within the district.

Modelling domain

2.2 The report provides an update for the current Chichester AQMAs and additional locations of concern, identified as follows.

Chichester District Council AQMAs

2.3 CDC currently has four declared AQMAs in Chichester District:

- Orchard Street, Chichester;
- Stockbridge A27 roundabout, Chichester; and
- St Pancras, Chichester.
- Rumbold's Hill, Midhurst;

2.4 CDC has recently reviewed air quality measurements and identified the following further locations as areas of concern:

- The Hornet, Chichester;
- Whyke A27 roundabout, Chichester; and
- Oving Road/A27 cross-roads, Chichester.

Chichester AQAP Process

2.5 The review of the Chichester AQMAs (and candidate AQMAs) will follow the process set out under the LAQM Policy Guidance (LAQM.PG(16))[1] below and Technical Guidance (LAQM.TG(16)) [1].

2.6 The AQAP review will follow LAQM (PG & TG (16)) guidance on developing AQAPs and will follow the process described below.

- Review the (baseline) concentrations by undertaking an air quality modelling assessment;
- Undertake a source apportionment (emissions) assessment;
- Undertake an AQAP options assessment; and
- Undertake air quality modelling of refined AQAP options with cost benefit analysis;

[1] Defra. 2018. Part IV of the Environment Act 1995, Environment (Northern Ireland) Order 2002 Part III, Local Air Quality Management, Policy and Technical Guidance LAQM.PG(16) LAQM.TG(16). London: Defra.

2.7 The key assessment methodology this assessment follows is detailed in LAQM.TG(16) sections 2.13 – 2.24. These include sections titled:

1. Develop the AQAP in stages;
2. Undertake Appropriate Local Monitoring and Assessment (Source Apportionment) for Development Phase;
3. Decide what Level of Actions is required.

2.8 This review will provide the information required by CDC to identify AQMAs, refine AQAP options and the level of those actions to achieve compliance with the UK AQSs and Air Quality Objectives.

Assessment guidance and input information

2.9 The air quality modelling and source apportionment assessment for the five identified (AQMAs and candidate AQMAs) locations will follow LAQM.PG(16) and LAQM.TG(16) on assessing air quality for determining AQMAs in preparation of a revised AQAP. The assessments will be undertaken:

- using CERC ADMS Roads model;
- for pollutants nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$) for annual mean concentrations;
- for the base year 2018 and future years 2020 and 2025;
- predicted for relevant receptor locations as specified in the tender specification (where the relevant UK AQSs apply);
- utilising CDC air quality monitoring data and reports;
- using Defra UK-AIR background data;
- using Defra EFT emissions factors;
- using West Sussex County Council (WSCC), Department for Transport (DfT) or Highways England (HE) data sets and agreed growth factors;
- detailed traffic data will be used (multiple categories where available) in Annual Average Daily Traffic (AADT) data in addition to any available CDC surveys;
- additional operational bus data (Stagecoach) was utilised; and
- the air quality model will be set-up to reflect the urban topography of the AQMAs as set out in the specification.

2.10 The assessment outputs for both the detailed air quality modelling assessments of the AQMAs and associated source apportionment studies will follow the detailed requirements of the tender specification. The review will additionally identify further areas adjacent to the AQMAs where concentrations are within (approx.) 10% of the AQS.

Review approach

2.11 The review is to be undertaken in two parts:

Part 1: Air quality modelling and source apportionment:

- to determine current and future concentrations of key pollutants at locations across the district, identify the sources of those pollutants.

Part 2: Air quality management area scenario testing:

- undertake modelling assessments to test scenarios which could reduce emissions and improve air quality.

2.12 The review and associated reports are set out as follows.

Part 1: Air quality modelling and source apportionment

2.13 The detailed air quality modelling assessment will provide:

- detailed air quality modelling assessments for each AQMA using ADMS Roads model;
- include baseline (predicted) outputs with Local Plan (LP) allocations (plus any additional transport schemes provided by WSCC/HE);
- identify potential new or revised AQMAs boundary areas and/or compliance of AQSs to determine any revocations for 2020 and 2025;

2.14 A source apportionment (SA) study will be undertaken for:

- for current and potential candidate AQMAs;
- to review current baseline (2017/18) and projected 2020 and 2025 modelled results; and

2.15 Provide report for review (R1 - Report 1).

Part 2: AQMA scenario testing

2.16 CDC is aware that the air quality actions will be, to some extent, informed by the modelling outputs and as such some AQMAs will require similar measures but also unique ones to help improve air quality in these areas. At this stage it is difficult to quantify the level or number of measures required to reduce emissions and achieve compliance of the AQS. Therefore, as suggested in the tender specification it is recommended that a range of one to five scenarios be allowed for in each AQMA.

2.17 The scenario testing will involve using ADMS Roads and introducing a percentage of non-car mode scenarios which may include traffic speed reductions, low emission vehicles, volume changes or other suggested options.

2.18 The AQAP scenario testing will be undertaken using air quality modelling (max. 5) scenario tests:

- Agree selection of measures with CDC;
- Model each AQMA scenario and produce assessment of exposure (concentration) impacts; and
- Simple cost and benefit statement.

2.19 Provide draft AQAP scenario report for discussion (R2 – Report 2)

2.20 Following consultation with CDC an assessment of two favourable air quality scenario options will be undertaken:

- Model and assess wider network impacts of the two best modelled scenarios; and
- Update CDC with scenario results.

2.21 Following the completion of Report 2, a Technical Modelling Report will be provided (R3 – Report 3).

3. Local Air Quality Management

3.1 This report will contribute toward the development of a new Chichester AQAP which will fulfil the requirements of Local Air Quality Management (LAQM) as set out in Part IV of the Environment Act (1995) and the relevant Policy and Technical Guidance documents.

3.2 The LAQM process places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether or not the air quality objectives are likely to be achieved. Where an exceedance is considered likely the local authority must declare an AQMA and prepare an AQAP setting out the measures it intends to put in place in pursuit of the objectives.

3.3 Table 3.1 below sets out the UK AQSs and Air Quality Objectives.

Table 3.1: UK Air Quality Standards and Objectives

Pollutant	Averaging Period	Air quality standard (AQS) (μg.m^{-3})	Air quality objective (AQO)
Nitrogen dioxide (NO_2)	1 hour	200	200 μg.m^{-3} not to be exceeded more than 18 times a year
	Annual	40	40 μg.m^{-3}
Particulate Matter (PM_{10})	24 hours	50	50 μg.m^{-3} not to be exceeded more than 35 times a year
	Annual	40	40 μg.m^{-3}
Sulphur dioxide (SO_2)	1 hour	350	350 μg.m-^{3}, not to be exceeded more than 24 times a year
	24-hour	125	125 μg.m-^{3}, not to be exceeded more than 3 times a year
	15-minute	266	266 μg.m-^{3}, not to be exceeded more than 35 times a year
Particulate Matter ($PM_{2.5}$)	Annual	25	25 μg.m^{-3}

Pollutants of concern

3.4 The major pollutant of concern in the district is NO_2, and although no exceedances of AQS's for fine particulates have been measured, small respirable sized particulates are also a concern to human health. Therefore, although the assessment of air quality within the AQMAs will focus on NO_2 impacts additional reduction measures for particulates smaller than 10 and 2.5 microns in diameter (PM_{10} and $PM_{2.5}$) will also be assessed.

3.5 CDC monitors air quality at a variety of locations across the district and reports the ratified data in their Annual Status Reports (ASRs). Details of monitoring locations and species of pollutants are provided in the ASR including NO_2, PM_{10}, and ozone (O_3). A summary of CDC's most recent monitoring data can be found in Appendix A of this document.

3.6 The 2019 ASR[2] for Chichester District identified two locations where concentrations were above the NO_2 40µg.m^{-3} AQS concentration in 2019, these were at:

- St Pancras, within the St Pancras AQMA, Chichester
- Rumbold's Hill, Midhurst - not within an AQMA.

3.7 There were no exceedances of the 40µg.m^{-3} AQS at the any other monitoring locations. There was one additional location which measured concentration of NO_2 that were within 10% of the AQS (i.e. >36.0µg.m^{-3}), this was at receptor 16 (outside the Nag's Head) which is also within the St Pancras AQMA.

3.8 It should also be noted that no monitoring location measured over 60µg.m^{-3} and therefore currently there is no likely risk of exceeding the 1-hour NO_2 objective across the district.

3.9 There were no exceedances of the annual or daily mean AQSs for PM_{10} in Chichester District from 2015 through to 2019.

Pollutant sources

3.10 The main source of emissions which impact on residential receptors in these locations are from road traffic. As such the focus of the AQAP actions and initiatives to reduce emissions will focus on road traffic emissions.

3.11 Other (background) air pollutant sources contribute to local pollution. These include emissions from; domestic, commercial, industrial and marine sources as well as transboundary sources. These emissions are accounted for in this assessment and are included within background pollution concentrations.

3.12 Background concentrations of NO_2 can account for up to one third of the total of NO_2 concentrations within urban centres and as such wider regional and national emissions schemes play an important part reducing local exposure.

[2] Chichester District Council (2020) - 2019 Air Quality Annual Status Report.

4. Assessment Methodology

Baseline modelling assumptions

4.1 Baseline modelling was undertaken in July 2020. The baseline modelling assessment provides a baseline of predicted concentrations at receptor locations across Chichester and Midhurst. The baseline modelling provides results as a "do nothing" scenario, i.e. business as usual for current and predicted future traffic growth without any additional AQAP actions or interventions to reduce emissions locally.

4.2 The air quality modelling is based on predicted traffic growth across the district as provided by West Sussex County Council (WSCC). This data includes current and Chichester Local Plan development traffic for the period 2018 – 2025.

4.3 The modelling results do not consider non-implemented highways changes such as the proposed Oving Road/A27 (left-in, left-out) alterations in this baseline assessment.

4.4 The results identify baseline annual average NO_2 concentrations for the years 2018, 2020 and 2025.

Modelling inputs

4.5 To determine the concentrations of pollutants across the study areas, emissions from local roads have been assessed using a detailed air dispersion model. The model used was ADMS-Roads (version 5.0), which is produced by CERC and has been validated and approved by Defra for use as an assessment tool for calculating the dispersion of pollutants from traffic on UK roads.

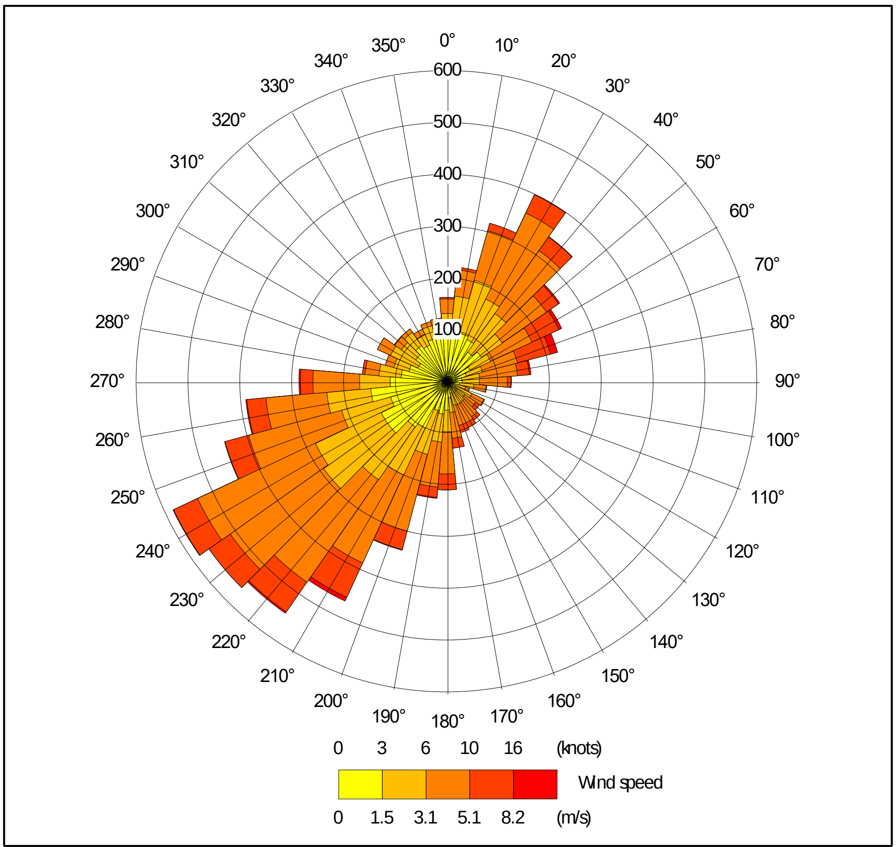
4.6 Model inputs, including traffic data and background concentrations used in the assessment are provided in Appendix B.

Meteorological data

4.7 Detailed, hourly sequential, meteorological (met.) data are used by the model to determine pollutant transportation and levels of dilution by the wind and vertical air movements. The met. data used for this assessment were from Charlwood near Gatwick Airport for the year 2018. This year was also selected as the most recent available met. year for model verification purposes. It was considered to be the most representative meteorological station for conditions in Chichester and Midhurst. The wind-rose for Charlwood is shown in Plate 4.1 below.

4.8 The surface roughness applied to the met. site was 0.3m, whilst the roughness applied to the modelled domain was 1m, which is an appropriate figure for a built up area.

Plate 4.1: Charlwood Wind Rose 2018



Traffic data

4.9 Traffic data was sourced from West Sussex County Council (WSCC) and DfT/Highways England (HE) traffic counts.

4.10 Traffic data included baseline (predicted) outputs without Local Plan (LP) allocations and with LP (plus any additional transport schemes provided by WSCC/HE). WSCC provided modelled traffic flows from Chichester Area Transport Model - transport evidence base study 2018 for Chichester Local Plan Review, based on 2014 base flows. Midhurst traffic data was source from DfT and WSCC traffic count sites.

4.11 The traffic data was provided in AADT format and scaled to 2018, 2020 and 2025, on a pro-rata basis in Chichester (The Local Plan traffic modelling, which was used for this assessment had a forecast year of 2035). TEMPro growth factors were provided by WSCC for Midhurst, which fell outside the domain of the Local Plan traffic model.

4.12 Bus Euro classifications were adjusted to align with the Stagecoach information provided in June 2020.

Emission factors

4.13 Defra updated the UK emissions factor toolkit (EFT version 9) in May 2019[3]. The EFT update included most recent UK/EU real-world vehicle emission test data and included the effect of loading and gradients on Heavy Duty Vehicle (HDVs) activity.

4.14 Defra's EFT has been used to provide emission factors for NO_x, PM_{10} and $PM_{2.5}$.

Background concentrations

4.15 Defra also updated the estimated background concentrations of the UKAQS pollutants on the UK Air Information Resource (UK-AIR) website[4]. These were updated in May 2019 and are based on monitoring data from 2017.

4.16 Background concentrations used in this assessment were derived from UK AIR predictions for the relevant UK grid square. To ensure conservative predictions of pollutant concentrations, no reduction has been applied to the annual mean background concentrations used in this assessment for future years (despite such a decline being predicted by Defra).

4.17 The NO_2 Adjustment for NO_X Sector Removal Tool was also used to remove the contribution of modelled roads from background concentrations (i.e. the contribution of A roads were removed). This prevented a 'double counting' of the contribution of A roads in the predictions.

Receptor locations

4.18 Discrete model receptors were positioned at the façades of buildings at selected locations and modelled at "breathing height", which is, by convention, 1.5 metres above ground (or floor) level. Modelled receptor locations are shown in Table 4.1 and Figures 1 to 7.

Table 4.1: Receptor locations.

Receptor ID	Location			
	x	y	Locality	AQMA
Chichester				
1	485773.91	103960.26	Kings Ave/ Southbank Junction	Stockbridge Roundabout AQMA
2	485771.47	103847.47	Claremont Court	Stockbridge Roundabout AQMA
(3,4,5)	485880.84	103791.63	AQMS on Chichester Bypass (A27) and Stockbridge Roundabout	Stockbridge Roundabout AQMA
6	485695.78	103730.9	Stockbridge Rd South (A286)	Stockbridge Roundabout AQMA
8	487340.41	105474.71	Westhampnett Rd	-
9	486502.25	104793.87	The Hornet	(South of) St Pancras AQMA
10	486532.97	104860.06	St Pancras	St Pancras AQMA

[3] Defra Emissions Factor Toolkit: (v9.0) https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html
[4] http://uk-air.defra.gov.uk

Receptor ID	Location			
	x	y	Locality	AQMA
12	485913.44	105186.34	174 Orchard St	Orchard St AQMA
CI1	485880.84	103791.63	Stockbridge, near to the Chichester Bypass and Stockbridge R'about	Stockbridge Roundabout AQMA
CI4	485981.41	105222.45	Orchard St	Orchard St AQMA
15	486575.92	104799.25	32 The Hornet	(South of) St Pancras AQMA
Additional receptor locations in Chichester				
W1	486916.28	103709.01	Nursing Home, Whyke Rd (B2135)	NE of Whyke/A27 roundabout
W2	486843.81	103719.1	22/23 Whyke Close	NW of Whyke/A27 roundabout
O1	487745.06	105015.62	Church Rd property	NW of Oving Rd/A27 intersection
O2	487803.03	104975.94	187/188 Oving Rd property	SE of Oving Rd/A27 intersection
Midhurst				
14	488559.88	121478.29	Rumbold's Hill	
18	488544.69	121434.01	Rumbold's Hill (Stationary Shop)	
19	488583.53	121511.69	Rumbold's Hill (Natwest)	
20	488601.94	121538.76	Rumbold's Hill (Nationwide)	
21	488629.56	121614.62	North Street (BHF)	

Note: Receptor IDs correspond to those in the Chichester District Council's LAQM Annual Status Report (2019); AQMS = (Automatic) Air Quality Monitoring Station.

Model Verification

4.19 It is recommended, following guidance set out in LAQM.TG(16), that the model results be compared with measured data to determine whether they need adjusting to more accurately reflect local air quality. This process is known as verification and reduces the uncertainty associated with local effects on pollution dispersion and allows the model results to be more site-specific.

4.20 The model verification was undertaken for 3 separate areas:

- Stockbridge AQMA;
- Chichester; and
- Midhurst.

4.21 A verification study for NO_2 has been undertaken using CDC local authority monitoring data (2018). The model was found to be under-predicting concentrations at locations around the Stockbridge AQMA, an adjustment factor of 1.81 was applied to model outputs for these locations. The model was found to perform well without adjustment across the rest of Chichester and Midhurst. Full details of this study are included in Appendix C.

Model Uncertainty

4.22 There are a number of inherent uncertainties associated with the modelling process, including:

- Model uncertainty – due to model formulations;
- Data uncertainty – due to inaccuracies in input data, including emissions estimates, background estimates and meteorology; and
- Variability – randomness of measurements used from external sources, such as met. data inputs.

4.23 Using a validated air quality model such as ADMS Roads, as well as undertaking the model verification takes into account modelling uncertainty. The choices of the practitioner throughout the air quality assessment process are also essential in the management of uncertainty, and to whether the predicted impact tends towards a worst-case estimate or a central estimate.

4.24 This assessment has chosen inputs tending towards 'worst-case', where appropriate, to ensure a conservative and robust approach. For example, it has been assumed that there will be no improvement in annual mean background concentrations (for NO_2, PM_{10} and $PM_{2.5}$) beyond 2018.

5. Baseline Modelling

Predicted NO_2 results

5.1 The predicted concentrations of NO_2 in a 'do nothing' scenario are included in Table 5.1 below. Baseline year (2018) and future year results for 2020 and 2025 are presented to identify where there are predicted exceedances of the AQS and locations of concern for air quality going forward.

Table 5.1: NO_2 concentration results

Receptor	Concentration NO_2 – annual average ($\mu g.m^{-3}$)		
	2018	2020	2025
	Chichester		
1	35.0	31.9	24.2
2	<u>39.2</u>	35.8	26.6
(3,4,5)	32.3	29.5	22.5
6	33.5	30.6	23.2
8	33.3	31.4	25.3
9	**41.5**	<u>39.0</u>	31.3
10	**50.2**	**47.0**	<u>36.6</u>
12	<u>36.6</u>	34.4	27.6
Cl1	32.3	29.5	22.5
Cl4	24.7	23.4	19.7
15	**40.0**	<u>37.6</u>	30.3
W1	**44.1**	**40.1**	30.0
W2	31.7	29.0	22.3
O1	31.1	28.8	23.0
O2	**43.0**	<u>39.6</u>	30.8
	Midhurst		
14	**40.1**	<u>37.3</u>	29.5
18	<u>37.2</u>	34.6	27.5
19	<u>38.4</u>	35.7	28.3
20	35.5	33.0	26.3
21	32.4	30.2	24.2

Note: Receptors in **bold** (> AQS), receptors <u>underlined</u> (within 10% of AQS)

2018 results

5.2 Table 5.1 shows that six locations are predicted to exceed the 40$\mu g.m^{-3}$ long-term AQS in 2018, with four other locations within 10% of the AQS. The locations in exceedance include:

- St Pancras AQMA (receptor 10);

- locations in the Hornet (9 and 15);
- Nursing Home, Whyke Rd (W1);
- 187/188 Oving Rd (O2); and
- Rumbold's Hill, Midhurst (14).

5.3 One location was also predicted to be marginally under the AQS at Stockbridge Roundabout AQMA (2), with a further three locations Orchard St AQMA (12), Rumbold's Hill (Stationary Shop) (18) and Rumbold's Hill (Natwest) (19) also being within 10% of the AQS.

2020 results

5.4 The modelling predicted that there will be three exceedances of the 40µg.m^{-3} AQS in 2020, at:

- St Pancras AQMA (receptor 10);
- the Hornet (9); and
- Nursing Home, Whyke Rd (W1).

5.5 Two locations were also predicted to be marginally under the AQS at the Hornet (9) and at 187/188 Oving Rd (O2). Results from the model also predicted two other locations, the Hornet (15) and Rumbold's Hill (14), being within 10% of the AQS.

2025 results

5.6 In 2025, it is predicted that all locations within Chichester District will be compliant with the 40µg.m^{-3} AQS for NO_2.

AQMA results

5.7 No exceedances of the NO_2 AQS were predicted in any assessment years at:

- Orchard Street AQMA;
- Stockbridge Roundabout AQMA ;

5.8 Modelled results identified exceedances were only found at St Pancras AQMA and Whyke Rd locations in 2020.

5.9 Modelled results identified no exceedances in 2025, however results showed St Pancras AQMA would likely still be within 10% of the AQS in this future year.

Particulates

5.10 PM_{10} and $PM_{2.5}$ modelling was undertaken, and results showed no exceedance of the long or short-term AQSs in any baseline scenarios from 2018 to 2025. These results are provided in Appendix D.

6. Source Apportionment Results

6.1 Source apportionment assessments provide a location specific break-down of emissions of pollutants from different vehicle classes. These are based on the number of vehicles, the type of vehicles and their respective emissions control systems. Traffic data and local speed information is used as an input into the latest Defra EFT (v9.0)[3]. The EFT calculates the emissions ratios of a pollutant from each vehicle type to produce the source apportionment results.

6.2 The source apportionment study for the study areas was undertaken for NOx emissions and particulates (PM_{10} and $PM_{2.5}$). As the modelling assessment results showed no exceedance of the long-term or short-term AQS for particulates as such the focus of the AQAP will on reducing NO_2 concentrations. As a result, the source apportionment results presented in this report are for NOx emissions.

6.3 It should be noted that the ratio of emissions control systems or Euro standard data are based on DfT data for the local region. The data is not sourced from local verification of vehicle ANPR data or Chichester specific traffic counts.

Source apportionment of NOx

6.4 The source apportionment assessment of traffic emissions from different vehicle types was undertaken at the key locations of concern:

- St Pancras AQMA/The Hornet
- Stockbridge AQMA /A27
- Midhurst (A286)

6.5 The traffic flows used in the source apportionment locations are provided in Appendix B, Table B.1.

6.6 The following charts and associated tables present the ratios (%) of NOx emissions from vehicles operating in these three key locations of concern.

6.7 Taxis are included in the source apportionment assessment, however the traffic data provided for the emissions assessment does not separate Taxis out from other vehicles. Therefore, all Taxi emissions are included in the diesel car sector of the source apportionment. Taxis can be included in future source apportionment studies if detailed traffic counts are provided.

6.8 Bus emissions for 2018 and 2020 are based on the Stagecoach ratios. A reasoned adjustment is applied in 2025, to replicate the removal of all Euro III buses and 10% Euro IV buses from the fleet with Euro VI bus (16%) replacements.

St Pancras

Chart 6.1: NOx source apportionment for St Pancras (2018)

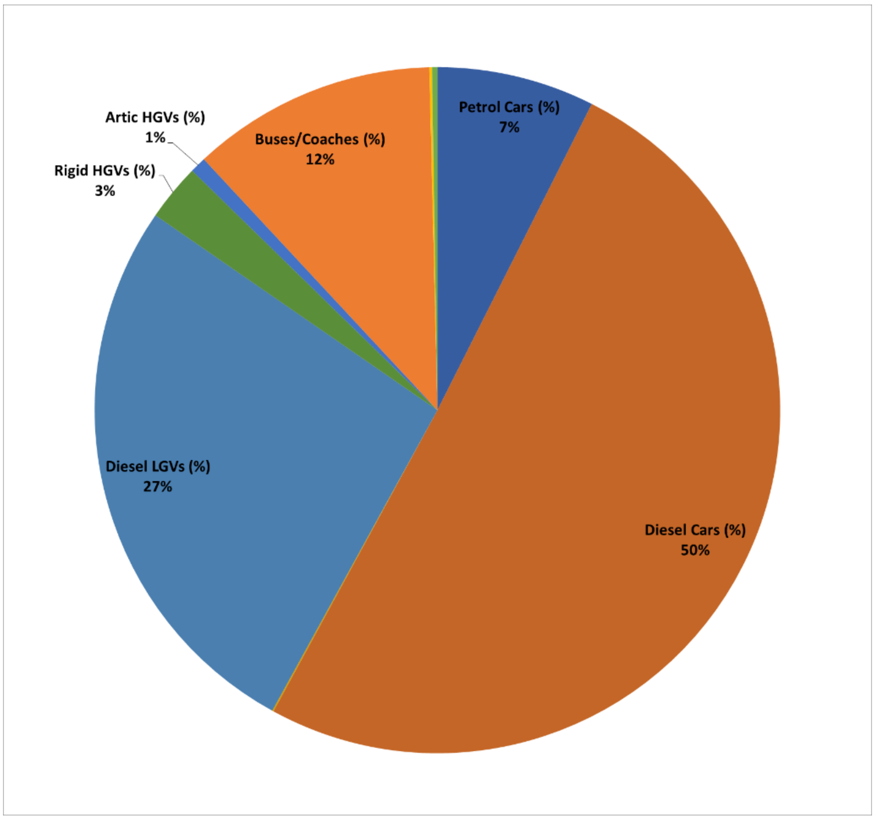


Chart 6.2: NOx source apportionment for St Pancras (2020)

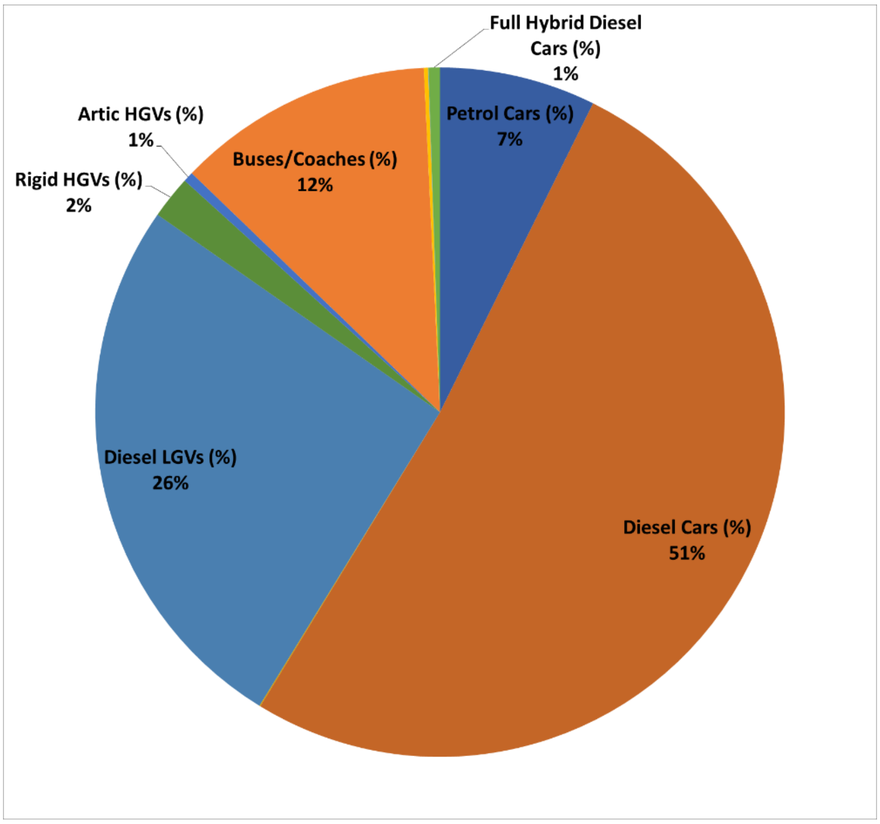
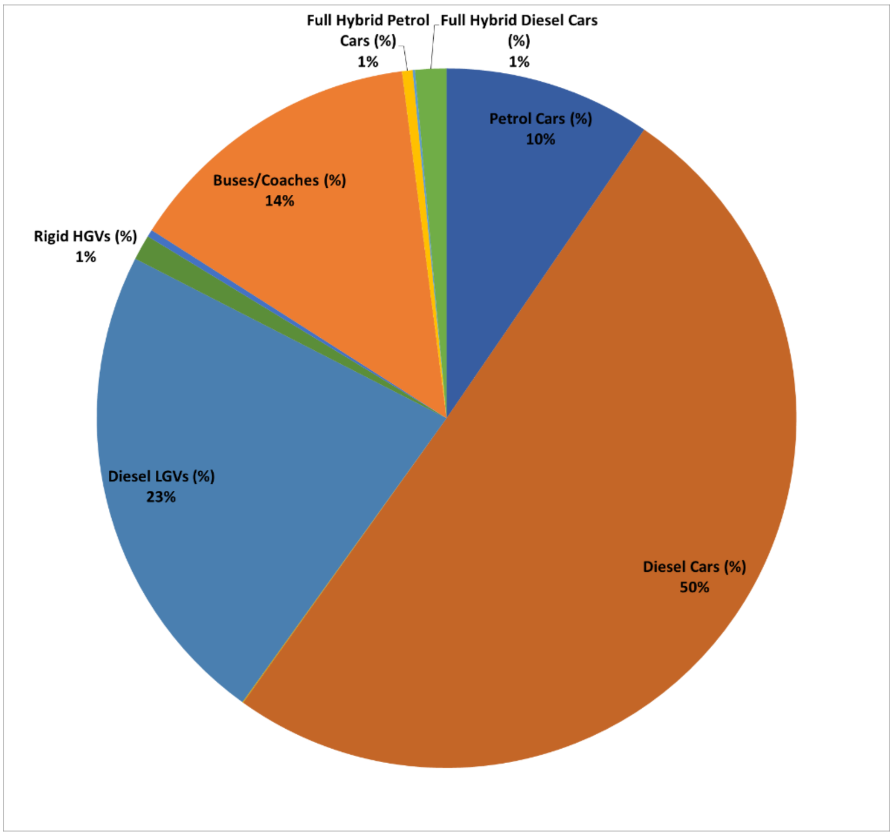


Chart 6.3: NOx source apportionment for St Pancras (2025)



6.9 Table 6.1 provides a summary of the NOx source apportionment for St Pancras AQMA.

Table 6.1: NOx source apportionment for St Pancras AQMA

Vehicle	Source apportionment of NOx		
	2018	2020	2025
Petrol Cars (%)	7.4%	7.3%	9.5%
Diesel Cars (%)	50.5%	51.4%	50.3%
Taxis (%)	-	-	-
Petrol LGVs (%)	0.1%	0.0%	0.0%
Diesel LGVs (%)	26.6%	25.9%	22.6%
Rigid HGVs (%)	2.7%	2.0%	1.2%
Artic HGVs (%)	0.8%	0.5%	0.3%
Buses/Coaches (%)	11.6%	12.0%	13.9%
Motorcycles (%)	-	-	-
Full Hybrid Petrol Cars (%)	0.1%	0.2%	0.5%
Plug-In Hybrid Petrol Cars (%)	0.0%	0.0%	0.1%
Full Hybrid Diesel Cars (%)	0.2%	0.5%	1.4%
Battery EV Cars (%)	-	-	-

6.10 The source apportionment results from St Pancras AQMA/The Hornet show NOx emissions are dominated by diesel cars and diesel Light Goods Vehicles (LGVs) across the period (2018 – 2025). Bus and coach NOx emissions increased from 11.6% to 14% over this period. HGV NOx emissions reduce over the period.

Stockbridge AQMA /A27

Chart 6.4: NOx source apportionment for Stockbridge AQMA /A27 (2018)

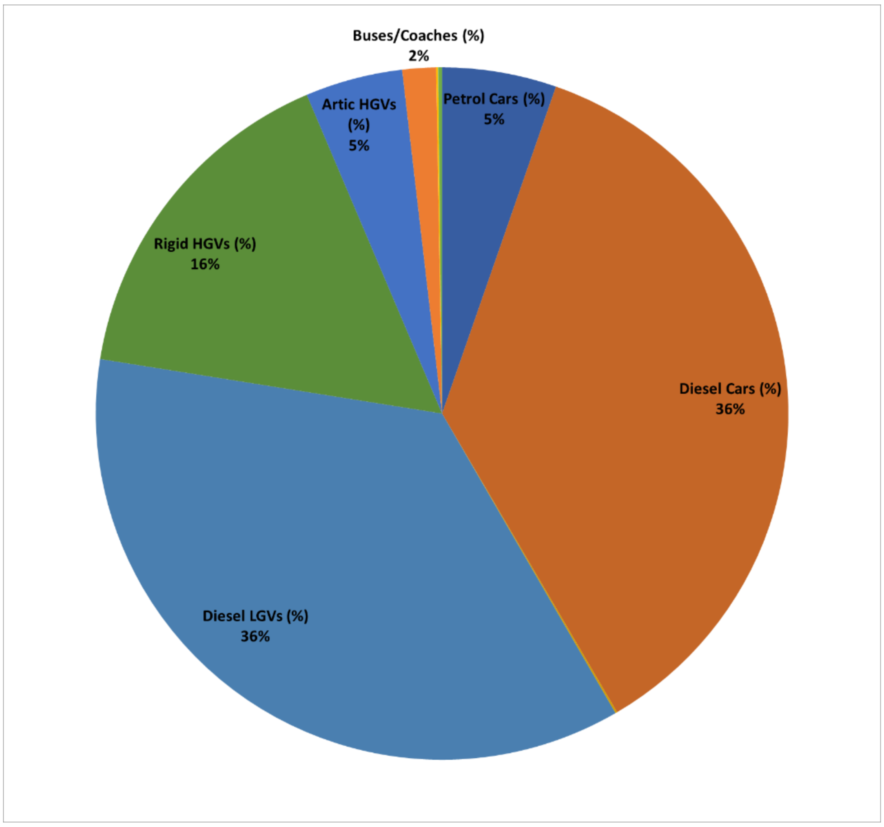


Chart 6.5: NOx source apportionment for Stockbridge AQMA /A27 (2020)

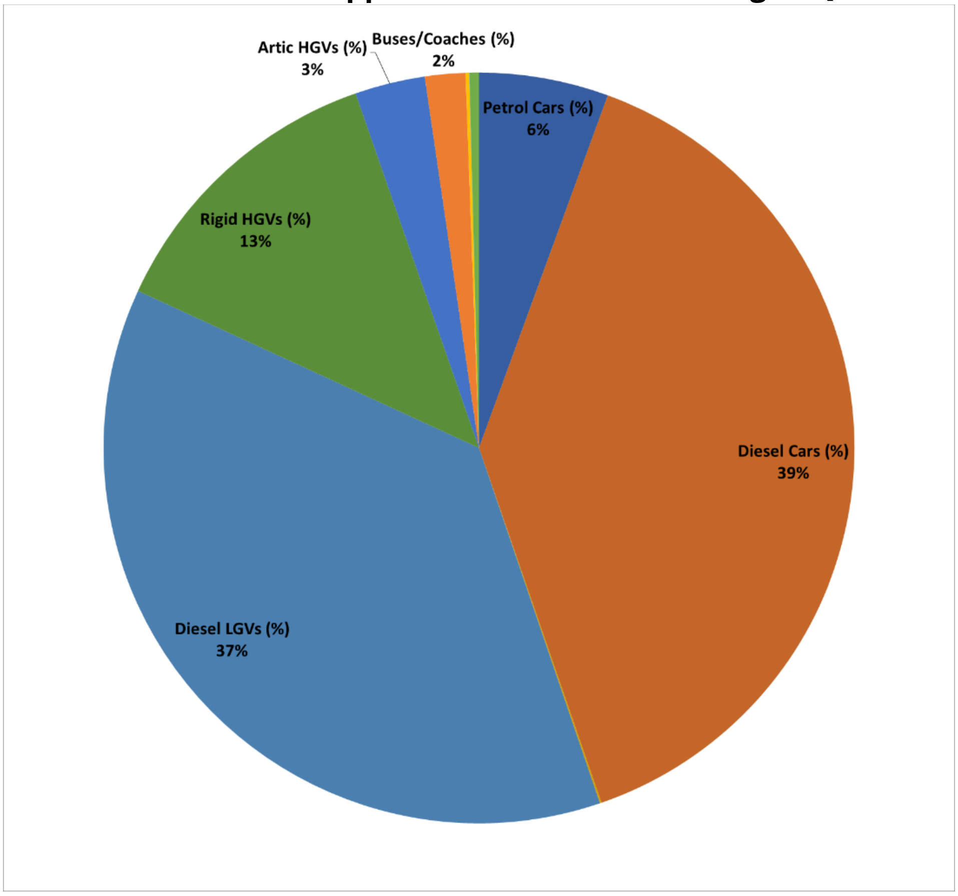
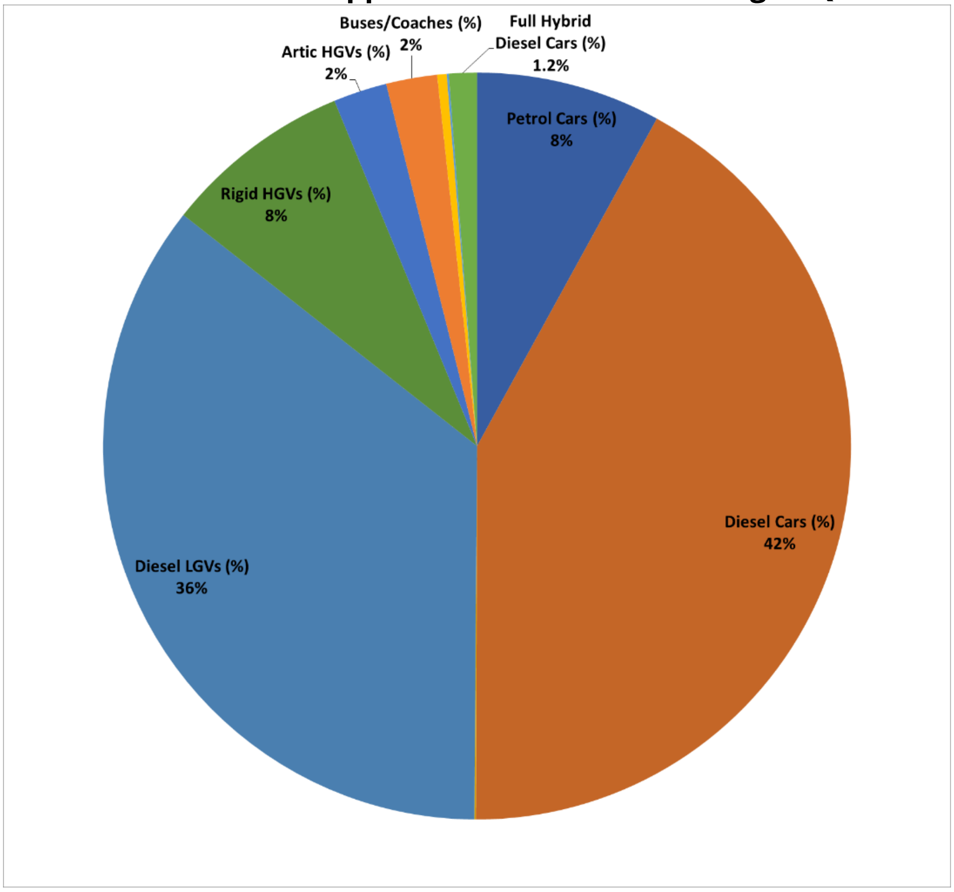


Chart 6.6: NOx source apportionment for Stockbridge AQMA /A27 (2025)



6.11 Table 6.2 provides a summary of the NOx source apportionment for Stockbridge AQMA /A27.

Table 6.2: NOx source apportionment for Stockbridge AQMA /A27

Vehicle	Source apportionment of NOx		
	2018	2020	2025
Petrol Cars (%)	5.3%	5.6%	8.0%
Diesel Cars (%)	36.2%	39.1%	42.1%
Taxis (%)	-	-	-
Petrol LGVs (%)	0.1%	0.1%	0.1%
Diesel LGVs (%)	35.9%	37.1%	35.5%
Rigid HGVs (%)	16.1%	12.8%	8.1%
Artic HGVs (%)	4.5%	3.0%	2.3%
Buses/Coaches (%)	1.6%	1.7%	2.2%
Motorcycles (%)	-	-	-
Full Hybrid Petrol Cars (%)	0.1%	0.2%	0.4%
Plug-In Hybrid Petrol Cars (%)	0.0%	0.0%	0.1%
Full Hybrid Diesel Cars (%)	0.2%	0.4%	1.2%
Battery EV Cars (%)	-	-	-

6.12 The source apportionment results from Stockbridge AQMA /A27 show NOx emissions are dominated by diesel cars and diesel LGVs over the period (2018 – 2025). HGV's proportion of the NOx emissions declines from 20.6% to 10.4% over the period. Buses and coaches are small contributors however these vehicles do show an increase in the percentage of NOx emissions over the period.

Midhurst (A286)

Chart 6.7: NOx source apportionment for Midhurst (A286) (2018)

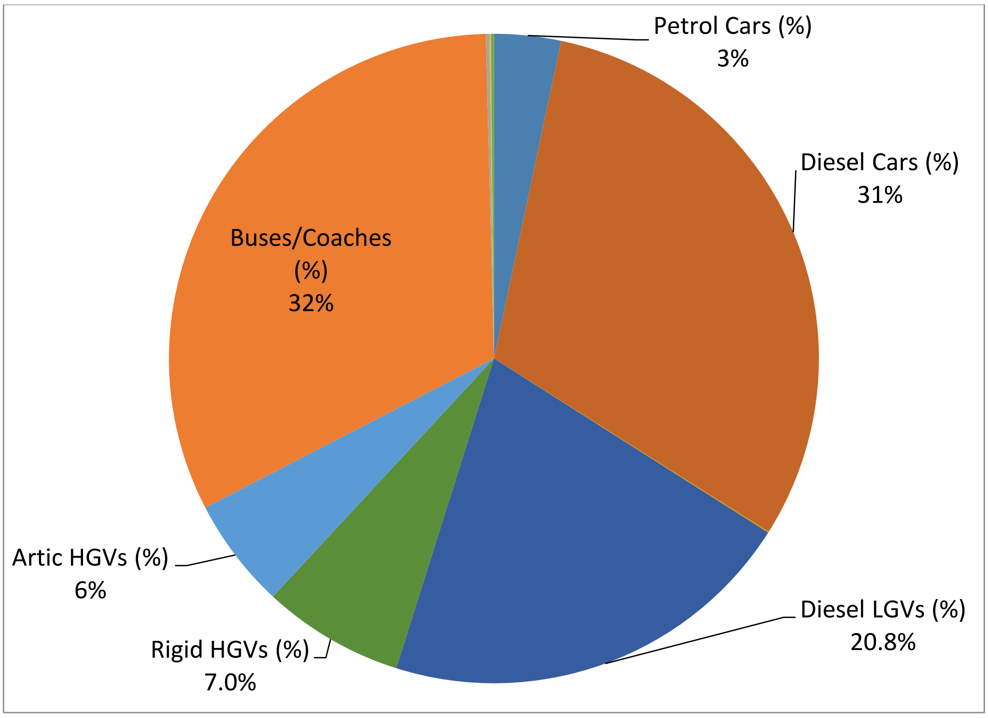


Chart 6.8: NOx source apportionment for Midhurst (A286) (2020)

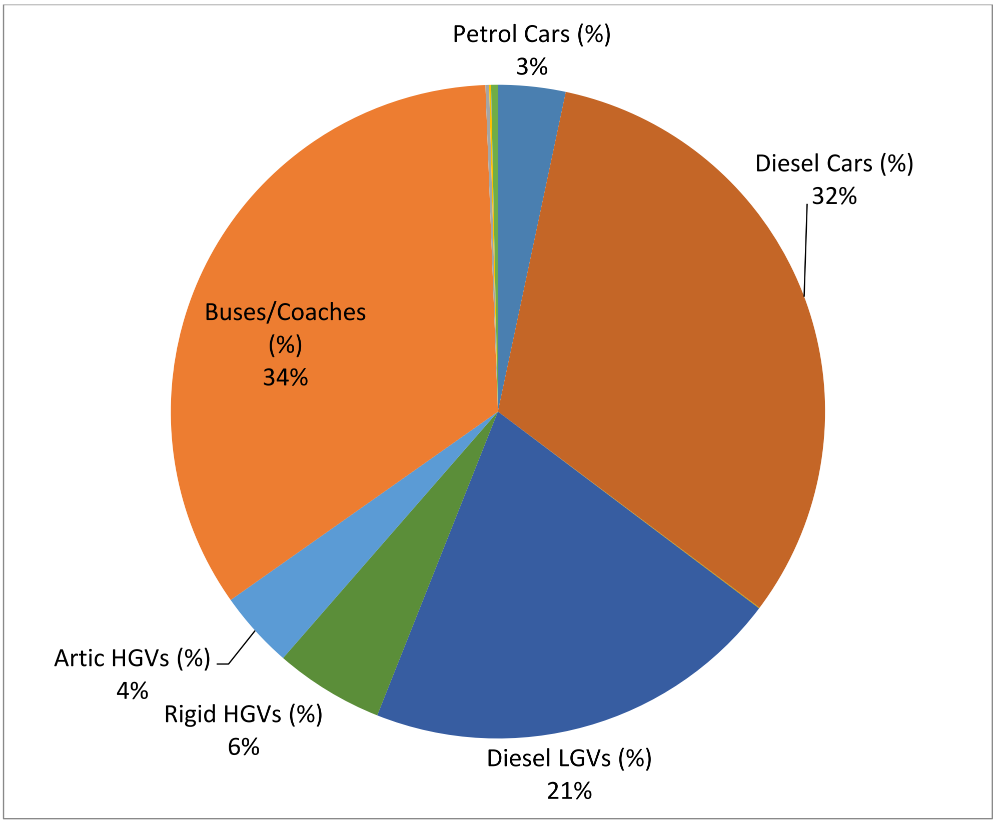
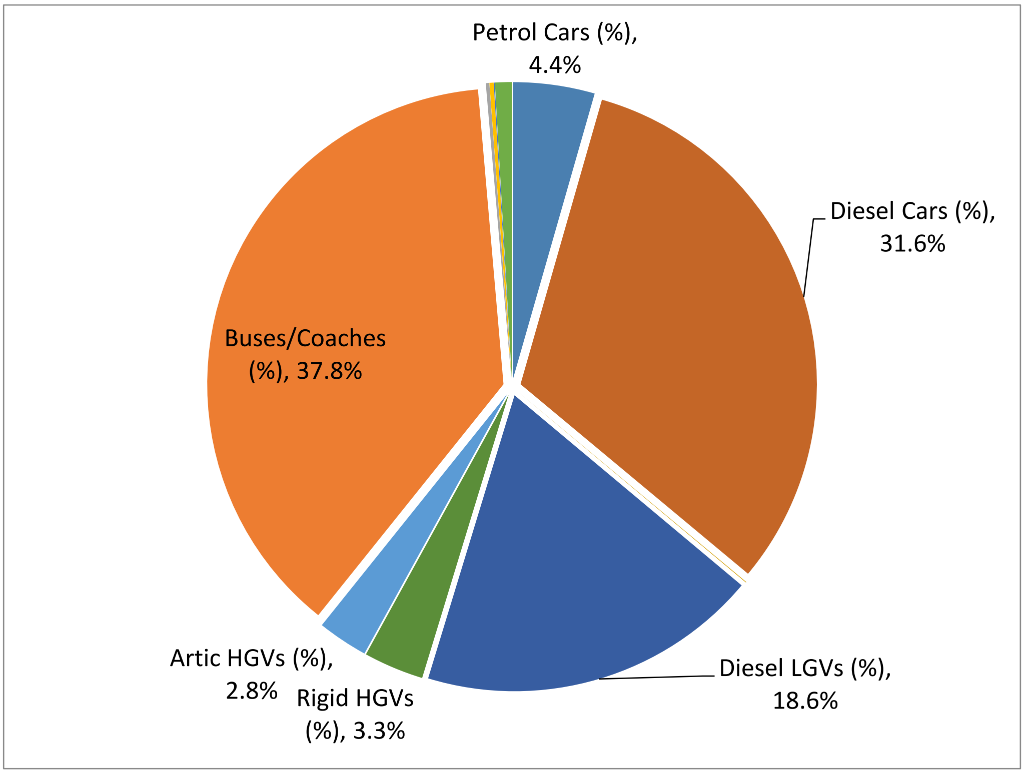


Chart 6.9: NOx source apportionment for Midhurst (A286) (2025)



6.13 Table 6.3 provides a summary of the NOx source apportionment for Midhurst (A286).

Table 6.3: NOx source apportionment for Midhurst (A286).

Vehicle	Source apportionment of NOx		
	2018	2020	2025
Petrol Cars (%)	3.3%	3.3%	4.4%
Diesel Cars (%)	30.6%	31.8%	31.6%
Taxis (%)	-	-	-
Petrol LGVs (%)	0.0%	0.0%	0.0%
Diesel LGVs (%)	20.8%	20.7%	18.6%
Rigid HGVs (%)	7.0%	5.4%	3.3%
Artic HGVs (%)	5.5%	3.8%	2.8%
Buses/Coaches (%)	32.1%	34.1%	37.8%
Motorcycles (%)	0.2%	0.2%	0.2%
Full Hybrid Petrol Cars (%)	0.1%	0.1%	0.2%
Plug-In Hybrid Petrol Cars (%)	0.0%	0.0%	0.0%
Full Hybrid Diesel Cars (%)	0.1%	0.3%	0.9%
Battery EV Cars (%)	-	-	-

6.14 The source apportionment results from Midhurst (A286) show NOx emissions are dominated by buses and coaches, and diesel cars followed by diesel LGVs over the period (2018 – 2025).

Summary of source apportionment study

NOx

6.15 The source apportionment assessment study identified key emission sources of NOx were dominated by the diesel fuelled vehicle sector.

6.16 Petrol and other fuelled vehicles such as cars hybrid petrol cars were identified as contributing only approx. 7 - 9% of NOx emissions between 2018 -2025 within the St Pancras AQMA and similarly on the A27. Midhurst (A286) showed lower NOx source apportionment results for non-diesel fuelled vehicles at 4 - 5% of NOx emissions between 2018 -2025.

St Pancras AQMA

6.17 NOx emissions from the diesel car and diesel LGV sector dominate the St Pancras AQMA location with the ratio of NOx emissions at approx. 77% in 2018 but reducing to 73% toward 2025. Bus and coach emissions are lower but significant over the period, increasing slightly from 11.6% to 14%. The ratio of HGV emissions is relatively small with a decline over this period from approx. 3.5% to 1.5%.

Stockbridge AQMA /A27

6.18 NOx emissions from the diesel car and diesel LGV sector dominate the Stockbridge AQMA /A27 location with the ratio of NOx emissions between approx. 72% to 77.5% over the period between 2018 and 2025. HGV emissions are significant at 20.5% in 2018, however reduce to approx. 10.5% by 2025. Bus and coach emissions are small in comparison at 1.6% in 2018 and increasing to 2.2% by 2025.There is an increase in Hybrid Diesel vehicle emissions as a contribution over the period 2018 – 2025 with emissions rising from 0.2% to 1.2% by 2025.

Midhurst

6.19 NOx emissions from the Bus, diesel car and diesel LGV sectors dominate the Midhurst location with the ratio of NOx emissions at approx. 85% over the period between 2018 and 2025. HGV emissions decline as a proportion of the total NOx emissions over this period with a reduction from approx. 12.5% to 6%.

Particulates

6.20 PM_{10} and $PM_{2.5}$ source apportionment from vehicles was also undertaken at all key locations of concern with results presented in Appendix E.

6.21 Diesel emissions are a major source of exhaust emissions of particulate matter. However, over time emissions are predicted to improve for diesel vehicles through the increased uptake of Euro VI vehicles, in conjunction with the replacement of older pre—Euro VI vehicles.

6.22 It should be noted that the source (apportionment) ratio of particulate emissions remains similar even though there is a predicted growth in the number of vehicles between 2018 and 2025 (see Table B.1: AADT traffic data used in the assessment).

6.23 The emissions contribution for both PM_{10} and $PM_{2.5}$ reflects the ratio of vehicle types operating in the location as a key source of particulate emissions is from brake, tyre wear and resuspension of dusts from vehicle movements. For example, as more hybrid and electric vehicles increase in numbers toward 2025, the ratio of emissions attributable to these vehicle types increase.

7. Summary of Assessment

7.1 A review of air quality across Chichester District was undertaken to assess key areas of concern for air quality. The review has been provided as an input into the development of a new Air Quality Action Plan (AQAP) for Chichester District Council.

7.2 The air quality modelling and source apportionment assessment followed Defra Local Air Quality Management Technical Guidance (LAQM.TG(16)) and included using the latest Defra Emission Factor Toolkit (EFT v9.0).

Nitrogen dioxide results

7.3 The air quality assessment predicted likely exceedances of the nitrogen dioxide (NO_2) 40µg.m^{-3} annual mean Air Quality Standard (AQS) in 2018. The locations identified were:

- St Pancras AQMA (receptor 10);
- the Hornet (9 and 15);
- Whyke/A27 roundabout (W1);
- Oving Rd/A27 intersection (O2); and
- Rumbold's Hill (Midhurst) (14).

7.4 The Stockbridge Roundabout AQMA (2) was predicted to be marginally below the AQS by 0.8 µg/m^{-3}.

7.5 Predicted exceedances of the NO_2 annual mean AQS in 2020 occurred in three locations in Chichester District at:

- St Pancras AQMA;
- the Hornet; and
- Whyke roundabout.

7.6 In 2025, it is predicted that all locations within Chichester District will be compliant with the NO_2 annual mean AQS.

7.7 No exceedances of the NO_2 40µg.m^{-3} AQS were predicted within the Orchard Street AQMA, the Stockbridge Roundabout AQMA, or on Westhampnett Road in any assessment years. Although the Stockbridge Roundabout AQMA was only marginally below the AQS in 2018.

Particulates results

7.8 No exceedances of the particulate (PM_{10} and $PM_{2.5}$) AQS were identified at any of the modelled locations in 2018, 2020 and 2025.

Source Apportionment

7.9 The source apportionment study identified sources of emissions at the three key locations of concern (St Pancras AQMA, Stockbridge AQMA/A27 and Midhurst) for emissions of oxides of nitrogen (NOx) and particulates.

7.10 The diesel sector emissions were the dominant source for both NOx and particulate emissions in all locations assessed. Petrol and diesel fuelled cars were also identified as a major contributing source of PM_{10} and $PM_{2.5}$ as tyre and brake wear particulate emissions make up a more significant source of total PM emissions than exhaust emissions. As such, as there are significantly more cars than other vehicles travelling through these locations, their proportion of emissions is subsequently higher.

Next Report

7.11 The following report, Report 2, will assess and quantify potential Air Quality Action Plan interventions and identify the most effective measures to take forward to improve air quality in Chichester District.

Glossary

Term	Definition
ADMS	Atmospheric Dispersion Modelling System
ANPR	Automatic Number Plate Recognition
Air quality objective	Policy target generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedances within a specific timescale (see also air quality standard).
Air quality standard	The concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on the assessment of the effects of each pollutant on human health including the effects on sensitive sub groups (see also air quality objective).
Ambient air	Outdoor air in the troposphere.
Annual mean	The average (mean) of the concentrations measured for each pollutant for one year. Usually this is for a calendar year, but some species are reported for the period April to March, known as a pollution year. This period avoids splitting winter season between two years, which is useful for pollutants that have higher concentrations during the winter months.
AQAP	Air Quality Action Plan.
AQMA	Air Quality Management Area.
AQS	Air Quality Standard
ASR	Annual Status Report
CERC	Cambridge Environmental Research Consultants
Defra	Department for Environment, Food and Rural Affairs
Exceedance	A period of time where the concentrations of a pollutant is greater than, or equal to, the appropriate air quality standard.
HDV	Heavy Duty Vehicles: Heavy Goods Vehicles and buses.
HGV	Heavy Goods Vehicles
LAQM	Local Air Quality Management.
LDV	Light Duty Vehicles: motorcycles, cars and Light Goods Vehicles.
NO	Nitrogen monoxide, a.k.a. nitric oxide.
NO_2	Nitrogen dioxide.
NO_x	Nitrogen oxides.
Percentile	The percentage of results below a given value.
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 micrometres.
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 2.5 micrometres.
$\mu g/m^{-3}$. micrograms per cubic metre	A measure of concentration in terms of mass per unit volume. A concentration of 1µg/cu.m. means that one cubic metre of air contains one microgram (millionth of a gram) of pollutant.
UK-AIR	UK Air Information Resource: data resource for UK measurements and tools
UKAQS	United Kingdom Air Quality Strategy.
Validation (modelling)	Refers to the general comparison of modelled results against monitoring data carried out by model developers.
Validation (monitoring)	Screening monitoring data by visual examination to check for spurious and unusual measurements (see also ratification).
Verification (modelling)	Comparison of modelled results versus any local monitoring data at relevant locations.

Figures and Appendices

Figures 1- 7: Chichester and Midhurst modelled links and receptor maps.

Figure 1: Chichester modelled links and receptors.

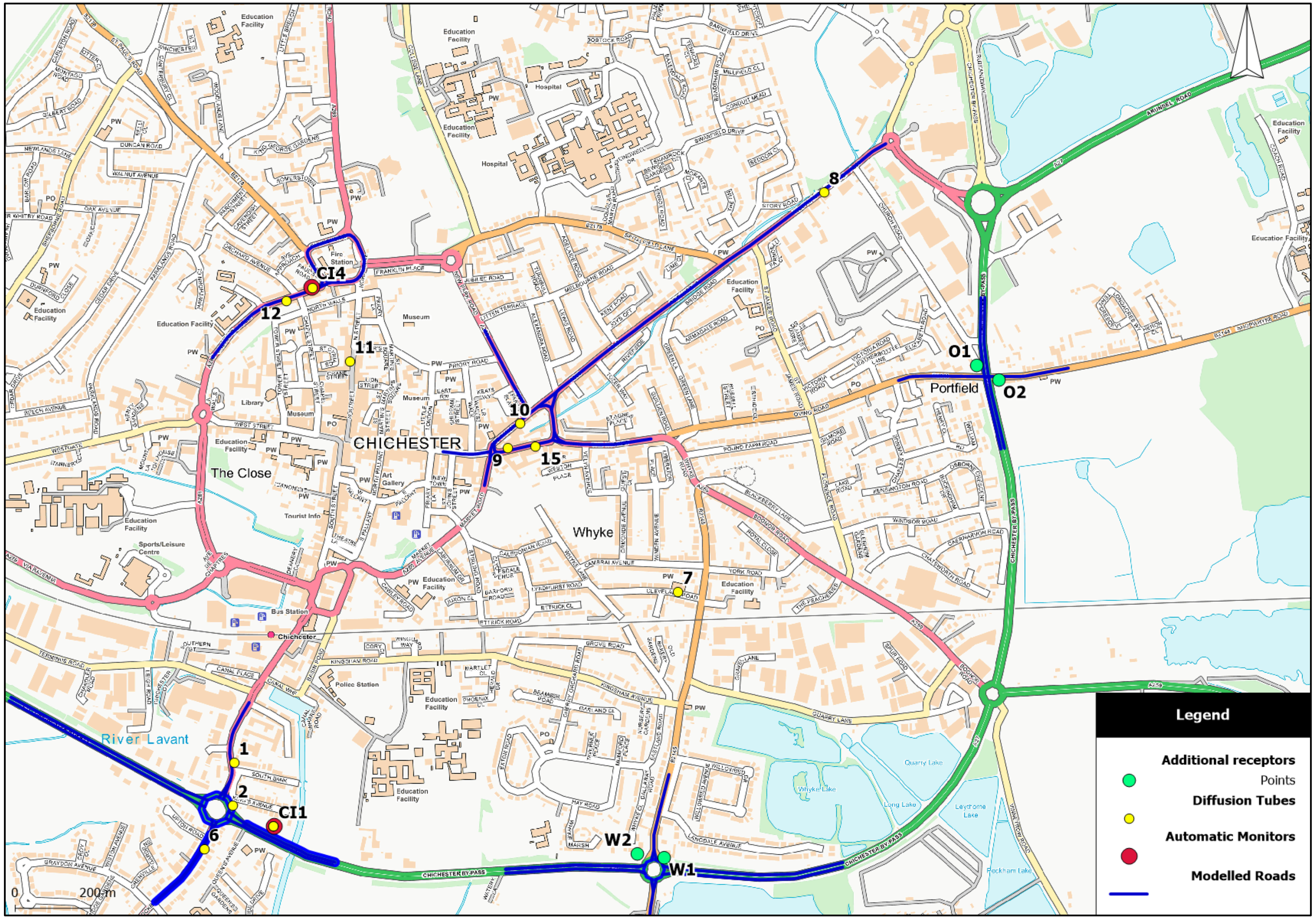


Figure 2: St Pancras AQMA and Hornet modelled links and receptors.

Figure 3: Orchard Street AQMA modelled links and receptors

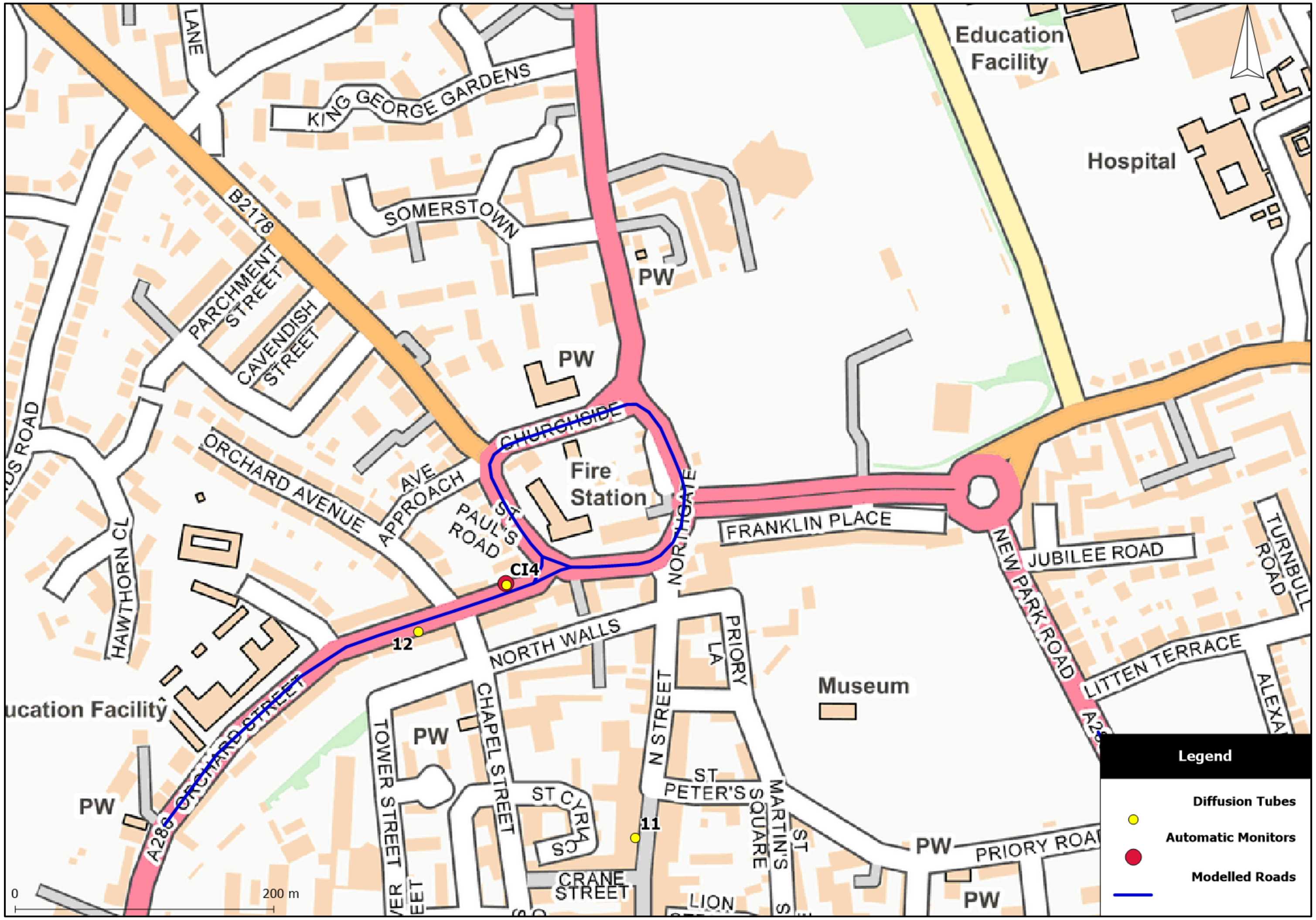


Figure 4: Oving Rd/A27 Intersection modelled links and receptors

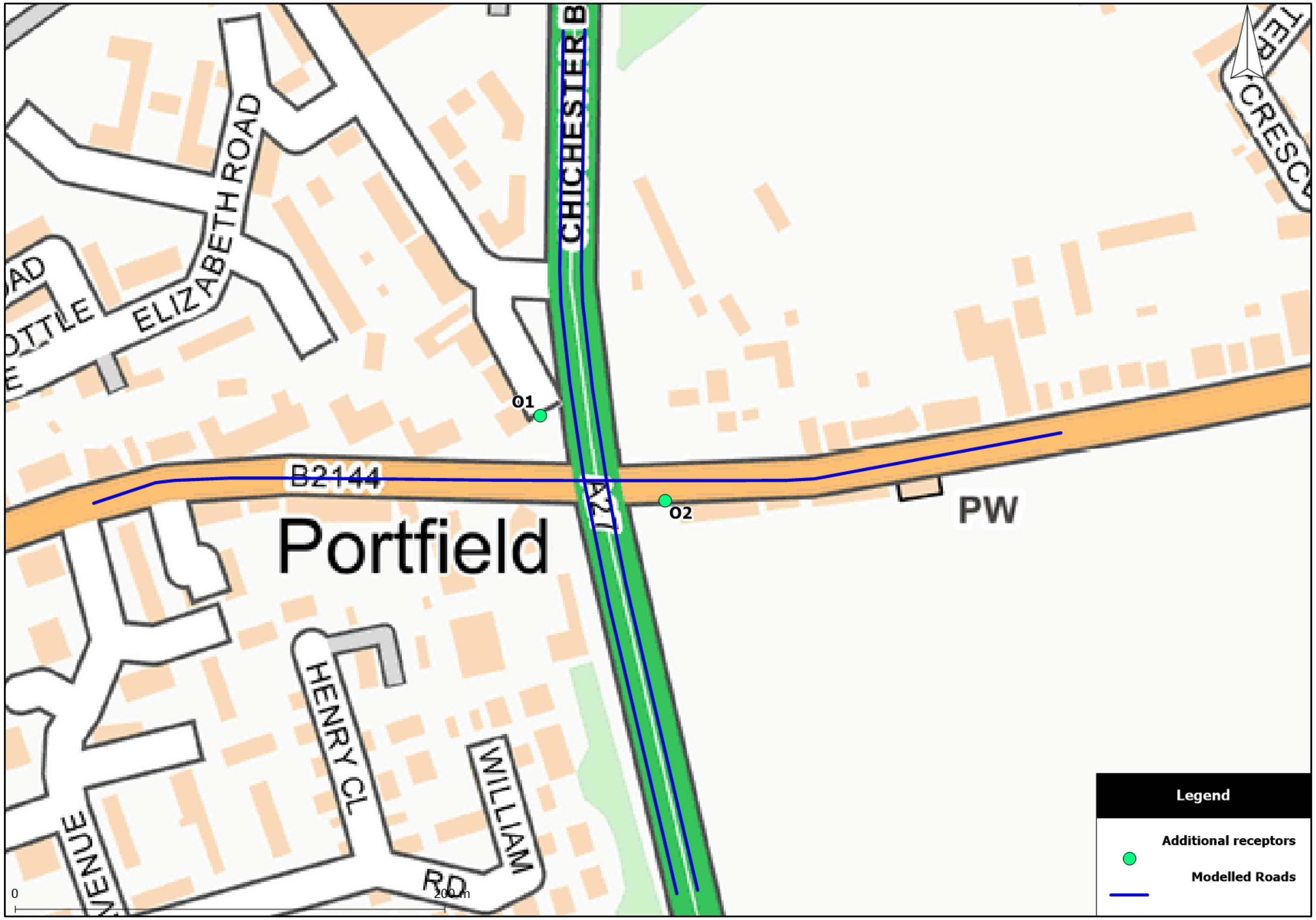


Figure 5: Stockbridge AQMA modelled links and receptors

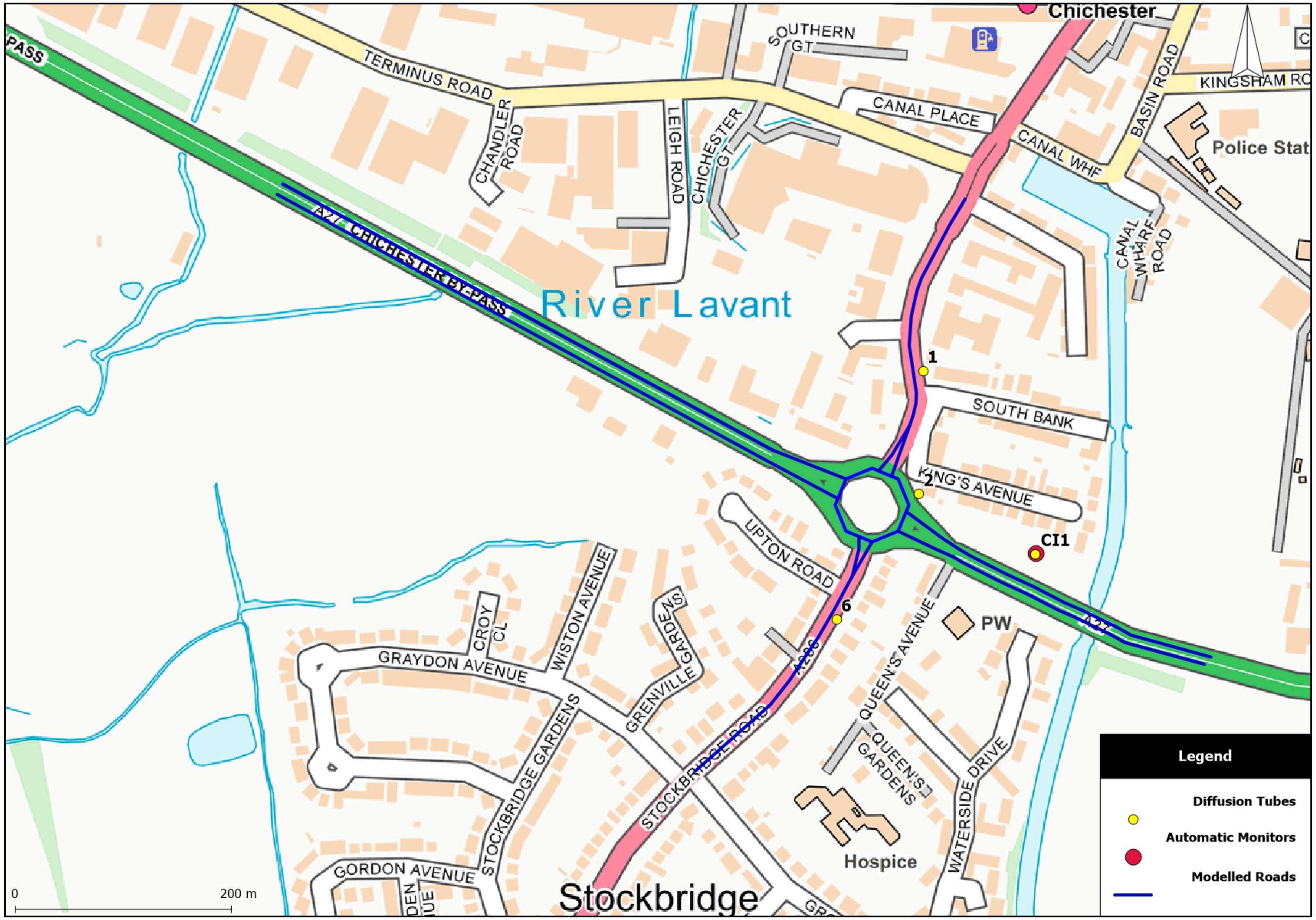


Figure 6: Whyke Roundabout modelled links and receptors

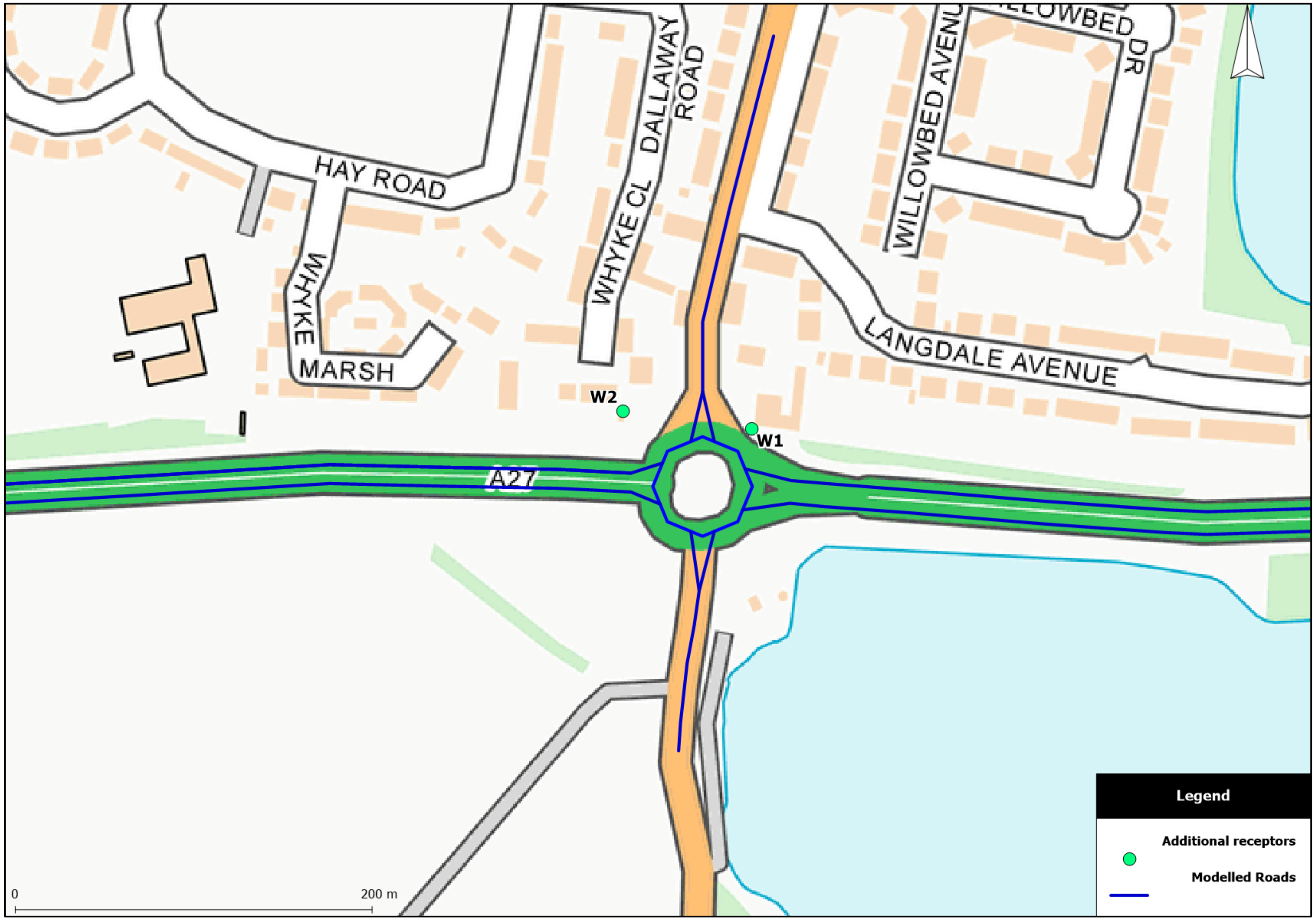
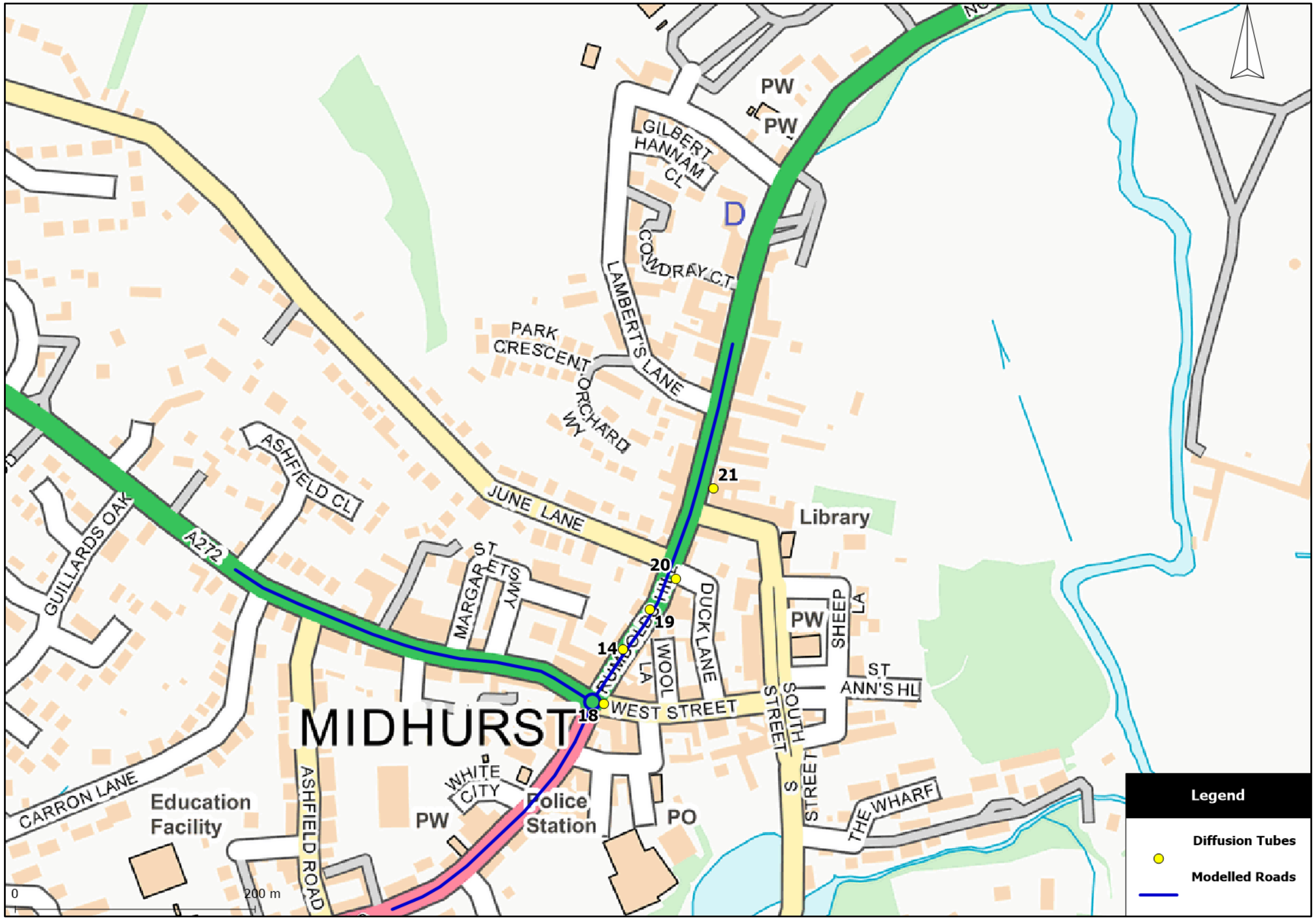


Figure 7: Midhurst modelled links and receptors



Appendix A: Summary of Air Quality Data (2015 – 2019)

Table A.1: Summary of annual mean NO_2 monitoring results (2015 - 2019)

Monitor		Concentration NO_2 – annual average ($\mu g.m^{-3}$)				
ID	**Location**	**2015**	**2016**	**2017**	**2018**	**2019**
CI1	Stockbridge AQMS	34	34	33	29	28
CI4	Orchard Street AQMS	x	29	23	22	21
CI5	Westhampnett Road AQMS	x	x	x	x	27
1	Kings Ave/Southbank Jct	30	33	29	27	25
2	Claremont Court	**42**	**42**	39	33	33
3	Cabin	34	34	33	29	28
4	Cabin	34	33	32	30	28
5	Cabin	34	35	34	29	28
6	Stockbridge Road South	**41**	**43**	36	34	33
7	Cleveland Rd	17	18	16	15	14
8	Westhampnett Road	30	31	30	29	27
9	Hornet	40	41	38	36	34
10	St Pancras	**46**	**51**	**44**	**45**	**42**
11	Arthur Purchase	18	20	18	17	17
12	174 Orchard St	33	38	33	33	30
14	Rumbold's Hill, Midhurst	**48**	**51**	**49**	**42**	**40**
15	Sussex Cleaners	x	x	x	32	31
16	Nag's Head	x	x	x	38	37
17	Orchard St cabin	x	x	x	22	20
18	Midhurst Stationery	x	x	x	28	26
19	Nat West Bank	x	x	x	37	37
20	Nationwide	x	x	x	38	33
21	British Heart Foundation	x	x	x	27	24

Note: AQMS = Air Quality Monitoring Station, x = no readings for year, **bold** denotes exceedance of annual mean objective (40$\mu g/m^{-3}$).

Table A.1: Summary of 1-hour mean NO_2 monitoring results (2015 - 2019)

Monitor		Concentration NO_2 1-hour mean ($\mu g.m^{-3}$)				
ID	**Location**	**2015**	**2016**	**2017**	**2018**	**2019**
CI1	Stockbridge AQMS	0	0	0	0	0
CI4	Orchard Street AQMS	x	0	0	0	0
CI5	Westhampnett Road AQMS	x	x	x	x	0

Exceedances of the NO_2 1-hour mean objective (200$\mu g/m^{-3}$ not to be exceeded more than 18 times/year) are shown in **bold**.

Table A.2: Summary of annual mean PM_{10} monitoring results (2015 - 2019)

Monitor		Concentration PM_{10} – annual mean ($\mu g.m^{-3}$)				
ID	**Location**	**2015**	**2016**	**2017**	**2018**	**2019**
CI1	Stockbridge AQMS	21	20	19	18	19

Note: AQMS = Air Quality Monitoring Station, x = no readings for year, **bold** denotes exceedance of annual mean objective (40$\mu g/m^{-3}$).

Table A.3: Summary of 24-Hour mean PM_{10} monitoring results (2015 - 2019)

Monitor		Exceedances of PM_{10} 24-hour mean >50$\mu g.m^{-3}$				
ID	**Location**	**2015**	**2016**	**2017**	**2018**	**2019**
CI1	Stockbridge AQMS	3	2	1	0	0

Note: AQMS = Air Quality Monitoring Station, x = no readings for year. Exceedances of the PM_{10} 24-hour mean objective (50$\mu g/m^{-3}$ not to be exceeded more than 35 times/year) are shown in **bold.**

Appendix B: Model Inputs

Table B.1: AADT traffic data used in the assessment.

Link Name	2018		2020		2025	
	AADT	%HDV	AADT	%HDV	AADT	%HDV
Orchard Street	16100	2.9%	16362	2.9%	17015	2.9%
St Pauls Road on Gyratory	17273	2.9%	17519	2.9%	18132	2.9%
St Pauls Road	12982	2.3%	13167	2.3%	13628	2.3%
Churchside	17250	2.9%	17371	2.9%	17675	2.9%
Northgate Gyratory Southbound	16859	2.6%	17212	2.6%	18093	2.6%
Northgate gyratory westbound	19600	2.2%	19883	2.2%	20591	
St Pancras on gyratory	16192	2.2%	16311	2.2%	16609	2.2%
St Pancras	12598	3.6%	12487	3.6%	12211	3.6%
The Hornet	22213	3.3%	22585	3.3%	23515	3.3%
The Hornet on Gyratory	16992	3.8%	17284	3.8%	18013	3.8%
Needlemakers	17760	3.6%	18049	3.6%	18772	3.6%
Westhampnett Rd W	22610	2.3%	22974	2.3%	23883	2.3%
Orchard Street (North of Westgate Roundabout)	14922	2.9%	15165	2.9%	15770	2.9%
A27 W westbound (Stockbridge)	23695	6.8%	24120	6.8%	25184	6.8%
A27 W eastbound (Stockbridge)	21808	6.7%	22199	6.7%	23178	6.7%
Stockbridge Rd N	10558	4.7%	10748	4.7%	11222	4.7%
A27 E eastbound (Stockbridge)	21121	6.8%	21501	6.8%	22449	6.8%
A27 E westbound (Stockbridge)	22768	7.0%	23177	7.0%	24199	7.0%
Stockbridge Rd S	23057	3.7%	23471	3.7%	24507	3.7%
A27 SW westbound (Bognor Roundabout)	22408	7.6%	23344	7.6%	25685	7.6%
A27 SW eastbound (Bognor Roundabout)	20515	7.4%	21373	7.4%	23516	7.4%
Bognor Rd NW eastbound	16968	4.9%	17677	4.9%	19450	4.9%
A27 N northbound (Bognor Roundabout)	16121	9.1%	16794	9.1%	18478	9.1%
A27 N southbound (Bognor Roundabout)	18445	9.4%	19216	9.4%	21143	9.4%
Bognor Rd E eastbound	25942	5.6%	27026	5.6%	29736	5.6%
Oving Rd	7433	1.9%	7641	1.9%	8163	1.9%
A27 N northbound (Oving Rd Signals)	16243	9.1%	16699	9.1%	17838	9.1%
A27 N southbound (Oving Rd Signals)	18289	9.8%	18802	9.8%	20085	9.8%

Shopwyke Rd	7909	2.3%	8131	2.3%	8685	2.3%
A27 S southbound (Oving Rd Signals)	17958	9.5%	18462	9.5%	19721	9.5%
A27 S northbound (Oving Rd Signals)	15551	9.1%	15988	9.1%	17078	9.1%
Whyke Road	7622	0.6%	7926	0.6%	8740	0.6%
A27 W EB (Whyke Roundabout)	21121	6.8%	21501	6.8%	22449	6.8%
A27 W WB (Whyke Roundabout)	22768	7.0%	23177	7.0%	24199	7.0%
A27 E WB (Whyke Roundabout)	22408	7.6%	23344	7.6%	25685	7.6%
A27 E EB (Whyke Roundabout)	20515	7.4%	21373	7.4%	23516	7.4%
A286 (Rumbolds Hill)	11159	10.6	11496	10.6	12462	10.6
A286 South	8150	2.4	8396	2.4	9102	2.4
A272	9989	3.6	10281	3.6	11145	3.6

Table B.2: Background data used in the assessment.

Monitor	UK AIR Grid Square		Annual mean concentration ($\mu g.m^{-3}$)		
	X	Y	NO_2	PM_{10}	$PM_{2.5}$
1	485500	103500	9.2	14.8	9.8
2	485500	103500	9.2	14.8	9.8
3	485500	103500	9.2	14.8	9.8
6	485500	103500	9.2	14.8	9.8
8	487500	105500	11.0	14.9	10.2
9	486500	104500	12.1	14.9	10.3
10	486500	104500	12.1	14.9	10.3
12	485500	105500	11.2	14.8	10.2
CI1	485500	103500	9.2	14.8	9.8
CI4	485500	105500	11.2	14.8	10.2
15	486500	104500	12.1	14.9	10.3
W1	486500	103500	9.7	14.9	9.8
W2	486500	103500	9.7	14.9	9.8
O1	487500	105500	11.4	14.9	10.2
O2	487500	104500	11.4	14.9	10.2
14	488500	121500	8.70	13.7	9.3
18	488500	121500	8.70	13.7	9.3

Monitor	UK AIR Grid Square		Annual mean concentration (µg.m^{-3})		
	X	Y	NO_2	PM_{10}	$PM_{2.5}$
19	488500	121500	8.70	13.7	9.3
20	488500	121500	8.70	13.7	9.3
21	488500	121500	8.70	13.7	9.3

Note: based on 2018 monitoring data; the contribution of A roads and trunk roads has been removed from background concentrations.

Appendix C: Model Verification Study

Model Verification

Model verification studies are undertaken in order to check the performance of dispersion models and, where modelled concentrations are significantly different to monitored concentrations, a factor can be established by which the modelled results can be adjusted in order to improve their reliability. The model verification process is detailed in the Defra LAQM.TG(16) guidance.

Model verification can only be undertaken where there is sufficient roadside monitoring data in the vicinity of the subject scheme being assessed. LAQM.TG(16) recommends that a combination of automatic and diffusion tube monitoring data is used; although this may be limited by data availability.

Model verification process

Modelling at locations with robust monitoring data is undertaken to compare "monitored" concentrations against "modelled" results as part of the verification process. The model outputs are "unadjusted" results and can be provided for a variety of pollutants.

If unadjusted NO_2 results are within 25% of the monitored NO_2 results or there is no systematic under or overprediction, no further adjustment to the modelling output is required. However, if unadjusted NO_2 results are outside (i.e. + or -) 25% of the monitored NO_2 results or systematically under or overpredicting, then adjustments to the modelled NO_x outputs are required.

Unadjusted results

Table C.1 below shows the difference between monitored NO_2 and unadjusted modelled NO_2.

Table C.1: Monitored and Unadjusted Modelled NO_2

Monitor ID	Monitored Road Total NO_2 ($\mu g.m^{-3}$)	Modelled Unadjusted Total NO_2 ($\mu g.m^{-3}$)	Difference (%)
Chichester			
8	29.4	27.3	-6.9%
9	35.4	36.6	3.3%
10	45.2	46.0	1.9%
12	33.3	34.2	2.7%
CI4	22.0	23.8	8.3%
15	32.3	38.2	18.3%
Stockbridge AQMA			
1	27.0	20.7	-23.2%
2	33.0	23.8	-28.0%

(3,4,5)	29.0	21.2	-26.8%
6	33.8	20.3	-40.1%
CI1	29.0	20.8	-28.2%
Midhurst			
14	41.0	38.9	-5.0%
18	28.0	28.3	1.1%
19	37.0	35.0	-5.4%
20	38.0	34.1	-10.4%
21	27.0	28.7	6.3%

As the majority of modelled NO_2 results at Stockbridge AQMA location were outside 25% of the monitored NO_2 results, it was decided to proceed with adjustment as the model was systematically under predicting NO_x concentrations. This was done in order to ensure conservative results.

NO_x adjustment factors

As it is primary NO_x, rather than secondary NO_2, emissions that are modelled, an adjustment factor must be derived for the road contribution of NO_x output from the model.

The following Figures C.1 to C.3 show the results of the road NOx adjustment calculations for each modelling domain.

Figure C.1 Monitored vs Modelled Road NOx (Chichester)

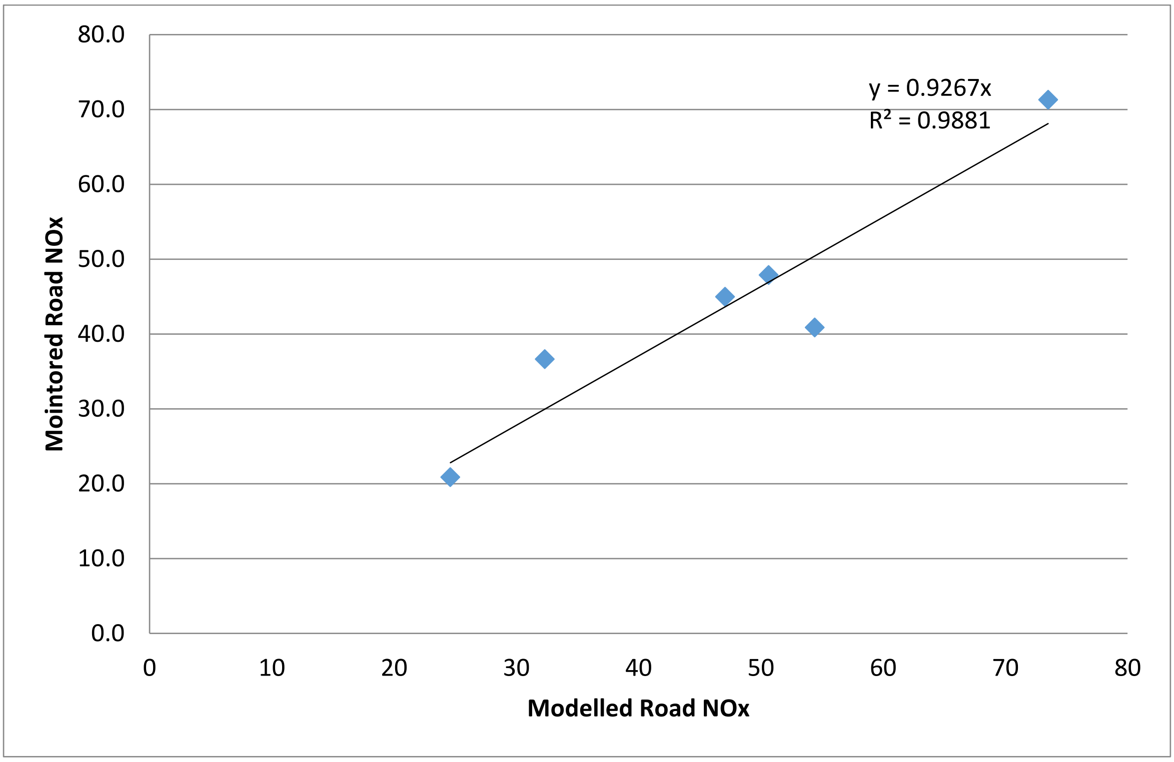


Figure C.2 Monitored vs Modelled Road NOx (Stockbridge AQMA)

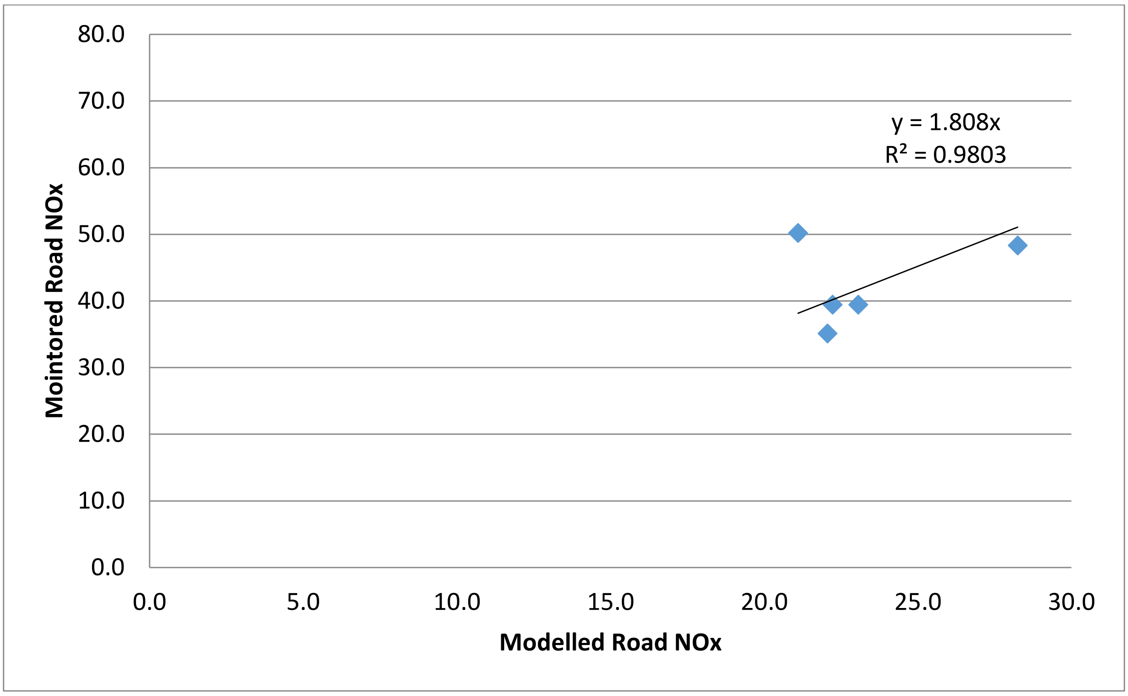
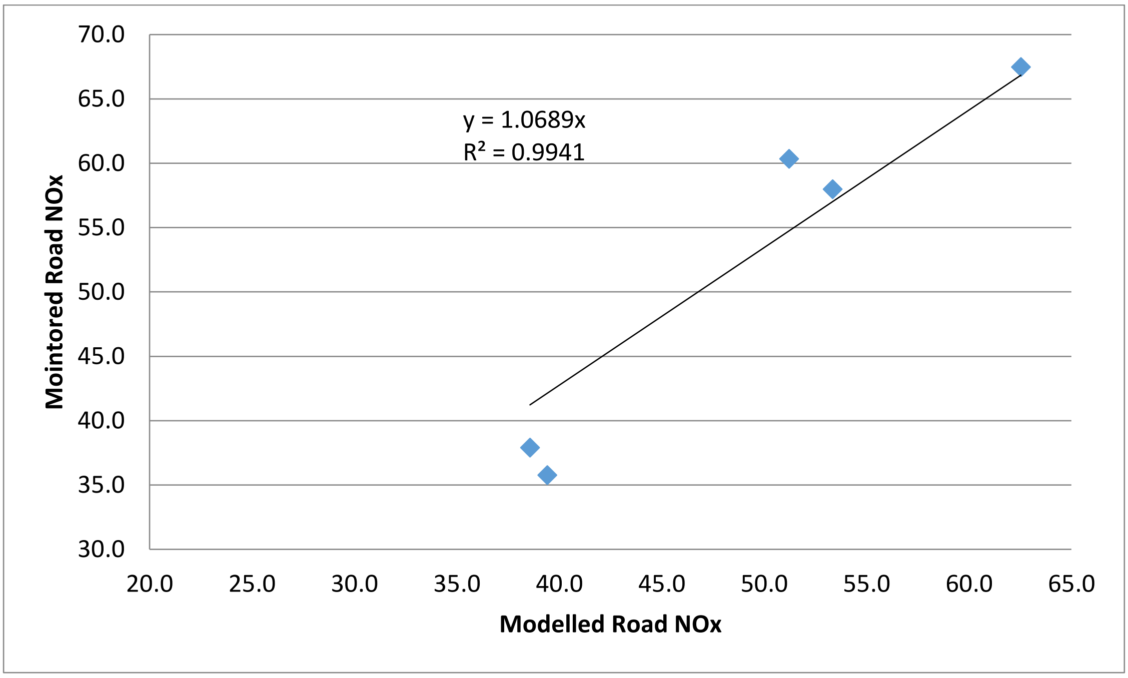


Figure C.3 Monitored vs Modelled Road NOx (Midhurst)



LAQM.TG(16) Box 7.15 sets out the equation to determine the adjustment factor.

> *The equation of the trend line should be in the format of:*
> - *y = mx (intercept at 0)*

- *y is monitored road contribution NOx and*
- *x is modelled road contribution NOx*

m is the regression correction factor to apply to the modelled road contribution NOx.

By plotting a trend line through the points on the graphs; a factor of 0.927 (m value) was derived (1.0 was used) for Chichester locations; a factor of 1.81 was derived in for Stockbridge AQMA; and a factor of 1.07 (1.0 was used) in Midhurst.

Adjusted NO_2 results

Table C.2 shows total monitored NO_2 versus modelled total NO_2 following the adjustment of the road contribution of NO_x by the appropriate factor. It shows that, following this adjustment, all modelled concentrations of NO_2 were within 25% of monitored concentrations at these locations.

As a result, the factors were considered appropriate for the adjustment of modelled road contributions of NO_x.

Table C.2: Monitored and Adjusted Modelled Total NO_2 at Monitoring Sites

ID	Monitored Total NO_2 (µg.m-^{3})	Modelled Total NO_2 (µg.m-^{3})	Difference (%)
Inner Chichester			
8	29.4	27.3	-6.9%
9	35.4	36.6	3.3%
10	45.2	46.0	1.9%
12	33.3	34.2	2.7%
CI4	22.0	23.8	8.3%
15	32.3	38.2	18.3%
Stockbridge AQMA			
1	27.0	29.2	8.3%
2	33.0	34.2	3.7%
(3,4,5)	29.0	30.1	3.7%
6	33.8	28.4	-15.9%
CI1	29.0	29.4	1.3%
Midhurst			
14	41.0	41.1	0.3%
18	28.0	29.4	5.1%
19	37.0	36.4	-1.7%
20	38.0	35.3	-7.1%
21	27.0	30.3	12.4%

RMSE

LAQM.TG(16) also provides several statistical procedures to evaluate model performance and assess the uncertainties These parameters estimate how the model results agree or diverge from the observations.

The Root Mean Square Error (RMSE) is used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared (i.e. $\mu g/m^{-3}$) with the ideal value being 0.0.

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(Obs_i - Pred_i)^2}$$

Calculation taken from LAQM.TG(16) Box 7.17 – Methods and Formulae for Description of Model Uncertainty.

An RMSE value of within 10% of the national air quality objective of $40\mu g/m^{-3}$ is considered to be ideal i.e. 4 $\mu g/m^{-3}$ (LAQM.TG(16)).

The RMSE value for the adjusted model is $2.86\mu g/m^{-3}$ for Chichester (including Stockbridge AQMA) and $2.04\mu g/m^{-3}$ for Midhurst, so it is considered to be robust.

Appendix D: Modelling results for PM_{10} and $PM_{2.5}$

Table D.1: PM_{10} concentration results

Receptor	Concentration PM_{10} – annual average ($\mu g.m^{-3}$)		
	2018	2020	2025
Chichester			
1	19.7	19.6	19.6
2	20.6	20.5	20.5
(3,4,5)	19.3	19.2	19.1
6	19.1	19.0	19.0
8	18.9	18.9	18.8
9	20.6	20.5	20.5
10	23.0	22.8	22.7
12	19.7	19.7	19.7
CI1	19.3	19.2	19.1
CI4	17.2	17.2	17.2
15	20.3	20.2	20.2
W1	21.8	21.7	21.8
W2	19.1	19.0	19.0
O1	18.7	18.6	18.7
O2	22.1	22.0	22.1
Midhurst			
14	17.3	17.2	17.3
18	17.0	16.9	17.0
19	17.1	17.0	17.0
20	16.7	16.6	16.7
21	16.3	16.2	16.3

Table D.2: $PM_{2.5}$ concentration results

Receptor	Concentration $PM_{2.5}$ – annual average ($\mu g.m^{-3}$)		
	2018	2020	2025
Chichester			
1	12.0	11.9	11.8
2	12.6	12.5	12.4
(3,4,5)	12.2	12.0	12.0
6	11.8	11.7	11.6
8	11.9	11.8	11.8
9	13.1	13.0	12.9
10	14.5	14.3	14.1
12	12.8	12.7	12.6
CI1	12.1	12.0	11.9
CI4	11.5	11.5	11.4
15	13.3	13.2	13.1
W1	12.7	12.5	12.5
W2	13.2	13.0	12.9
O1	12.9	12.7	12.6
O2	13.9	13.8	13.7
Midhurst			
14	11.7	11.6	11.6
18	12.7	12.6	12.5
19	14.1	13.9	13.7
20	12.3	12.1	12.1
21	10.8	10.7	10.7

Appendix E: Source apportionment for PM_{10} and $PM_{2.5}$

St Pancras AQMA

Table E.1: PM_{10} source apportionment for St Pancras AQMA.

Vehicle	Source apportionment of PM_{10}		
	2018	2020	2025
Petrol Cars (%)	36.8%	36.2%	34.3%
Diesel Cars (%)	37.1%	36.7%	33.7%
Taxis (%)	-	-	-
Petrol LGVs (%)	0.4%	0.3%	0.2%
Diesel LGVs (%)	14.7%	14.5%	14.1%
Rigid HGVs (%)	2.5%	2.5%	2.4%
Artic HGVs (%)	1.0%	1.0%	1.0%
Buses/Coaches (%)	5.1%	4.9%	4.6%
Motorcycles (%)	-	-	-
Full Hybrid Petrol Cars (%)	1.4%	2.1%	3.5%
Plug-In Hybrid Petrol Cars (%)	0.5%	0.9%	3.8%
Full Hybrid Diesel Cars (%)	0.2%	0.5%	1.4%
Battery EV Cars (%)	0.1%	0.2%	0.6%

Table E.2: $PM_{2.5}$ source apportionment for St Pancras AQMA.

Vehicle	Source apportionment of $PM_{2.5}$		
	2018	2020	2025
Petrol Cars (%)	34.8%	35.1%	34.3%
Diesel Cars (%)	38.8%	38.0%	34.3%
Taxis (%)	-	-	-
Petrol LGVs (%)	0.3%	0.3%	0.2%
Diesel LGVs (%)	15.0%	14.6%	14.0%
Rigid HGVs (%)	2.5%	2.4%	2.3%
Artic HGVs (%)	1.0%	1.0%	1.0%
Buses/Coaches (%)	5.3%	5.0%	4.4%
Motorcycles (%)	-	-	-
Full Hybrid Petrol Cars (%)	1.3%	2.1%	3.5%
Plug-In Hybrid Petrol Cars (%)	0.5%	0.8%	3.6%
Full Hybrid Diesel Cars (%)	0.2%	0.5%	1.4%
Battery EV Cars (%)	0.1%	0.2%	0.6%

Stockbridge AQMA/ A27

Table E.3: PM_{10} source apportionment for Stockbridge AQMA /A27.

Vehicle	Source apportionment of PM_{10}		
	2018	2020	2025
Petrol Cars (%)	27.2%	26.9%	25.6%
Diesel Cars (%)	27.4%	27.3%	25.1%

Taxis (%)	-	-	-
Petrol LGVs (%)	0.5%	0.4%	0.3%
Diesel LGVs (%)	20.5%	20.3%	19.7%
Rigid HGVs (%)	15.6%	15.5%	15.1%
Artic HGVs (%)	6.3%	5.9%	6.1%
Buses/Coaches (%)	0.7%	0.7%	0.6%
Motorcycles (%)	-	-	-
Full Hybrid Petrol Cars (%)	1.1%	1.6%	2.6%
Plug-In Hybrid Petrol Cars (%)	0.4%	0.7%	2.8%
Full Hybrid Diesel Cars (%)	0.1%	0.4%	1.0%
Battery EV Cars (%)	0.1%	0.2%	0.4%

Table E.4: $PM_{2.5}$ source apportionment for Stockbridge AQMA /A27

Vehicle	Source apportionment of $PM_{2.5}$		
	2018	2020	2025
Petrol Cars (%)	25.8%	26.2%	25.7%
Diesel Cars (%)	28.7%	28.3%	25.7%
Taxis (%)	-	-	-
Petrol LGVs (%)	0.5%	0.4%	0.3%
Diesel LGVs (%)	20.8%	20.5%	19.7%
Rigid HGVs (%)	15.4%	15.2%	14.4%
Artic HGVs (%)	6.4%	6.0%	6.2%
Buses/Coaches (%)	0.7%	0.7%	0.6%
Motorcycles (%)	-	-	-
Full Hybrid Petrol Cars (%)	1.0%	1.5%	2.6%
Plug-In Hybrid Petrol Cars (%)	0.3%	0.6%	2.7%
Full Hybrid Diesel Cars (%)	0.1%	0.4%	1.0%
Battery EV Cars (%)	0.1%	0.2%	0.4%

Midhurst (A286)

Table E.5: PM_{10} source apportionment for Midhurst (A286).

Vehicle	Source apportionment of PM_{10}		
	2018	2020	2025
Petrol Cars (%)	19.7%	19.7%	19.7%
Diesel Cars (%)	28.0%	27.7%	25.5%
Taxis (%)	-	-	-
Petrol LGVs (%)	0.3%	0.3%	0.2%
Diesel LGVs (%)	14.7%	14.4%	14.2%
Rigid HGVs (%)	7.8%	7.5%	7.1%
Artic HGVs (%)	8.3%	8.2%	8.6%
Buses/Coaches (%)	19.3%	19.6%	18.8%
Motorcycles (%)	0.5%	0.5%	0.5%

Full Hybrid Petrol Cars (%)	0.8%	1.2%	2.0%
Plug-In Hybrid Petrol Cars (%)	0.3%	0.5%	2.1%
Full Hybrid Diesel Cars (%)	0.1%	0.4%	1.0%
Battery EV Cars (%)	-	-	-

Table E.6: $PM_{2.5}$ source apportionment for Midhurst (A286).

Vehicle	Source apportionment of $PM_{2.5}$		
	2018	2020	2025
Petrol Cars (%)	17.9%	18.5%	19.3%
Diesel Cars (%)	28.9%	28.2%	25.7%
Taxis (%)	-	-	-
Petrol LGVs (%)	0.3%	0.3%	0.2%
Diesel LGVs (%)	14.8%	14.3%	14.0%
Rigid HGVs (%)	7.6%	7.1%	6.6%
Artic HGVs (%)	8.1%	7.9%	8.4%
Buses/Coaches (%)	20.6%	21.1%	20.0%
Motorcycles (%)	0.6%	0.6%	0.6%
Full Hybrid Petrol Cars (%)	0.7%	1.1%	2.0%
Plug-In Hybrid Petrol Cars (%)	0.2%	0.4%	2.0%
Full Hybrid Diesel Cars (%)	0.1%	0.4%	1.0%
Battery EV Cars (%)	-	-	-

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