Air Quality CONSULTANTS

AQMA Review:
Canterbury

October 2023

Experts in air quality
management & assessment

Document Control

Client	Canterbury City Council	**Principal Contact**	Andrew Thompson

Job Number	J10/13286C/10

Report Prepared By:	Jack Buckley and Dr Clare Beattie

Document Status and Review Schedule

Report No.	Date	Status	Reviewed by
J10/13286C/10/1/F1	12 October 2023	Final	Dr Denise Evans (Associate Director)

Air Quality Consultants Ltd
23 Coldharbour Road, Bristol BS6 7JT Tel: 0117 974 1086
24 Greville Street, Farringdon, London, EC1N 8SS Tel: 020 3873 4780
aqc@aqconsultants.co.uk

Registered Office: 23 Coldharbour Road, Bristol BS6 7JT
Companies House Registration No: 2814570

1 Introduction

1.1 Canterbury City Council (CCC) currently has two Air Quality Management Areas (AQMAs) designated for exceedances the annual mean nitrogen dioxide (NO_2) objective, covering major roads in Canterbury and a small part of Herne Street in Herne. Within the Canterbury AQMA, the only locations exceeding the objective, or within 10% of the objective, according to the latest monitoring data, are located adjacent to the A28, A290 and A257, which are the focus of the model within Canterbury. The Herne AQMA has also been modelled.

1.2 This report presents the results of modelling at locations of specific concern. The output of the dispersion modelling has been used to estimate source contributions from different vehicle types, and different Euro classes, in line with the methodology set out in LAQM.TG(22) (Defra, 2022).

1.3 Detailed modelling of the area of interest has been undertaken for a baseline year (2022) to inform the extent of the area of exceedance.

1.4 This report has been carried out by Air Quality Consultants Ltd (AQC) on behalf of CCC. It has been prepared taking account of the requirements set out in LAQM.TG(22). The professional experience of the consultants who have undertaken the assessment is summarised in Appendix A1.

2 Modelling In Canterbury and Herne

Modelling Methodology

2.1 Annual mean concentrations of NO_2 have been predicted for the baseline (2022). Concentrations have been predicted in Herne and along the A28, A290 and A257 in Canterbury using the ADMS-Roads dispersion model, with vehicle emissions derived using Defra's Emission Factor Toolkit (EFT) (v11.0). Details of the model inputs, assumptions and the verification are provided in Appendix A2, together with the method used to derive background concentrations. Where assumptions have been made, a realistic worst-case approach has been adopted.

Receptors

2.2 Concentrations have been predicted at residential properties adjacent to the A28, A290 and A257, and within Herne, as derived from GIS data provided by CCC. Concentrations have been predicted at heights of relevant exposure. The specific receptors modelled are shown in Figure 1 and Figure 2.

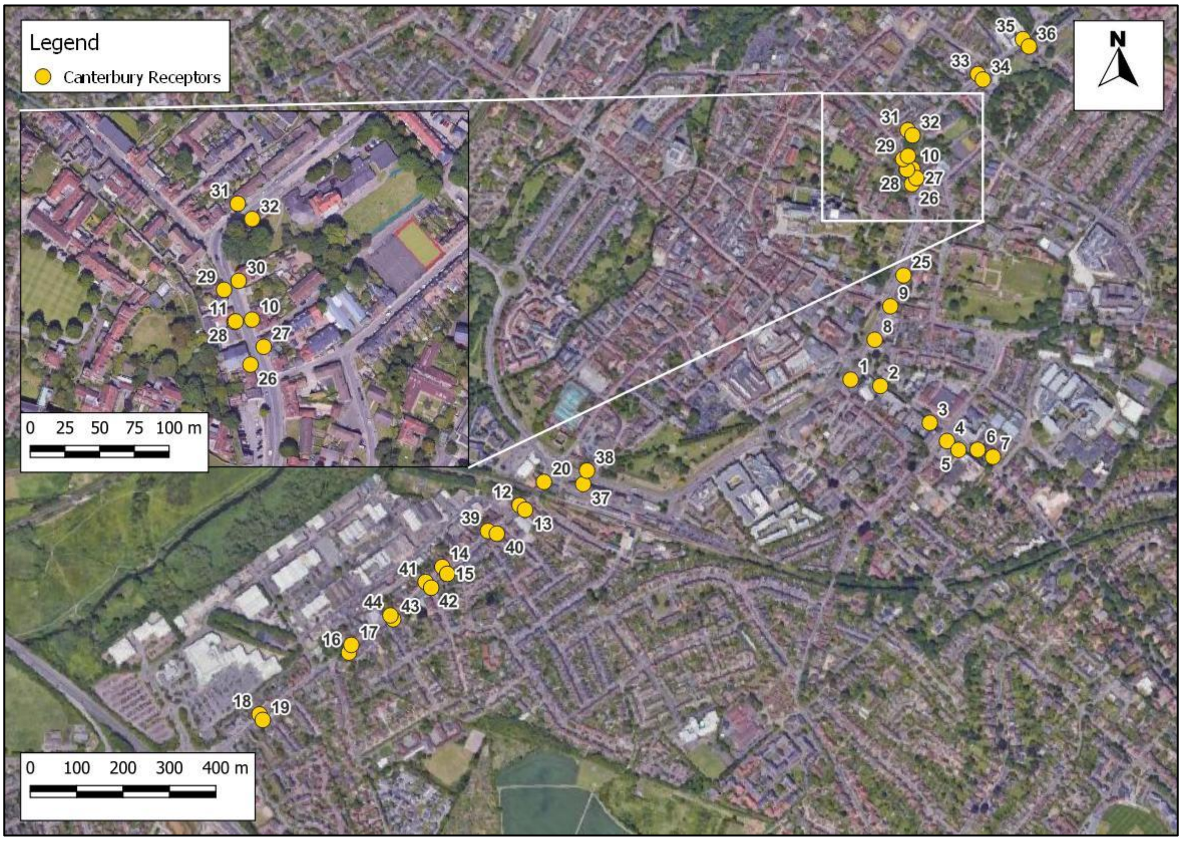

Figure 1: Canterbury Receptor Locations

Imagery ©2023 Google, Imagery ©2023 Airbus, CNES / Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Landsat / Copernicus, Maxar Technologies, Map data ©2023.

Figure 2: Herne Receptor Locations

Imagery ©2023 Google, Imagery ©2023 Airbus, CNES / Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Landsat / Copernicus, Maxar Technologies, Map data ©2023.

Traffic Data

2.3 Automatic Number Plate Recognition (ANPR) data, provided by Intelligent Data, were collected on the A28 Wincheap close to the junction with the A290 and on the A28 Broad Street on the 15th June and 18th July 2023, respectively. The dataset provides traffic counts and a breakdown of vehicles by type and Euro class. This information has been used together with traffic flows for 2022 in the area (provided by Kent County Council (KCC)), to estimate traffic flows, fleet composition and speed across the area of focus in 2022.

Uncertainty

2.4 There are many components that contribute to the uncertainty of modelling predictions.

2.5 The road traffic emissions dispersion model used in this assessment is dependent upon the traffic data that have been input, which will have inherent uncertainties associated with them, and any uncertainties inherent in these data will carry into the assessment. There will also be uncertainties within the ANPR data.

2.6 Uncertainty is also introduced when calculating the effect of gradients on vehicle emissions within the EFT, which has been considered within the modelling undertaken in Herne.

2.7 There are then additional uncertainties as models are required to simplify real-world conditions into a series of algorithms. An important stage in the process is model verification, which involves comparing the model output with measured concentrations (see Appendix A2). Because the model has been verified and adjusted, there can be reasonable confidence in the prediction of 2022 concentrations. LAQM.TG22 (Defra, 2022) provides guidance on the evaluation of model performance. An analysis of the verification is shown in Table A2.5 in Appendix A2.

2.8 All of the measured concentrations presented will also have an intrinsic margin of error, which will also have been carried into the results of the modelling.

Modelling Results

2.9 Figure 3 and Figure 4 show modelled annual mean NO_2 concentrations at the specific receptors in the 2022 Baseline. This indicates that the annual mean objective is achieved at the majority of receptors in Canterbury, with exceedances indicated at five receptors all located at the roadside of Wincheap. It also indicates that the objective is achieved at most receptors in Herne, with the exception of one receptor close to the junction.

2.10 Predicted concentrations at all receptors are well below 60 µg/m^3, indicating that exceedances of the 1-hour mean NO_2 objective are unlikely, according to the methodology set out in LAQM.TG(22). Full modelling results are presented in Appendix A3.

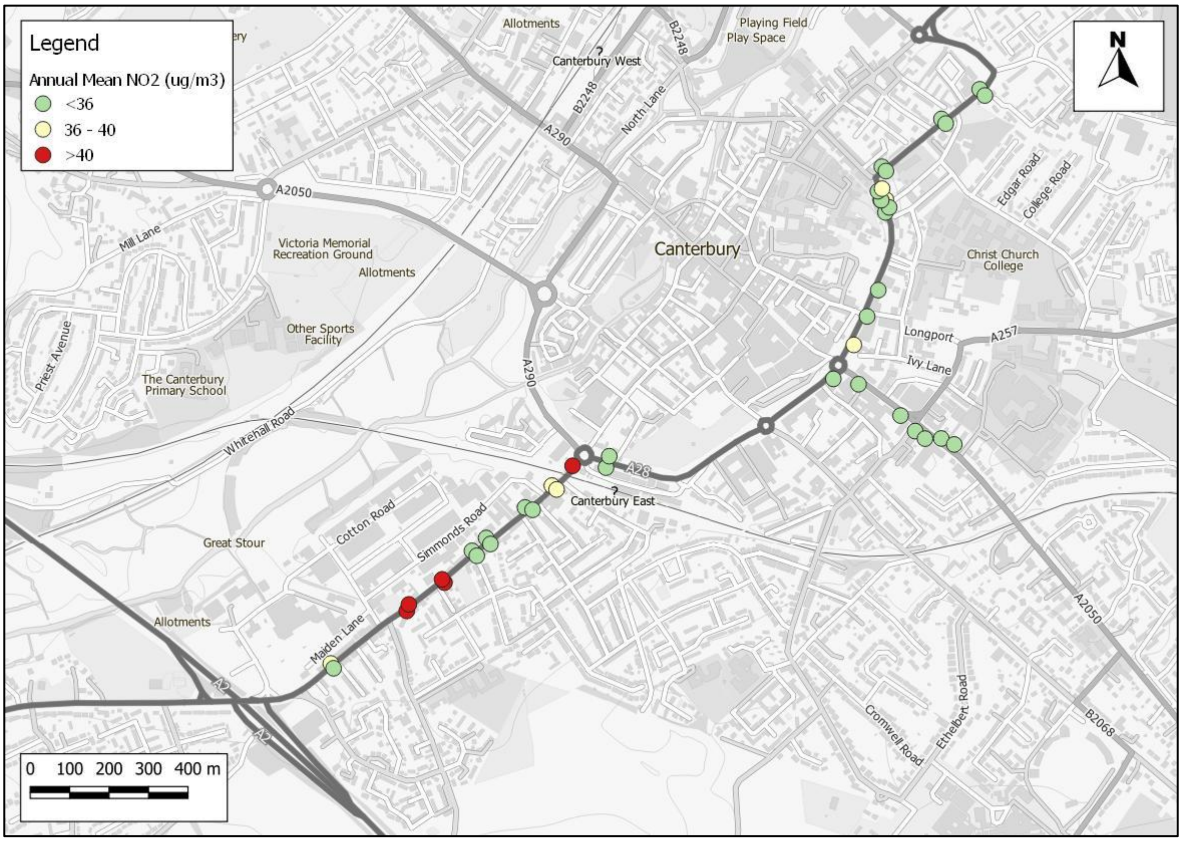

Figure 3: Modelled Annual Mean NO_2 Concentrations at Specific Receptors in 2022 Baseline in Canterbury

Figure 4: Modelled Annual Mean NO_2 Concentrations at Specific Receptors in 2022 Baseline in Herne

AQMA Recommendation

2.11 The modelling indicates that within Canterbury, the AQMA is still required. Exceedances are still being experienced locations of relevant exposure alongside Wincheap. Additionally, there are further locations alongside the A28 where predicted concentrations remain within 10% of the objective in 2022.

2.12 In Herne, location very close to the junction are predicted to be close to, or exceeding, the annual mean objective in 2022.

2.13 It is therefore recommended that both AQMAs are retained as currently declared.

Source Apportionment

2.14 Defra's EFT has been used to provide an indication of the proportion of road traffic emissions within Canterbury, from each vehicle and Euro class type in 2022.

2.15 Figure 5 and Table 1 show the percentage of emissions by vehicle type. This has been calculated using the total modelled annual emissions on across all roads in 2022 and the Source Apportionment option within the EFT. The results indicate that the majority of road NOx emissions in 2022 were produced by Diesel Cars (39.3%), followed by Diesel LGVs (31.4%), Petrol Cars (9.3%), Buses/Coaches (9.1%) and Diesel Rigid Heavy Goods Vehicles (HGVs) (8.0%).

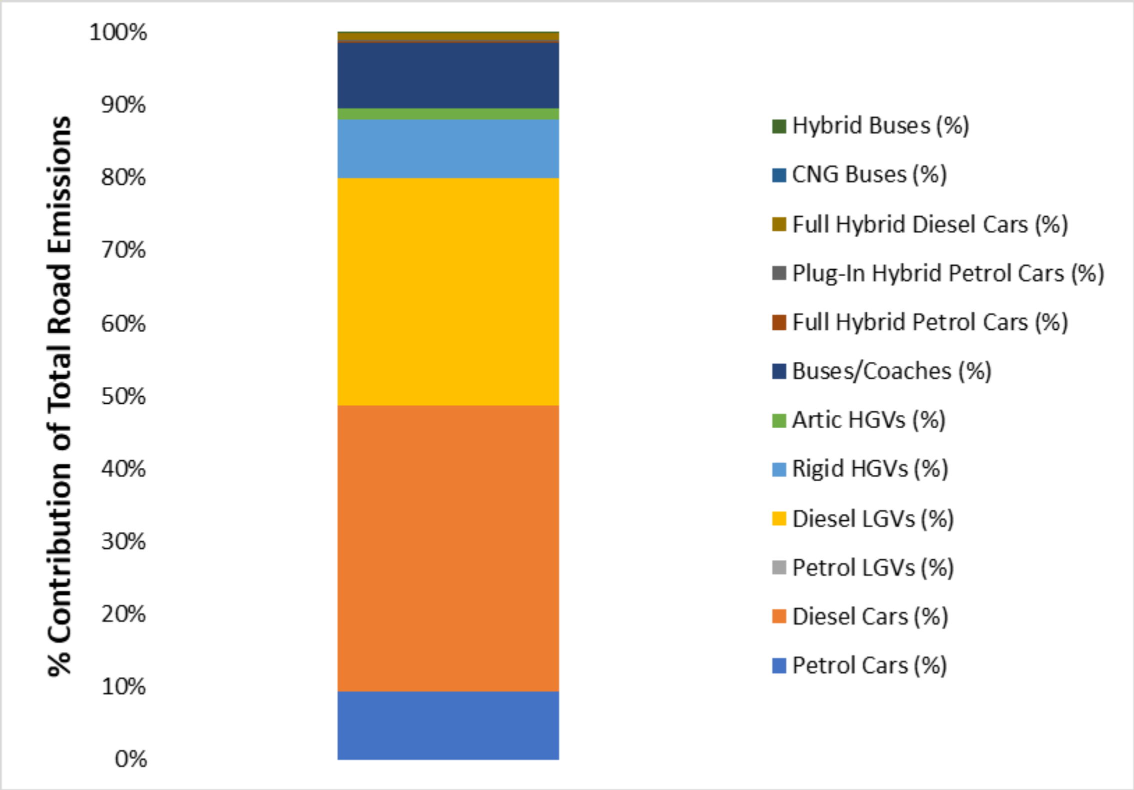

Figure 5: Percentage Contribution of Total Road Emissions by Vehicle Type (2022 Baseline)

Table 1: Percentage Contribution of Total Road Emissions by Vehicle Type (2022)

Vehicle Type	NOx (%)
Petrol Cars	9.3
Diesel Cars	39.3
Petrol LGVs	0.0
Diesel LGVs	31.4
Rigid HGVs	8.0
Artic HGVs	1.4
Buses/Coaches	9.1
Full Hybrid Petrol Cars	0.2
Plug-In Hybrid Petrol Cars	0.1
Full Hybrid Diesel Cars	0.9
CNG Buses	0.0
Hybrid Buses	0.1

Canterbury

2.16 Figure 6, Figure 7, Table 2 and Table 3 show the percentage contribution of NOx emissions by vehicle Euro class for LDVs and HDVs (HGVs and Buses/Coaches), respectively, along Wincheap in Canterbury. The proportions have been calculated based on the annual emissions from all modelled roads using the EFT's Euro Emissions Standards Summary for NOx.

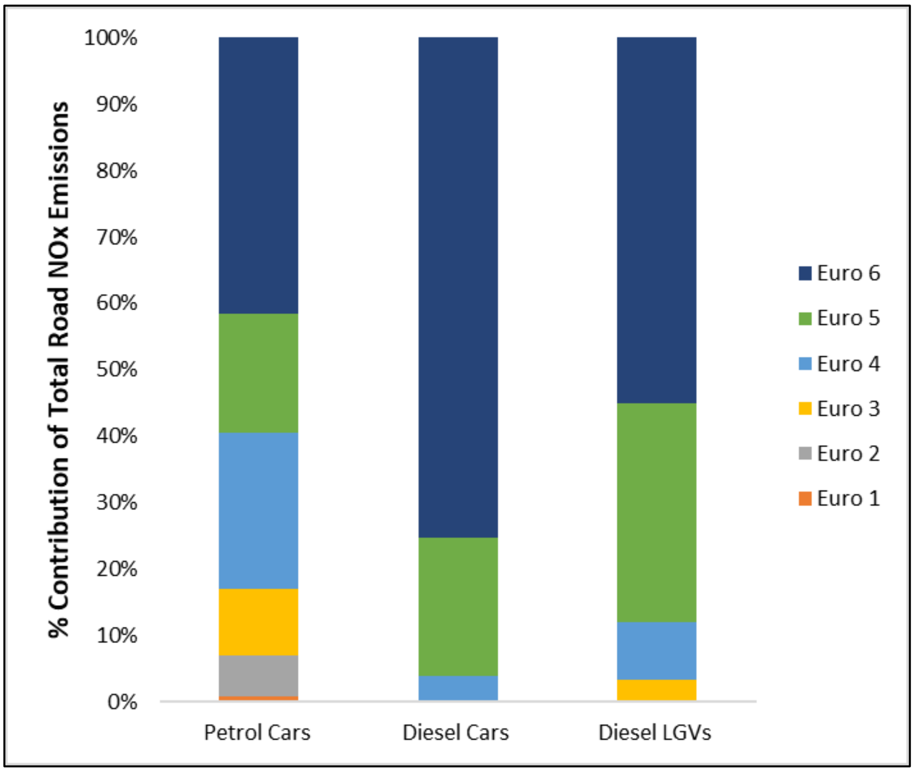

Figure 6: Percentage Contribution of Total Road NOx Emissions from Light Duty Vehicles on Wincheap by Euro Class Type (2022 Baseline)

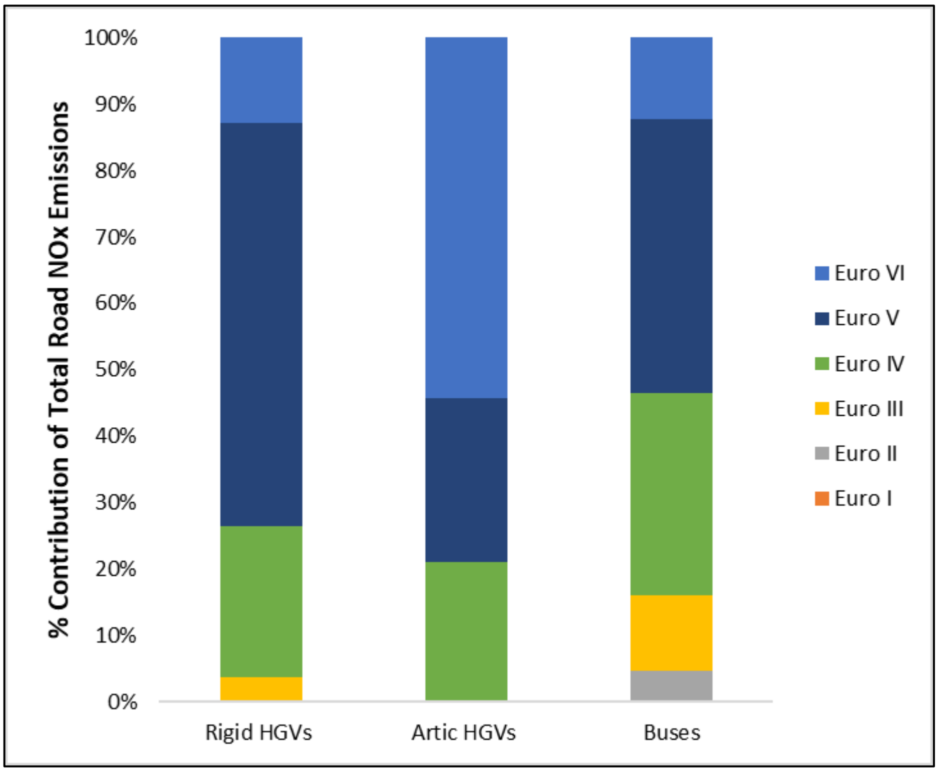

Figure 7: Percentage Contribution of Total Road NOx Emissions from Heavy Duty Vehicles on Wincheap by Euro Class Type (2022 Baseline)

Table 2: Percentage Contribution of Total Road Emissions from Light Duty Vehicles by Euro Class Type (2022)

Euro Standard	Petrol Cars (%)	Diesel Cars (%)	Diesel LGVs (%)
Euro 1	0.9	0.0	0.1
Euro 2	6.2	0.1	0.2
Euro 3	9.9	0.2	3.0
Euro 4	23.5	3.7	8.7
Euro 5	17.9	20.8	32.8
Euro 6	41.5	75.2	55.1

Table 3: Percentage Contribution of Total Road Emissions from Heavy Duty Vehicles by Euro Class Type (2022)

Vehicle Type	Rigid HGVs	Artic HGVs	Buses/Coaches
Euro I	0.0	0.0	0.0
Euro II	0.0	0.0	4.6
Euro III	3.7	0.0	11.4
Euro IV	22.8	21.0	30.4
Euro V	60.6	24.8	41.2
Euro VI	12.9	54.2	12.3

2.17 Figure 6 and Table 2 indicate that the majority of NOx emissions from Petrol Cars in 2022 are from Euro 6 vehicles (41.5%), while for Diesel Cars and LGVs Euro 6 vehicles also emit the highest proportion of NOx (75.2% and 55.1%, respectively). In terms of HDVs, Figure 7 and Table 3 indicate that the majority of NOx emissions from Rigid HGVs and Buses/Coaches in 2019 are from Euro V vehicles (60.6% and 41.2%, respectively), while for Artic HGVs the majority of emissions are from Euro VI vehicles (54.2%).

2.18 The ANPR data (after manual assignment of Euro classes as described in Paragraph A2.1) show that approximately 67% of the bus fleet within Canterbury centre in 2023 are Euro VI vehicles, 17% are Euro V and 12% are Euro IV. This is taken to indicate a relatively new bus fleet, although this assumption should be treated with some caution (see Paragraph A2.1).

2.19 It should be noted that these proportions are calculated based on a series of assumptions (as described in Paragraph A2.1), and are estimated for 2022 using Defra's EFT, based on ANPR data collected in 2023.

Herne

2.20 Figure 8, Figure 7, Table 4and Table 3 show the percentage contribution of NOx emissions by vehicle Euro class for LDVs and HDVs (HGVs and Buses/Coaches), respectively, in Herne.

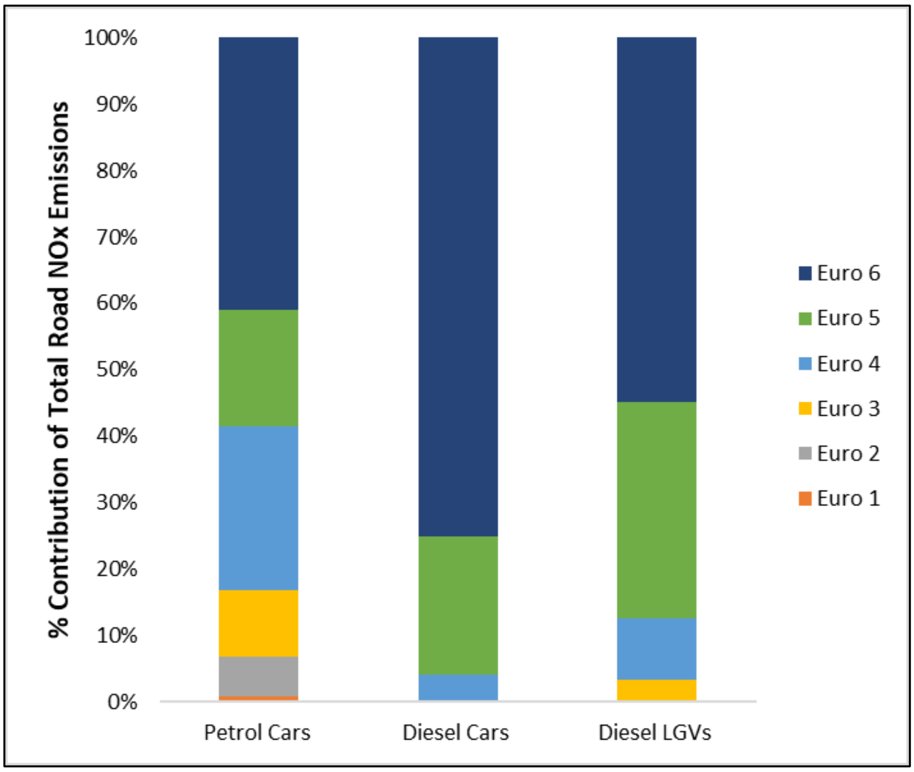

Figure 8: Percentage Contribution of Total Road NOx Emissions from Light Duty Vehicles in Herne by Euro Class Type (2022 Baseline)

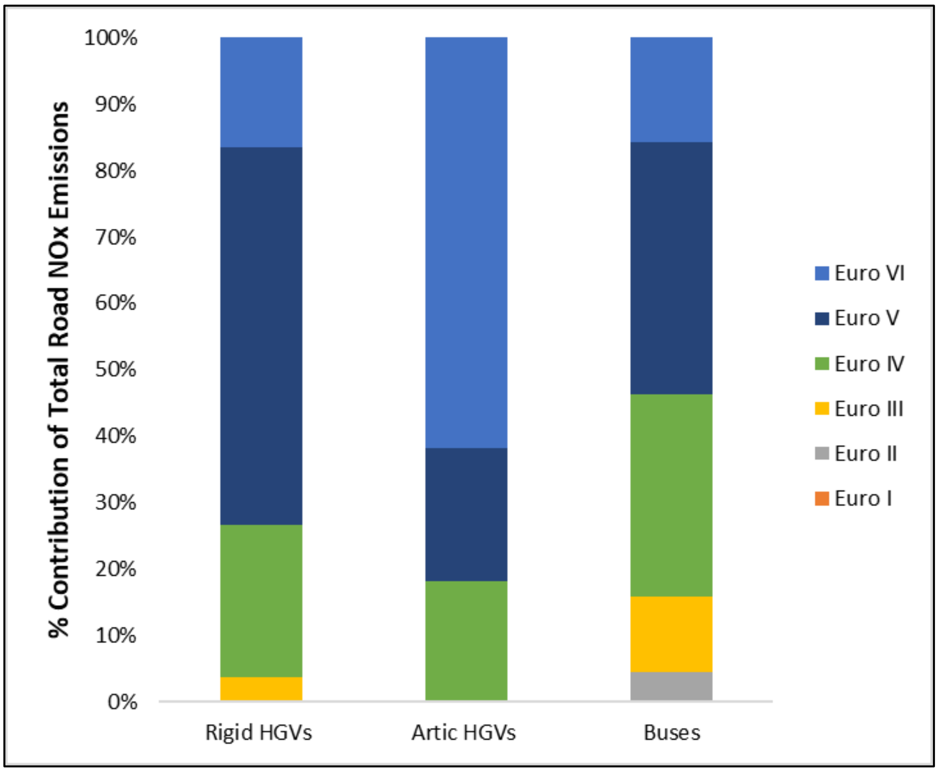

Figure 9: Percentage Contribution of Total Road NOx Emissions from Heavy Duty Vehicles in Herne by Euro Class Type (2022 Baseline)

Table 4: Percentage Contribution of Total Road Emissions from Light Duty Vehicles by Euro Class Type (2022)

Euro Standard	Petrol Cars (%)	Diesel Cars (%)	Diesel LGVs (%)
Euro 1	0.9	0.0	0.1
Euro 2	5.9	0.1	0.2
Euro 3	9.9	0.2	3.1
Euro 4	24.6	3.8	9.1
Euro 5	17.6	20.7	32.6
Euro 6	41.0	75.2	54.8

Table 5: Percentage Contribution of Total Road Emissions from Heavy Duty Vehicles by Euro Class Type (2022)

Vehicle Type	Rigid HGVs	Artic HGVs	Buses/Coaches
Euro I	0.0	0.0	0.0
Euro II	0.0	0.0	4.6
Euro III	3.7	0.0	11.4
Euro IV	23.0	18.1	30.3
Euro V	56.8	20.1	37.9
Euro VI	16.5	61.8	15.8

2.21 Figure 6 and Table 4Table 2 indicate that the majority of NOx emissions from Petrol Cars in 2022 are from Euro 6 vehicles (41.0%), while for Diesel Cars and LGVs Euro 6 vehicles also emit the highest proportion of NOx (75.2% and 54.8%, respectively). In terms of HDVs, Figure 9and Table 5 indicate that the majority of NOx emissions from Rigid HGVs and Buses/Coaches in 2019 are from Euro V vehicles (56.8% and 37.9%, respectively), while for Artic HGVs the majority of emissions are from Euro VI vehicles (61.8%).

3 Summary

3.1 Detailed modelling in Herne and central Canterbury has shown that the predicted annual mean NO_2 concentrations in 2022 exceed the objective at one location representing relevant exposure close to the junction in Herne and at locations alongside Wincheap in Canterbury. There are also locations where the predicted concentrations remain within 10% of the objective. The majority of road NOx emissions in Herne and central Canterbury in 2022 can be attributed to diesel vehicles; primarily cars and light goods vehicles, followed by buses and coaches, and HGVs.

3.2 As there are predicted exceedances within both AQMA in 2022 at locations of relevant exposure, and locations at which the objective is approached (concentrations within 10% of the objective), it is recommended that both AQMA are retained.

4 References

AQC. (2020). *Calibrating Defra's 2018-based Background NOx and NO2 Maps against 2019 Measurements.* Retrieved from https://www.aqconsultants.co.uk/CMSPages/GetFile.aspx?guid=163e7362-578e-4a4c-8feb-0006f1531ff1

Canterbury City Council. (2023). *2023 Air Quality Annual Status Report (ASR).*

Defra. (2022). *Review & Assessment: Technical Guidance LAQM.TG22 August 2022 Version.* Retrieved from https://laqm.defra.gov.uk/wp-content/uploads/2022/08/LAQM-TG22-August-22-v1.0.pdf

Defra. (2023). *Local Air Quality Management (LAQM) Support Website.* Retrieved from http://laqm.defra.gov.uk/

DfT. (2023). *DfT Road traffic statistics (TRA03).* Retrieved from https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra

5 Glossary

AADT	Annual Average Daily Traffic
ADMS-Roads	Atmospheric Dispersion Modelling System model for Roads
ANPR	Automatic Number Plate Recognition
AQC	Air Quality Consultants
AQMA	Air Quality Management Area
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EFT	Emission Factor Toolkit
Exceedance	A period of time when the concentration of a pollutant is greater than the appropriate air quality objective. This applies to specified locations with relevant exposure
HDV	Heavy Duty Vehicles (> 3.5 tonnes)
HGV	Heavy Goods Vehicle
IAQM	Institute of Air Quality Management
kph	Kilometres Per hour
LAQM	Local Air Quality Management
LDV	Light Duty Vehicles (<3.5 tonnes)
LGV	Light Goods Vehicle
$\mu g/m^3$	Microgrammes per cubic metre
NO	Nitric oxide
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides (taken to be NO_2 + NO)
Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides
OGV	Other Goods Vehicle
Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal

6 Appendices

A1 Professional Experience

Dr Clare Beattie, BSc (Hons) MSc PhD CSci MIEnvSc MIAQM

Dr Beattie is a Technical Director with AQC, with more than 20 years' relevant experience. She has been involved in air quality management and assessment, and policy formulation in both an academic and consultancy environment. She has prepared air quality review and assessment reports, strategies and action plans for local authorities and has developed guidance documents on air quality management on behalf of central government, local government and NGOs. She has led on the air quality inputs into Clean Air Zone feasibility studies and has provided support to local authorities on the integration of air quality considerations into Local Transport Plans and planning policy processes. Dr Beattie has appraised local authority air quality assessments on behalf of the UK governments, and provided support to the Review and Assessment helpdesk. She has carried out numerous assessments for new residential and commercial developments, including the negotiation of mitigation measures where relevant. She has also acted as an expert witness for both residential and commercial developments. She has carried out BREEAM assessments covering air quality for new developments. Dr Beattie has also managed contracts on behalf of Defra in relation to allocating funding for the implementation of air quality improvement measures. She is a Member of the Institute of Air Quality Management, Institution of Environmental Sciences and is a Chartered Scientist.

Dr Denise Evans, BSc (Hons) PhD MIEnvSc MIAQM

Dr Evans is an Associate Director with AQC, with more than 24 years' relevant experience. She has prepared air quality review and assessment reports for local authorities, and has appraised local authority air quality assessments on behalf of the UK governments, and provided support to the Review and Assessment helpdesk. She has extensive modelling experience, completing air quality and odour assessments to support applications for a variety of development sectors including residential, mixed use, urban regeneration, energy, commercial, industrial, and road schemes, assessing the effects of a range of pollutants against relevant standards for human and ecological receptors. Denise has acted as an Expert Witness and is a Member of the Institute of Air Quality Management.

Jack Buckley, BSc (Hons) MSc MIEnvSc MIAQM

Mr Buckley is a Senior Consultant with AQC. He has six years' experience in the field of air quality, carrying out technical work for a range of projects, including road and rail infrastructure schemes, residential and mixed-use developments and industrial facilities. Jack has produced air quality, greenhouse gas and climate change assessments for numerous EIA schemes, using qualitative and quantitative methods, and has air quality monitoring experience. He also has a strong understanding of relevant local, regional and national policies, having been seconded to the Greater London

Authority to undertake technical reviews of planning applications, and has assisted in the development of new Air Quality Neutral and Air Quality Positive guidance. Jack completed a BSc (Hons) in Chemistry and an MSc in Environmental Science and Management, with both dissertations investigating the performance of low-cost air quality sensors. He is a Member of both the Institute of Air Quality Management and the Institution of Environmental Sciences.

A2 Modelling Methodology

Assumptions

A2.1 It is necessary to make a number of assumptions when carrying out an air quality assessment; in order to account for some of the uncertainty in the approach, assumptions made have generally sought to reflect a realistic worst-case scenario. Key assumptions made in carrying out this assessment include:

- a small proportion of vehicles across a number of vehicle types within the ANPR dataset do not have a Euro class assigned. Intelligent Data, who collected the data, have advised that the Euro status data is derived from the Motor Vehicle Registration Information System (MVRIS; a database of new vehicle registration details in the UK for cars and commercial vehicles <6 t gross vehicle weight). For commercial vehicles and buses/coaches of 6 t gross vehicle weight and over, this data service launched in 2016, thus for heavy vehicles registered before 2016, there are a high proportion of missing Euro class records in DVLA database. This will have skewed the Euro mix for these vehicles towards later classes. To mitigate this effect, classes for bus/coach, OGV1 and OGV2 vehicles have been assigned based on the vehicle registration date (where available) where no Euro class is already defined. Where no registration date is available, where possible, classes have been assigned based on the vehicle model and make;
- the vehicle categories for HGVs used within the ANPR dataset do not match the definitions within the EFT; EFT uses Rigid and Articulated HGV categories, while the ANPR separates HGVs by Other Goods Vehicles groups (OGV1; rigid vehicles >3.5 tonnes with two or three axles, and OGV2; rigid vehicles with four or more axles and articulated vehicles). Based on the proportions of these vehicles within the default EFT fleet mix, it is considered appropriate to assume that all OGV1 vehicles represent Rigid HGVs and OGV2 vehicles represent Articulated HGVs within the modelling;
- it has been assumed that the EFT fleet projections for 2022 are representative, based on ANPR data collected in 2023;
- it has been assumed that a number of roads in the modelled road network (specifically in Herne) are on steep gradients, and these have been used in the EFT based on estimates made using Google Earth imagery; and
- it has been assumed that the Manston meteorological monitoring station appropriately represents conditions in the study area (this is discussed further in Paragraph A2.7).

Background Concentrations

A2.2 Background concentrations have been defined using Defra's 2018-based background maps (Defra, 2023). The background annual mean nitrogen dioxide maps for 2019 have been calibrated against concurrent measurements from national monitoring sites (AQC, 2020) and the calculated calibration factor has been applied to the 2022 backgrounds.

Model Inputs

A2.3 Predictions have been carried out using the ADMS-Roads dispersion model (v5). The model requires the user to provide various input data, including emissions from each section of road and the road characteristics (including road width). Vehicle emissions have been calculated based on vehicle flow, composition and speed data using the EFT (Version 11.0) published by Defra.

A2.4 Vehicle fleet composition data have been based on ANPR data, provided by Intelligent Data, which were collected on Wincheap and Broad Street on the 15th June and 18th July 2023 respectively. The dataset provides a breakdown of vehicles by type and Euro class. The average fleet composition across both surveys was used for the entire modelled road network (summarised in Table A2.1). This information has been used together with traffic counts collected in 2019 and 2022 in the area (provided by KCC), to estimate traffic flows, fleet composition and speed across the area of focus in 2022. Speeds have been based on professional judgement, taking account of the road layout, speed limits and the proximity to junctions.

Table A2.1: Summary of Traffic Data used in the Assessment

Vehicle Type	% of Fleet
Petrol Car	54.3
Diesel Car	29.9
LGV	12.1
Rigid HGV	1.5
Articulated HGV	0.7
Bus and Coach	1.5
Motorcycle	0.0

A2.5 The traffic data used in this assessment are summarised in Table A2.2. The diurnal flow profile for the traffic has been derived using the ANPR data, and the monthly flow profile has been derived from the national profiles published by DfT (2023).

Table A2.2: Summary of Traffic Data used in the Assessment

Road Link	AADT	Speed (kph)
A28 Wincheap	24,199	20 – 48
A290 Rheims Way	38,634	20 – 64
A28 Pin Hill	24,414	20 – 64
A28 Upper Bridge Street	24,414	20 – 48
A257 St George's Place	22,940	20 – 32
A28 Lower Bridge Street	20,004	20 – 48
A257 Lower Chantry Lane	13,794	20 – 48

Upper Chantry Lane	5,377	20 – 32
A2050 New Dover Road	15,272	20 – 48
A291 Canterbury Road, Herne	9,236	20 – 48
A291 Herne Street, Herne	9,046	20 – 32
School Lane, Herne	4,362	20 – 32

A2.6 Figure A2.1 and Figure A2.2 shows the road network included within the model, along with the speed at which each link was modelled.

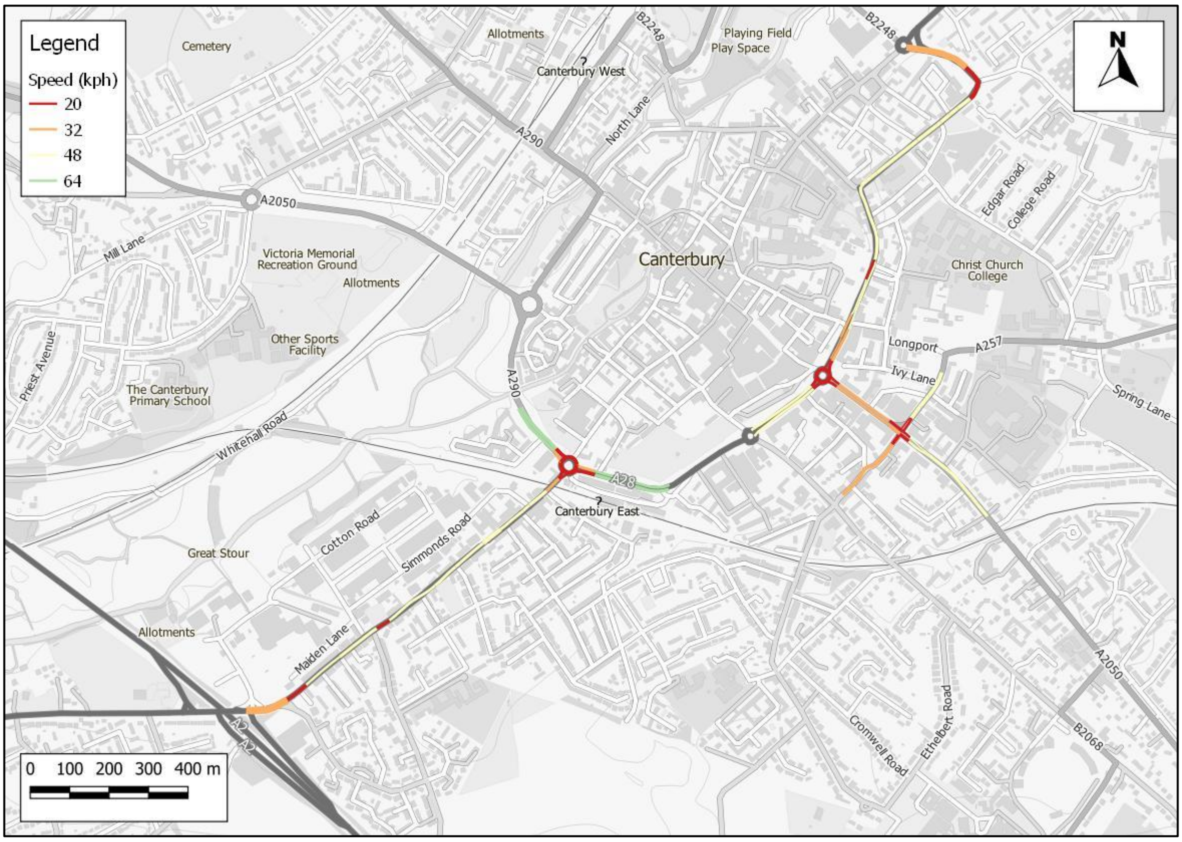

Figure A2.1: Modelled Road Network & Speed in Canterbury

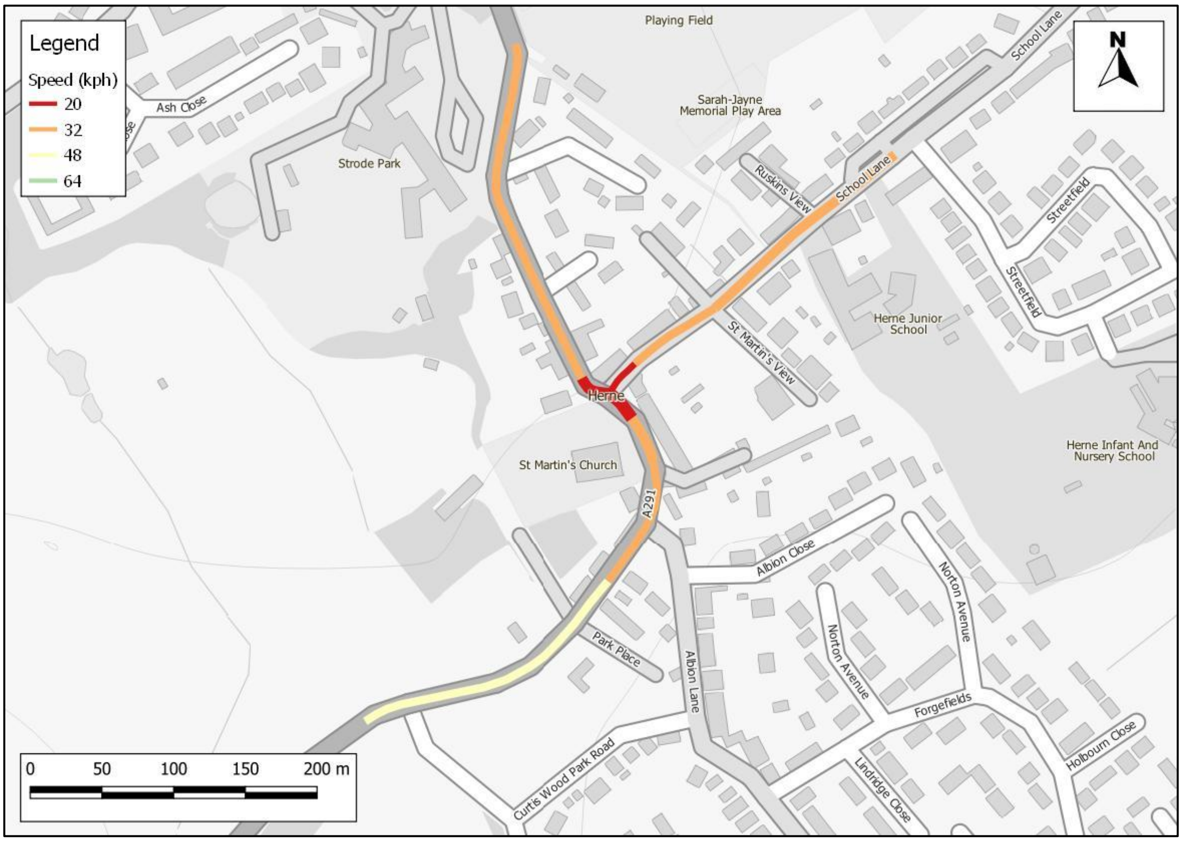

Figure A2.2: Modelled Road Network & Speed in Herne

A2.7 Hourly sequential meteorological data in sectors of 10 degrees from Manston in 2022 have been used in the model. The Manston meteorological monitoring station is located approximately 20 km to the northeast of Canterbury. It is deemed to be the nearest monitoring station representative of meteorological conditions in the vicinity of Canterbury; both are located in the south-east of England, where they will be influenced by the effects of similar meteorology. A wind rose for the site for the year 2022 is provided in Figure A2.3. The station is operated by the UK Met Office. Raw data were provided by the Met Office and processed by AQC for use in ADMS. Meteorological model input parameters are summarised in Table A2.3.

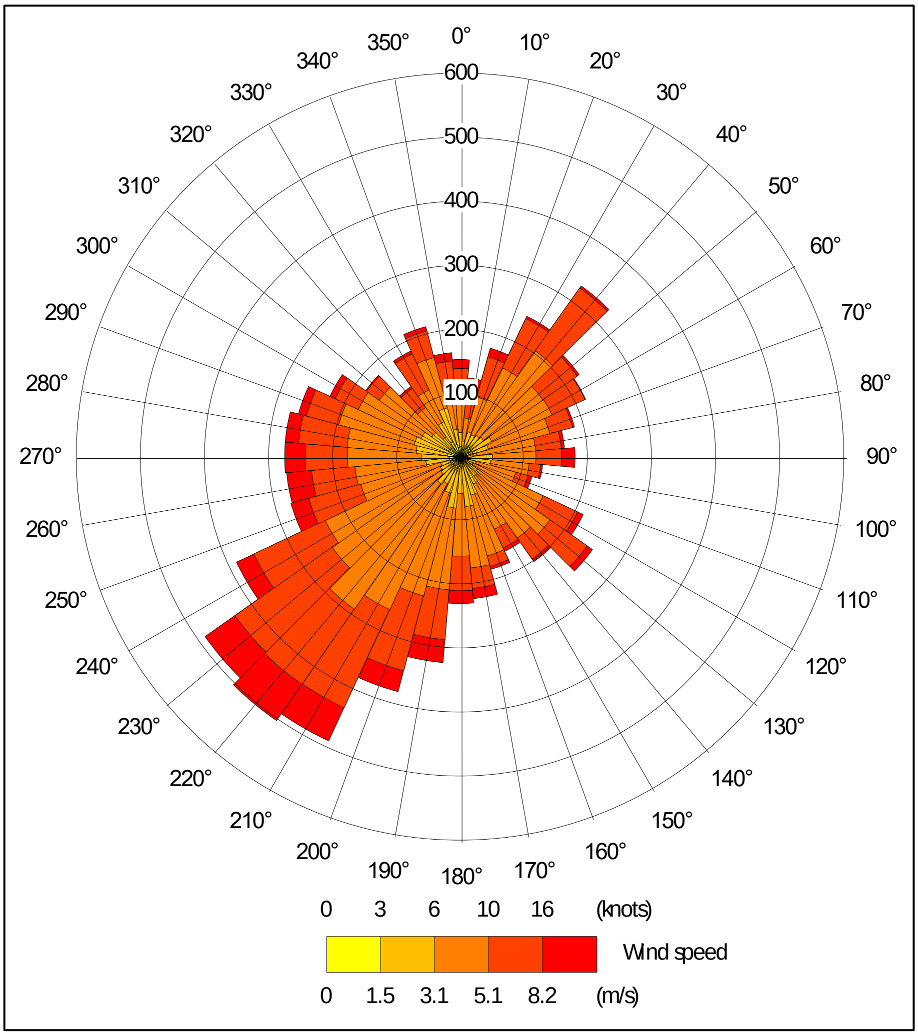

Figure A2.3: Manston 2022 Wind Rose

Table A2.3: Summary Model Inputs

Model Parameter	Value Used
Terrain Effects Modelled?	No
Variable Surface Roughness File Used?	No
Urban Canopy Flow Used?	No
Gradients Modelled?	Yes
Advanced Street Canyons Modelled?	No
Noise Barriers Modelled?	No
Meteorological Monitoring Site	Manston
Meteorological Data Year	2022
Dispersion Site Surface Roughness Length (m)	1
Dispersion Site Minimum MO Length (m)	75
Met Site Surface Roughness Length (m)	0.2
Met Site Minimum MO Length (m)	1

Model Verification

A2.8 In order to ensure that ADMS-Roads accurately predicts local concentrations, it is necessary to verify the model against local measurements. The model has been run to predict the annual mean concentrations during 2022 a number of monitoring sites in Canterbury and Herne. The locations of the monitoring sites are shown in Figures A2.4 and A2.5, and the measured annual mean concentrations are presented in Table A2.4. Exceedances of the objectives are shown in bold. The monitoring data have been taken from Canterbury City Council's 2023 Annual Status Report (Canterbury City Council, 2023).

Table A2.4: Annual Mean NO_2 Concentrations (µg/m³)

Site ID	Site Type	Location	2022
Canterbury			
CM3	Roadside	Military Road	21.0
DT1	Roadside	92b Broad Street	36.7
DT12	Roadside	Green Island, Military Road	37.5
DT14	Roadside	Non Conformist Burial Ground, Wincheap	34.0
DT15	Roadside	284 Wincheap	34.9
DT23	Kerbside	10-16 Wincheap	39.8
DT44	Kerbside	17 New Dover Road	27.6
DT68	Kerbside	32 St George's Place	**40.5**
Herne			
DT26	Roadside	11 Herne Street	23.1
DT61	Kerbside	29 Herne Street	29.6
DT62	Roadside	33 Herne Street	31.0
DT63	Kerbside	The Forge, Herne Street	29.9
DT64	Roadside	32 Herne Street	34.0
DT77	Kerbside	9 to 11 School Lane	21.0
Objective			**40**

A2.9 Most NO_2 is produced in the atmosphere by reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides (NOx = NO + NO_2).

A2.10 The model output of road-NOx (i.e., the component of total NOx coming from road traffic) has been compared with the 'measured' road-NOx. Measured road-NOx has been calculated from the measured NO_2 concentrations and the predicted background NO_2 concentration using the NOx from NO_2 calculator (Version 8.1) available on the Defra LAQM Support website.

A2.11 Due to the distinct characteristics of each area, separate verification factors have been calculated for the two modelled areas in Canterbury and Herne.

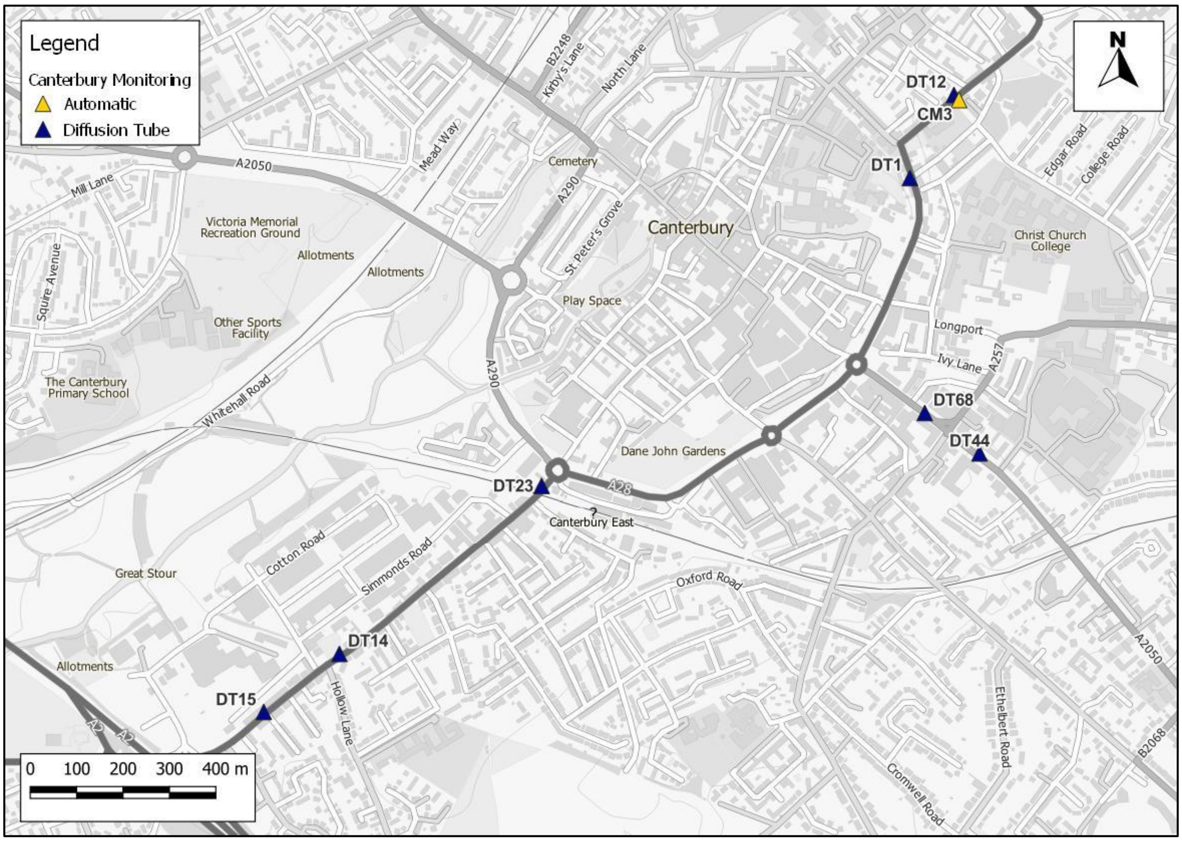

Figure A2.4: Monitoring Sites in Canterbury

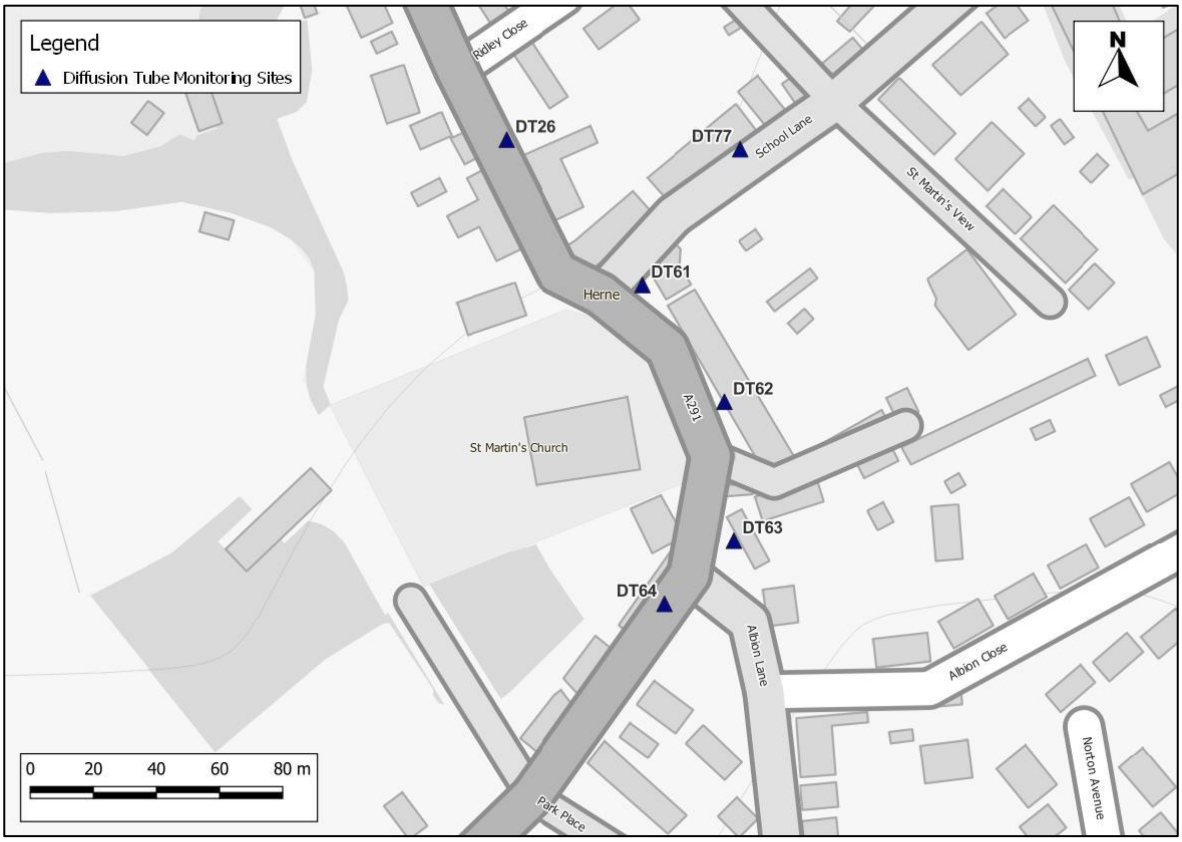

Figure A2.5: Monitoring Sites in Herne

Canterbury

A2.12 The unadjusted model has under predicted the road-NOx contribution at each of the monitoring locations; this is a common experience with this and most other road traffic emissions dispersion models. An adjustment factor has been determined as the slope of the best-fit line between the 'measured' road contribution and the model derived road contribution, forced through zero (Figure A2.6). The calculated adjustment factor of **4.7964** has been applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations.

A2.13 The total NO_2 concentrations have then been determined by combining the adjusted modelled road-NOx concentrations with the predicted background NO_2 concentration within the NOx to NO_2 calculator. Figure A2.7 compares final adjusted modelled total NO_2 at each of the monitoring sites to measured total NO_2.

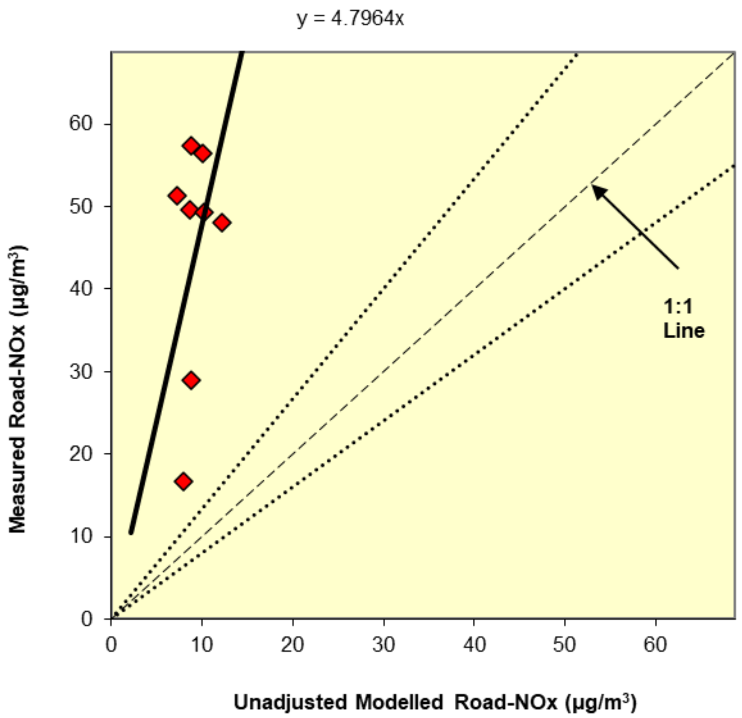

Figure A2.6: Comparison of Measured Road NOx to Unadjusted Modelled Road NOx Concentrations. The dashed lines show ± 25%.

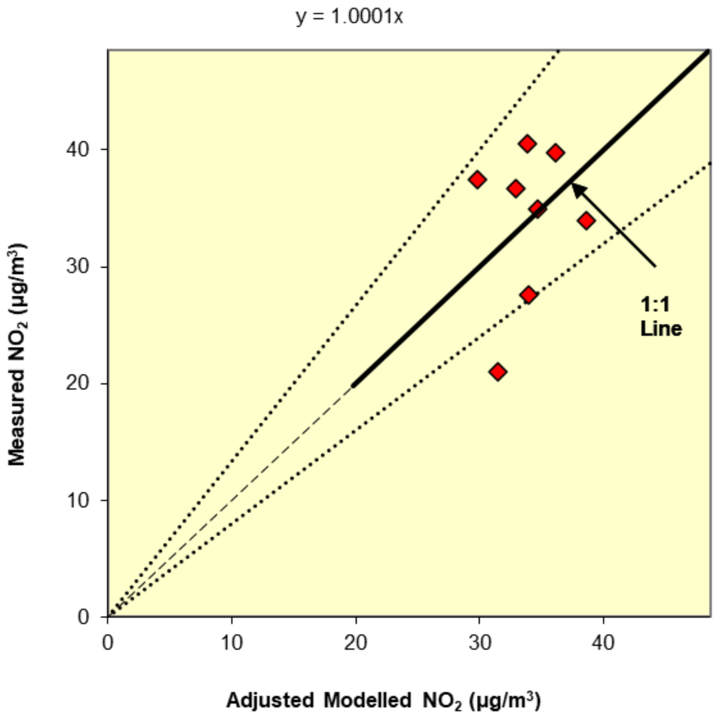

Figure A2.7: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations. The dashed lines show ± 25%.

A2.14 Table A2.5 shows the statistical parameters relating to the performance of the model, as well as the 'ideal' values (Defra, 2022). There is a large degree of scatter within the model results, as demonstrated by the high RMSE presented in Table A2.5; this is due to the model performing better at the automatic monitoring site CM3 than at the diffusion tubes. However, the fractional bias is close to zero, indicating that the overall adjustment factor is appropriate for this data set.

Table A2.5: Statistical Model Performance

Statistical Parameter	Model-Specific Value	'Ideal' Value
Correlation Coefficient [a]	0.23	**1**
Root Mean Square Error (RMSE) [b]	6.15	**0**
Fractional Bias [c]	0.00	**0**

[a] 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.

[b] Used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared (i.e., $\mu g/m^3$). TG22 (Defra, 2022) outlines that, ideally, a RMSE value within 10% of the air quality objective (4 $\mu g/m^3$) would be derived. If RMSE values are higher than 25% of the objective (10 $\mu g/m^3$) it is recommended that the model is revisited.

[c] Used to identify if the model shows a systematic tendency to over or under predict. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.

Herne

A2.1 In Herne, the unadjusted model has also under predicted the road-NOx contribution at several monitoring locations. The calculated adjustment factor of **7.4652** has been applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations.

A2.2 The total NO_2 concentrations have then been determined by combining the adjusted modelled road-NOx concentrations with the predicted background NO_2 concentration within the NOx to NO_2 calculator. Figure A2.7 compares final adjusted modelled total NO_2 at each of the monitoring sites to measured total NO_2.

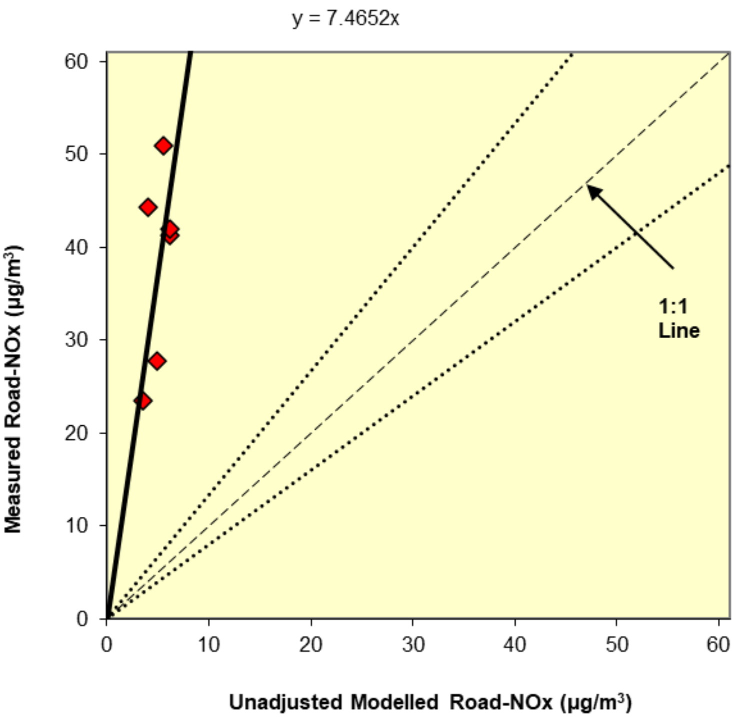

Figure A2.8: Comparison of Measured Road NOx to Unadjusted Modelled Road NOx Concentrations. The dashed lines show ± 25%.

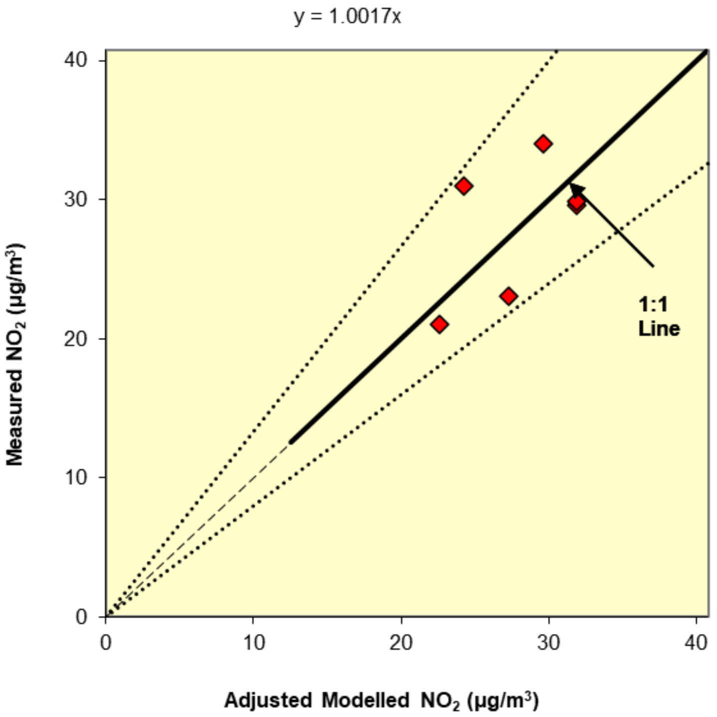

Figure A2.9: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations. The dashed lines show ± 25%.

A2.3 Table A2.6 shows the statistical parameters relating to the performance of the model, as well as the 'ideal' values (Defra, 2022). The values calculated demonstrate that the model is performing well.

Table A2.6: Statistical Model Performance

Statistical Parameter	Model-Specific Value	'Ideal' Value
Correlation Coefficient [a]	0.55	**1**
Root Mean Square Error (RMSE) [b]	3.96	**0**
Fractional Bias [c]	0.01	**0**

[a] 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.

[b] Used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared (i.e., $\mu g/m^3$). TG22 (Defra, 2022) outlines that, ideally, a RMSE value within 10% of the air quality objective (4 $\mu g/m^3$) would be derived. If RMSE values are higher than 25% of the objective (10 $\mu g/m^3$) it is recommended that the model is revisited.

[c] Used to identify if the model shows a systematic tendency to over or under predict. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.

Post-processing

A2.4 The model predicts road-NOx concentrations at each receptor location. These concentrations have been adjusted using the appropriate adjustment factor set out above, which, along with the background NO_2, has been processed through the NOx to NO_2 calculator available on the Defra LAQM Support website. The traffic mix within the calculator has been set to "All other urban UK traffic", which is considered suitable for the study area. The calculator predicts the component of NO_2 based on the adjusted road-NOx and the background NO_2.

A3 2022 Baseline Modelling Results

Table A3.1: Modelled Receptor Locations and 2022 Baseline Concentrations [a]

Receptor	Grid Reference	Height	Annual Mean NO_2 Concentrations (µg/m^3)
Canterbury			
1	615167, 157565	4.5	29.3
2	615231, 157551	4.5	26.5
3	615338, 157472	1.5	31.9
4	615375, 157433	1.5	28.8
5	615400, 157414	1.5	23.4
6	615441, 157414	1.5	31.0
7	615474, 157399	1.5	23.7
8	615219, 157651	1.5	37.7
9	615253, 157723	4.5	26.1
10	615301, 158019	1.5	37.1
11	615288, 158017	1.5	32.4
12	614454, 157294	1.5	38.2
13	614465, 157285	1.5	36.8
14	614287, 157162	1.5	31.8
15	614298, 157147	1.5	34.7
16	614085, 156977	1.5	**46.0**
17	614091, 156994	1.5	**41.5**
18	613893, 156844	1.5	37.7
19	613900, 156832	1.5	33.7
20	614506, 157345	1.5	**44.3**
25	615281, 157790	1.5	33.5
26	615300, 157987	1.5	33.9
27	615309, 157999	1.5	34.8
28	615289, 158018	1.5	34.6
29	615281, 158040	1.5	34.0
30	615291, 158047	1.5	36.5
31	615290, 158103	1.5	31.3
32	615301, 158092	1.5	35.2
33	615442, 158224	1.5	30.4
34	615452, 158212	1.5	34.6
35	615539, 158299	1.5	35.1
36	615552, 158283	1.5	27.1
37	614591, 157340	4.5	25.9

38	614599, 157369	1.5	34.3
39	614385, 157239	1.5	35.2
40	614405, 157233	1.5	34.6
41	614251, 157129	1.5	32.9
42	614263, 157117	1.5	35.0
43	614181, 157049	1.5	**41.7**
44	614175, 157057	1.5	**41.9**
Herne			
21	618290, 165902	1.5	28.8
22	618266, 165906	1.5	**41.1**
23	618250, 165938	1.5	28.4
24	618243, 165929	1.5	37.5
45	618272, 165778	1.5	26.6
46	618286, 165773	1.5	22.2
47	618298, 165822	1.5	25.6
48	618300, 165883	1.5	28.5
49	618256, 165918	1.5	38.2
50	618234, 165948	1.5	33.5
51	618294, 165927	1.5	28.8
52	618309, 165939	1.5	26.7
53	618285, 165911	1.5	37.5

[a] Exceedances of the objective are shown in **bold**.