Guildford Borough Council

LAQM Detailed Assessment and Action Plan for Compton Village, Guildford

Air Quality Assessment

November 2017

Amec Foster Wheeler Environment
& Infrastructure UK Limited

Report for

Gary Durrant
Team Leader
Health and Community Care Services

Guildford Borough Council
Millmead House
Guildford
Surrey
GU2 4BB

Main contributors

Rachel Hicks

Issued by

....
Rachel Hicks

Approved by

pp. ....
Ben Warren

Amec Foster Wheeler

Floor 12
25 Canada Square
Canary Wharf
London E14 5LB
United Kingdom
Tel +44 (0) 203 215 1610

Doc Ref. 40043rri2

"H:\Projects\40043 STH Compton AQAP Guildford\D Design\Report\40043 Compton AQAP Guildford_Issue2.docx"

Copyright and non-disclosure notice

The contents and layout of this report are subject to copyright owned by Amec Foster Wheeler (© Amec Foster Wheeler Environment & Infrastructure UK Limited 2016) save to the extent that copyright has been legally assigned by us to another party or is used by Amec Foster Wheeler under licence. To the extent that we own the copyright in this report, it may not be copied or used without our prior written agreement for any purpose other than the purpose indicated in this report. The methodology (if any) contained in this report is provided to you in confidence and must not be disclosed or copied to third parties without the prior written agreement of Amec Foster Wheeler. Disclosure of that information may constitute an actionable breach of confidence or may otherwise prejudice our commercial interests. Any third party who obtains access to this report by any means will, in any event, be subject to the Third Party Disclaimer set out below.

Third-party disclaimer

Any disclosure of this report to a third party is subject to this disclaimer. The report was prepared by Amec Foster Wheeler at the instruction of, and for use by, our client named on the front of the report. It does not in any way constitute advice to any third party who is able to access it by any means. Amec Foster Wheeler excludes to the fullest extent lawfully permitted all liability whatsoever for any loss or damage howsoever arising from reliance on the contents of this report. We do not however exclude our liability (if any) for personal injury or death resulting from our negligence, for fraud or any other matter in relation to which we cannot legally exclude liability.

Management systems

This document has been produced by Amec Foster Wheeler Environment & Infrastructure UK Limited in full compliance with the management systems, which have been certified to ISO 9001, ISO 14001 and OHSAS 18001 by LRQA.

Document revisions

No.	Details	Date
1	Draft Report	06/10/16
2	Issue 1	01/11/17
3	Issue 2	24/11/17

Executive summary

As part of the Local Air Quality Management (LAQM) process, Amec Foster Wheeler Environment & Infrastructure UK Ltd (Amec Foster Wheeler) has prepared an Air Quality Action Plan (AQAP) to support improvements in air quality around Compton on behalf of Guildford Borough Council (GBC).

Exceedances of the annual mean Air Quality Objective (AQO) for NO_2 were recorded in 2014 and 2015 at diffusion tube C4 located in the Village of Compton, Guildford. As recommended in LAQM.TG(16)[1] guidance, detailed dispersion modelling work was carried out to provide an assessment of the likelihood of an AQO being exceeded at locations with relevant exposure. An air quality assessment undertaken in October 2016[2] determined that there are exceedances likely at residential receptor locations. It is understood that an Air Quality Management Area (AQMA) will be declared. In accordance with the LAQM process, GBC has a duty to declare an AQMA and to implement an Air Quality Action Plan (AQAP) to reduce air pollution levels towards the AQOs.

Further modelling has been undertaken to more accurately determine the boundaries of the AQMA through further atmospheric dispersion modelling if necessary.

ADMS-Roads (version 4.1) modelling has been used to model dispersion from traffic to determine likely NO_2 concentrations at residential receptors. Predicted concentrations at receptors were then compared to the Air Quality Objectives (AQOs).

Dispersion modelling indicates that concentrations at some receptor locations with relevant exposure are exceeding the AQO of 40 μgm^{-3} for NO_2 as a result of road traffic emissions around Compton.

- It is recommended that an AQMA is declared along The Street, with the extent of the boundary determined in this assessment;
- AQAP measures recommended in this assessment should be implemented along The Street. It is possible that a combination of measures could result in the largest reductions in pollutant concentrations but the feasibility of introducing these options would need to be investigated further; and
- Diffusion tube monitoring should continue along The Street in order to confirm if the NO_2 annual mean AQO is exceeded where there is relevant exposure, and quantify any reduction in NO_2 concentrations as a result of the actions implemented.

Some traffic management measures in the area have been recommended. Measures have been recommended that are likely to improve traffic flow through The Street, for example, through introducing road signs and speed limits. In addition, the reduced emissions associated with the replacement of older vehicles with newer, lower emitting models is likely to go a long way to reducing NO_2 concentrations so that the annual mean AQO is not exceeded in future.

The progress towards compliance should be tracked using the monitoring data collected by GBC and reported in the Annual Status Reports produced by the Council. The AQMA will be revoked when monitoring results from several consecutive years show no exceedance of the AQO, so that a permanent improvement in air quality can be demonstrated.

[1] Defra, 2016, Local Air Quality Management, LAQM.TG(16)

[2] AECOM (2016) The Street, Compton – Air Quality Assessment

Contents

© Amec Foster Wheeler Environment & Infrastructure UK Limited

1. Introduction

1.1 Purpose of this report

Part IV of the Environment Act 1995[3] places a statutory duty on local authorities to review and assess the air quality within their area through the Local Air Quality Management (LAQM) process. Where it has been identified that there is a risk of the Air Quality Objectives (AQOs) not being achieved, the authority will need to carry out further assessment to determine if an Air Quality Management Area (AQMA) needs to be declared[4] and the extent of any AQMA required.

Guildford Borough Council (GBC) has recorded exceedances of the NO_2 annual mean AQO in the area around Compton village. Exceedances of the annual mean AQO for NO_2 were recorded in 2014 and 2015 at diffusion tube C4 located in Compton Village. As recommended in LAQM.TG(16)[1] guidance, detailed dispersion modelling work was carried out to provide an assessment of the likelihood of an AQO being exceeded at locations with relevant exposure. An air quality assessment undertaken in October 2016[2] determined that there are exceedances likely at residential receptor locations. In accordance with the LAQM process, GBC has a duty to declare an AQMA and to implement an Air Quality Action Plan (AQAP) to reduce air pollution levels towards the AQOs.

This AQAP has been prepared with the following objectives:

- detailed dispersion modelling to more accurately determine the extent of the AQMA to be declared;
- confirm the findings of the original air quality assessment[2];
- calculate detailed source apportionment of vehicle types;
- calculate more accurately how much of an improvement in air quality would be needed to deliver the AQOs;
- refine knowledge of the sources of pollution so that AQAP measures can be properly targeted;
- discussion with GBC and Surrey County Council (SCC) to determine preferred actions for improving air quality;
- identify actions to improve air quality with the highest priority;
- dispersion modelling to quantify improvements in air quality as a result of three proposed actions; and
- provide recommendations for further work.

1.2 Legislative background

The legislative framework for air quality consists of legally enforceable EU Limit Values that are transposed into UK legislation as Air Quality Standards (AQS) that must be at least as challenging as the EU Limit Values. Action in the UK is then driven by the UK's Air Quality Strategy[5] that sets the AQOs.

The EU Limit Values are set by the European directive on air quality and cleaner air for Europe (2008/50/EC)[6] and the European directive relating to arsenic, cadmium, mercury, nickel, and polycyclic

[3] HMSO (1995) Environment Act 1995.
[4] Defra (2016) Local Air Quality Management Technical Guidance LAQM.TG (16).
[5] Defra in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland.
[6] Official Journal of the European Union, (2008) Directive 2008/50/EC of the European Parliament and of The Council of 21 May 2008 on ambient air quality and cleaner air in Europe.

aromatic hydrocarbons in ambient air (2004/107/EC)[7] as the principal instruments governing outdoor ambient air quality policy in the EU. The Limit Values are legally binding levels for concentrations of pollutants for outdoor air quality.

The two European directives, as well as the Council's decision on exchange of information were transposed into UK Law via the Air Quality Standards Regulations 2010[8], which came into force in the UK on 11 June 2010, replacing the Air Quality Standards Regulations 2007[9]. Air Quality Standards are concentrations recorded over a given time period, which are considered to be acceptable in terms of what is scientifically known about the effects of each pollutant on health and on the environment. The Air Quality Strategy sets the AQOs, which give target dates and some interim target dates to help the UK move towards achievement of the EU Limit Values. The AQOs are a statement of policy intentions or policy targets and as such, there is no legal requirement to meet these objectives except in as far as they mirror any equivalent legally binding Limit Values in EU legislation. The most recent UK Air Quality Strategy for England, Scotland, Wales and Northern Ireland was published in July 2007.

Since Part IV of the Environment Act 1995[10] came into force, local authorities have been required to regularly review concentrations of the UK Air Quality Strategy pollutants within their areas and to identify areas where the AQOs may not be achieved by their relevant target dates. This LAQM process is an integral part of delivering the Government's AQOs detailed in the Strategy. When areas are identified where some or all of the AQOs might potentially be exceeded and where there is relevant public exposure, i.e. where members of the public would regularly be exposed over the appropriate averaging period, the local authority has a duty to declare an AQMA and to implement an AQAP to reduce air pollution levels towards the AQOs.

As part of recent changes to the LAQM system, England and Scotland have adopted a new streamlined approach which places greater emphasis on action planning to bring forward improvements in air quality and to include local measures as part of EU reporting requirements. The Annual Status Report (ASR) will replace the cycle of Updating and Screening Assessments and Progress Reports. This Detailed Assessment refers to both the latest guidance on the LAQM process given in Defra's 2016 Local Air Quality Management Technical Guidance (LAQM TG (16))[4].

The nitrogen oxides (NO_X - NO and NO_2) emitted from vehicle exhausts and other combustion sources undergoes photochemical oxidation in the atmosphere, with NO_2 being formed by oxidation of NO to NO_2 and, conversely, NO_2 undergoing photolysis (in the presence of sunlight) to create NO and ozone.

For NO_2, it is the annual mean objective that is the more stringent AQO; it is generally considered that the 1-hour mean NO_2 AQO will not be exceeded if the annual mean objective is not exceeded. The likelihood of exceedance of the NO_2 short-term AQO can be assessed with reference to the predicted annual means and the relationships recommended by LAQM.TG(16)[4]. The 1-hour mean NO_2 objective is unlikely to be exceeded if the annual mean is less than 60 μgm^{-3}. Table 1.1 sets out the AQOs that are relevant to this assessment, and the dates by which they are to be achieved.

Table 1.1 Summary of relevant air quality standards and objectives

Pollutant	Objective (UK)	Averaging Period	Date to be Achieved by and Maintained thereafter (UK)
Nitrogen dioxide - NO_2	200 μgm^{-3} not to be exceeded more than 18 times a year	1-hour mean	31 Dec 2005
	40 μgm^{-3}	Annual mean	31 Dec 2005

[7] Official Journal of the European Union, (2004) Directive 2004/107/EC of the European Parliament and of The Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air.
[8] The Stationery Office Limited (2010) Statutory Instrument 2010 No. 1001 Environmental Protection – The Air Quality Standards Regulation 2010.
[9] The Stationery Office Limited (2007) Statutory Instrument 2010 No. 64 Environmental Protection – The Air Quality Standards Regulation 2007.
[10] HMSO (1995) Environment Act 1995.

2. Scope of the assessment

The assessment will determine exposure through quantitative assessment of NO_2 concentrations at residential receptor locations using the ADMS-Roads atmospheric dispersion modelling software.

2.1 Public exposure

Guidance from the UK Government and Devolved Administrations makes clear that exceedances of the health based objectives should be assessed at outdoor locations where members of the general public are regularly present over the averaging time of the objective. Workplaces are excluded, as explained in Table 2.1 which provides an indication of those locations that may or may not be relevant for each averaging period.

Table 2.1 Examples of where the air quality objectives should apply

Averaging Period	Objectives should apply at:	Objectives should generally not apply at:
Annual mean	All locations where members of the public might be regularly exposed	Building facades of offices or other places of work where members of the public do not have regular access.
	Building facades of residential properties, schools, hospitals, care homes etc.	Hotels, unless people live there as their permanent residence.
		Gardens of residential properties.
		Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
24-hour mean and 8-hour mean	All locations where the annual mean objectives would apply, together with hotels	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
	Gardens or residential properties[1]	
1-hour mean	All locations where the annual mean and 24 and 8-hour mean objectives would apply.	Kerbside sites where the public would not be expected to have regular access.
	Kerbside sites (e.g. pavements of busy shopping streets).	
	Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where the public might reasonably be expected to spend one hour or more.	
	Any outdoor locations at which the public may be expected to spend one hour or longer.	
15-minute mean	All locations where members of the public might reasonably be expected to spend a period of 15 minutes or longer.	

Note: [1] For gardens and playgrounds, such locations should represent parts of the garden where relevant public exposure is likely, for example where there is seating or play areas. It is unlikely that relevant public exposure would occur at the extremities of the garden boundary, or in front gardens, although local judgement should always be applied.

2.2 Receptor locations

This assessment has predicted pollutant concentrations at existing residential receptor locations, that is, the façade of residential properties. Receptors were plotted at the front of the residential unit, to represent the locations of receptors which would likely experience the highest exposure. A height of 1.5 m was used for the residential receptors on ground floor to represent an average human inhalation height.

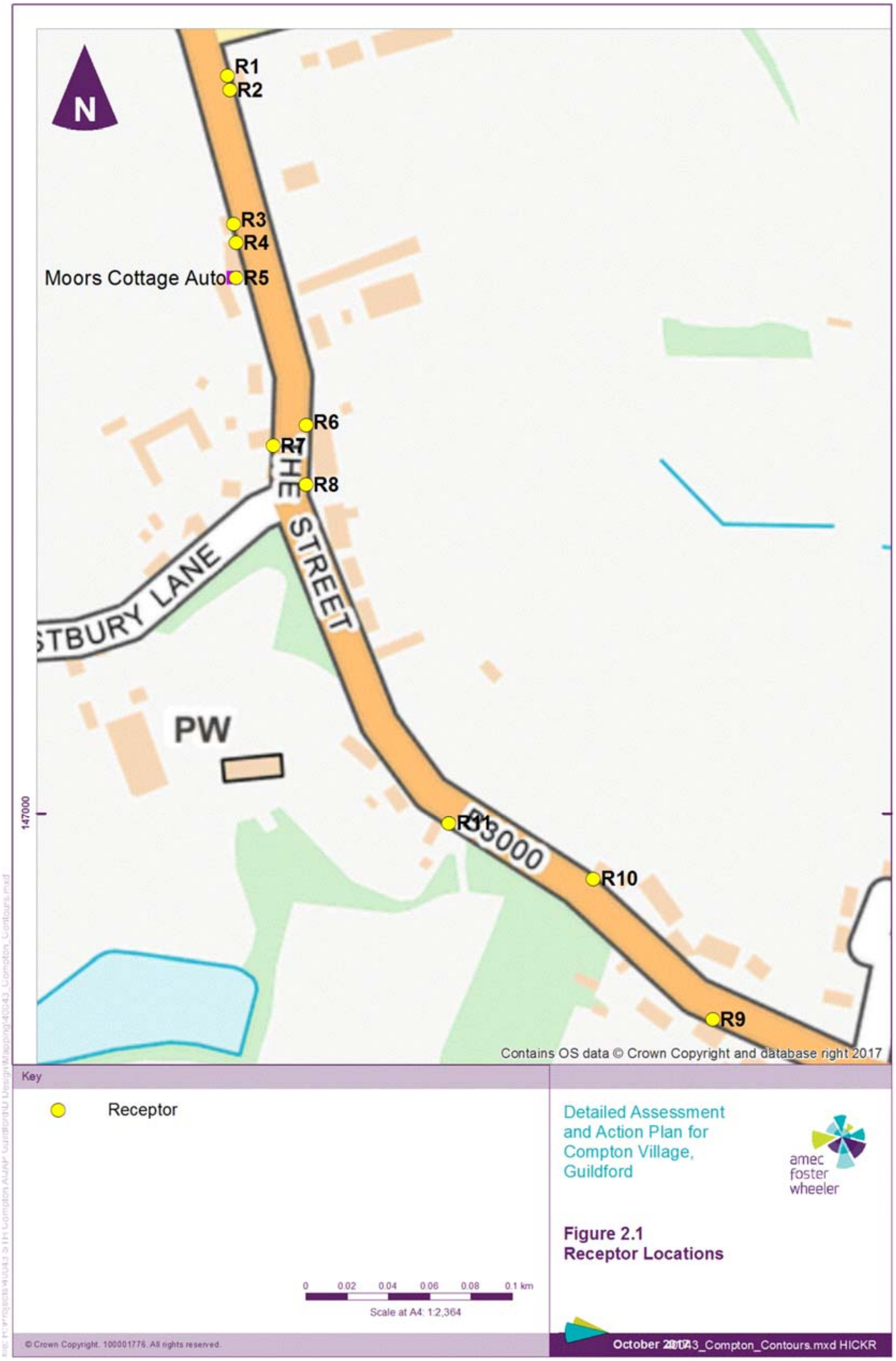
Receptor locations were selected based on those included in the original air quality assessment.

Figure 2.1 shows the receptor locations and Table 2.2 provides the Ordnance Survey grid coordinates and receptor heights for each of the receptor locations included within the air quality assessment.

Table 2.2 Human receptor locations

Receptor	Location	X (m)	Y(m)	Height (m)
R1	Brooklands Cottage	495432	147353	1.5
R2	Handpost Cottage	495433	147350	1.5
R3	The Little Cottage	495438	147285	1.5
R4	Squirrel Cottage	495439	147276	1.5
R5	Moors Cottage	495439	147259	1.5
R6	The Old Post Office	495473	147188	1.5
R7	Vine Cottage	495461	147178	1.5
R8	Mission Cottage	495467	147160	1.5
R9	The Harrow PH	495670	146900	1.5
R10	Stores Cottage	495612	146968	1.5
R11	45 The Street	495542	146995	1.5

Figure 2.1 Receptor locations



3. Baseline air quality

3.1 Summary of review and assessment by Guildford Borough Council

The GBC comprises a population of around 130,000, approximately half of which live in the urban area. The main source of air pollution in the borough is road traffic emissions from road traffic. The M25, A3 and A331 are some road sources contributing to air quality issues in the borough. Other pollution sources, including commercial, industrial and domestic sources, also make a contribution to background pollution concentrations.

GBC currently has no AQMAs declared, however recent studies have indicated that an AQMA should be declared at Compton Village.

GBC's 2016 Annual Status Report determined that the monitoring programme indicated that all sites had sites below the AQO levels except at one site. It was recommended that further monitoring and modelling is taking place to ascertain whether any further action is required.

3.2 Air Quality monitoring

Automatic monitoring sites

GBC has no continuous automatic monitoring sites in the borough.

GBC undertook six months of automatic monitoring from March to August 2017 at Moors Cottage Compton in order to support diffusion tube monitoring in the area.

Compton Table details the location and results of the monitor. As monitoring was only carried out for six months, the data were used to derive concentrations that would be likely to be recorded over an entire year, using data on regional pollution patterns from the nearest background monitoring stations monitored through Defra's AURN network (London Hillingdon and Reading New Town). This annualisation process was carried out following the procedure given in Box 7.9 of LAQM.TG(16)[1]. Full details are provided in Appendix E.

Table 3.1 Results of six months automatic monitoring at Moors Cottage Compton

Site ID	X	Y	Classification	In AQMA?	Annualised Annual Mean NO_2 (μgm^{-3})	Maximum hourly mean (μgm^{-3})
Moors Cottage Auto	495443	147262	Roadside	N	**58.1**	164

The annualised results show that the annual mean AQO for NO_2 is likely to be exceeded at Moors Cottage. The hourly mean objective of 200 μgm^{-3} was not exceeded during the six months monitoring.

Non-automatic monitoring sites

Table 3.2 and Figure 3.1 detail the locations of the diffusion tubes in Compton.

Table 3.2 Diffusion tube sites

Site ID	Site Name	X	Y	Classification	In AQMA?
C1	New Pond Road E	497005	146328	Kerbside	N

Site ID	Site Name	X	Y	Classification	In AQMA?
C2	New Pond Road W	495411	147412	Kerbside	N
C3	2-3 Church Cottages	495509	147024	Roadside	N
C4	Little Cottage	495437	147288	Roadside	N
C5	South Cottage	495498	147097	Roadside	N
C6	Wisteria Cottage	495453	147206	Roadside	N

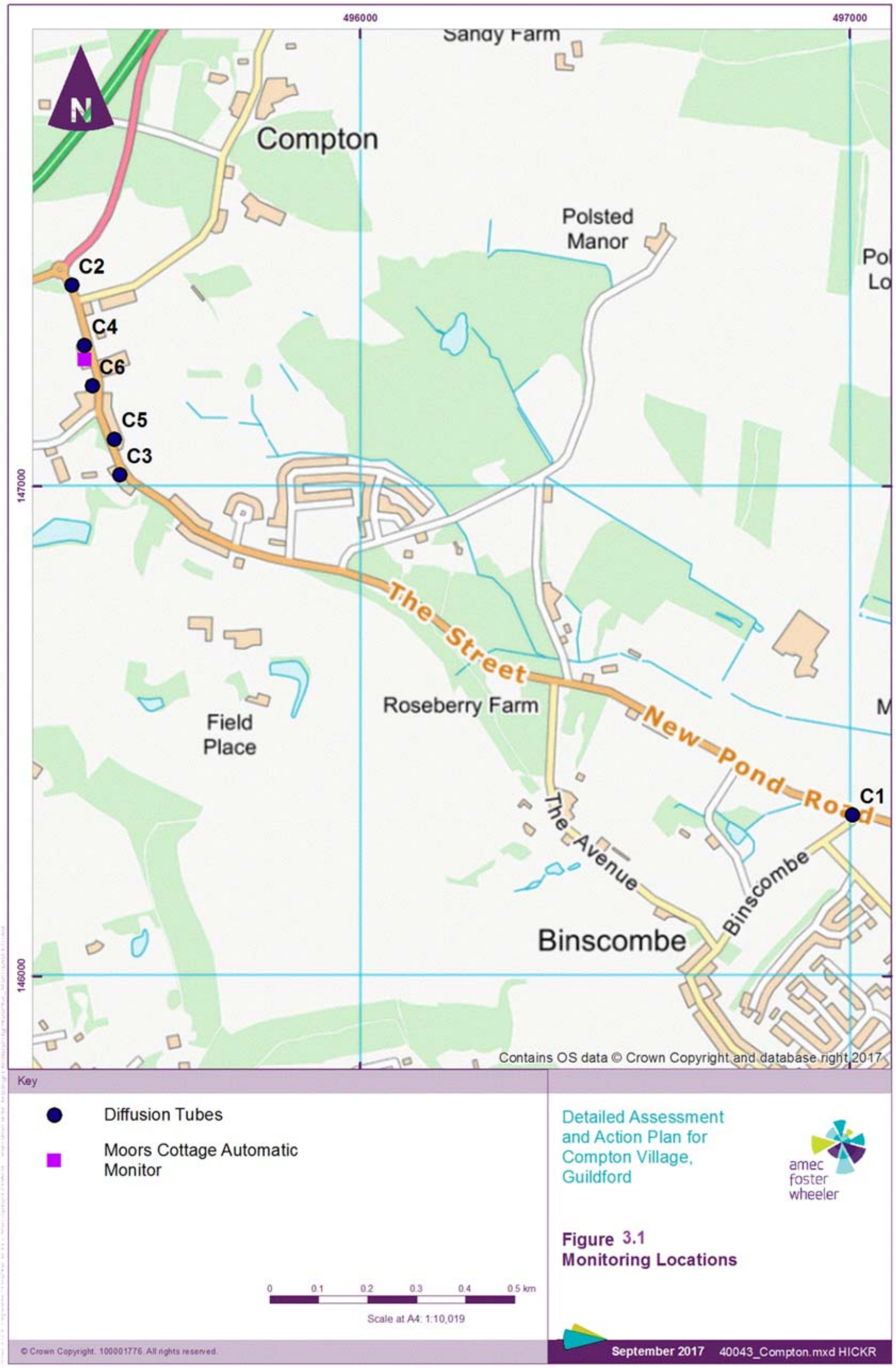
Table 3.3 Results of 2014 - 2017 NO_2 diffusion tubes

Site ID	2014	2015	2016	2017
C1	22	28	29*	-
C2	32	28	28*	-
C3	-	21*	23*	-
C4	**67***	**53**	**50***	**49****
C5	-	27*	28*	-
C6	-	17*	19*	-

Notes:
(-) Data not available
* Annualised because data capture was below 75%.
** 2017 data for January to April only.
Exceedances of the AQO are shown in **bold**.

Table 3.3 shows that there were exceedances of the AQO for NO_2 recorded at the Little Cottage from 2014 to 2017 (to date). The highest annual mean NO_2 concentration of 67 μgm^{-3} was recorded in 2014.

Figure 3.1 Monitoring locations in Compton



3.3 Estimated background concentrations

Defra has made estimates of background pollution concentrations on a 1 km^2 grid for the UK for seven of the main pollutants, including NO_2, using data for a base year of 2013, making projections for years from 2013 to 2030 inclusive[11]. Table 3.4 shows the estimated values of the pollutants for 2016 and 2017 for the cells that will be used in the modelling.

Table 3.4 Defra mapped background annual mean pollutant concentrations (µg m^{-3})

Pollutant	2016	2017
Grid Square Centre: 495500,147500		
Nitrogen Dioxide, NO_2	14.2	13.4
Nitrogen Oxides, NO_x	19.7	18.6
Grid Square Centre: 495500,146500		
Nitrogen Dioxide, NO_2	11.5	10.9
Nitrogen Oxides, NO_x	15.7	14.9

The last full calendar year for which meteorological and monitoring data are available is 2016. Traffic data is based on traffic surveys undertaken in 2017. On this basis, 2016 monitoring data was used to test the performance of the dispersion model and undertake verification of the model outputs, by comparing predicted concentrations against the actual nearby monitoring data collected close by and in a similar location that is representative of the site. The Defra gridded values have been used in the modelling. The existing baseline scenario and modelled future scenarios have been based on 2017 emission factors and background concentrations.

[11] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

4. Dispersion modelling

4.1 Assessment methodology

Modelling methodology

Annual average concentrations in air of NO_2 have been determined using the ADMS-Roads version 4.1 atmospheric dispersion model[12]. Further information on the ADMS-Roads model is provided in Appendix A.

Annual mean concentrations of NO_2 were derived from the model-predicted NO_x concentrations, through application of the NO_x to NO_2 conversion tool version 5.1 developed for LAQM purposes, which takes into account the interaction between NO_x and background ozone[13].

The modelling assessment requires source, emissions, meteorological and other site specific data. For modelling traffic impacts, one year of data is used and model verification is carried out following Defra's guidance.

The results of the assessment have been compared with the AQOs (Table 1.1) to assess whether the AQOs may be exceeded in the area.

A queue length survey was undertaken at the roundabout at the northern end of The Street. The results showed that there was no queuing traffic during the 24-hour survey on 12 September 2017 therefore queuing traffic is unlikely to be contributing to pollutant concentrations and has not been included in the model.

Model inputs

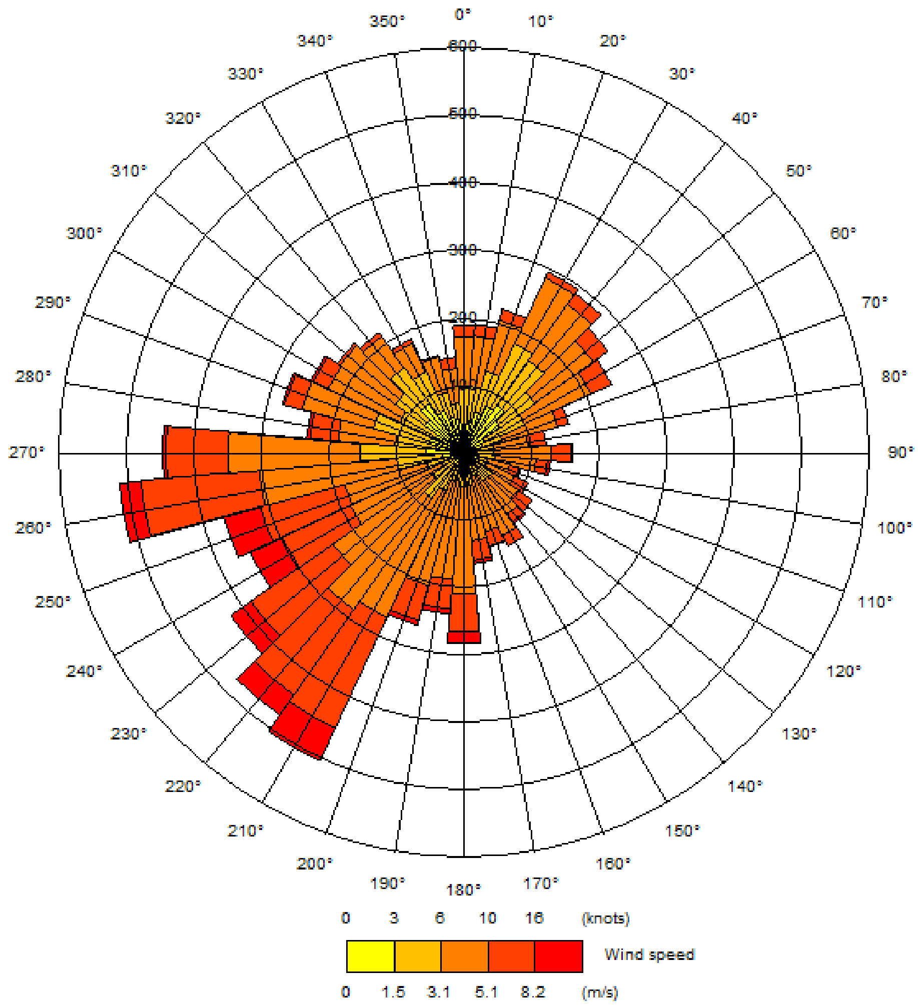
Meteorological data

Detailed dispersion modelling requires hourly sequential meteorological data from a representative synoptic observing station. Hourly sequential meteorological data was obtained for the year 2016 for Heathrow Airport, which is considered to provide representative data for the roads of interest. The meteorological data for 2016 has been used with monitoring data from 2016 in the model verification.

Figure 4.1 summarises the hourly wind speed and wind direction for the meteorological data as a wind rose. The wind rose shows a predominance of winds from the south and south-west which the usual pattern is observed in and around the south-east of England.

[12] www.cerc.co.uk/environmental-software/ADMS-Roads-model.html
[13] AEA Technology (2013). *NO_x to NO_2 Calculator version 4.1.* http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

Figure 4.1 Heathrow Airport wind rose for 2016



The road network

Traffic data comprising Annual Average Daily Traffic (AADT) flows and numbers of different vehicle types were obtained for the roads around The Street, Compton. Traffic data for four points along the Street were obtained from surveys carried out on by MHC Traffic Ltd in 2017.

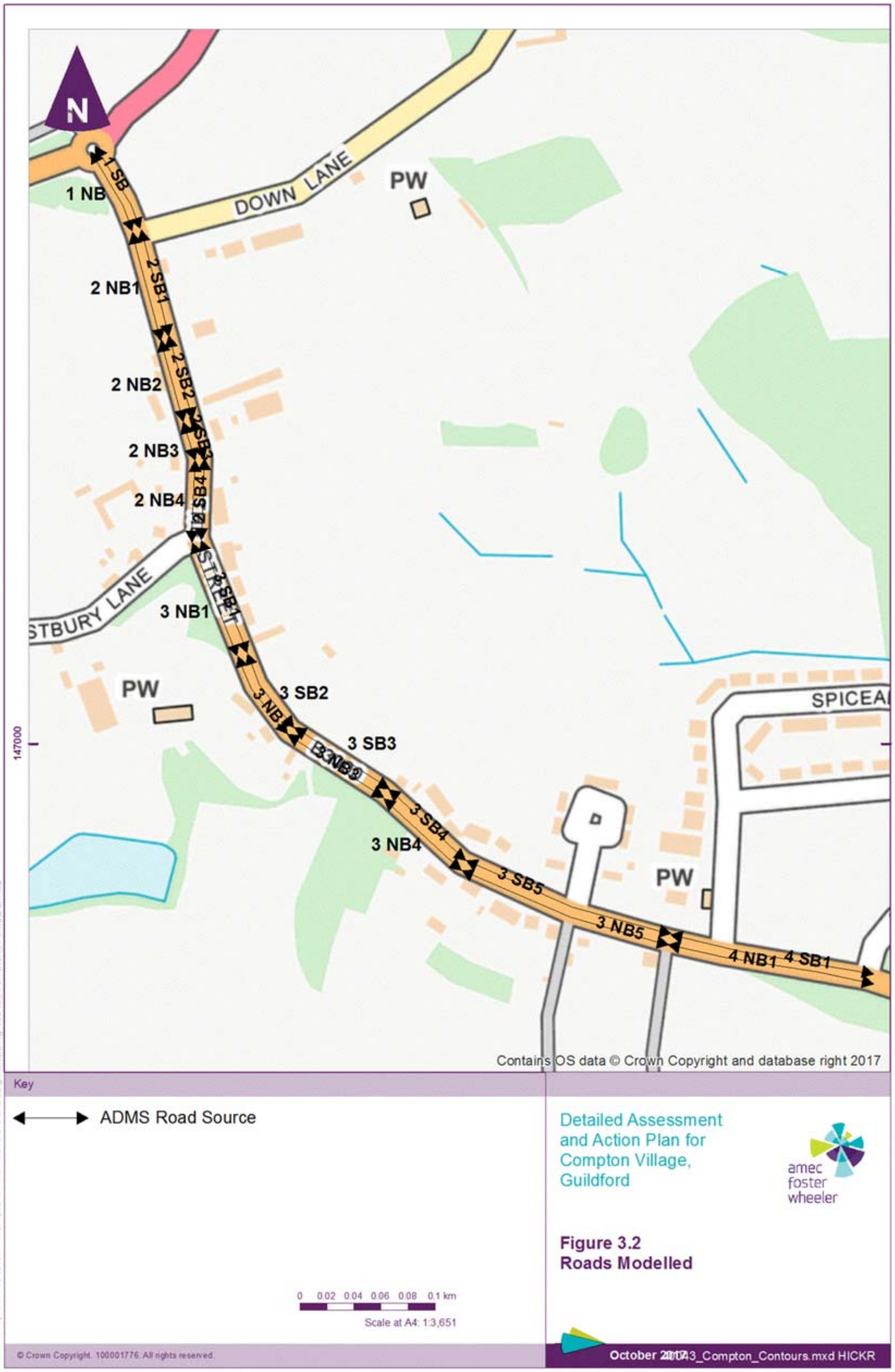
The traffic data were used to estimate emissions for the 2016 verification scenario and 2017 existing baseline scenario, based on 2017 emission factors and background concentrations.

Emissions were calculated using the latest emissions factors from Defra, the Emission Factor Toolkit v7.0[14], which is used to predict emissions which are imported into ADMS-Roads. Particulate generated due to brake and tyre wear are also included in the Toolkit.

Figure 4.2 shows the road links that have been modelled in this assessment. The traffic data used are given in Appendix B.

[14] http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#eft

Figure 4.2 Roads modelled



Model verification

Model verification enables an estimation of uncertainty and systematic errors associated with the dispersion modelling components of the air quality assessment to be considered. There are many explanations for these errors, which may stem from uncertainty in the modelled number of vehicles, speeds and vehicle fleet composition. Defra has provided guidance in terms of preferred methods for undertaking dispersion model verification[9]. Model verification involves the comparison of modelled concentrations and local monitoring data.

Full details of the model verification procedure are provided in Appendix C. The diffusion tubes used in the verification process are shown in Figure 3.1. NO_2 concentrations have been amended using the adjustment factor of 3.78.

Modelled scenarios

Five scenarios were modelled in order to quantify potential reductions in NO_2 concentrations with different air quality measures in place. Full details on the scenarios are provided in Appendix B.

Scenario 1 – Ban on HGVs

The first scenario has assumed that all articulated and rigid Heavy Goods Vehicles (HGVs) are banned from travelling through the proposed AQMA area and would need to find an alternative route. This action would remove the most polluting vehicles from The Street. This scenario provides an indication of reductions in emissions that could be achieved by focusing on freight movements. Similar measures, which do not introduce a complete ban on HGVs but encourage the use of alternative routes for HGVs without using The Street, should also be considered if a complete ban is not deemed feasible.

Scenario 2 – 20 mph Zone

The second scenario modelled assumed that a 20 mph zone is created along The Street. The speed of all road links was changed to 20 mph in the model. This action is likely to improve stop/start conditions through ensuring cars are maintaining a consistent speed, rather than accelerating up to 30 mph and braking regularly.

Scenario 1 & 2 Combined – Ban on HGVs & 20 mph Zone

This scenario modelled is a combination of scenarios 1 and 2. This scenario assumed that a ban on HGVs and a 20 mph zone were introduced along The Street. This action is likely to deliver the combined benefits from both actions.

Scenario 3 – Traffic lights

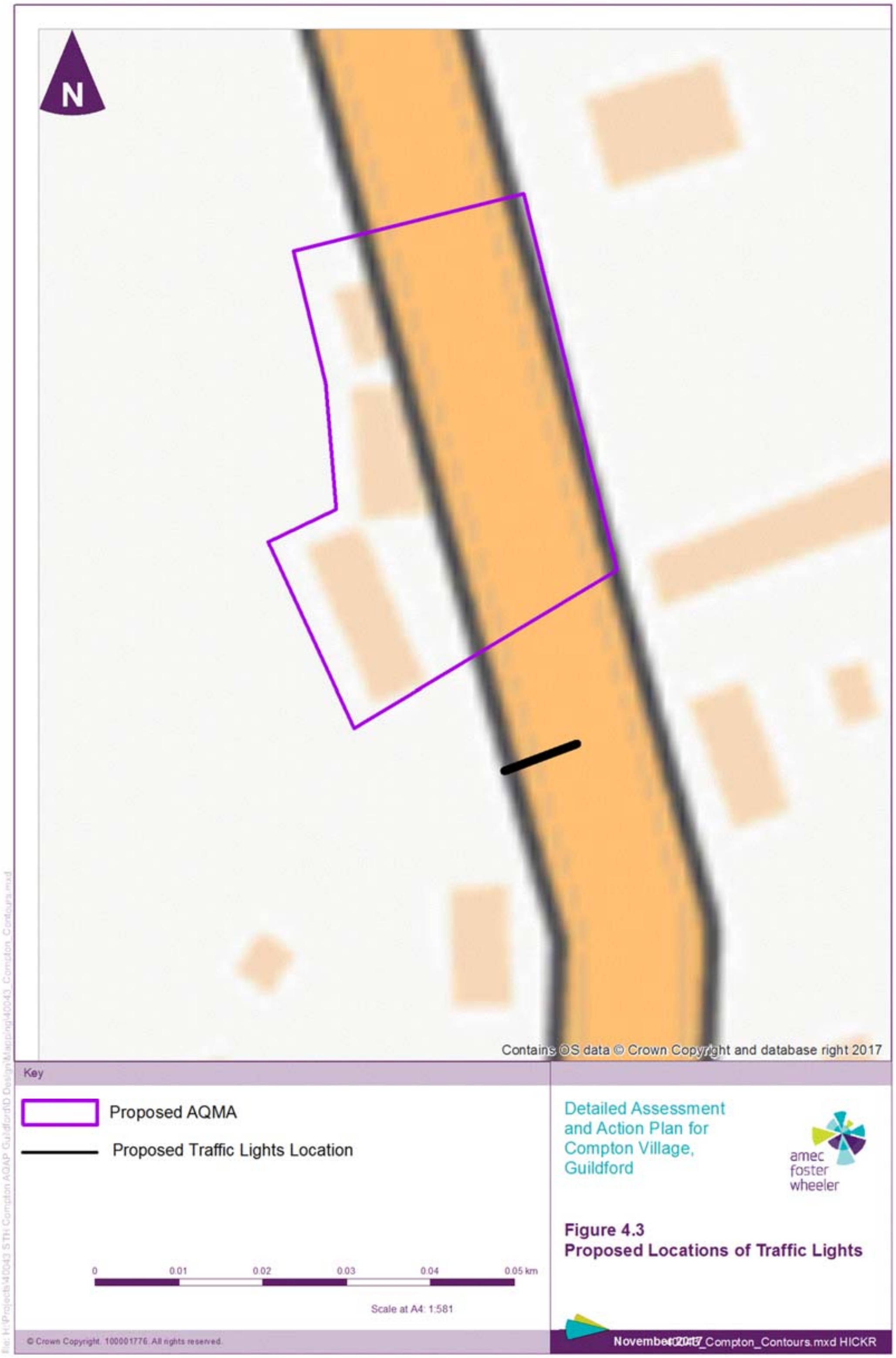
The third scenario modelled assumes that traffic lights are introduced on the north-bound carriageway of The Street around 20m south of the proposed AQMA boundary, to control traffic travelling through the AQMA to the A3/B3000. Whilst it will be necessary to consider the feasibility of this intervention, to provide an indication of impacts, the impact of the traffic lights has been modelled by assuming that traffic along road links leading up to the suggested lights (2NB3 and 2NB4) would be queuing (indicated by average speeds of 5 km/h in the model) and traffic along road links inside/adjacent to the AQMA (2 NB2 and 2NB1) would increase from 10 km/h to 20 km/h. Figure 4.3 shows an indicative location of the proposed traffic lights, aimed at reducing congestion within the proposed AQMA.

Scenario 3 & 1 Combined – Traffic lights & ban on HGVs

The fifth scenario modelled was a combination of scenarios 1 and 3. This scenario assumed that a ban on HGVs and traffic lights were introduced along The Street. This action is likely to deliver the combined benefits from both actions.

© Amec Foster Wheeler Environment & Infrastructure UK Limited

Figure 4.3 Location of traffic lights



4.2 Results

This section presents a summary of the modelling assessment in relation to the concentrations of NO_2. Detailed results are provided in Appendix D.

Baseline

Table D1 presents the annual mean NO_2 concentrations for receptors around Guildford Road in the current baseline and five modelled scenarios. Exceedances of the AQO of 40 μgm^{-3} are predicted at receptor R3 in the existing baseline scenario, reflecting results of the initial assessment[2].

The highest concentration at a relevant receptor location is predicted at receptor R3 on Guildford Road, where a concentration of 44.0 μgm^{-3} is predicted which exceeds the AQO of 40 μgm^{-3}. This location is a relevant residential receptor location. Diffusion tube C4 is located near this location, and recorded a concentration exceeding the AQO in 2016. A concentration within 5% of the AQO was predicted at nearby receptor R4, where a concentration of 39.2 μgm^{-3} was predicted.

Figure 4.4 shows the mapped NO_2 concentration contours which give an indication of residential locations where NO_2 concentrations may be exceeding the AQO. Due to exceedances of the AQO for NO_2 being predicted at residential receptor locations along The Street, it is proposed that an AQMA is declared in this area, as a result of road traffic emissions. The proposed boundary includes properties where the predicted concentrations are within 5% of the AQO. The proposed boundary of the AQMA is shown in Figure F1.

Figure 4.4 Mapped NO_2 concentrations

Scenario 1

The results in Table D1 indicate that concentrations at all relevant receptor locations would be reduced if all articulated and rigid HGVs are banned from travelling through the proposed AQMA area. The predicted annual mean NO_2 concentration decreases from 44 μgm^{-3} to 41 μgm^{-3} when this measure alone is modelled.

The results indicate that this action could reduce the annual mean NO_2 concentration at receptor R3 up to 8%, with an average reduction in pollutant concentrations of around 4% over all modelled receptors.

Scenario 2

The results in Table D1 indicate that concentrations at all relevant receptor locations would be reduced to below the AQO of 40 μgm^{-3} if a 20 mph zone is introduced along The Street.

The results indicate that this action could reduce the annual mean NO_2 concentration at receptor R3 up to 25%, due to improvements in the stop/start conditions through ensuring cars are maintaining a consistent speed, rather than accelerating and braking regularly along the bends in the road.

Scenario 1 & 2 Combined

The results in Table D1 indicate that concentrations at all relevant receptor locations would be reduced to below the AQO of 40 μgm^{-3} if both a ban on HGVs and a 20 mph zone were introduced along The Street.

The results indicate that this action could reduce the annual mean NO_2 concentration at receptor R3 up to 28%, due to a combination of reductions in stop/start conditions by encouraging drivers to maintain a consistent speed, rather than accelerating and braking regularly, and banning some of the largest contributors to diesel emissions from travelling along the road.

Scenario 3

The results in Table D1 indicate that concentrations at all relevant receptor locations would be reduced to below the AQO of 40 μgm^{-3} if traffic lights were introduced along The Street.

However, the results indicate that this action would likely only reduce the annual mean NO_2 concentration at receptor R3 to 39.8 μgm^{-3}, only just below the AQO of 40 μgm^{-3}. Additionally, this action is likely to increase pollutant concentrations elsewhere along The Street as the traffic is shifted. The results indicate that the introduction of traffic lights at the proposed location could result in increases in NO_2 concentrations of 3-4% at receptors R6, R7 and R8, and no improvement in concentrations at receptors R9, R10 or R11.

Scenario 3 & 1 combined

The results in Table D1 indicate that concentrations at all relevant receptor locations would be reduced to below the AQO of 40 μgm^{-3} if both traffic lights and a ban on HGVs is introduced along The Street.

The results indicate that this action could reduce the annual mean NO_2 concentration at receptor R3 up to 16%.

Summary

Results indicate that scenarios 1 & 2 combined would be likely to deliver the largest reduction in NO_2 concentrations within the proposed AQMA at The Street. It is likely that introducing a combination of measures, such as banning HGVs and introducing a 20 mph zone, would improve traffic flow along The Street and lead to reduced concentrations within the AQMA. The feasibility of these options operationally has not been assessed and local transport teams would need to be consulted with to determine the suitability of these options. The results have indicated that introducing traffic lights along The Street may deliver marginal improvements in certain areas but would be likely to shift emissions rather than create large decreases in concentrations within the AQMA.

5. Further analysis

5.1 Estimate of the population exposed to exceedance of the annual mean NO_2 AQO

The average number of people per household in 2016 in the UK was 2.4 (Office for National statistics, 2015)[15]. It has been estimated using online mapping systems available (e.g. Google Earth) that there are 3 residential units included with the proposed AQMA boundary. It is therefore estimated that there are approximately 7 people living within the proposed AQMA boundary that may be exposed to concentrations of NO_2 exceeding the AQO.

5.2 Required reductions

The issue of NO_2 reduction is complex as a certain reduction in NO_X emissions does not necessarily deliver an equivalent improvement in air quality (reduction in NO_2 concentrations) since non-linear chemical transformations take place between the emitted NO_X and the background NO_X and atmospheric ozone. The non-linear chemistry is taken into account when estimating the amount of emission reduction necessary to achieve the AQOs.

The calculated emissions reduction required at the modelled receptor (R3) with the highest NO_2 concentration in the AQMA is given in Table 5.1. This shows the reductions required to achieve the annual mean NO_2 AQO as both road-NO_X concentrations and the percentage reductions required in road-NO_X emissions. The reductions were calculated using the methodology in LAQM.TG (09).

Table 5.1 Estimates of emissions reductions required to achieve the annual NO_2 AQO.

Receptor	Modelled NO_2 concentration ($\mu g\ m^{-3}$)	Road-NO_X concentration ($\mu g\ m^{-3}$)	Road-NO_X concentration required for NO_2 concentration of 38 $\mu g\ m^{-3}$ ($\mu g\ m^{-3}$)	% Road-NO_X emissions reduction required (%)
Receptor 3	44.0	71.4	55.0	24.0

The calculations highlighted that a reduction in road-NO_X emissions and, therefore, road-NO_X concentrations of 20% is required to achieve a NO_2 concentration of 38 $\mu g\ m^{-3}$. This concentration represents an achievable level lower than the AQO.

The reduced emissions associated with the replacement of older vehicles with newer, lower emitting models and the improvement of road traffic management on The Street, will help to reduce NO_2 concentrations so that the annual mean AQO will no longer be exceeded in the AQMA.

5.3 Detailed source apportionment of vehicle types

The detailed traffic data provided were used to calculate detailed source apportionment of vehicle types. The default fleet compositions in the Defra Emissions Factor Toolkit were used to derive emissions and give an estimation of source contributions for motorbikes, petrol/diesel cars, petrol/diesel Light Goods Vehicles (LGVs), rigid HGVs, Articulated HGVs and Buses/ Coaches.

Figure 5.1 shows the source apportionment of traffic emissions along road link 2 NB2 (the modelled road link alongside receptor R3.

15 http://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2015-11-05#household-size

© Amec Foster Wheeler Environment & Infrastructure UK Limited

Figure 5.1 NOx source apportionment for road link 2 NB2 (northbound on The Street)

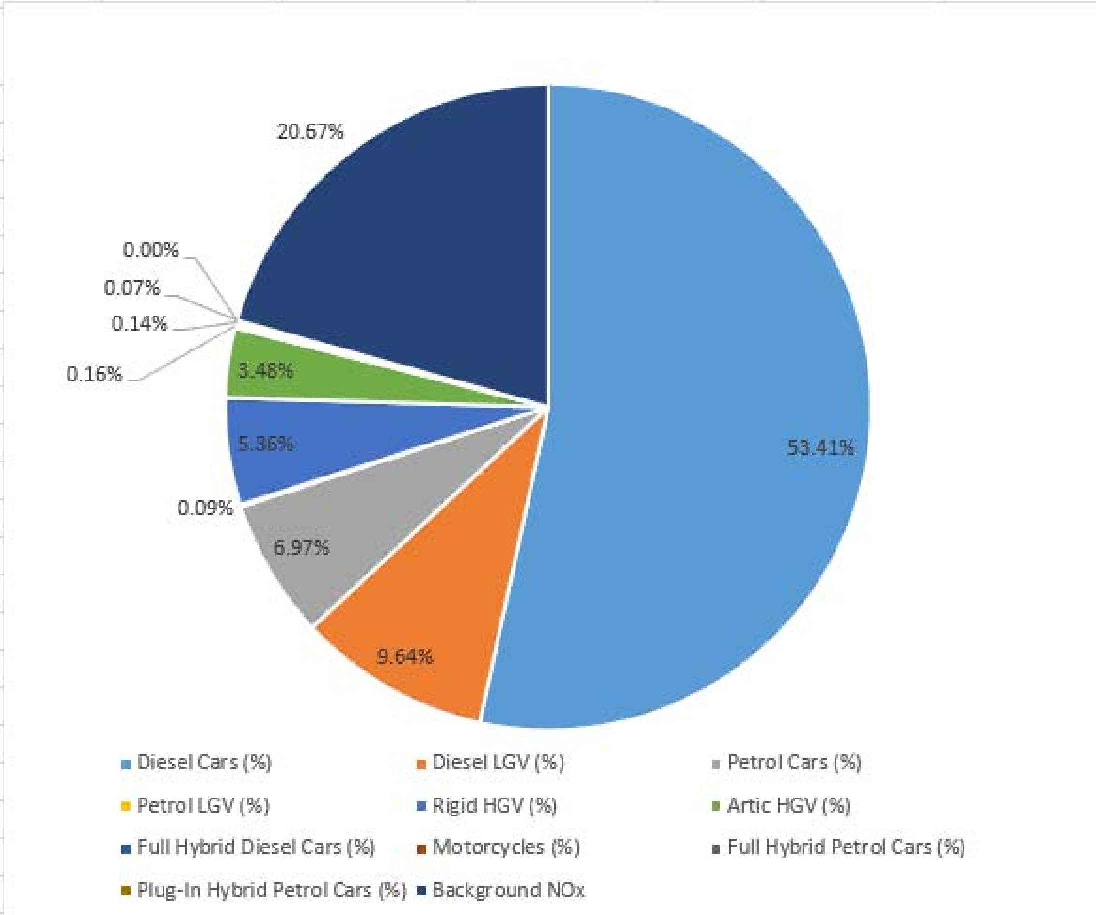


Figure 5.1 shows that approximately 8% of NOx emissions from traffic travelling on The Street are from Heavy Duty Vehicles (HDVs). Figure 5.1 shows that the majority of NOx emissions are from diesel fuelled vehicles (diesel cars - 53%, diesel LGVs - 9%). Petrol fuelled cars only emit 7% of NO_X emissions on this link.

6. Existing policies

6.1 European policies

Traffic emissions are predicted to decline each year as new vehicles replace older ones. Following the introduction of European emission standards for road vehicles in 1992, emissions from the overall road vehicle fleet have been decreasing due to the penetration of new vehicles and trucks meeting the emission regulations. Future emissions (per vehicle) are therefore likely to continue to decrease as new vehicles, meeting the increasingly stringent emission regulations, replace older vehicles and form a greater part of the UK fleet. Market demand and future UK and European policies are likely to achieve further reductions in vehicle emissions.

Table 6.1 shows the background NO_X and NO_2 concentrations from the Defra concentration maps for the AQMA. NO_2 concentrations are expected to decrease by between 0.7 μg m^{-3} per year on average between 2017 and 2020.

Table 6.1 Annual mean background concentrations (495500, 147500)

Year	NO_X	NO_2
2017	18.6	13.4
2018	17.5	12.7
2019	16.4	12.0
2020	15.3	11.3

6.2 Regional policies

Surrey Transport Plan[16]

The Surrey Transport Plan[17] is the third Local Transport Plan (LTP) for the county. It is a statutory plan (required by the Local Transport Act 2008 and Transport Act 2000), which replaced the second LTP on 1 April 2011. In common with the previous Plans, the Surrey Transport Plan is partly an aspirational document. The strategies look forward to 2026 and will be reviewed every three to five years as necessary. The Local Transport Strategies and Implementation Programmes will cover a three-year cycle and will be updated and rolled forward annually. The accompanying strategic environmental assessment used a set of criteria to evaluate the likely environmental performance of the Plan, specifically including air quality. Air quality and climate change were found to represent a significant opportunity for impact, due to the accessibility and congestion measures planned. The assessment, based solely on the vision and objectives for the Plan, suggested that emissions of transport related air pollutants would be expected to fall over the lifetime of the Plan, although there would be potential for localised adverse impacts as a consequence of construction works associated with the maintenance and improvement of the transport network.

Surrey air quality strategy[18]

The Surrey Transport Plan Air Quality Strategy (2016) contains the following aims and objectives:

[16] Surrey County Council (November 2014) Surrey Transport Plan: Guildford Borough Draft Local Transport Strategy and Forward Programme.

[17] http://new.surreycc.gov.uk/roads-and-transport/surrey-transport-plan-ltp3 - Accessed July 2017

[18] Surrey County Council (January 2016) Surrey County Council: Air Quality Strategy.

- *Aim: To improve air quality in AQMAs on the county road network such that Surrey's borough and districts are able to undeclare (sic) these areas as soon as possible, with regard to other strategies and funding constraints.*
- Objectives:
  - *1. Working with the accountable borough or district council for each designated AQMA, to incorporate physical transport measures in the borough or district council's Infrastructure Delivery Plan, agree options for the enforcement of existing regulations and agree options for supporting smarter travel choices, for future implementation as and when funding becomes available, in order to reduce air pollution from road traffic sources;*
  - *2. To provide assistance to the borough and district councils in producing their review and assessment reports, and Action Plan progress reports; and,*
  - *3. To consider air quality impacts when identifying and assessing transport measures in Surrey.*

A twin-track preferred strategy approach is proposed:

- ***A focus on AQMAs*** *through incorporating appropriate physical transport measures in Infrastructure Delivery Plans, enforcing existing regulations for parking and loading, supporting travel choices that are better for air quality and considering air quality issues in planning and other processes and areas of responsibility; and*
- ***Countywide air quality improvements*** *delivered through synergies with other Surrey Transport Plan strategies and other county council strategies when and where these tend to restrain traffic growth, reduce vehicle delay, reduce vehicle emissions and improve the provision of travel information to people on the air quality impacts of their travel choices.*

Partnership working with the boroughs and districts, the Highways Agency and with wider partners in Surrey is essential to the delivery of this strategy.

The Surrey Transport Plan Congestion Strategy (2014)[19] contains the following aims and objectives:

- *Aim: To improve the reliability of journeys, reduce delays at congestion hotspots and improve the provision of journey planning information for travel in Surrey.*
- *Objectives:*
  - *1. Improve the reliability of journeys in terms of how long they take;*
  - *2. Reduce delays for all modes of transport (car, bus and community transport, freight, pedestrians, cyclists) on key routes within Surrey and at congestion hotspots on Surrey's roads; and*
  - *3. Improve the provision of information to allow people to plan their journeys.*

6.3 Local policies

Guildford Borough Local Plan[20]

The Local Plan has a focus on improving air quality in the Borough. Several policies reiterate the importance of encouraging residents to use public transport and improving the walking and cycling infrastructure in the Borough. Appendix C in the Guildford Borough Local Plan provides an Infrastructure Schedule which details a proposed significant programme of schemes to provide and improve opportunities to use active modes of public transport.

[19] https://www.surreycc.gov.uk/roads-and-transport/roads-and-transport-policies-plans-and-consultations/surrey-transport-plan-ltp3/surrey-transport-plan-strategies/congestion-strategy - Accessed July 2017
[20] Guildford Borough Council (June 2017) Guildford borough Proposed Submission Local Plan: strategy and sites.

There are also several policies in place which state that new developments will have to enhance air quality in the Borough and not lead to detrimental impacts on the environment.

Policy ID3 on sustainable transport for new developments states that:

"*New developments will be required to contribute to the delivery of an integrated, accessible and safe transport system, maximising the use of the sustainable transport modes of walking, cycling and the use of public and community transport.*"

Paragraph 4.6.27 states that "*Well designed developments may actively help to enhance air quality and reduce overall emissions, therefore reducing possible health impacts.*"

Guildford Borough Transport Strategy[21]

The Guildford Borough Transport Strategy draws together the key strands from the forward plans and transport providers and funders. Chapter 6 presents Guildford's transport and air quality strategy.

Key weaknesses in the air quality strategy are identified as follows:

- Significant traffic congestion during peak hours experienced on links and junctions of the Strategic Road Network and Local Road Network; and
- Local Air Quality Management system:
  - Air quality is poor in some locations
  - No real time monitoring of air quality in the borough
  - No monitoring of smaller $PM_{2.5}$ fraction.

One of the anticipated improvements in the Borough includes 'Hotspots' improvements to tackle congestion on the Local Road Network. This Action Plan aims to tackle congestion along The Street in Compton to reduce concentrations in the air quality 'hotspot' identified during local diffusion tube monitoring.

[21] Guildford Borough Council (June 2017) Guildford Borough Transport Strategy 2017.

© Amec Foster Wheeler Environment & Infrastructure UK Limited

7. Compton Village AQAP measures

The proposed AQMA on The Street covers approximately 230 metres of the road.

NO2 levels were monitored with diffusion tubes at four sites located in the AQMA and near its outer boundary in 2016. In 2017, diffusion tubes C1-C3 and C5-C6 were decommissioned as they monitored concentrations below the AQO of 40 µgm-3. It is recommended that monitoring is continued at least two locations within the AQMA in order to review progress at meeting the AQO in the proposed AQMA. A monitoring location at a relevant receptor location has been recommended in Figure F1.

In order to reduce NO2 levels in the AQMA and prevent any increase, several actions should be put in place. Recommended measures have been developed from the information available in the London Local Air Quality Management (LLAQM) Borough Air Quality Action Matrix[22]. The actions considered are included in Table 7.1 below. Measures 1 and 2 have been modelled as part of this assessment. The full feasibility of these measures has not been assessed here, but dispersion modelling results indicate that they could result in the required reductions in NOX emissions.

Measure 1 is to stop HGVs from travelling down The Street. If suitable alternate freight routes could be found, this would be very likely to result in reduced concentrations through the proposed AQMA.

Measure 2 is to reduce the speed limit to 20 mph, to reduce acceleration, when the majority of emissions occur. This speed reduction measure should be displayed with traffic signs, rather than speed bumps, as there is evidence to suggest that speed bumps increase stop-start driving conditions and subsequently increase emissions.

Measure 3 is to introduce temporary traffic signals along The Street. Traffic signals at a location away from residents' houses would allow a more fluid traffic flow and reduce congestion. However, it is not clear where it would be suitable to install lights along The Street without introducing new congested areas or shifting the congestion elsewhere along the road.

Measures 4 and 5 are actions that were considered in relation to reducing emissions from local residents. These measures are more expensive and may be overall more difficult to implement, but were considered as alternative measures which GBC may wish to consider over the long-term if improvements are not made from the less intrusive measures recommended (Measures 1-3) along The Street, or GBC may wish to be implemented elsewhere across the Borough. Measure 4 was considered as it is possible that introducing cycling lanes would encourage residents to use bikes instead of cars, especially for short distance travel. Measure 5 was considered as the installation of residential electric charge points in the area could encourage the uptake of low and zero emission vehicles, in order to reduce emissions in the area. Evidence suggests that the majority of plug-in vehicle owners want to charge their vehicles at home, at night, as this is the most convenient time. However, discussion with the Health and Community Care Services Leader at GBC determined that Measures 4 and 5 are not currently feasible to implement and would only deliver limited benefit in any case, as residents are unlikely to contribute a significant portion of total emissions. There is not enough space to introduce a cycle lane, and it is unlikely that residents in the proposed AQMA are contributing a portion of road traffic emissions large enough to support investment in charging infrastructure. As a result, Measures 4 and 5 have not been recommended at this moment in time.

[22] https://www.london.gov.uk/sites/default/files/air_quality_action_matrix.pdf - Accessed July 2017

© Amec Foster Wheeler Environment & Infrastructure UK Limited

Table 7.1 Air Quality Action Plan Measures

Measure No.	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
1	**Ban HGVs on The Street**	Traffic Management	Other	GBC	N/a	N/a	Reduced NO2 levels monitored	High	N/a	N/a	Signs should be put in place in the area to encourage HGVs to use alternative routes.
2	**Lowering the speed limit to 20 mph on The Street**	Traffic Management	Reduction of speed limits, 20mph zones	GBC	N/a	N/a	Reduced NO_2 levels monitored	Medium	N/a	N/a	Speed limits signs could be introduced, rather than speed bumps as there is evidence that suggests that speed bumps increase stop-start driving conditions.
3	**Introduce temporary traffic signals along The Street**	Traffic Management	Other	GBC	N/a	N/a	Reduced NO_2 levels monitored and decreased traffic congestion	Medium	N/a	N/a	Traffic signals at a location away from residents' houses would allow a more fluid traffic flow and reduce congestion.
4	**Provision of cycling infrastructure on The Street**	Transport Planning and Infrastructure	Cycle network	GBC	N/a	N/a	Reduced NO_2 levels monitored and decreased traffic congestion	Low	N/a	N/a	Introduction of cycle lanes on The Street would encourage residents to cycle.

Measure No.	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
5	**Installation of residential electric charge point in Guilford Road neighbourhood**	Promoting Low Emission Transport	Procuring alternative refuelling infrastructure to promote Low Emission Vehicles, EV recharging	GBC	N/a	N/a	Reduced NO_2 levels monitored	High	N/a	N/a	Installation of residential charge point close to houses would increase the uptake of low and zero emission vehicles.

8. Consultation and stakeholder engagement

This AQAP was prepared by Amec Foster Wheeler on behalf of the Health and Community Care Services of Guildford Borough Council.

This AQAP will be subject to an annual review, appraisal of progress and reporting to the relevant Council Panel. Progress will be reported in the Annual Progress Reports produced by the Council.

Any comments should be addressed to:

Gary Durrant
Team Leader
Health and Community Care Services
Guildford Borough Council
Millmead House
Guildford
Surrey

gary.durrant@guildford.gov.uk
01483-444373

9. Conclusions

An air quality assessment has been prepared to determine the extent of exceedances of the AQOs at relevant receptor locations around The Street in Guildford. ADMS-Roads (version 4.1) modelling has been used to model dispersion from traffic to determine likely NO_2 concentrations at residential receptors. Predicted concentrations at receptors were then compared to the Air Quality Objectives.

The highest NO_2 concentration is predicted at receptor R3 where a concentration of 44.0 μgm^{-3} is predicted on Guildford Road, which exceeds the AQO of 40 μgm^{-3}, and is a relevant residential receptor location.

Dispersion modelling therefore indicates that concentrations at receptor locations with relevant exposure are exceeding the AQO of 40 μgm^{-3} for NO_2 as a result of road traffic emissions around The Street.

9.1 Recommendations

- It is recommended that an AQMA is declared along The Street, with the extent of the boundary determined in this assessment;
- AQAP measures recommended in this assessment should be implemented along The Street, It is possible that a combination of measures could result in the largest reductions in pollutant concentrations but the feasibility of introducing these options would need to be investigated further; and
- Diffusion tube monitoring should continue along The Street in order to confirm if the NO_2 annual mean AQO is exceeded where there is relevant exposure, and quantify any reduction in NO_2 concentrations as a result of the actions implemented.

© AMEC Environment & Infrastructure UK Ltd

Appendix A
ADMS model

Introduction

The ADMS-Roads dispersion model, developed by CERC[6], is a tool for investigating air pollution problems due to small networks of roads that may be in combination with industrial sites, for instance small towns or rural road networks. It calculates pollutant concentrations over specified domains at high spatial resolution (street scale) and in a format suitable for direct comparison with a wide variety of air quality standards for the UK and other countries. The latest version of the model, version 4.1, was used in this study.

ADMS-Roads is referred to as an advanced Gaussian or, new generation, dispersion model as it incorporates the latest understanding of the boundary layer structure. It differs from old generation models such as ISC, R91 and CALINE in two main respects:

- it characterises the boundary layer structure and stability using the boundary layer depth and Monin-Obukhov length to calculate height-dependent wind speed and turbulence, rather than using the simpler Pasquill-Gifford stability category approach; and
- it uses a skewed-Gaussian vertical concentration profile in convective meteorological conditions to represent the effect of thermally generated turbulence.

Model features

A description of the science used in ADMS-Roads and the supporting technical references can be found in the model's User Guide[23]. The main features of ADMS-Roads are:

- it is an advanced Gaussian, "new generation" dispersion model;
- includes a meteorological pre-processor which calculates boundary layer parameters from a variety of input data e.g. wind speed, day, time, cloud cover and air temperature;
- models the full range of source types encountered in urban areas including industrial sources (up to 3 point sources, up to 3 lines sources, up to 4 area sources, up to 25 volume sources) and road sources (up to 150 roads, each with 50 vertices);
- generates output in terms of average concentrations for averaging times from 15minutes to 1 year, percentile values and exceedances of threshold values. Averages can be specified as rolling (running) averages or maximum daily values;
- the option to calculate emissions from traffic count data, speed and fleet split (light duty/ heavy duty vehicles) using UK emission factors. Alternatively, road emissions may be entered directly as user specified values;
- models plume rise by solving the integral conservation equations for mass, momentum and heat;
- models the effect of street canyons on concentrations within the canyon and vehicle–induced turbulence using a formulation based on the Danish OSPM model. It is usually only important to model street canyons when the aspect ratio (ratio of the height of buildings along the road to the width of the road) is greater than 0.5;
- models the effects of noise barriers on concentrations outside the road;
- models NO_X chemistry using the 8 reaction Generic Reaction Set plus transformation of SO_2 to sulphate particles, which are added to the PM_{10} concentration;
- models the effect of a small number of buildings on dispersion from point sources;

23 CERC (2011) ADMS-Roads, an Air Quality Management System, Version 3.1 User Guide, http://www.cerc.co.uk/environmental-software/assets/data/doc_userguides/CERC_ADMS-Roads3.1_User_Guide.pdf Date of access: 19th October 2012.

- models the effect of complex terrain (hills) and spatially varying surface roughness. Terrain effects only become noticeable for gradients greater than 1:10, but for ground level sources in a built up area, such as urban roads, low gradients will have a negligible effect;
- models concentrations in units of $ou_E m^{-3}$ for odour studies;
- link to MapInfo and ArcGIS for input of source geometry, display of sources, aggregation of emissions and plotting of contours; and
- link to an emissions inventory in Microsoft Access for input and export of source and emissions data.

In this study, noise barriers, buildings and complex terrain were not modelled. The link to ArcGIS was used to enter source geometry.

Validation

ADMS-Roads has been validated using UK and US data and has been compared with the DMRB spreadsheet model and the US model, CALINE. Validation of the ADMS and ADMS-Urban models are also applicable to the performance of ADMS-Roads as they test common features: basic dispersion, modelling of roads and street canyons, the effect of buildings and the effect of complex terrain. These validation studies are all reported on the CERC web site[24]. In addition, ADMS-Urban has been validated during its use in modelling many urban areas in the UK for local authorities as part of LAQM, Heathrow Airport for the Department for Transport[25] and all of Greater London for a Defra model inter-comparison exercise[26].

Surface Roughness

A surface roughness length of 0.2 m was chosen to represent conditions in the area.

Street canyon

ADMS-Roads includes a module to model the effect of street canyons on concentrations within the canyon based on the Operational Street Pollution Model (OSPM). It is usually only important to model street canyons when the aspect ratio (ratio of the height of buildings along the road to the width of the road) is greater than 0.5. ADMS-Roads 4.1 includes an advanced street canyon feature which enables one-sided street canyons to be inputted to the model[i].

The monitored NO_2 concentrations at certain locations along The Street indicate that there is reduced dispersion as a result of high walls and thick tree coverage along the roadside. A one-sided street canyon was modelled along three of the modelled road links in all scenarios to account for the reduced dispersion at certain locations. Full details of the street canyon parameters are provided in Table A1. The verification process, also detailed in Appendix C shows that the model performs well and accurately predicts the annual mean concentration of NO_2 at diffusion tube C4 when the one-sided street canyon is included.

[24] http://www.cerc.co.uk/environmental-software/model-documentation.html#validation Date of access: 19 October 2012
[25] CERC (2007) Air Quality Studies for Heathrow: Base Case, Segregated Mode, Mixed Mode and Third Runway Scenarios Modelled Using ADMS-Airport, prepared for the Department for Transport, HMSO Product code 78APD02904CERC
[26] Carslaw, D. (2011), Defra urban model evaluation analysis – Phase 1, a report to Defra and the Devolved Authorities. http://uk-air.defra.gov.uk/library/reports?report_id=654 Date of access: 19 October 2012

Table A1 One-sided street canyon data inputs

ID	Name	X1	Y1	X2	Y2	Canyon side	Width	Avg Height	Min Height	Max Height	Canyon Length	End Length	Build Length
0	2 NB1	495416.52	147379.58	495437.69	147299.54	Left	8	14	12	15	82	0	82
1	2 NB2	495437.78	147299.37	495454.4	147239.25	Left	10	10	0	15	60	0	60
2	3 NB1	495461.06	147149.08	495494.46	147065.07	Left	12	1	1	2	90	0	90
3	3 SB1	495467.67	147151.06	495502.07	147067.39	Right	8	12	10	15	90	0	90

© AMEC Environment & Infrastructure UK Ltd

Appendix B
ADMS-roads input

© Amec Foster Wheeler Environment & Infrastructure UK Limited

Table B1 shows the traffic data obtained from the Compton traffic counts.

Table B1 ADMS-roads input data to the Existing Baseline Scenario

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
1 NB	6434	89.1	7.6	1.7	0.5	0.9	15.0	24	5
1 SB	8515	92.0	6.4	0.6	0.3	0.7	15.0	24	5
2 NB1	6957	90.0	8.1	0.7	0.5	0.7	10.0	24	4
2 SB1	8120	90.6	7.9	0.4	0.4	0.7	10.0	24	4
2 NB2	6957	90.0	8.1	0.7	0.5	0.7	10.0	24	4
2 SB2	8120	90.6	7.9	0.4	0.4	0.7	10.0	24	4
2 NB3	6957	90.0	8.1	0.7	0.5	0.7	20.0	24	4
2 SB3	8120	90.6	7.9	0.4	0.4	0.7	20.0	24	4
2 NB4	6957	90.0	8.1	0.7	0.5	0.7	20.0	24	4
2 SB4	8120	90.6	7.9	0.4	0.4	0.7	20.0	24	4
3 NB1	7276	91.1	7.4	0.2	0.5	0.7	20.0	24	4
3 SB1	7880	92.8	4.1	1.7	0.6	0.8	20.0	24	4
3 NB2	7276	91.1	7.4	0.2	0.5	0.7	48.2	24	4
3 SB2	7880	92.8	4.1	1.7	0.6	0.8	46.5	24	4
3 NB3	7276	91.1	7.4	0.2	0.5	0.7	48.2	24	4
3 SB3	7880	92.8	4.1	1.7	0.6	0.8	46.5	24	4
3 NB4	7276	91.1	7.4	0.2	0.5	0.7	48.2	24	4
3 SB4	7880	92.8	4.1	1.7	0.6	0.8	46.5	24	4
3 NB5	7276	91.1	7.4	0.2	0.5	0.7	48.2	24	4

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
3 SB5	7880	92.8	4.1	1.7	0.6	0.8	46.5	24	4
4 NB1	6863	89.9	8.0	0.6	0.6	0.8	48.7	24	4
4 SB1	8051	90.5	7.5	0.7	0.5	0.8	51.5	24	4
3 SB4	6434	89.1	7.6	1.7	0.5	0.9	15.0	24	4
3 NB5	8515	92.0	6.4	0.6	0.3	0.7	15.0	24	4
4 NB1	6957	90.0	8.1	0.7	0.5	0.7	10.0	24	4
4 SB1	8120	90.6	7.9	0.4	0.4	0.7	10.0	24	4

Table B2 ADMS-roads input data to Modelled Scenario 1

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
1 NB	6287	91.2	7.8	0.0	0.0	1.0	15.0	24	5
1 SB	8437	92.8	6.5	0.0	0.0	0.7	15.0	24	5
2 NB1	6875	91.0	8.2	0.0	0.0	0.7	10.0	24	4
2 SB1	8050	91.3	8.0	0.0	0.0	0.7	10.0	24	4
2 NB2	6875	91.0	8.2	0.0	0.0	0.7	10.0	24	4
2 SB2	8050	91.3	8.0	0.0	0.0	0.7	10.0	24	4
2 NB3	6875	91.0	8.2	0.0	0.0	0.7	20.0	24	4
2 SB3	8050	91.3	8.0	0.0	0.0	0.7	20.0	24	4
2 NB4	6875	91.0	8.2	0.0	0.0	0.7	20.0	24	4
2 SB4	8050	91.3	8.0	0.0	0.0	0.7	20.0	24	4
3 NB1	7219	91.9	7.5	0.0	0.0	0.7	20.0	24	4

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
3 SB1	7700	95.0	4.2	0.0	0.0	0.8	20.0	24	4
3 NB2	7219	91.9	7.5	0.0	0.0	0.7	48.2	24	4
3 SB2	7700	95.0	4.2	0.0	0.0	0.8	46.5	24	4
3 NB3	7219	91.9	7.5	0.0	0.0	0.7	48.2	24	4
3 SB3	7700	95.0	4.2	0.0	0.0	0.8	46.5	24	4
3 NB4	7219	91.9	7.5	0.0	0.0	0.7	48.2	24	4
3 SB4	7700	95.0	4.2	0.0	0.0	0.8	46.5	24	4
3 NB5	7219	91.9	7.5	0.0	0.0	0.7	48.2	24	4
3 SB5	7700	95.0	4.2	0.0	0.0	0.8	46.5	24	4
4 NB1	6778	91.1	8.1	0.0	0.0	0.8	48.7	24	4
4 SB1	7952	91.6	7.6	0.0	0.0	0.8	51.5	24	4
3 SB4	6287	91.2	7.8	0.0	0.0	1.0	15.0	24	4
3 NB5	8437	92.8	6.5	0.0	0.0	0.7	15.0	24	4
4 NB1	6875	91.0	8.2	0.0	0.0	0.7	10.0	24	4
4 SB1	8050	91.3	8.0	0.0	0.0	0.7	10.0	24	4

© Amec Foster Wheeler Environment & Infrastructure UK Limited

Table B3 ADMS-roads input data to Modelled Scenario 2

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
1 NB	6434	89.1	7.6	1.7	0.5	0.9	32.0	24	5
1 SB	8515	92.0	6.4	0.6	0.3	0.7	32.0	24	5
2 NB1	6957	90.0	8.1	0.7	0.5	0.7	32.0	24	4
2 SB1	8120	90.6	7.9	0.4	0.4	0.7	32.0	24	4
2 NB2	6957	90.0	8.1	0.7	0.5	0.7	32.0	24	4
2 SB2	8120	90.6	7.9	0.4	0.4	0.7	32.0	24	4
2 NB3	6957	90.0	8.1	0.7	0.5	0.7	32.0	24	4
2 SB3	8120	90.6	7.9	0.4	0.4	0.7	32.0	24	4
2 NB4	6957	90.0	8.1	0.7	0.5	0.7	32.0	24	4
2 SB4	8120	90.6	7.9	0.4	0.4	0.7	32.0	24	4
3 NB1	7276	91.1	7.4	0.2	0.5	0.7	32.0	24	4
3 SB1	7880	92.8	4.1	1.7	0.6	0.8	32.0	24	4
3 NB2	7276	91.1	7.4	0.2	0.5	0.7	32.0	24	4
3 SB2	7880	92.8	4.1	1.7	0.6	0.8	32.0	24	4
3 NB3	7276	91.1	7.4	0.2	0.5	0.7	32.0	24	4
3 SB3	7880	92.8	4.1	1.7	0.6	0.8	32.0	24	4
3 NB4	7276	91.1	7.4	0.2	0.5	0.7	32.0	24	4
3 SB4	7880	92.8	4.1	1.7	0.6	0.8	32.0	24	4
3 NB5	7276	91.1	7.4	0.2	0.5	0.7	32.0	24	4
3 SB5	7880	92.8	4.1	1.7	0.6	0.8	32.0	24	4

© Amec Foster Wheeler Environment & Infrastructure UK Limited

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
4 NB1	6863	89.9	8.0	0.6	0.6	0.8	48.7	24	4
4 SB1	8051	90.5	7.5	0.7	0.5	0.8	51.5	24	4
3 SB4	6434	89.1	7.6	1.7	0.5	0.9	32.0	24	4
3 NB5	8515	92.0	6.4	0.6	0.3	0.7	32.0	24	4
4 NB1	6957	90.0	8.1	0.7	0.5	0.7	32.0	24	4
4 SB1	8120	90.6	7.9	0.4	0.4	0.7	32.0	24	4

Table B4 ADMS-roads input data to Modelled Scenarios 1 & 2

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
1 NB	6287	91.2	7.8	0.0	0.0	1.0	32.0	24	5
1 SB	8437	92.8	6.5	0.0	0.0	0.7	32.0	24	5
2 NB1	6875	91.0	8.2	0.0	0.0	0.7	32.0	24	4
2 SB1	8050	91.3	8.0	0.0	0.0	0.7	32.0	24	4
2 NB2	6875	91.0	8.2	0.0	0.0	0.7	32.0	24	4
2 SB2	8050	91.3	8.0	0.0	0.0	0.7	32.0	24	4
2 NB3	6875	91.0	8.2	0.0	0.0	0.7	32.0	24	4
2 SB3	8050	91.3	8.0	0.0	0.0	0.7	32.0	24	4
2 NB4	6875	91.0	8.2	0.0	0.0	0.7	32.0	24	4
2 SB4	8050	91.3	8.0	0.0	0.0	0.7	32.0	24	4
3 NB1	7219	91.9	7.5	0.0	0.0	0.7	32.0	24	4

© Amec Foster Wheeler Environment & Infrastructure UK Limited

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
3 SB1	7700	95.0	4.2	0.0	0.0	0.8	32.0	24	4
3 NB2	7219	91.9	7.5	0.0	0.0	0.7	32.0	24	4
3 SB2	7700	95.0	4.2	0.0	0.0	0.8	32.0	24	4
3 NB3	7219	91.9	7.5	0.0	0.0	0.7	32.0	24	4
3 SB3	7700	95.0	4.2	0.0	0.0	0.8	32.0	24	4
3 NB4	7219	91.9	7.5	0.0	0.0	0.7	32.0	24	4
3 SB4	7700	95.0	4.2	0.0	0.0	0.8	32.0	24	4
3 NB5	7219	91.9	7.5	0.0	0.0	0.7	32.0	24	4
3 SB5	7700	95.0	4.2	0.0	0.0	0.8	32.0	24	4
4 NB1	6778	91.1	8.1	0.0	0.0	0.8	48.7	24	4
4 SB1	7952	91.6	7.6	0.0	0.0	0.8	51.5	24	4
3 SB4	6287	91.2	7.8	0.0	0.0	1.0	32.0	24	4
3 NB5	8437	92.8	6.5	0.0	0.0	0.7	32.0	24	4
4 NB1	6875	91.0	8.2	0.0	0.0	0.7	32.0	24	4
4 SB1	8050	91.3	8.0	0.0	0.0	0.7	32.0	24	4

Table B5 ADMS-roads input data to Modelled Scenario 3

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
1 NB	6434	89.1	7.6	1.7	0.5	0.9	15.0	24	5
1 SB	8515	92.0	6.4	0.6	0.3	0.7	15.0	24	5
2 NB1	6957	90.0	8.1	0.7	0.5	0.7	20.0	24	4

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
2 SB1	8120	90.6	7.9	0.4	0.4	0.7	10.0	24	4
2 NB2	6957	90.0	8.1	0.7	0.5	0.7	20.0	24	4
2 SB2	8120	90.6	7.9	0.4	0.4	0.7	10.0	24	4
2 NB3	6957	90.0	8.1	0.7	0.5	0.7	5.0	24	4
2 SB3	8120	90.6	7.9	0.4	0.4	0.7	20.0	24	4
2 NB4	6957	90.0	8.1	0.7	0.5	0.7	5.0	24	4
2 SB4	8120	90.6	7.9	0.4	0.4	0.7	20.0	24	4
3 NB1	7276	91.1	7.4	0.2	0.5	0.7	20.0	24	4
3 SB1	7880	92.8	4.1	1.7	0.6	0.8	20.0	24	4
3 NB2	7276	91.1	7.4	0.2	0.5	0.7	48.2	24	4
3 SB2	7880	92.8	4.1	1.7	0.6	0.8	46.5	24	4
3 NB3	7276	91.1	7.4	0.2	0.5	0.7	48.2	24	4
3 SB3	7880	92.8	4.1	1.7	0.6	0.8	46.5	24	4
3 NB4	7276	91.1	7.4	0.2	0.5	0.7	48.2	24	4
3 SB4	7880	92.8	4.1	1.7	0.6	0.8	46.5	24	4
3 NB5	7276	91.1	7.4	0.2	0.5	0.7	48.2	24	4
3 SB5	7880	92.8	4.1	1.7	0.6	0.8	46.5	24	4
4 NB1	6863	89.9	8.0	0.6	0.6	0.8	48.7	24	4
4 SB1	8051	90.5	7.5	0.7	0.5	0.8	51.5	24	4
3 SB4	6434	89.1	7.6	1.7	0.5	0.9	15.0	24	4
3 NB5	8515	92.0	6.4	0.6	0.3	0.7	15.0	24	4

© Amec Foster Wheeler Environment & Infrastructure UK Limited

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
4 NB1	6957	90.0	8.1	0.7	0.5	0.7	20.0	24	4
4 SB1	8051	90.5	7.9	0.4	0.4	0.7	10.0	24	4

Table B2 ADMS-roads input data to Modelled Scenarios 3 & 1 Combined

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
1 NB	6287	91.2	7.8	0.0	0.0	1.0	15.0	24	5
1 SB	8437	92.8	6.5	0.0	0.0	0.7	15.0	24	5
2 NB1	6875	91.0	8.2	0.0	0.0	0.7	20.0	24	4
2 SB1	8050	91.3	8.0	0.0	0.0	0.7	10.0	24	4
2 NB2	6875	91.0	8.2	0.0	0.0	0.7	20.0	24	4
2 SB2	8050	91.3	8.0	0.0	0.0	0.7	10.0	24	4
2 NB3	6875	91.0	8.2	0.0	0.0	0.7	5.0	24	4
2 SB3	8050	91.3	8.0	0.0	0.0	0.7	20.0	24	4
2 NB4	6875	91.0	8.2	0.0	0.0	0.7	5.0	24	4
2 SB4	8050	91.3	8.0	0.0	0.0	0.7	20.0	24	4
3 NB1	7219	91.9	7.5	0.0	0.0	0.7	20.0	24	4
3 SB1	7700	95.0	4.2	0.0	0.0	0.8	20.0	24	4
3 NB2	7219	91.9	7.5	0.0	0.0	0.7	48.2	24	4
3 SB2	7700	95.0	4.2	0.0	0.0	0.8	46.5	24	4
3 NB3	7219	91.9	7.5	0.0	0.0	0.7	48.2	24	4
3 SB3	7700	95.0	4.2	0.0	0.0	0.8	46.5	24	4

© Amec Foster Wheeler Environment & Infrastructure UK Limited

Road ID	Traffic Flow (AADT)	% Car	% LGV	% Rigid HGV	% Artic HGV	% Motorcycle	Speed (kmh^{-1})	Number of Hours	Road Width (m)
3 NB4	7219	91.9	7.5	0.0	0.0	0.7	48.2	24	4
3 SB4	7700	95.0	4.2	0.0	0.0	0.8	46.5	24	4
3 NB5	7219	91.9	7.5	0.0	0.0	0.7	48.2	24	4
3 SB5	7700	95.0	4.2	0.0	0.0	0.8	46.5	24	4
4 NB1	6778	91.1	8.1	0.0	0.0	0.8	48.7	24	4
4 SB1	7952	91.6	7.6	0.0	0.0	0.8	51.5	24	4
3 SB4	6287	91.2	7.8	0.0	0.0	1.0	15.0	24	4
3 NB5	8437	92.8	6.5	0.0	0.0	0.7	15.0	24	4
4 NB1	6875	91.0	8.2	0.0	0.0	0.7	20.0	24	4
4 SB1	8050	91.3	8.0	0.0	0.0	0.7	10.0	24	4

© AMEC Environment & Infrastructure UK Ltd

Appendix C
ADMS-roads model verification

The ADMS-Roads dispersion model has been widely validated for this type of assessment and was specifically listed in the Defra's LAQM.TG (09) guidance as an accepted dispersion model.

Model validation undertaken by the software developer (CERC) will not have included validation in the vicinity of the proposed Development Site. It is therefore necessary to perform a comparison of modelled results with local monitoring data at relevant locations. This process of verification attempts to minimise modelling uncertainty and systematic error by correcting modelled results by an adjustment factor to gain greater confidence in the final results.

The predicted results from a dispersion model may differ from measured concentrations for a large number of reasons, including uncertainties associated with:

- background concentration estimates;
- meteorological data;
- source activity data such as traffic flows and emissions factors;
- model input parameters such as surface roughness length, minimum Monin-Obukhov length;
- monitoring data, including locations; and
- overall model limitations.

Model verification is the process by which these and other uncertainties are investigated and where possible minimised. In reality, the differences between modelled and monitored results are likely to be a combination of all of these aspects.

Model setup parameters and input data were checked prior to running the models in order to reduce these uncertainties. The following were checked to the extent possible to ensure accuracy:

- traffic data;
- road widths;
- distance between sources and monitoring as represented in the model;
- speed estimates on roads;
- source types, such as elevated roads and street canyons;
- selection of representative meteorological data;
- background monitoring and background estimates; and
- monitoring data.

NO_2 Verification

Suitable local monitoring data for the purpose of verification of NO_2 was available at three diffusion tube locations.

Annual mean NO_x/NO_2 concentrations as shown in Table C1 below.

Table C1 Local monitoring data suitable for ADMS-roads model verification

Location	2016 Monitored NO_2 (μgm^{-3})	X (m)	Y (m)	Suitability for Verification
C1	29*	497005	146328	Not suitable as traffic data was not available this road link.
C2	28*	495411	147412	Not suitable as this tube is located near to a roundabout where there is no traffic data available for the other links.
C3	23*	495509	147024	Suitable
C4	50*	495438	147288	Suitable
C5	28*	495498	147097	Suitable
C6	19*	495453	147206	Not suitable as this tube is located behind vegetation which are likely to screen the emissions from the road.
Automatic Monitor	58.1*	495443	147262	Suitable

*Annualised

Verification calculations

The verification of the modelling output was performed in accordance with the methodology provided in Chapter 7 of LAQM.TG(16). Table C2 shows that there was systematic under prediction of monitored concentrations at all three tubes; therefore, it was considered necessary to adjust modelled concentrations.

Table C2 Verification, modelled versus monitored

Site	2016 Modelled Annual Mean NO_2 (μgm^{-3})	2016 Monitored Annual Mean NO_2 (μgm^{-3})	% (Modelled-Monitored)/ Monitored
C3	17.1	23.0	-25.65%
C4	26.4	50.0	-47.20%
C5	21.3	28.0	-23.96%
Auto	23.3	58.1	-59.90%

Table C3 shows the comparison of modelled road-NO_X, a direct output from the ADMS-Roads modelling, with the monitored road-NO_X, determined from the LAQM NO_X to NO_2 conversion tool. An adjustment factor of 3.78 was used to adjust modelled results.

Table C3 Comparison of modelled and monitored road NO_x to determine verification factor

Site	2016 Modelled Annual Mean Road NO_X (μgm^{-3})	2016 Monitored Annual Mean Road NO_X (μgm^{-3})	Ratio	Average Adjustment Factor
C3	5.58	17.19	3.08	3.78
C4	24.19	80.12	3.31	
C5	13.75	27.57	2.00	
Auto	17.80	102.5	5.76	

Table C4 shows the comparison of the modelled NO_2 concentration calculated by multiplying the modelled road NO_X by the adjustment factors and using the LAQM's NO_X to NO_2 conversion tool to calculate the total adjusted modelled NO_2.

Table C4 Comparison of adjusted modelled NO_2 and modelled NO_2

Location	2016 Background NO_X Concentration	2016 Background NO_2 Concentration	2016 Adjusted Modelled Annual Mean NO_2 (μgm^{-3})	2016 Monitored Annual Mean NO_2 (μgm^{-3})	% (Modelled- Monitored)/ Monitored
C3	19.7	14.2	24.9	23	8.26%
C4	19.7	14.2	54.1	50	8.26%
C5	19.7	14.2	38.8	28	38.68%
Auto	19.7	14.2	45.0	58.1	-22.48%

All modelled NO_x concentrations have been amended using the adjustment factor of 3.78. It is likely that the predicted concentrations will be over-predicted at the location of diffusion tube C5 which should be considered when the results are discussed and extent of the AQMA is determined

© AMEC Environment & Infrastructure UK Ltd

Appendix D
ADMS-roads results

Table D1 Annual mean NO_2 predicted concentrations (μgm^{-3})

Receptor	Baseline	Scenario 1	Scenario 1 concentration reduction %	Scenario 2	Scenario 2 concentration reduction %	Scenarios 1 & 2 combined	Scenarios 1 & 2 combined concentration reduction %	Scenario 3	Scenario 3 concentration reduction %	Scenario 3 & 1 combined	Scenario 3 & 1 combined concentration reduction %
R1	34.2	32.2	-5%	27.2	-17%	26.2	-20%	32.8	-3%	31.0	-8%
R2	35.7	33.6	-5%	28.3	-19%	27.2	-21%	34.2	-4%	32.4	-8%
R3	**44.0**	**41.0**	-8%	34.2	-25%	32.7	-28%	*39.8*	-11%	37.5	-16%
R4	*39.2*	36.6	-7%	30.7	-21%	29.5	-24%	35.6	-9%	33.7	-14%
R5	31.6	29.6	-5%	25.3	-16%	24.4	-18%	29.1	-6%	27.6	-10%
R6	32.9	31.4	-4%	29.3	-9%	28.3	-12%	34.2	3%	32.5	-1%
R7	25.8	24.7	-3%	23.3	-6%	22.5	-8%	27.6	4%	26.1	1%
R8	29.8	28.4	-4%	26.8	-8%	25.8	-10%	30.8	3%	29.3	-1%
R9	26.6	25.5	-3%	29.6	7%	28.2	4%	26.6	0%	25.5	-3%
R10	22.7	21.5	-3%	25.0	6%	23.4	2%	22.7	0%	21.5	-3%
R11	21.7	20.8	-2%	23.7	5%	22.5	2%	21.7	0%	20.8	-2%

Exceedances of the AQOs are shown in **bold.**

Concentrations within 5% of the AQO are *in italics.*

© AMEC Environment & Infrastructure UK Ltd

Appendix E
Annualisation

Data capture at the temporary automatic monitoring site at Moors Cottage was below the recommended 75%, therefore annualisation was undertaken, in accordance with the guidance in Box 3.2 of LAQM.TG(09) and Box 7.9 of LAQM.TG(16). The correction factors in the table below have been derived using the average ratio of the annual mean to the period mean for the monitoring data obtained from the London Hillingdon and Reading New Town monitors. These factors were applied to the measured period mean at the temporary automatic site to annualise the data.

Annual mean concentrations for 2015 were based on monitoring data between March and August 2017 inclusive.

Table E1 Adjustment factors to estimate annual mean concentrations at the temporary automatic monitor at Moors Cottage

Pollutant	Dates	Long term site	Annual mean (August 2016 to August 2017)	Period mean	Ratio	Average
NO_2	March - August 2017	London Hillingdon	54.98	46.73	1.22	1.24
		Reading New Town	31.40	24.25	1.30	

The average results before annualisation are presented in Table E2.

Table E2 Temporary automatic monitor results pre- and post-annualisation (µgm^{-3})

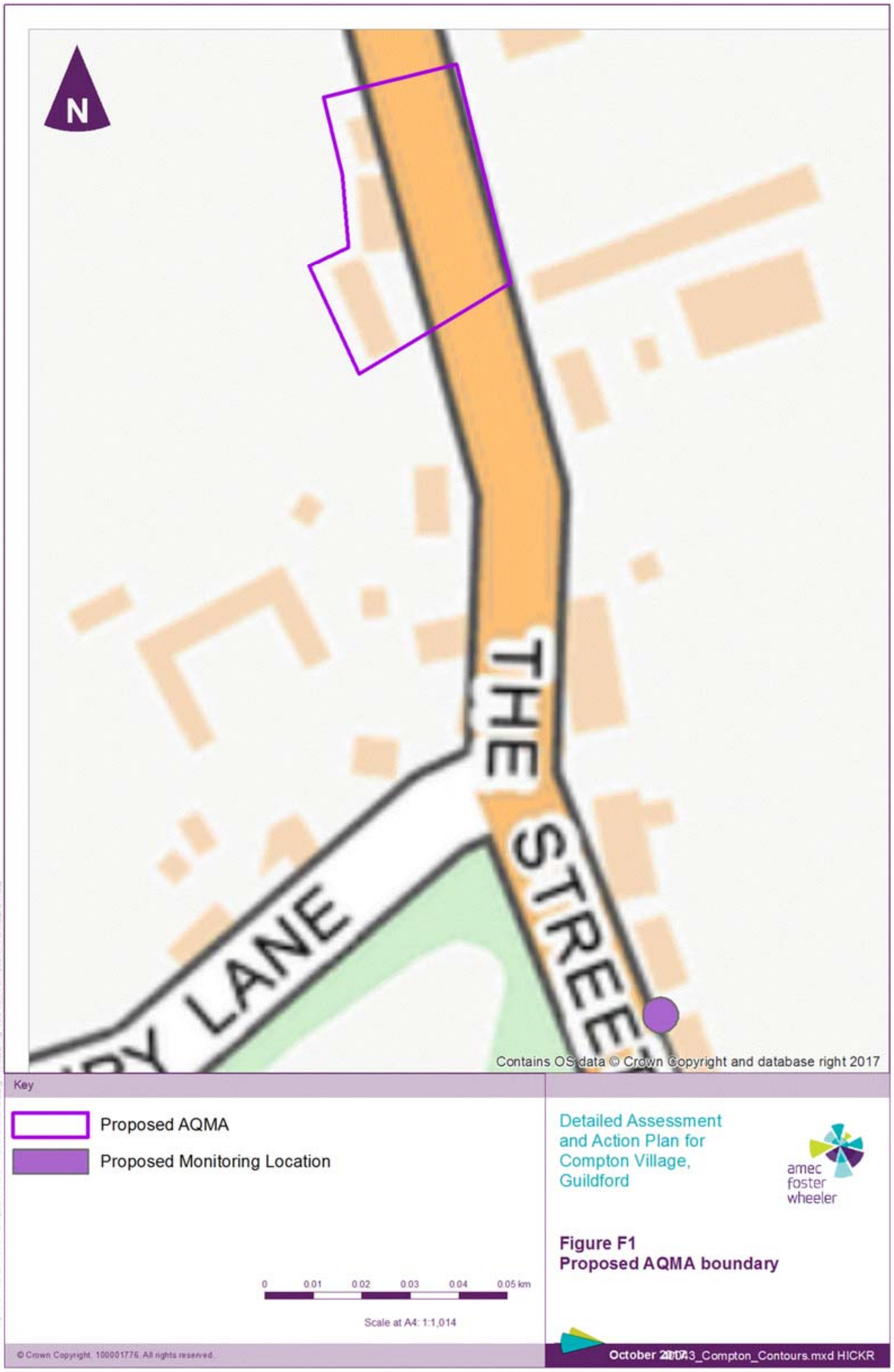
Pollutant	Pre-Annualisation	Post-Annualisation
NO_2	47.0	58.1

© AMEC Environment & Infrastructure UK Ltd

Appendix F
Recommendations

© AMEC Environment & Infrastructure UK Limited

Figure F1 Proposed AQMA boundary



November 2017
Doc Ref. 40043rri2