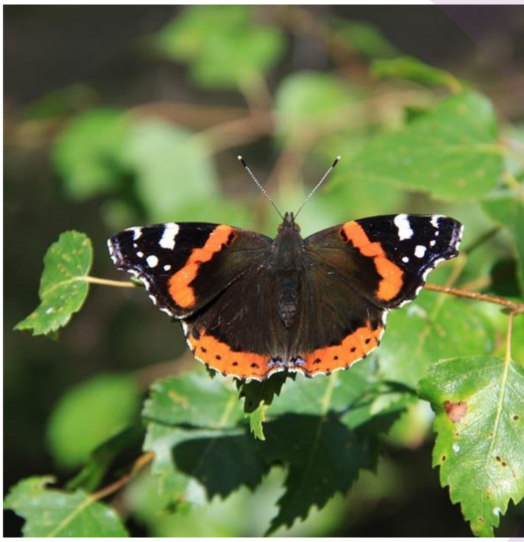
Mid Sussex District Council

Air quality modelling to inform the Site Allocations Development Plan Document

Stonepound Crossroads AQMA - Scenario 4 Results

Air Quality Assessment



Wood Environment & Infrastructure Solutions UK Limited – September 2019

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Document revisions

No.	Details	Date
1	Draft report	10/06/2019
2	Final report	04/09/2019

Executive summary

Purpose of this report

This report has been produced on behalf of Mid Sussex District Council (MSDC) to determine potential significant air quality impacts in Stonepound Crossroads Air Quality Management Area (AQMA) associated with the Scenario 4 site allocations, to inform the preparation of the MSDC Site Allocations Development Plan Document (DPD).

Transport modelling was carried out for eight different site allocation scenarios in total. However, only Scenarios 4, 7 and 8 were brought forward as potential site allocation options to be considered in terms of impact to air quality at Ashdown Forest and Stonepound Crossroads. The Scenarios modelled for air quality are as follows:

- Scenario 4 comprised 32 sites, plus a large site at Haywards Heath Golf Course (33 sites in total).
- Scenario 7 comprised 26 constant sites, plus a large site at Haywards Heath Golf Course (27 sites in total).
- Scenario 8 comprised 26 constant sites, plus four sites at Folders Lane, Burgess Hill (30 sites in total).

More detailed information on the three MSDC site allocation scenarios modelled (Scenarios 4, 7 and 8) are provided in the Transport Assessment[1].

This air quality assessment considers the Scenario 4 site allocations in terms of the impact to air quality in the Stonepound Crossroads AQMA. The impacts of the Scenario 4 site allocations on air quality at Ashdown Forest are included in a separate HRA[2]. Similarly, impacts of the Scenarios 7 and 8 site allocations on air quality at Ashdown Forest and Stonepound Crossroads are included in separate HRA[3] and air quality assessment[4].

ADMS-Roads dispersion model has been used to model the dispersion of pollutants from traffic emissions at residential receptors within and near the AQMA. Concentrations of NO_2 were predicted without and with traffic flows associated with MSDC site allocations, including consideration of in-combination traffic flows from adjoining local authorities' development plans.

It should be noted that a conservative approach has been adopted throughout, including the assumption that background concentrations will not improve in future years.

With the Scenario 4 operational, which includes the MSDC site allocations together with in-combination traffic flows from adjoining local authorities' development plans, the main findings of the assessment include:

NO_2 annual mean concentrations are predicted to be well below the annual mean AQO of 40 μgm^{-3} at all modelled sensitive receptor locations;

[1] Systra (2019) Mid Sussex Transport Study.
[2] Wood (2019) Air quality modelling to inform Mid Sussex District Council Site Allocations Development Plan Document – Scenarios 4 results.
[3] Wood (2019) Air quality modelling to inform Mid Sussex District Council Site Allocations Development Plan Document – Scenarios 7 and 8 results
[4] Wood (2019) Stonepound Crossroads AQMA – Site Allocations Development Plan Document – Scenarios 7 and 8 results.

The largest predicted NO_2 annual mean concentration at a residential receptor is 31.3 μgm^{-3} and the largest predicted increase in NO_2 annual mean concentration is 3.1 μgm^{-3};

Under Table 6.3 of the IAQM/EPUK guidance[15], three receptors will experience a 'slight adverse impact', one receptor will experience a 'moderate adverse impact' and all other receptors will experience a negligible impact;

Considering that NO_2 concentrations are predicted to be well below the annual mean AQO at all modelled sensitive receptor locations, and that a conservative approach has been adopted by assuming that background concentrations will not improve in future years, the air quality effects of Scenario 4 on sensitive receptors within the AQMA are considered to be not significant.

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Contents

1. Introduction

Wood Environment and Infrastructure Solutions Ltd. ('Wood') has undertaken an air quality assessment on behalf of Mid Sussex District Council (MSDC) to inform the preparation of the MSDC Site Allocations Development Plan Document (DPD). The housing requirement for the MSDC District Plan has been agreed at 876 dwellings per annum (dpa) up to 2023/2024, and 1090 dpa to 2031 thereafter subject to further Habitats Regulations Assessment work.

Transport modelling was carried out for eight different site allocation scenarios in total. However, only Scenarios 4, 7 and 8 were brought forward as potential site allocation options to be considered in terms of impact to air quality at Ashdown Forest and Stonepound Crossroads. The Scenarios modelled for air quality are as follows:

- Scenario 4 comprised 32 sites, plus a large site at Haywards Heath Golf Course (33 sites in total).
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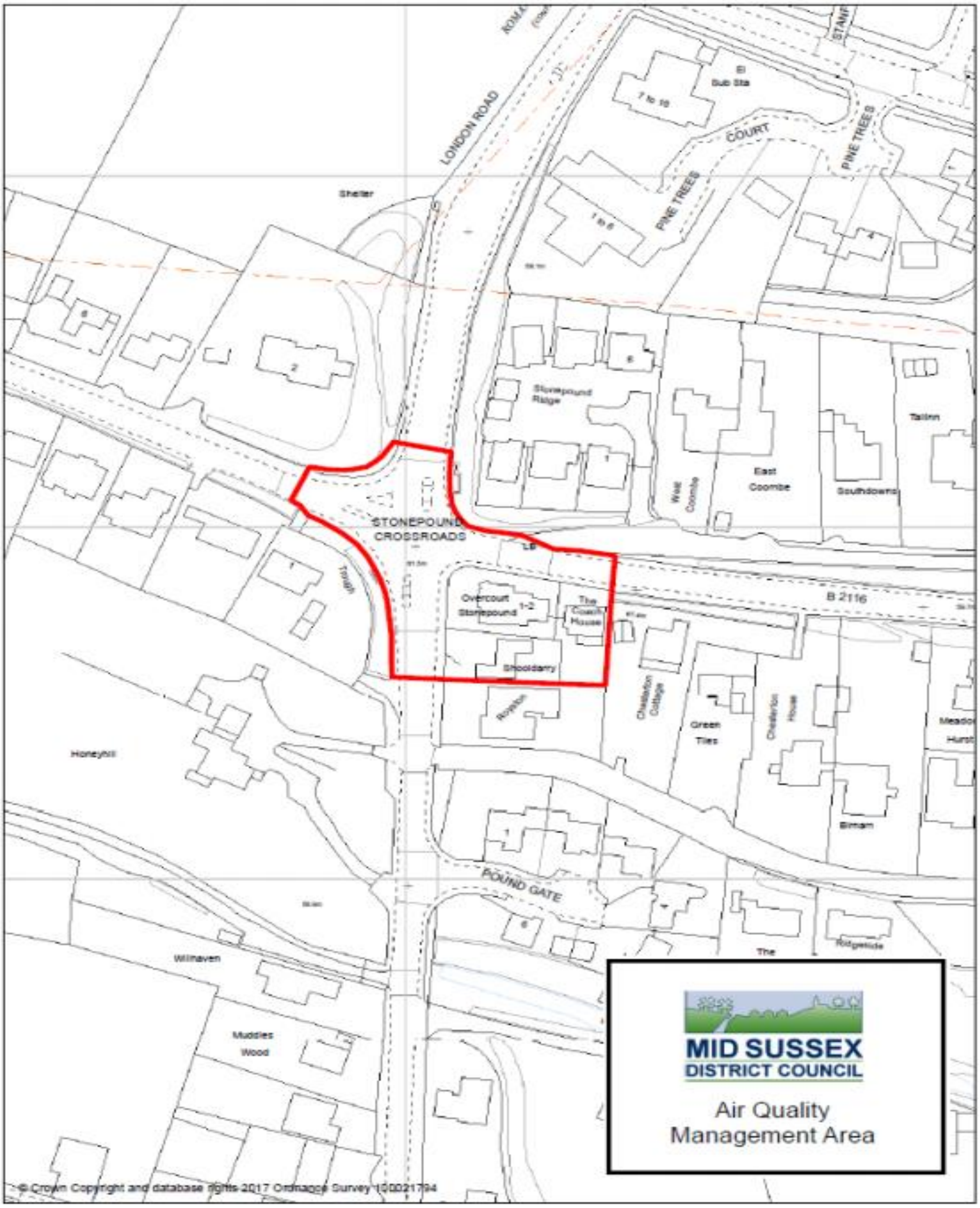
More detailed information on the three MSDC site allocation scenarios modelled (Scenarios 4, 7 and 8) are provided in the Transport Assessment[5].

This air quality assessment considers the Scenario 4 site allocations in terms of the impact to air quality in the Stonepound Crossroads AQMA. The impacts of the Scenario 4 site allocations on air quality at Ashdown Forest are included in a separate HRA[2]. Similarly, impacts of the Scenarios 7 and 8 site allocations on air quality at Ashdown Forest and Stonepound Crossroads are included in separate HRA[3] and air quality assessment[4].

Figure 1.1 shows the location of the Stonepound Crossroads AQMA in Hassocks.

[5] Systra (2019) Mid Sussex Transport Study.

Figure 1.1 Stonepound Crossroads AQMA location



2. Policy and Legislative Context

2.1 Relevant policy

Table 2.1 provides a summary of the key topic-specific policies which have informed the scope of the assessment and are relevant to the assessment of the effects on air quality.

Table 2.1 Policy issues relevant to air quality assessment

Policy reference	Policy issues
National Policy	
National Planning Practice Guidance (NPPG) March 2014[6]	It is stated in the NPPG (Paragraph: 005 Reference ID: 32-005-20140306) that air quality is relevant to planning applications when the development could "Expose people to existing sources of air pollutants. This could be by building new homes, workplaces or other development in places with poor air quality."
National Planning Policy Framework (NPPF) February 2019[7]	Paragraph 181 of the NPPF states that "Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas" and "Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan".

2.2 Relevant legislation

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[8] that sets the Air Quality Objectives (AQOs).

The EU Limit Values are set by the European directive on air quality and cleaner air for Europe (2008/50/EC)[9] and the European directive relating to arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons in ambient air (2004/107/EC)[10] 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[11], which came into force in the UK on 11 June 2010, replacing the Air Quality Standards Regulations 2007[12]. 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

[6] Ministry of Housing, Communities and Local Government (2014) National Planning Practice Guidance – Air quality
[7] Ministry of Housing, Communities and Local Government (2019) National Planning Policy Framework
[8] 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.
[9] 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.
[10] 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.
[11] The Stationery Office Limited (2010) Statutory Instrument 2010 No. 1001 Environmental Protection – The Air Quality Standards Regulation 2010.
[12] The Stationery Office Limited (2007) Statutory Instrument 2010 No. 64 Environmental Protection – The Air Quality Standards Regulation 2007.

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[13] came into force, local authorities have been required periodically to 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 process of Local Air Quality Management (LAQM) 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 Air Quality Action Plan (AQAP) to reduce air pollution levels towards the AQOs. The latest guidance on the LAQM process is given in Defra's 2016 Local Air Quality Management Technical Guidance (LAQM TG (16))[14].

The UK Government and the Devolved Administrations have set national AQOs for particulate matter smaller than 2.5 µm in diameter ($PM_{2.5}$). These objectives have not been incorporated into the LAQM Regime, and authorities have no statutory obligation to review and assess air quality against them.

Emissions of nitrogen oxides (NO_X), have been modelled in this assessment in order to assess concentrations of NO_2, as this is the pollutant relevant to the Stonepound Crossroads AQMA. The 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. Table 2.2 sets out the AQOs that are relevant to this assessment, and the dates by which they are to be achieved.

Table 2.2 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

The likelihood of exceeding the NO_2 and PM_{10} short-term AQOs can be assessed with reference to the predicted annual means and the relationships recommended by LAQM.TG(16):

The 1-hour mean NO_2 objective is unlikely to be exceeded[14] if the annual mean is less than 60 μgm^{-3}.

2.3 Relevant guidance

The Institute of Air Quality Management (IAQM) and Environmental Protection UK (EPUK)

The IAQM and Environmental Protection UK (EPUK) has produced guidance[15] regarding the assessment of air quality issues within planning applications, which includes a summary of relevant legislation and the assessment of significance. Using this guidance, the magnitude of change due to an increase/decrease in the

[13] HMSO (1995) Environment Act 1995.
[14] Defra (2016) Local Air Quality Management Technical Guidance LAQM.TG (16).
[15] IAQM and EPUK (2017) Land-Use Planning & Development Control: Planning For Air Quality

annual mean concentration of NO_2 and PM_{10} and other pollutants due to the development is described using specified criteria. The overall significance of the development is then determined using professional judgement.

3. Scope of the assessment

The Stonepound Crossroads AQMA was declared in 2012 due to high levels of NO_2 (annual mean) for which source apportionment showed that traffic sources were the main contributor. Therefore, the potential impact of an increase in traffic flows due to the housing requirement outlined in the Mid Sussex District Plan is an important consideration. NO_2, PM_{10} and $PM_{2.5}$ are the pollutants most associated with traffic emissions. As an AQMA was declared for NO_2 concentration and PM_{10} and $PM_{2.5}$ are comfortably within the related AQS, the assessment focuses on NO_2 only.

3.1 Public exposure

Guidance from the UK Government and Devolved Administrations makes clear that exceedance 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 3.1 which provides an indication of those locations that may or may not be relevant for each averaging period.

Table 3.1 Relevant locations of exposure

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.	

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.

3.2 Receptor locations

Eleven local receptors have been identified, focusing on residential properties within and near the Stonepound Crossroads AQMA, alongside roads potentially affected by the development. These receptors represent 'worst-case' locations where people are likely to be regularly exposed (i.e. where the annual mean objective is applicable).

Pollutant concentrations have been predicted at existing building façades within and near the AQMA boundary. Pollutant concentrations have also been predicted at five diffusion tubes located within and near the AQMA for the model verification purpose.

A height of 1.5m was used for the residential receptors to represent an average human inhalation height. Table 3.2 and

Figure 3.1 shows the proposed and existing receptor locations.

Table 3.2 Modelled receptors and diffusion tubes locations

Receptor	Receptor Type	X (m)	Y (m)	Height (m)
R1	Residential	529920	115514	1.5
R2	Residential	529920	115532	1.5
R3	Residential	529882	115540	1.5
R4	Residential	529919	115484	1.5
R5	Residential	529918	115443	1.5
R6	Residential	529943	115476	1.5
R7	Residential	529949	115511	1.5
R8	Residential	529878	115487	1.5
R9	Residential	529823	115518	1.5
R10	Residential	529829	115547	1.5
R11	Residential	529864	115429	1.5
MSAQ10	Diffusion tube	529917	115489	1.7
MSAQ11	Diffusion tube	529930	115481	2.5
MSAQ16	Diffusion tube	529918	115441	2.4
MSAQ18	Diffusion tube	529907	115428	2.5
MSAQ23	Diffusion tube	529935	115478	2

Figure 3.1 Modelled receptors and diffusion tubes locations

4. Assessment methodology

4.1 Dispersion modelling methodology

The dispersion model

ADMS-Roads (v4.1) has been used to predict annual mean and daily mean concentrations of NO_2 at modelled residential receptor locations. Full details of the ADMS-Roads model used are 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 7.1 developed for LAQM purposes[16].

The modelling assessment requires source, emissions, meteorological and other site-specific data. For modelling traffic impacts, one year of hourly sequential meteorological data is used and model verification is carried out following Defra guidance[17].

Model Scenarios

The modelled scenarios include:

- Model verification: using 2017 background concentrations, emissions factors, monitoring data, and traffic flows (which is the year in which the traffic counts were carried out and the baseline traffic model is validated for);
- 2017 Baseline: using 2017 background concentrations, emissions factors and traffic flows;
- Reference Case 4: 2031 Baseline + in-combination – using 2017 background concentrations, 2030 emission factors and predicted traffic flows; and
- Scenario 4: 2031 Baseline + in-combination + MSDC impact – using 2017 background concentrations, 2030 emissions factors and predicted traffic flows.

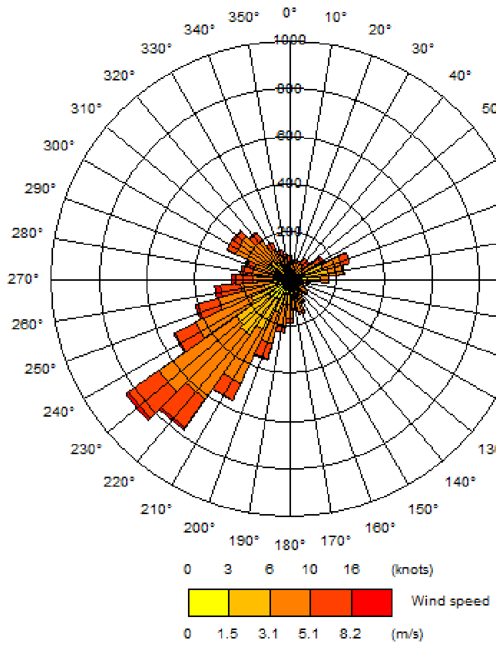
Meteorology

Detailed dispersion modelling requires hourly sequential meteorological data from a representative synoptic observing station. Hourly sequential meteorological data was obtained for the year 2017 for Gatwick Airport, which is considered to provide representative data for the area of interest.

Figure 4.1 summarises the hourly wind speed and direction for the meteorological data used in this assessment.

[16] AEA Technology (2019). *NO_x to NO_2 Calculator version 7.1*. http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc
[17] Defra (2016) Local Air Quality Management Technical Guidance (LAQM.TG(16)).

Figure 4.1 Windrose for Gatwick Airport (2017)



Surface roughness

Surface roughness is determined based on land use within the assessment are and at the appropriate weather station. For this assessment, a surface roughness of 0.5 m was selected for the assessment area and a surface roughness of 0.2 m was used for Gatwick Airport Weather Station[18].

Traffic data

Systra developed the Mid Sussex Strategic Highway Model (MSSHM) in line with Department for Transport WebTAG guidelines. The 2017 Base Year Highway Model has been validated in line with the Department for Transport's WebTAG guidance. The modelling is considered to be reliable and accurate for the purposes of the Transport Study, as well as an input for air quality modelling purposes. Annual Average Daily Traffic (AADT) flows for 2031 were provided by Systra, Transport Consultants for the project based on traffic counts outlined in the model validation report[19] and Scenario 4 Note[20]. Traffic data for modelled links are provided in Appendix B.

Queuing traffic

As information regarding queuing traffic at the junction was provided, emission from queuing traffic was also included in the assessment. Queue lengths were estimated using the expected number of vehicles in the queues and an assumption of vehicle length (4m for a car). Queuing vehicles were modelled at the lowest possible speed in ADMS-Roads, 5 kph. To account for the variation in queueing traffic throughout the day, a time-varying (*.fac*) file that modelled queuing traffic between 0600 and 2000 was applied to the model. Estimates queue lengths were provided by Systra[21]. The length of the queue links modelled were as follows:

2017: 40m; and

2031: 100m.

[18] Gatwick Airport (2014) A Second Runway for Gatwick.
[19] Systra (2018) Local Model Validation Report – Mid Sussex Strategic Highway Model - Draft.
[20] Systra (2019) Mid Sussex strategic Highway Model: Scenario 4 Note.
[21] Systra (2018) Email dated 18/12/2018.

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_X and NO_2, using data for a base year of 2017, making projections for years from 2017 to 2030 inclusive[22]. Interpolation was carried out using ArcGIS to provide a better representation of background concentration at each receptor point.

Due to uncertainty in future predicted concentrations, background concentrations for 2017 will be used in all modelled scenarios.

Table 4.1 shows the estimated background concentrations of NO_2 for 2017 for the receptor modelled.

Table 4.1 Defra mapped interpolated background annual mean NO_2 concentrations (µgm^{-3}) for 2017

Receptors modelled	NO_2 concentrations (µgm^{-3})
R1	10.2
R2	10.2
R3	10.2
R4	10.2
R5	10.2
R6	10.3
R7	10.3
R8	10.2
R9	10.2
R10	10.2
R11	10.2
MSAQ10	10.2
MSAQ11	10.3
MSAQ16	10.2
MSAQ18	10.2
MSAQ23	10.3

Model verification

Model verification is a process by which modelled concentrations of air pollutants from road traffic emissions are adjusted based on actual measurement data. It 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, as well as uncertainty associated with the emission factors. Defra has provided guidance in terms of preferred methods for undertaking dispersion model verification in

[22] https://uk-air.defra.gov.uk/data/laqm-background-home

LAQM.TG(16). Model verification involves the comparison of modelled concentrations and local monitoring data.

Suitable local monitoring data for the purpose of verification is available for annual mean NO_X/NO_2 concentrations as shown in Table C1 below. Monitoring sites MSAQ10, MSAQ11, MSAQ16, MSAQ18 and MSAQ23 were used for verification purposes as they are located on modelled roads for this assessment. Diffusion tube MSAQ24 was not used in the verification. The tube is located behind a hedge, which is likely to affect dispersion in a way that cannot be replicated by the model.

Full details of the model verification procedure are provided in Appendix C. In summary, the verification process led to the use of a modelled Road-NO_X adjustment factor of 1.495.

Emissions calculations of oxides of nitrogen (NO_X)

Air Quality Consultants' Calculator Using Realistic Emissions for Diesels[23] (CURED V3A) was used to predict emissions to import into ADMS-Roads. This tool was originally developed to overcome the disparity between future emissions factors predicted using Defra's Emissions factor Toolkit (EFT) and real-world emissions testing and is considered to be a more conservative approach. Road-NO_X concentrations were adjusted using the above factor.

[23] Air Quality Consultants (2018) Calculator Using Realistic Emissions for Diesels (CURED V3A) http://www.aqconsultants.co.uk/News/January-2018/UPDATED-CURED-TO-V3A.aspx

5. Baseline air quality

MSDC carry out monitoring as part of their LAQM duties within and near Stonepound Crossroads AQMA. Data was taken from MSDC latest available Annual Status Report (ASR)[24], published in 2018 and including monitoring data for up to 2017 in order to be aligned with the traffic data base year.

The 2018 ASR states that the main source of air pollution in the district is road traffic emissions mostly from major roads, notably the increased use by HGV traffic on the A2300 link from the A23 and the A273 north and south of Hassocks. Air quality monitoring and modelling carried out by MSDC indicated that despite good air quality within most of the District, the NO_2 AQO were not being met in the Stonepound Crossroads area of Hassocks. Therefore, in March 2012 an AQMA was declared at Stonepound Crossroads in Hassocks. Within the AQMA the main pollutant (NO_2) is from road traffic emissions. Exceedances are due to the topography and volume of road traffic Monitoring results in 2017 show a decrease in NO_2 levels across the district compared to those recorded in 2016. The long-term trend, despite an increase in 2016, appears to be downwards.

5.1 Nitrogen dioxide monitoring

Diffusion tubes were deployed by Mid Sussex District Council at a number of locations within and near the AQMA. Table 5.1 includes those tubes where location data is available and that are located near Stonepound Crossroads AQMA, as reported in the MSDC 2018 ASR. Figure 5.1 shows the location of monitors included in this section.

Table 5.1 Diffusion tube located near the AQMA[24]

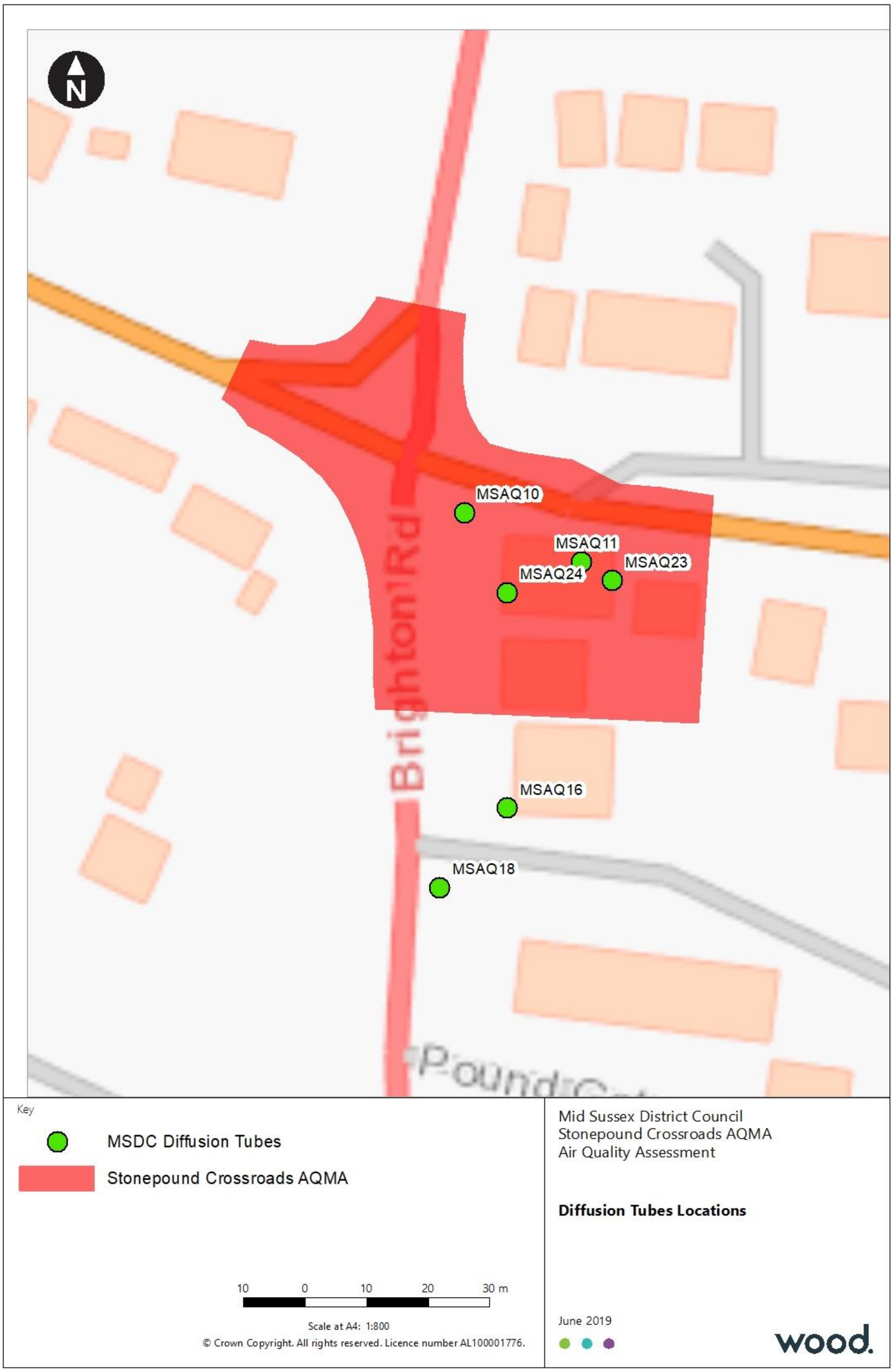
				Monitored annual mean concentration of NO_2 (μgm^{-3})				
Monitor ID	**X (m)**	**Y (m)**	**Distance from road (m)**	**2013**	**2014**	**2015**	**2016**	**2017**
MSAQ10	529911	115489	1.5	**48.2**	**41.1**	**40.4**	**43.4**	38.8
MSAQ11	529930	115481	5.5	**43.4**	**42.7**	**40.5**	**43.2**	38.5
MSAQ16	529918	115441	11.5	24.4	20.4	19.2	20.7	19.8
MSAQ18	529907	115428	2.0	35.2	33.3	32.2	33.4	29.5
MSAQ23	529935	115478	5.8	35.4	33.3	31.8	35.3	33.9
MSAQ24	529918	115476	7.5	28.7	22.5	22.5	28.3	23.1

Exceedances of the NO_2 annual mean objective of 40µg/m^3 are shown in **bold**.

The above diffusion tubes were all used in the model verification, except MSAQ24. The tube is located behind a hedge, which is likely to affect dispersion in a way that cannot be replicated by the model. Full details are included in Appendix C.

[24] Mid Sussex District Council, 2018 Annual Status Report (ASR), July 2018.

Figure 5.1 Diffusion tubes located near the AQMA



6. Results

6.1 Assessment of nitrogen dioxide impacts

Table 6.1 presents the annual mean NO_2 concentrations predicted for the 2017 baseline, the 2031 Reference Case 4 and the 2031 Scenario 4. In 2031, all concentrations are predicted to be below the AQO of 40 μgm^{-3} for NO_2 in both scenarios. The 1-hour mean NO_2 objective is unlikely to be exceeded as the annual mean is less than 60 μgm^{-3} at all modelled receptor locations.

The highest annual mean concentration predicted for the Scenario 4 is 31.3 μgm^{-3} at residential receptor R1 located to the northeast of the Stonepound Crossroads which is well below the AQO of 40 μgm^{-3}, however under IAQM/EPUK guidance[15], the increase of 1.6 μgm^{-3} (or 4%) in concentration represents a slight adverse impact.

The largest predicted increase in NO_2 annual mean concentration at a residential receptor is 3.1 μgm^{-3} at residential receptor R2 located to the northeast of the junction. Under IAQM/EPUK guidance[15] this represents a moderate adverse impact.

The IAQM/EPUK guidance[15] recommends evaluating the magnitude of impacts at individual receptors using Table 6.3 of the guidance. Impacts can be 'negligible', 'slight', 'moderate' or 'substantial'. The methodology is based on assessing the annual mean concentration at the receptor against the change in concentration relative to the annual mean AQO.

Based on Table 6.3 of the guidance,with Scenario 4 operational in 2031, residential receptors R1, R3, R10 are predicted to experience a 'slight adverse impact', residential receptor R2 a 'moderate adverse impact' and all other receptors a 'negligible impact'.

6.2 Significance of Effects

As recommended by the IAQM Guidance "Planning for Air Quality", the judgement on significance relates to the consequences of the impacts and whether they are expected to have an effect on human health that could be considered significant.

With the Scenario 4 operational, which includes the MSDC site allocations together with in-combination traffic flows from adjoining local authorities' development plans, NO_2 annual mean concentrations are predicted to be well below the annual mean AQO of 40 μgm^{-3} at all modelled sensitive receptor locations with a maximum predicted concentration of 31.3 μgm^{-3}.

Because only one receptor is predicted to experience a 'moderate adverse impact' in terms of IAQM guidance (Table 6.3) with a concentration well below the annual mean AQO, the overall effect at residential properties within and near Stonepound Crossroads AQMA of the proposed developments for all three scenarios is judged to be not significant.

Based on the result of the assessment no mitigation measures are deemed necessary

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Table 6.1 Model predicted annual mean NO_2 concentrations (μgm^{-3})

Receptors	2017 Baseline (μgm^{-3})	Reference Case 4 – 2031 (μgm^{-3})	Scenario 4 – 2031 (μgm^{-3})	Difference (μgm^{-3})	Change (%)	Assessment Concentration in percentage of AQS (%)	Impact[15]
R1	**40.5**	29.7	31.3	1.6	4%	78%	Slight Adverse
R2	37.7	27.8	30.9	3.1	8%	77%	Moderate Adverse
R3	26.5	20.6	23.4	2.8	7%	58%	Slight Adverse
R4	37.1	27.7	28.5	0.8	2%	71%	Negligible
R5	25.0	20.7	21.8	1.1	3%	54%	Negligible
R6	25.2	20.1	21.1	1.0	2%	53%	Negligible
R7	26.2	20.6	22.0	1.4	3%	55%	Negligible
R8	23.6	18.6	19.2	0.7	2%	48%	Negligible
R9	18.1	15.4	17.4	2.0	5%	44%	Negligible
R10	22.0	18.8	21.8	2.9	7%	54%	Slight Adverse
R11	14.0	12.8	13.0	0.2	1%	32%	Negligible
MSAQ10	**43.4**	31.9	32.3	0.4	1%	81%	Negligible
MSAQ11	27.0	21.2	22.1	0.8	2%	55%	Negligible
MSAQ16	22.1	18.7	19.5	0.8	2%	49%	Negligible
MSAQ18	25.1	22.3	23.8	1.5	4%	60%	Negligible
MSAQ23	26.3	20.8	21.7	0.9	2%	54%	Negligible

Notes: **Bold** denotes exceedance of the 40 μgm^{-3} annual mean NO_2 AQO.

7. Conclusions

Wood Environment and Infrastructure Solutions Ltd. (Wood) has prepared an air quality assessment on behalf of Mid Sussex District Council (MSDC) for preparation of the MSDC Site Allocations Development Plan Document. This assessment is based on Scenario 4 site allocations and considers the potential air quality impact in Stonepound Crossroads AQMA in Hassocks.

ADMS-Roads dispersion model has been used to model pollutants from traffic emissions in Stonepound Crossroads AQMA. Concentrations of NO_2 were predicted without and with traffic flows associated with the MSDC Scenario 4 site allocations, including consideration of in-combination traffic flows from adjoining local authorities' development plans. It should be noted that a conservative approach has been adopted throughout, including the use of baseline year background concentrations.

With the Scenario 4 operational, which includes the MSDC site allocations together with in-combination traffic flows from adjoining local authorities' development plans, the main findings of the assessment include:

NO_2 annual mean concentrations are predicted to be well below the annual mean AQO of 40 μgm^{-3} at all modelled sensitive receptor locations.

The largest predicted NO_2 annual mean concentration at a residential receptor is 31.3 μgm^{-3} and the largest predicted increase in NO_2 annual mean concentration is 3.1 μgm^{-3};

Under Table 6.3 of the IAQM/EPUK guidance[15], three receptors will experience a 'slight adverse impact', one receptor will experience a 'moderate adverse impact' and all other receptors will experience a negligible impact.

Considering that NO_2 concentrations are predicted to be well below the annual mean AQO at all modelled sensitive receptor locations, and that a conservative approach has been adopted by assuming that background concentrations will not improve in future years, the air quality effects of Scenario 4 on sensitive receptors within the AQMA are considered to be not significant.

Appendix A ADMS-Roads dispersion 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[25]. 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;

[25] 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 a small number of buildings on dispersion from point sources;
- 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_Em^{-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, street canyons, noise barriers, buildings and complex terrain were not modelled.

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[26]. 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[27] and all of Greater London for a Defra model inter-comparison exercise[28].

[26] http://www.cerc.co.uk/environmental-software/model-documentation.html#validation Date of access: 19 October 2012

[27] 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

[28] 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

Appendix B Modelled Roads

Tables B1 shows the traffic data supplied by Systra based on traffic surveys. Data includes AADT, the proportion of Heavy Goods Vehicles (HGV), and speeds averaged over AM and PM peak hours.

Table B2 shows the road names and their relevant link index numbers as provided by Systra. Each road modelled was split into two links to account for a lower speed (5kph) approaching a junction.

Queuing traffic was also included in the model and the queuing road links are included in Table B1 and B2.

The roads modelled are represented in Figure B1, and the road links modelled to represent queuing are represented in Figure B2.

Table B1 ADMS-Roads input data

Source ID	2017 Baseline			2031 Reference Case 4			2031 Scenario 4		
	AADT	%HDV	Speed (kph)	AADT	%HDV	Speed (kph)	AADT	%HDV	Speed (kph)
1.1	6096	2.2	32.0	6697	2.0	32.0	7239	1.8	5.0
1.2	6096	2.2	5.0	6697	2.0	5.0	7239	1.8	5.0
2.1	6626	7.0	12.1	7574	6.1	7.2	7468	6.2	10.0
2.2	6626	7.0	5.0	7574	6.1	5.0	7468	6.2	10.0
3.1	9620	3.6	32.0	12367	2.8	30.2	13171	2.7	5.0
3.2	9620	3.6	5.0	12367	2.8	5.0	13171	2.7	5.0
4.1	7160	2.7	4.7	7559	2.2	3.1	8469	1.9	5.0
4.2	7160	2.7	5.0	7559	2.2	5.0	8469	1.9	5.0
5.1	6107	1.5	22.2	6857	1.5	17.4	7835	1.5	16.4
5.2	6107	1.5	5.0	6857	1.5	5.0	7835	1.5	16.4
6.1	7026	4.0	31.4	5863	4.4	31.4	6232	4.0	5.0
6.2	7026	4.0	5.0	5863	4.4	5.0	6232	4.0	5.0
7.1	3066	2.2	31.6	3708	2.2	31.6	3923	2.1	5.0
7.2	3066	2.2	5.0	3708	2.2	5.0	3923	2.1	5.0
8.1	5781	1.5	11.6	6373	1.5	7.7	6484	1.4	7.4
8.2	5781	1.5	5.0	6373	1.5	5.0	6484	1.4	7.4
2Q	6626	7.0	5.0	7574	6.1	5.0	7468	6.2	10.0
8Q	5781	1.5	5.0	6373	1.5	5.0	6484	1.4	7.4
4Q	7160	2.7	5.0	7559	2.2	5.0	8469	1.9	5.0
5Q	6107	1.5	5.0	6857	1.5	5.0	7835	1.5	16.4

Table B2 Roads parameters

ADMS Source ID	Road name	Link Index
1.1	A273 Brighton Road (southbound)	21102_12814
1.2	A273 Brighton Road (southbound)	21102_12814
2.1	A273 Brighton Road junction approach (northbound)	12814_21102
2.2	A273 Brighton Road junction approach (northbound)	12814_21102
3.1	A273 London Road (northbound)	21102_21117
3.2	A273 London Road (northbound)	21102_21117
4.1	A273 London Road junction approach (southbound)	21117_21102
4.2	A273 London Road junction approach (southbound)	21117_21102
5.1	Hurst Road junction approach (eastbound)	21224_21102
5.2	Hurst Road junction approach (eastbound)	21224_21102
6.1	Hurst Road (westbound)	21102_21224
6.2	Hurst Road (westbound)	21102_21224
7.1	Keymer Road (eastbound)	21102_21230
7.2	Keymer Road (eastbound)	21102_21230
8.1	Keymer Road junction approach (westbound)	21230_21102
8.2	Keymer Road junction approach (westbound)	21230_21102
2Q	A273 Brighton Road junction approach (northbound)	12814_21102
8Q	Keymer Road junction approach (westbound)	21230_21102
4Q	A273 London Road junction approach (southbound)	21117_21102
5Q	Hurst Road junction approach (eastbound)	21224_21102

Figure B1 ADMS-Roads input data

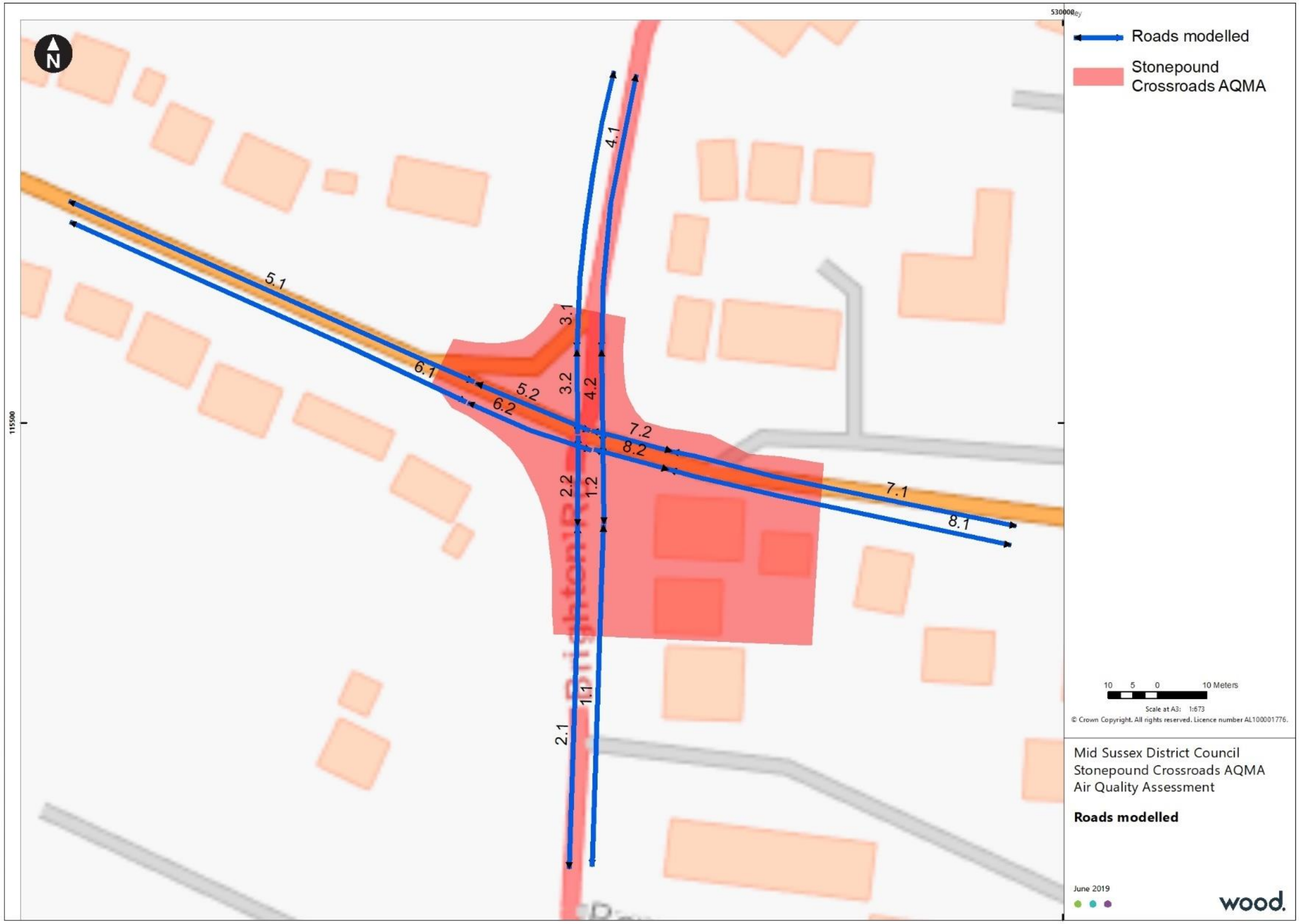

Figure B2 Road links modelled to account for queuing in 2017 (top) and 2031 (bottom).

Appendix C Model Verification

The ADMS-Roads dispersion model has been widely validated for this type of assessment and is specifically listed in Defra's LAQM.TG(16)[14] guidance as an accepted dispersion model.

It is 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.

Suitable local monitoring data for the purpose of verification is available for annual mean NO_X/NO_2 concentrations as shown in Table C1 below. Monitoring sites MSAQ10, MSAQ11, MSAQ16, MSAQ18 and MSAQ23 were used for verification purposes as they are located on modelled roads for this assessment. Diffusion tube MSAQ24 was not used in the verification. The tube is located behind a hedge, which is likely to affect dispersion in a way that cannot be replicated by the model.

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

Location	2017 Annual Mean NO_2 (μgm^{-3})	X (m)	Y (m)
MSAQ10	38.8	529917*	115489*
MSAQ11	38.5	529930	115481
MSAQ16	19.8	529918	115441
MSAQ18	29.5	529907	115428
MSAQ23	33.9	529935	115478

*Coordinates for MSAQ10 cited in MSDC 2018 ASR were "529911, 115489". They were adjusted to "529917, 115489" after verification of the exact location using Google Street View [29].

Verification Calculations

The verification of the modelling output was performed in accordance with the methodology provided in Box 7.16 of LAQM.TG(16)[14]. Table C2 shows that the model was under-predicting NO_2 annual concentrations at the monitoring sites.

Table C2 Verification, modelled versus monitored

Site	2017 Unadjusted Modelled Annual Mean NO_2 (μgm^{-3})	2017 Monitored Annual Mean NO_2 (μgm^{-3})	% (Unadjusted Modelled-Monitored)/ Monitored
MSAQ10	35.6	38.8	-8%
MSAQ11	22.8	38.5	-41%
MSAQ16	19.0	19.8	-4%
MSAQ18	21.4	29.5	-28%
MSAQ23	22.3	33.9	-34%

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 (Diffusion Tube calculator tab).

[29] https://www.google.co.uk/maps

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

Site	2017 Unadjusted Modelled Annual Mean Road NO_X (μgm^{-3})	2017 Monitored Annual Mean Road NO_X (μgm^{-3})	Ratio
MSAQ10	51.9	60.0	1.2
MSAQ11	24.2	59.2	2.4
MSAQ16	16.7	18.3	1.1
MSAQ18	21.3	38.6	1.8
MSAQ23	23.0	48.4	2.1

Table C4 shows the comparison of the modelled NO_2 concentration calculated by multiplying the modelled road NO_X by the average adjustment factor of 1.495 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

Site	2017 Background NO_2 Concentration	2017 Adjusted Modelled Annual Mean NO_2 (μgm^{-3})	2017 Monitored Annual Mean NO_2 (μgm^{-3})	% (Adjusted Modelled-Monitored)/ Monitored
MSAQ10	10.2	43.4	38.8	12%
MSAQ11	10.3	27.0	38.5	-30%
MSAQ16	10.2	22.1	19.8	11%
MSAQ18	10.2	25.1	29.5	-15%
MSAQ23	10.3	26.3	33.9	-23%

The majority of modelled NO_2 concentrations are within 25% of monitored concentrations as specified by LAQM.TG(16), which is considered acceptable given the high number of monitoring sites used in verification and broad area covered, therefore NO_2 concentrations have been amended using this adjustment factor of 1.495.

Model uncertainty

In line with LAQM.TG(16) , statistical procedures have been carried out to assess the uncertainties within the model as shown in Table C5.

Table C5 Assessment of model uncertainty

Statistical parameter	Ideal value	Calculated value	Comment
Correlation coefficient	1	0.7	Model shows a relationship between monitored and modelled concentrations.
Root mean square error (RMSE)	0	6.9	Within the 10 μgm^{-3} value indicated by LAQM.TG(16) to revisit model inputs and verification, so no further action taken.
Fractional bias	0	0.1	Model shows no overall tendency to over or under predict after adjustment