



Air Quality Assessment: Roundstone Lane, Angmering, West Sussex.

July 2012



Experts in air quality
management & assessment

Document Control

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1 Introduction

- 1.1 This report describes the potential air quality impacts associated with the proposed development on Roundstone Lane, Angmering, in West Sussex. The assessment has been carried out by Air Quality Consultants Ltd on behalf of Barratt David Wilson Southampton.
- 1.2 The proposed development consists of 150 residential dwellings. The development would lead to an increase in traffic on the local roads, which may impact on air quality at existing residential properties. The new residential properties will also be subject to the impact of road traffic emissions from the adjacent road network, and this has also been assessed. The main air pollutants of concern related to traffic emissions are nitrogen dioxide and fine particulate matter (PM₁₀ and PM_{2.5}).
- 1.3 This report describes existing local air quality conditions (2011), and the predicted air quality in the future assuming that the proposed development does, or does not proceed. The assessment of traffic-related impacts focuses on 2013, which is the anticipated year of opening.
- 1.4 This report has been prepared taking into account all relevant local and national guidance and regulations, and follows a methodology agreed with Arun District Council.

2 Policy Context and Assessment Criteria

Air Quality Strategy

- 2.1 The Air Quality Strategy published by the Department for Environment, Food, and Rural Affairs (Defra) provides the policy framework for air quality management and assessment in the UK. It provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment (Defra, 2007). It also sets out how the different sectors: industry, transport and local government, can contribute to achieving the air quality objectives. Local authorities are seen to play a particularly important role. The strategy describes the Local Air Quality Management (LAQM) regime that has been established, whereby every authority has to carry out regular reviews and assessments of air quality in its area to identify whether the objectives have been, or will be, achieved at relevant locations, by the applicable date. If this is not the case, the authority must declare an Air Quality Management Area (AQMA), and prepare an action plan which identifies appropriate measures that will be introduced in pursuit of the objectives.

Planning Policy

National Policies

- 2.2 The National Planning Policy Framework (NPPF) (National Planning Policy Framework, 2012) introduced in March 2012 now sets out planning policy for the UK in one place. It replaces previous Planning Policy Statements, including PPS23 on Planning and Pollution Control. The NPPF contains advice on when air quality should be a material consideration in development control decisions. Existing, and likely future, air quality should be taken into account, as well as the EU limit values or national objectives for pollutants, the presence of any AQMAs and the appropriateness of both the development for the site, and the site for the development.
- 2.3 The NPPF places a general presumption in favour of sustainable development, stressing the importance of local development plans, and states that the planning system should perform an environmental role to minimise pollution. One of the twelve core planning principles notes that planning should “*contribute to...reducing pollution*”. To prevent unacceptable risks from air pollution, planning decisions should ensure that new development is appropriate for its location. The NPPF states that the effects of pollution on health and the sensitivity of the area and the development should be taken into account.
- 2.4 The need for compliance with any statutory air quality limit values and objectives is stressed, and the presence of AQMAs must be accounted for in terms of the cumulative impacts on air quality from individual sites in local areas. New developments in AQMAs should be consistent with local air quality action plans.

Local Transport Plan

- 2.5 The West Sussex Transport Plan 2011-2026 (West Sussex County Council, 2011) includes Arun District Council. The Long Term Strategy 1.2.4 Improving Safety, Health and Security relates to air quality and states that:

“Our strategy will focus on delivering outcomes which... improve air quality and public health.

Reduce negative impacts of transport on public health by working with district and borough councils when AQMAs are declared to develop Air Quality Action Plans (AQAPs) which include engineering, monitoring and promotional activities.

Implementing actions in the AQAPs for new and existing AQMAs. Providing information for air quality monitoring and forecasting.”

- 2.6 According to the transport plan the key issues specifically relating to air quality in the Arun District are:

- Road congestion on busy parts of the highway which leads to poor air quality; and
- Managing AQMAs that may be declared by Arun District Council through development of AQAPs, while avoiding potential poor air quality areas in the first place by developing a Low Emission Strategy.

- 2.7 The Strategic Environmental Assessment which was produced as part of the Provisional Sustainability Appraisal (West Sussex County Council, 2010) of the transport plan included Objective 4 *“To reduce air pollution and ensure air quality continues to improve.”* Measures include the promotion and encouragement of sustainable travel choices, cleaner vehicles and reducing the dependence on private cars.

Local Policies

- 2.8 Changes to the planning legislation require the Council to replace the Development Plan with a Local Development Framework (LDF). The LDF is a portfolio of planning documents, individually known as Local Development Documents, which will deliver the spatial development strategy for the Arun District and build upon existing local and regional strategies and initiatives.

- 2.9 On the 9th July 2012 the Arun District Council Draft Local Plan (2013 – 2028) Consultation Document (Arun District Council, 2012) was released. Policy SP25 Quality of the Environment relates to air quality:

“The council requires that all development contributes positively to the quality of the environment and will ensure that development does not impact negatively upon....the natural environment....”

2.10 Policy DM47 refers specifically to air pollution and states:

“All major development proposals will be required to assess the likely impacts of the development on air quality and mitigate any negative impacts by:

- i) Ensuring the development is located within easy reach of established public transport routes;*
- ii) Maximising provision for cycling and pedestrian facilities;*
- iii) Encouraging the use of cleaner transport fuels on site, through the inclusion of electric car charging points; and*
- iv) Contributing towards the improvement of the highway network where development is predicted to result in increased congestion on the highway network.*

...Developments shall also be consistent with all other Local Plan Policies.”

Assessment Criteria

Health Criteria

2.11 The Government has established a set of air quality standards and objectives to protect human health. The ‘standards’ are set as concentrations below which effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of an individual pollutant. The ‘objectives’ set out the extent to which the Government expects the standards to be achieved by a certain date. They take account of economic efficiency, practicability, technical feasibility and timescale. The objectives for use by local authorities are prescribed within the Air Quality Regulations, 2000, Statutory Instrument 928 (2000) and the Air Quality (England) (Amendment) Regulations 2002, Statutory Instrument 3043 (2002).

2.12 The objectives for nitrogen dioxide and PM₁₀ were to have been achieved by 2005 and 2004 respectively, and continue to apply in all future years thereafter. The PM_{2.5} objective is to be achieved by 2020. Measurements across the UK have shown that the 1-hour nitrogen dioxide objective is unlikely to be exceeded where the annual mean concentration is below 60 µg/m³ (Defra, 2009). Therefore, 1-hour nitrogen dioxide concentrations will only be considered if the annual mean concentration is above this level.

2.13 The objectives apply at locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. Defra explains where these objectives will apply in its Local Air Quality Management Technical Guidance (Defra, 2009). The annual mean objectives for nitrogen dioxide and PM₁₀ are considered to apply at the façades of residential properties, schools, hospitals etc.; they do not apply at hotels. The 24-hour objective

for PM₁₀ is considered to apply at the same locations as the annual mean objective, as well as in gardens of residential properties and at hotels. The 1-hour mean objective for nitrogen dioxide applies wherever members of the public might regularly spend 1-hour or more, including outdoor eating locations and pavements of busy shopping streets.

2.14 The European Union has also set limit values for nitrogen dioxide, PM₁₀ and PM_{2.5}. Achievement of these values is a national obligation rather than a local one (Directive 2008/50/EC of the European Parliament and of the Council, 2008). The limit values for nitrogen dioxide are the same levels as the UK objectives, but applied from 2010 (The Air Quality Standards Regulations 2010 (No. 1001), 2010). The limit values for PM₁₀ and PM_{2.5} are also the same level as the UK statutory objectives, but applied from 2005 for PM₁₀ and will apply from 2015 for PM_{2.5}. As the latter is more stringent than the UK objective (as it applies from 2015 rather than 2020) it is used as the relevant assessment criterion in this assessment.

2.15 The relevant air quality criteria for this assessment are provided in Table 1.

Table 1: Air Quality Criteria for Nitrogen Dioxide, PM₁₀ and PM_{2.5}

Pollutant	Time Period	Objective
Nitrogen Dioxide	1-hour mean	200 µg/m ³ not to be exceeded more than 18 times a year
	Annual mean	40 µg/m ³
Fine Particles (PM₁₀)	24-hour mean	50 µg/m ³ not to be exceeded more than 35 times a year
	Annual mean	40 µg/m ³
Fine Particles (PM_{2.5})^a	Annual mean	25 µg/m ³

^a The PM_{2.5} objective, which is to be met by 2020, is not in Regulations and there is no requirement for local authorities to meet it. The EU limit value is the same, but is to be met by 2015.

Descriptors for Air Quality Impacts and Assessment of Significance

2.16 There is no official guidance in the UK on how to describe air quality impacts nor to assess their significance. The approach developed by the IAQM¹ (Institute of Air Quality Management, 2009), and incorporated in Environmental Protection UK's (EPUK) guidance document on planning and air quality (Environmental Protection UK, 2010), has therefore been used. This approach includes elements of professional judgement. Full details of this approach are provided in Appendix A1, with the professional experience of the consultants preparing the report set out in Appendix A2.

¹ The IAQM is the professional body for air quality practitioners in the UK.

3 Assessment Approach

Consultation

- 3.1 The assessment follows a methodology agreed with Arun District Council via a telephone discussion between Graham Evans (Senior Environmental Health Officer at Arun District Council) and Dr Ben Marner (Air Quality Consultants) held on 6th July 2012.

Existing Conditions

- 3.2 Existing sources of emission within the study area have been defined using a number of approaches. Industrial and waste management sources that may affect the area have been identified using Defra's Pollutant Release and Transfer Register (Defra, 2012c). Local sources have also been identified through discussion with Arun District Council's Environmental Health Department, as well as through examination of the Council's air quality Review and Assessment reports.
- 3.3 Information on existing air quality has been obtained by collating the results of monitoring carried out by the local authority. The background concentrations across the study area have been defined using the national pollution maps published by Defra (Defra, 2012a). These cover the whole country on a 1x1 km grid.

Road Traffic Impacts

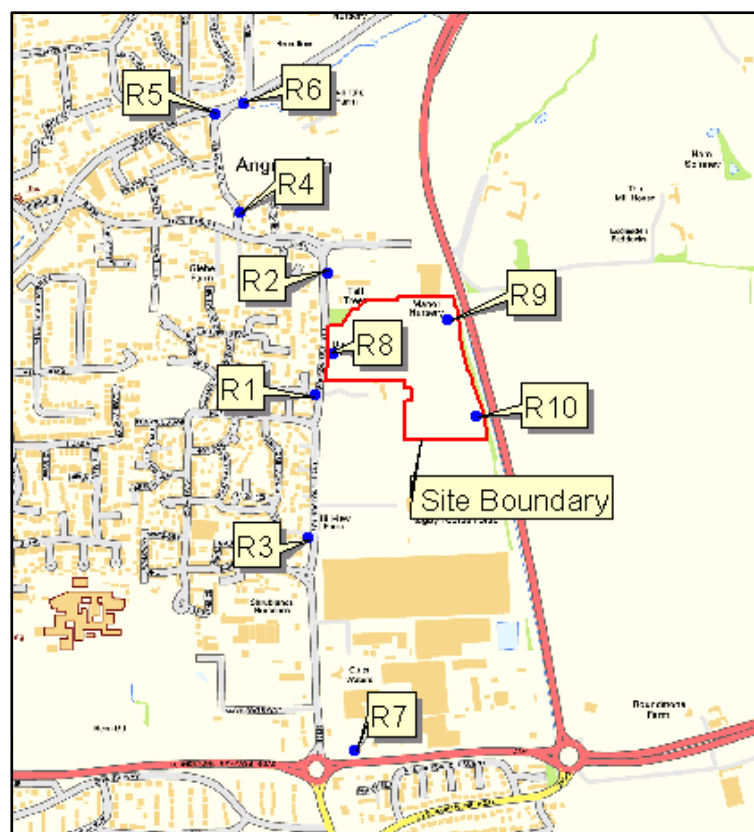
Sensitive Locations

- 3.4 Concentrations of nitrogen dioxide, PM₁₀ and PM_{2.5} have been predicted at a number of locations both within, and close to, the proposed development. Receptors have been identified to represent worst-case exposure within these locations. When selecting these receptors, particular attention has been paid to assessing impacts close to junctions, where there is a combined effect of several road links and also where there is predicted to be more than a five per cent increase in traffic flows with the proposed development. The receptors have been located on the façades of the properties closest to the sources.
- 3.5 Seven existing residential properties have been identified as receptors for the assessment. An additional three receptor locations have been identified within the new development, which will represent worst-case exposure to existing sources. These locations are described in Table 2 and shown in Figure 1. In addition, concentrations have been modelled at the diffusion tube monitoring site located on Worthing Road, Littlehampton in order to verify the modelled results (see Appendix A3 for verification method).

Table 2: Description of Receptor Locations

Receptor	Description
Existing properties^a	
Receptor 1	2 Brambley Cottages
Receptor 2	Pound House
Receptor 3	1 Hammond Close
Receptor 4	Malt Barn Cottage
Receptor 5	Weavers Cottage
Receptor 6	Residential property on Water Lane
Receptor 7	Appletree Cottage
New properties^a	
Receptor 8	Property within the proposed development
Receptor 9	Property within the proposed development
Receptor 10	Property within the proposed development

^a Receptors modelled at a height of 1.5 m

**Figure 1: Receptor Locations**

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Assessment Scenarios

- 3.6 Predictions of nitrogen dioxide, PM₁₀ and PM_{2.5} concentrations have been carried out for a base year (2011), and the proposed year of opening (2013). For 2013, predictions have been made assuming both that the development does proceed (With Scheme), and does not proceed (Without Scheme). A further 2013 sensitivity test has been carried out for nitrogen dioxide that involves assuming no reduction in emission factors for road traffic from the baseline year. This is to address the issue recently identified by Defra (Carslaw et al., 2011) that road traffic emissions have not been declining as expected (see later section on uncertainty). Nitrogen dioxide concentrations in 2013 with and without the scheme are thus presented for two scenarios: 'With Emissions Reduction' and 'Without Emissions Reduction'.

Modelling Methodology

- 3.7 Concentrations have been predicted for the baseline and future years using the ADMS-Roads dispersion model. Details of the model inputs and the model verification are provided in Appendix A3, together with the method used to derive current and future year background nitrogen dioxide concentrations.

4 Site Description and Baseline Conditions

- 4.1 The proposed development site is located in the south-east of Angmering Village. The site is bounded by Roundstone Lane to the west and the A280 to the east and currently consists of farmland. Worthing Rugby Football Club. is located to the south of the site. There are existing residential properties to the north and west of the site, and a small plant nursery to the north.
- 4.2 A search of the UK Pollutant Release and Transfer Register website (Defra, 2012c) did not identify any industrial or waste management sources within 1 km of the proposed development.
- 4.3 Arun District Council has investigated air quality within its area as part of its responsibilities under the LAQM regime. The 2012 Updating and Screening Assessment (Arun District Council, 2012) concluded that there are no exceedences of any of the objectives for both nitrogen dioxide and PM₁₀. It is therefore highly unlikely that existing nitrogen dioxide and PM₁₀ levels will exceed the objectives within the study area.
- 4.4 There are no automatic monitoring sites operating within the boundaries of Arun District Council for nitrogen dioxide, PM₁₀ or PM_{2.5}. The Council operates a number of nitrogen dioxide monitoring sites using diffusion tubes prepared and analysed by South Yorkshire Air Quality Samplers (SYAQS), using the 50% TEA in acetone method. The closest monitoring sites are deployed in Westlands, and on Worthing Road and are within 3.5 km of the development. Data for these sites has been provided by Arun District Council. Results for the years 2006 to 2011 are summarised in Table 3 and the monitoring locations are shown in Figure 2.

Table 3: Summary of Nitrogen Dioxide (NO₂) Monitoring (2006-2011)

Site Name	Site Type	Location	2006	2007	2008	2009	2010	2011
Diffusion Tubes - Annual Mean (µg/m³)^a								
Westlands	Urban Background	Littlehampton	19	18	19	18	17	14
A259 Worthing Road	Urban Roadside	Littlehampton	28	27	31	37	30	24
Objective			40					

^a 2006 and 2007 data have taken from the 2008 Progress Report (Arun District Council, 2008). 2008 to 2011 data have been taken from the 2012 Updating and Screening Assessment (Arun District Council, 2012).

- 4.5 Monitored concentrations have been below the objectives at both sites during the past six years. Although these sites are not in close proximity to the development site, the 2012 Updating and Screening Assessment produced by Arun District Council (Arun District Council, 2012) concluded

that the nitrogen dioxide objectives have been met across the district and therefore concentrations at the site are likely to be similar to the monitoring results summarised in Table 3.

- 4.6 There are no clear trends in monitoring results for the past six years. This contrasts with the expected decline due to the progressive introduction of new vehicles operating to more stringent standards. The implications of this are discussed later in Section 5 of this report.

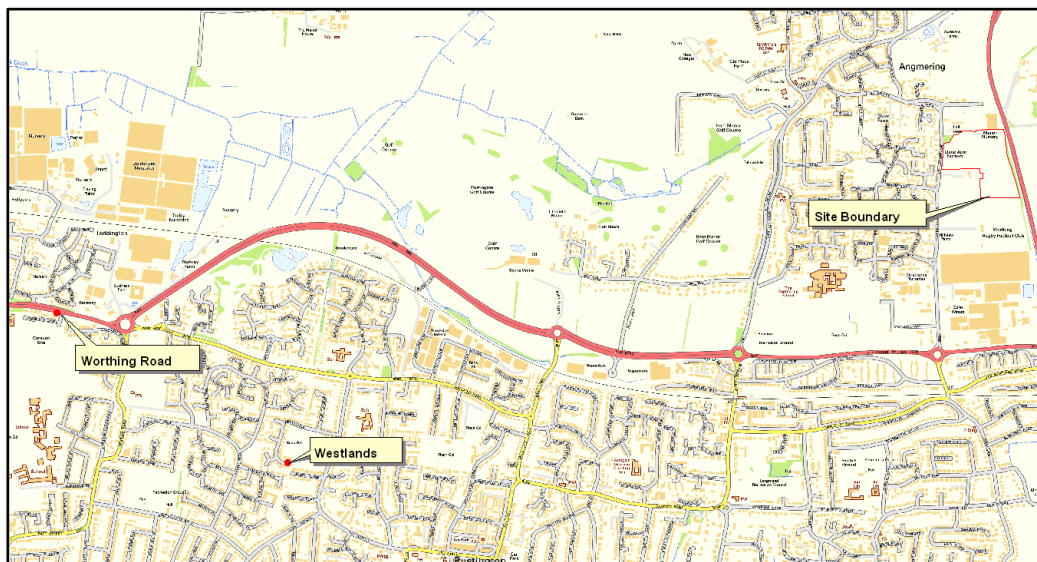


Figure 2: Monitoring Locations

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- 4.7 In addition to these locally measured concentrations, estimated background concentrations in the study area have been determined for 2011 and the opening year 2013 (Table 4). In the case of nitrogen dioxide, two sets of future-year backgrounds are presented to take into account uncertainty in future year vehicle emission factors. The derivation of background concentrations is described in Appendix A3. The background concentrations are all well below the objectives.

Table 4: Estimated Annual Mean Background Pollutant Concentrations in 2011 and 2013 ($\mu\text{g}/\text{m}^3$)

Year	Coordinates	NO ₂	PM ₁₀	PM _{2.5}
2011^a	507500, 103500	11.3	15.0	10.0
	507500, 104500	10.5	14.9	9.8
2013 – Without Reductions in Traffic Emissions^b	507500, 103500	12.2	n/a	n/a
	507500, 104500	11.0	n/a	n/a
2013 – With Reductions in Traffic Emissions^c	507500, 103500	11.8	14.7	9.7
	507500, 104500	10.7	14.9	9.6
Objectives		40	40	25^d

n/a = not applicable

^a This assumes vehicle emission factors in 2011 remain the same as 2008 (See Appendix A3).^b This assumes vehicle emission factors in 2013 remain the same as in 2011.^c This assumes vehicle emission factors reduce into the future at the current 'official' rates.^d There are no objectives for PM_{2.5} that apply during these years, however the European Union limit value of 25 $\mu\text{g}/\text{m}^3$ is to be met by 2015.

- 4.8 Baseline concentrations of nitrogen dioxide, PM₁₀ and PM_{2.5} have been modelled at each of the existing receptor locations (see Figure 1 and Table 2). The results for the 2011 baseline are set out in Table 5. The modelled road contributions have been adjusted by a verification factor of 3.02, see Appendix A3 for details of the model verification.

Table 5: Modelled Annual Mean Baseline Concentrations of Nitrogen Dioxide, PM₁₀ and PM_{2.5} (µg/m³) at Existing Receptors in 2011

Receptor	Nitrogen dioxide	PM ₁₀		PM _{2.5}
	Annual Mean (µg/m ³)	Annual Mean (µg/m ³)	No. Days >50 µg/m ^{3a}	Annual Mean (µg/m ³)
R1	15.9	15.5	0	10.3
R2	17.1	15.8	0	10.4
R3	15.9	15.5	0	10.3
R4	16.8	15.6	0	10.2
R5	19.1	17.0	1	11.1
R6	17.3	16.6	1	10.8
R7	22.1	17.3	1	11.5
Objective	40	40	35	25^b

^a The numbers of days with PM₁₀ concentrations greater than 50 µg/m³ have been estimated from the relationship with the annual mean concentration described in LAQM.TG(09) (Defra, 2009).

^b There are no objectives for PM_{2.5} that apply during these years, however the European Union limit value of 25 µg/m³ is to be met by 2015.

4.9 The predicted concentrations of nitrogen dioxide, PM₁₀ and PM_{2.5} in 2011 are well below the objectives (or limit values) at all existing receptors. These results are consistent with the conclusions of Arun District Council in the outcome of its air quality review and assessment work.

5 Impact Assessment

Road Traffic Impacts

- 5.1 Predicted annual mean concentrations of nitrogen dioxide, PM₁₀ and PM_{2.5}, as well as days with PM₁₀ >50 µg/m³, are set out in Table 6, Table 7 and Table 8 for both the “Without Scheme” and “With Scheme” scenarios. These tables also describe the impacts at each receptor using the impact descriptors given in Appendix A1. For nitrogen dioxide, results are presented for two scenarios: with the official reductions in vehicle emission factors and without these reductions. The modelled road NO_x contributions have been adjusted by a verification factor of 3.02, see Appendix A3 for details of the model verification.

With ‘Official’ Emission Reduction

- 5.2 The annual mean nitrogen dioxide concentrations are below the objective at all receptors. The magnitudes of change are all imperceptible and thus the impacts are negligible at all receptors. In terms of PM₁₀ and PM_{2.5}, no exceedences of the objectives are predicted and all of the impacts are negligible.

Without Emission Reduction

- 5.3 Assuming no reduction in emissions, the annual mean nitrogen dioxide concentrations are also below the objective at all receptors. The magnitudes of change are all imperceptible and thus the impacts are negligible at all receptors.

Table 6: Predicted Impacts on Annual Mean Nitrogen Dioxide Concentrations in 2013 (µg/m³)

Receptor	With ‘Official’ Emission Reduction ^a			Without Emissions Reduction ^b		
	Without Scheme	With Scheme	Impact Descriptor	Without Scheme	With Scheme	Impact Descriptor
R1	14.5	14.8	Negligible	15.5	15.8	Negligible
R2	15.4	15.8	Negligible	16.7	17.1	Negligible
R3	14.5	14.7	Negligible	15.4	15.7	Negligible
R4	15.2	15.5	Negligible	16.4	16.7	Negligible
R5	17.1	17.2	Negligible	18.7	18.8	Negligible
R6	15.6	15.9	Negligible	16.9	17.3	Negligible
R7	20.0	20.1	Negligible	21.9	22.0	Negligible
Objective	40		-	40		-

^a This assumes vehicle emission factors reduce into the future at the current ‘official’ rates.

^b This assumes vehicle emission factors in 2013 remain the same as in 2011.

Table 7: Predicted PM₁₀ Impacts in 2013 (µg/m³)

Receptor	Annual Mean (µg/m ³)			Days with PM ₁₀ > 50 µg/m ³ ^a		
	Without Scheme	With Scheme	Impact Descriptor	Without Scheme	With Scheme	Impact Descriptor
R1	15.2	15.3	Negligible	0	0	Negligible
R2	15.5	15.6	Negligible	0	0	Negligible
R3	15.2	15.2	Negligible	0	0	Negligible
R4	15.3	15.4	Negligible	0	0	Negligible
R5	16.6	16.6	Negligible	1	1	Negligible
R6	16.2	16.3	Negligible	0	0	Negligible
R7	16.9	17.0	Negligible	1	1	Negligible
Objective	40		-	35		-

^a The numbers of days with PM₁₀ concentrations greater than 50 µg/m³ have been estimated from the relationship with the annual mean concentration described in LAQM.TG(09) (Defra, 2009).

Table 8: Predicted PM_{2.5} Impacts in 2013 (µg/m³)

Receptor	Annual Mean (µg/m ³)		
	Without Scheme	With Scheme	Impact Descriptor
R1	10.1	10.1	Negligible
R2	10.1	10.2	Negligible
R3	10.1	10.1	Negligible
R4	10.0	10.0	Negligible
R5	10.8	10.8	Negligible
R6	10.5	10.6	Negligible
R7	11.2	11.2	Negligible
Objective	25^a		-

^a There are no objectives for PM_{2.5} that apply during these years, however the European Union limit value of 25 µg/m³ is to be met by 2015.

Impacts of Existing Sources on the Development

- 5.4 The modelled impacts of the existing traffic sources on air quality conditions for residents occupying the new residential units in the proposed development are set out in Table 9 for Receptors 8 to 10 (see Table 2 and Figure 1 for receptor locations). All the values are below the objectives. Air quality for future residents within the development would thus be acceptable.

Table 9: Predicted Concentrations of Nitrogen Dioxide (NO₂), PM₁₀ and PM_{2.5} in 2013 for New Receptors in the Development Site

Receptor	Annual Mean NO ₂ (µg/m ³)		PM ₁₀ (µg/m ³) ^a		PM _{2.5} (µg/m ³)
	With 'Official' Emission Reduction ^b	Without Emissions Reduction ^c	Annual Mean	No. Days >50 µg/m ³	Annual Mean
R8	14.1	15.1	15.3	0	10.0
R9	12.5	13.2	15.2	0	9.8
R10	13.8	14.7	15.2	0	10.1
Objectives	40		40	35	25^d

^a The numbers of days with PM₁₀ concentrations greater than 50 µg/m³ have been estimated from the relationship with the annual mean concentration described in LAQM.TG (09) (Defra, 2009).

^b This assumes vehicle emission factors reduce into the future at the current 'official' rates.

^c This assumes vehicle emission factors in 2013 will remain the same as in 2011.

^d There are no objectives for PM_{2.5} that apply during these years, however the European Union limit value of 25 µg/m³ is to be met by 2015.

Uncertainty in Road Traffic Modelling Predictions

- 5.5 There are many components that contribute to the uncertainty of modelling predictions. The model used in this assessment is dependent upon the traffic data that have been input, which will have inherent uncertainties associated with them. There are then additional uncertainties, as the model is required to simplify real-world conditions into a series of algorithms. An important stage in the process is model verification, which involves comparing the model output with measured concentrations (see Appendix A3). Because the model has been verified and adjusted, there can be reasonable confidence in the prediction of current year (2011) concentrations.
- 5.6 Predicting pollutant concentrations in a future year will always be subject to greater uncertainty. For obvious reasons, the model cannot be verified in the future, and it is necessary to rely on a series of projections as to what will happen to traffic volumes, background pollutant concentrations, and vehicle emissions. Recently however, a disparity between the road transport emission projections and measured annual mean concentrations of nitrogen oxides and nitrogen dioxide has been identified by Defra (Carslaw et al., 2011). This applies across the UK, although the effect appears to be greatest in inner London; there is also considerable inter-site variation. Whilst the emission projections suggest that both annual mean nitrogen oxides and nitrogen dioxide concentrations should have fallen by around 15-25% over the past 6 to 8 years, at many monitoring sites levels have remained relatively stable, or have even shown a slight increase. This pattern is mirrored in the monitoring data assembled for this study, as set out in paragraph 4.6.

- 5.7 The precise reason for this disparity is not known, but is thought to be related to the actual on-road performance of diesel vehicles when compared to the calculations based on the Euro standards. It may therefore be expected that nitrogen oxides and nitrogen dioxide concentrations will not fall as quickly in future years as the current projections indicate. However, at this stage, there is no robust evidence upon which to carry out any revised predictions.
- 5.8 The implications for this assessment are that the absolute nitrogen dioxide concentrations predicted in 2013 may be higher than shown, when based on the official emissions reduction forecasts. To account for this uncertainty in the projections, a sensitivity test has been conducted assuming that the future (2013) road traffic emissions per vehicle are unchanged from 2011 values.

Significance of Operational Air Quality Impacts

- 5.9 The operational air quality impacts are judged to be insignificant. This professional judgement is made in accordance with the methodology set out in paragraph A1.3 (Appendix A1) taking into account the factors set out in Table 10, and also taking into account the uncertainty over future projections of traffic-related nitrogen dioxide concentrations, which may not decline as rapidly as currently projected (see paragraph 5.6). The latter has been addressed by giving consideration to both sets of modelled results for nitrogen dioxide; those with and without reductions in traffic emissions. It is to be expected that concentrations will fall in the range between the two sets of results, although by 2013 the impacts are likely to be closer to the 'without reduction' results than the 'with reduction' results.
- 5.10 More specifically, the judgement that the air quality impacts will be insignificant takes account of the assessment that concentrations will be well below the air quality objectives and all of the impacts are predicted to be negligible.

Table 10: Factors Taken into Account in Determining the Overall Significance of the Scheme on Local Air Quality

Factors	Outcome of Assessment
Number of people affected by increases and/or decreases in concentrations and a judgement on the overall balance.	For all people the increases will be imperceptible.
The magnitude of the changes and the descriptions of the impacts at the receptors	The impacts at the receptors are all negligible.
Whether or not an exceedence of an objective or limit value is predicted to arise in the study area where none existed before or an exceedence area is substantially increased.	No new areas of exceedence of the objective are predicted.
Uncertainty, including the extent to which worst-case assumptions have been made	By assuming that all the development traffic is on the roads in the year of opening the assessment will have exaggerated the early impacts. The inclusion of the two scenarios for nitrogen dioxide covers the uncertainty over vehicle emission factors. The actual concentrations are likely to lie between the two scenarios. The actual concentrations in 2013 are likely to be closer to the without emissions reduction scenario.
The extent to which an objective or limit value is exceeded	None of the objectives are exceeded.

6 Mitigation

Road Traffic Impacts

- 6.1 The assessment has demonstrated that the scheme would not cause any exceedences of the air quality objectives in areas where they are not currently exceeded. Mitigation measures to reduce pollutant emissions from road traffic are principally being delivered in the longer term by the introduction of more stringent emissions standards, largely via European legislation. It is not considered appropriate to propose further mitigation measures for this scheme.

7 Summary and Conclusions

- 7.1 The air quality impacts associated with the operation of the proposed housing development at Roundstone Lane, Angmering have been assessed. Existing conditions within the study area show good air quality, with concentrations all below the air quality objectives.
- 7.2 The operational impacts of increased traffic emissions arising from the additional traffic on local roads, due to the development, have been assessed. Concentrations have been modelled for seven worst-case receptors, representing existing properties where impacts are expected to be greatest. In addition, the impacts of traffic from local roads on the air quality for future residents have been assessed at three worst-case locations within the new development itself. In the case of nitrogen dioxide, the modelling has been carried out assuming both a) vehicle emissions decrease (using 'official' emission factors) and b) do not decrease in future years. This is to allow for current uncertainty over emission factors for nitrogen oxides that has been identified by Defra (Carslaw et al., 2011).
- 7.3 It is concluded that concentrations of nitrogen dioxide, PM₁₀ and PM_{2.5} would remain below the objectives at all existing receptors in 2013, whether the scheme is developed or not. In the case of nitrogen dioxide this is also the case whether or not a reduction in vehicle emissions of nitrogen oxides is assumed. This conclusion is consistent with the outcomes of the reviews and assessments prepared by Arun District Council.
- 7.4 The proposed scheme would only increase traffic volumes on local roads by a small amount. These changes would lead to an imperceptible increase in concentrations of nitrogen dioxide, PM₁₀ and PM_{2.5} at all existing receptors, and the impacts would all be negligible. In the case of nitrogen dioxide, the impacts are still considered to be negligible assuming both the 'With Reductions in Traffic Emissions' and 'Without Reductions in Traffic Emissions' in 2013. The impacts of local traffic on the air quality for residents living in the proposed development have been shown to be acceptable at the worst-case locations assessed, with concentrations being well below the air quality objectives.
- 7.5 The overall operational air quality impacts of the development are judged to be insignificant. This conclusion, which takes account of the uncertainties in future projections, in particular for nitrogen dioxide, is based on the concentrations being well below the objectives and impacts all being negligible.
- 7.6 The proposed development is consistent with the NPPF. Furthermore, the scheme does not conflict with the requirements of Policies SP25 and DM47 of the Draft Local Plan (Arun District Council, 2012).

8 References

- Andy French (10 July 2012) *Email correspondence*.
- Arun District Council (2008) *Local Air Quality Management Progress Report - 2008*.
- Arun District Council (2012) *2012 Air Quality Updating and Screening Assessment for Arun District Council*.
- Arun District Council (2012) *Draft Local Plan (2013 - 2028). Consultation Document*.
- Carslaw, D., Beevers, S., Westmoreland, E. and Williams, M. (2011) *Trends in NO_x and NO₂ emissions and ambient measurements in the UK*, [Online], Available: uk-air.defra.gov.uk/reports/cat05/1108251149_110718_AQ0724_Final_report.pdf.
- Defra (2007) *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland*, Defra.
- Defra (2009) *Review & Assessment: Technical Guidance LAQM.TG(09)*, Defra.
- Defra (2012a) *Defra Air Quality Website*, [Online], Available: <http://www.defra.gov.uk/environment/quality/air/airquality/>.
- Defra (2012c) *UK Pollutant Release and Transfer Register*, [Online], Available: prtr.defra.gov.uk.
- DfT (2011) *TEMPRO (Version 6.2) System*, [Online], Available: www.tempro.org.uk.
- DfT (2012) *Annual Average Daily Flows*, [Online], Available: <http://www.dft.gov.uk/matrix/>.
- Directive 2008/50/EC of the European Parliament and of the Council* (2008).
- Environmental Protection UK (2010) *Development Control: Planning for Air Quality*, EPUK.
- Institute of Air Quality Management (2009) *Position on the Description of Air Quality Impacts and the Assessment of their Significance*, IAQM.
- National Planning Policy Framework* (2012), DCLG.
- The Air Quality (England) (Amendment) Regulations, 2002, Statutory Instrument 3043* (2002), HMSO.
- The Air Quality Regulations, 2000, Statutory Instrument 928* (2000), HMSO.
- The Air Quality Standards Regulations 2010 (No. 1001)* (2010), HMSO.
- West Sussex County Council (2010) *Provisional West Sussex Transport Plan 2011 - 2026 Sustainability Appraisal Report*.
- West Sussex County Council (2011) *West Sussex Transport Plan 2011-2026*.

9 Glossary

AADT Annual Average Daily Traffic

AQMA Air Quality Management Area

AURN Automatic Urban and Rural Network

Defra Department for Environment, Food and Rural Affairs

DfT Department for Transport

EFT Emissions Factor Toolkit

Exceedence A period of time when the concentration of a pollutant is greater than the appropriate air quality objective. This applies to specified locations with relevant exposure

HDV Heavy Duty Vehicles (> 3.5 tonnes)

LDV Light Duty Vehicles (<3.5 tonnes)

LEZ Low Emission Zone

µg/m³ Microgrammes per cubic metre

NO Nitric oxide

NO₂ Nitrogen dioxide

NO_x Nitrogen oxides (taken to be NO₂ + NO)

Objectives A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides

PHV Private Hire Vehicle

PM₁₀ Small airborne particles, more specifically particulate matter less than 10 micrometres in aerodynamic diameter

PM_{2.5} Small airborne particles less than 2.5 micrometres in aerodynamic diameter

Standards A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal

TEA Triethanolamine – used to absorb nitrogen dioxide

VCM Volatile Correction Model

10 Appendices

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A1 Impact Descriptors and Assessment of Significance

- A1.1 There is no official guidance in the UK on how to describe the nature of air quality impacts nor to assess their significance. The approach developed by the Institute of Air Quality Management² (Institute of Air Quality Management, 2009), and incorporated in Environmental Protection UK's guidance document on planning and air quality (Environmental Protection UK, 2010), has therefore been used. This involves three distinct stages: the application of descriptors for magnitude of change; the description of the impact at each sensitive receptor; and then the assessment of overall significance of the scheme.

Impact Descriptors

- A1.2 The definition of **impact magnitude** is solely related to the degree of change in pollutant concentrations, expressed in microgrammes per cubic metre, but originally determined as a percentage of the air quality objective. **Impact description** takes account of the impact magnitude and of the absolute concentrations and how they relate to the air quality objectives or other relevant standards. The descriptors for the magnitude of change due to the scheme are set out Table A1.1 while Table A1.2 sets out the impact descriptors. These tables have been designed to assist with describing air quality impacts at each specific receptor. They apply to the pollutants relevant to this scheme and the objectives against which they are being assessed.

² The IAQM is the professional body for air quality practitioners in the UK.

Table A1.1: Definition of Impact Magnitude for Changes in Ambient Pollutant Concentrations

Magnitude of Change	Annual Mean NO ₂ /PM ₁₀	No. days with PM ₁₀ concentration greater than 50 µg/m ³	Annual Mean PM _{2.5}
Large	Increase/decrease ≥4 µg/m ³	Increase/decrease >4 days	Increase/decrease ≥2.5 µg/m ³
Medium	Increase/decrease 2 - <4 µg/m ³	Increase/decrease 3 or 4 days	Increase/decrease 1.25 - <2.5 µg/m ³
Small	Increase/decrease 0.4 - <2 µg/m ³	Increase/decrease 1 or 2 days	Increase/decrease 0.25 - <1.25 µg/m ³
Imperceptible	Increase/decrease <0.4 µg/m ³	Increase/decrease <1 day	Increase/decrease <0.25 µg/m ³

Table A1.2: Air Quality Impact Descriptors for Changes to Annual Mean Nitrogen Dioxide, PM₁₀ and PM_{2.5} Concentrations and Changes to Number of Days with PM₁₀ Concentration Greater than 50 µg/m³ at a Receptor ^a

Absolute Concentration ^b in Relation to Objective/Limit Value	Change in Concentration/day ^c		
	Small	Medium	Large
Above Objective/Limit Value ^d	Slight	Moderate	Substantial
Just Below Objective/Limit Value ^e	Slight	Moderate	Moderate
Below Objective/Limit Value ^f	Negligible	Slight	Slight
Well Below Objective/Limit Value ^g	Negligible	Negligible	Slight

^a Criteria have been adapted from the published criteria to remove overlaps at transitions.

^b The 'Absolute Concentration' relates to the 'With-Scheme' air quality where there is an increase in concentrations and to the 'Without-Scheme' air quality where there is a decrease in concentrations.

^c Where the Impact Magnitude is *Imperceptible*, then the Impact Description is *Negligible*.

^d Where the Impact Magnitude is *Imperceptible*, then the Impact Description is *Negligible*.

^d 'Above': >40 µg/m³ annual mean NO₂ or PM₁₀, >25 µg/m³ annual mean PM_{2.5}, or >35 days with PM₁₀ > 50 µg/m³.

^e 'Just below': >36 – ≤40 µg/m³ of annual mean NO₂ or PM₁₀, >22.5 - ≤25 µg/m³ annual mean PM_{2.5}, or >32 – ≤35 days with PM₁₀ >50 µg/m³.

^f 'Below': >30 – ≤36 µg/m³ of annual mean NO₂ or PM₁₀, >18.75 - ≤22.5 µg/m³ annual mean PM_{2.5}, or >26 – ≤32 days with PM₁₀ >50 µg/m³.

^g 'Well below': ≤30 µg/m³ annual mean NO₂ or PM₁₀, ≤18.75 µg/m³ annual mean PM_{2.5}, or ≤26 days with PM₁₀ >50 µg/m³.

Assessment of Significance

A1.3 The IAQM (Institute of Air Quality Management, 2009) guidance is that the **assessment of significance** should be based on professional judgement, with the overall air quality impact of the scheme described as either, *insignificant*, *minor*, *moderate* or *major*. In drawing these conclusions,

the factors set out in Table A1.3 should be taken into account. A summary of the professional experience of staff contributing to this assessment is provided in Appendix A2.

Table A1.3: Factors Taken into Account in Determining Air Quality Significance

Factors
Number of people affected by increases and/or decreases in concentrations and a judgement on the overall balance.
The number of people exposed to levels above the objective or limit value, where new exposure is being introduced.
The magnitude of the changes and the descriptions of the impacts at the receptors using the criteria set out in Table A1.1 and Table A1.2.
Whether or not an exceedence of an objective or limit value is predicted to arise in the study area where none existed before or an exceedence area is substantially increased.
Whether or not the study area exceeds an objective or limit value and this exceedence is removed or the exceedence area is reduced.
Uncertainty, including the extent to which worst-case assumptions have been made
The extent to which an objective or limit value is exceeded, e.g. an annual mean NO ₂ of 41 µg/m ³ should attract less significance than an annual mean of 51 µg/m ³

A2 Professional Experience

Prof. Duncan Laxen, BSc (Hons) MSc PhD MEnvSc FIAQM

Prof Laxen is the Managing Director of Air Quality Consultants, a company which he founded in 1993. He has over forty years experience in environmental sciences and is a member of Defra's Air Quality Expert Group and the Department of Health's Committee on the Medical Effects of Air Pollution. He has been involved in major studies of air quality, including nitrogen dioxide, lead, dust, acid rain, PM₁₀, PM_{2.5} and ozone and was responsible for setting up UK's urban air quality monitoring network. Prof Laxen has been responsible for appraisals of all local authorities' air quality Review & Assessment reports. He has carried out air quality assessments for power stations; road schemes; ports; airports; railways; mineral and landfill sites; and residential/commercial developments. He has also been involved in numerous investigations into industrial emissions; ambient air quality; indoor air quality; nuisance dust and transport emissions. Prof Laxen has prepared specialist reviews on air quality topics and contributed to the development of air quality management in the UK. He has been an expert witness at numerous Public Inquiries and published over 70 scientific papers and given numerous presentations at conferences.

Dr Ben Marner, BSc (Hons) PhD CSci MEnvSc MIAQM

Dr Marner is a Technical Director with AQC, and has thirteen years relevant experience in the field of air quality. He has been responsible for air quality and greenhouse gas assessments of road schemes, rail schemes, airports, power stations, waste incinerators, commercial developments and residential developments in the UK and abroad. He has extensive experience of using detailed dispersion models, as well as contributing to the development of modelling best practices. Dr Marner has arranged and overseen air quality monitoring surveys, as well as contributing to Defra guidance on harmonising monitoring methods. He has been responsible for air quality review and assessments on behalf of numerous local authorities. He has also developed methods to predict nitrogen deposition fluxes on behalf of the Environment Agency, provided support and advice to the UK Government's air quality review and assessment helpdesk, Transport Scotland, Transport for London, and numerous local authorities. Dr Marner has provided public inquiry expert witness services.

Caroline Murrell, BA(Hons) MSc

Ms Murrell is a Consultant with AQC with over three years relevant experience. She is involved in the preparation of air quality assessments for a range of development projects. She has been responsible for a wide range of air quality projects covering impact assessments for new residential and commercial developments, local air quality management, ambient air quality monitoring of nitrogen dioxide and sulphur dioxide and the assessment of nuisance odours. She has extensive

modelling experience for road traffic and has worked with a variety of clients to provide expert air quality services and advice, including local authorities, planners, developers and process operators.

Full CVs are available at www.aqconsultants.co.uk

A3 Modelling Methodology

Background Concentrations

- A3.1 The background concentrations across the study area have been defined using the national pollution maps published by Defra (Defra, 2012a). These cover the whole country on a 1x1 km grid and are published for each year from 2008 until 2020. The maps include the influence of emissions from a range of different sources; one of which is road traffic. As noted in paragraph 3.6, there are some concerns that Defra may have over-predicted the rate at which road traffic emissions of nitrogen oxides will fall in the future. The maps currently in use were verified against measurements made during 2008 at a large number of automatic monitoring stations and so there can be reasonable confidence that the maps are representative of conditions during 2008. Similarly, there is reasonable confidence that the reductions which Defra predicts from other sectors (e.g. rail) will be achieved.
- A3.2 In order to calculate background nitrogen dioxide concentrations in 2011, it is assumed that there was no reduction in the road traffic component of backgrounds between 2008³ and 2011. This has been done using the source-specific background nitrogen oxides maps provided by Defra (Defra, 2012a). For each grid square, the road traffic component has been held constant at 2008 levels, while 2011 values have been taken for the other components. Nitrogen dioxide concentrations have then been calculated using the background nitrogen dioxide calculator which Defra (Defra, 2012a) publishes to accompany the maps. The result is a set of 'adjusted 2011 background' concentrations.
- A3.3 Two separate sets of 2013 background nitrogen dioxide concentrations have been used for the future-year assessment. The 2013 background 'without emissions reduction' has been calculated using the same approach as described for the 2011 data: the road traffic component of background nitrogen oxides has been held constant at 2011 values, while 2013 data are taken for the other components. Nitrogen dioxide has then been calculated using Defra's background nitrogen dioxide calculator. The 2013 background 'with emissions reduction' assumes that Defra's predicted reductions occur from 2011 onward. This dataset has been derived first by calculating the ratio of the unadjusted mapped value for 2013 to the unadjusted mapped value for 2011. This ratio has then been applied to the adjusted 2013.
- A3.4 For PM₁₀ and PM_{2.5}, there is no strong evidence that Defra's predictions are unrealistic and so the year-specific mapped concentrations have been used in this assessment.

³ This approach assumes that there has been no reduction in emissions per vehicle but also that traffic volumes have remained constant. This is not the same as the assumption made for dispersion modelling, in which emissions per vehicle are held constant while traffic volumes are assumed to change year on year. Overall, this discrepancy is unlikely to influence the overall conclusions of the assessment.

Model Inputs

- A3.5 Predictions have been carried out using the ADMS-Roads dispersion model (v3.1). The model requires the user to provide various input data, including the AADT flow, the proportion of HDVs, road characteristics (including road width and street canyon height, where applicable), and the vehicle speed. Vehicle emissions are calculated within ADMS-roads (v3.1) based on vehicle flow, composition and speed using the same emission factors as published within the EFT, version 4.2.2 (Defra, 2012a). For nitrogen dioxide future-year concentrations have been predicted once using year-specific emission factors from the EFT and once using emission factors for 2011⁴ which is the year for which the model has been verified.
- A3.6 The model has been run using the most recent full year of meteorological data (2011) from the monitoring station located at Shoreham Airport, which is considered suitable for this area.
- A3.7 AADT flows, diurnal flow profiles and vehicle fleet composition data have been provided by The Civil Engineering Practice (Andy French, 10 July 2012). These were derived from peak hour traffic models factored up based on the conversion factor taken from average daily flows for the Roundstone Bypass obtained by automatic traffic count. The traffic data used in this assessment are summarised in Table A3.1.

Table A3.1: Summary of Traffic Data used in the Assessment (AADT)

Road Link	2011	2011 % HGVs	2013 (Without Scheme)	2013 (Without Scheme) % HGVs	2013 (With Scheme)	2013 (With Scheme) % HGVs
A280 South of Water Lane	8,045	1.14%	8,119	1.14%	8,176	1.14%
Water Lane East of High Street	6,844	0.37%	6,907	0.37%	7,370	0.34%
Water Lane West of High Street	5,247	0.36%	5,295	0.36%	5,295	0.36%
Weavers Hill	1,126	11.9%	1,136	11.9%	1,436	9.42%
High Street	1,685	0.36%	1,701	0.36%	1,773	0.34%
Roundstone Lane	3,025	4.63%	3,053	4.63%	3,519	4.01%
A259 East	29,408	1.26%	29,677	1.26%	30,045	1.24%
A259 Roundstone Bypass	27,660	0.83%	27,913	0.83%	28,243	0.82%
Site Entrance	-	-	-	-	466 ^a	0%

^a This was calculated using the Roundstone Lane without and with development AADT flows.

⁴ i.e. combining current-year emission factors with future-year traffic data.

Model Verification

- A3.8 In order to ensure that ADMS-Roads accurately predicts local concentrations, it is necessary to verify the model against local measurements. The verification methodology is described below.
- A3.9 Background concentrations of nitrogen dioxide have been derived from the national maps of background concentrations available from the Defra LAQM Support website (Defra, 2012a) following the method outlined in Paragraph A3.2. The background concentration for the diffusion tube location is presented in Table A3.2.

Table A3.2: Background Concentrations used in the Verification for 2011

	Grid square	NO ₂
Worthing Road	503500, 103500	13.19

- A3.10 AADT flows, and the proportions of HDVs, for the A259 Worthing Road adjacent to the monitoring site, have been determined from the interactive web-based map provided by the Department for Transport (DfT, 2012). The 2010 AADT flows were factored forwards to 2011 for model verification purposes using the TEMPRO System v6.2 (DfT, 2011) (a growth factor of 1.0107 was applied). Traffic data used in the model verification are presented in Table A3.3.

Table A3.3: AADT Traffic Data used in the Model Verification

Road Link	2011					
	Motorcycles	Cars	Taxis	Buses/ Coaches	Light Goods Vehicles	HGVs
A259 Worthing Road	159	16,184	0	44	2,978	591

- A3.11 Most nitrogen dioxide (NO₂) is produced in the atmosphere by reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides (NO_x = NO + NO₂). The model has been run to predict the annual mean NO_x concentrations during 2011 at the Worthing Road diffusion tube monitoring site.
- A3.12 The model output of road-NO_x (i.e. the component of total NO_x coming from road traffic) has been compared with the 'measured' road-NO_x. Measured road-NO_x was calculated from the measured NO₂ concentration and the predicted background NO₂ concentration using the NO_x from NO₂ calculator available on the Defra LAQM Support website (Defra, 2012a).
- A3.13 An adjustment factor was determined as the ratio of the 'measured' road contribution and the model derived road contribution. This factor was then applied to the modelled road-NO_x concentration for each receptor to provide adjusted modelled road-NO_x concentrations. The total nitrogen dioxide concentrations were then determined by combining the adjusted modelled road-

NO_x concentrations with the predicted background NO₂ concentration within the NO_x from NO₂ calculator (Defra, 2012a).

A3.14 The data used to calculate the adjustment factor are provided below:

- Measured NO₂ : 24 µg/m³
- Background NO₂ : 13.19 µg/m³
- 'Measured' road-NO_x (from NO_x to NO₂ calculator): 21.99 µg/m³
- Modelled road-NO_x = 7.289 µg/m³
- Road-NO_x adjustment factor: 21.99/7.289 = **3.02**

A3.15 The factor implies that the unadjusted model is under-predicting the road-NO_x contribution. This is a common experience with this and most other models.

PM₁₀ and PM_{2.5}

A3.16 There are no nearby PM₁₀ or PM_{2.5} monitors. It has therefore not been possible to verify the model for PM₁₀ or PM_{2.5}. The model outputs of road-PM₁₀ and road-PM_{2.5} have therefore been adjusted by applying the primary adjustment factor calculated for road NO_x.

A3.17 The number of exceedences of 50 µg/m³ as a 24-hour mean PM₁₀ concentration has been calculated from the adjusted-modelled total annual mean concentration following the relationship advised by (Defra, 2009):

$$A = -18.5 + 0.00145 B^3 + 206/B$$

where A is the number of exceedences of 50 µg/m³ as a 24-hour mean PM₁₀ concentration and B is the annual mean PM₁₀ concentration. The relationship is only applied to annual mean concentrations greater than 16.5 µg/m³, below this concentration, the number of 24-hour exceedences is assumed to be zero.