



Manor Hayes Ltd

Residential Development, 128 Milton Road, Gravesend

Air Quality Assessment

February 2018



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Gravesham Borough Council

Document Control Sheet

Identification	
Client	Manor Hayes Ltd.
Document Title	Proposed Residential Development, 128 Milton Road, Gravesend
Bureau Veritas Ref No.	6474060

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Configuration				
Version	Date	Author	Reason for Issue/Summary of Changes	Status
01	16/02/2018	Hannah Smith	Draft for comment	Draft

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Gravesham Borough Council

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Executive Summary

Bureau Veritas UK Ltd has been commissioned by Manor Hayes Ltd to undertake an air quality assessment in support of an application for the conversion of an existing first floor residential property into eighteen new apartments spread across three floors at 128 Milton Road, Gravesend. It is understood that the development is currently midway through construction, with the main structure and roof construction completed.

Bureau Veritas prepared the original air quality impact assessment, which was issued in December 2007. Gravesham Borough Council (GBC) have since requested an updated assessment to take into consideration the changes in air quality in the area and the improvements to the dispersion modelling methodology since the original report was issued. Specific focus has been requested with regards to assessing potential exposure to poor air quality across the three floors of the building to help advise on ventilation options.

This assessment focuses on the quantitative prediction of pollutants associated with road traffic (the main pollution source in the vicinity of the development) in relation to levels of nitrogen dioxide (NO₂) and Particulate Matter (PM₁₀ and PM_{2.5}) to which residents may be exposed to upon completion of the development. Comparison with the relevant AQS objectives is made.

The ADMS-Roads dispersion model (version 4.0.1) has been used to determine the likely NO₂, PM₁₀ and PM_{2.5} concentrations at proposed receptor locations situated over the three floors allocated for residential use at the Site.

The main findings of the air quality assessment are summarised as follows:

- There are no exceedances of the NO₂ annual mean AQS objective at any of the assessed receptor locations. The maximum annual mean NO₂ concentration in the 2018 DS scenario was 23.7µg/m³, predicted on the first floor at locations D1 and D2. This represents 59.2% of the annual mean objective, and so it is unlikely that future residents will be exposed to elevated concentrations of NO₂. Exceedances of the 1-hour NO₂ AQS objective are also considered to be unlikely at any of the receptor locations assessed based on levels being lower than the empirically determined threshold of risk using 60µg/m³ (annual mean) as a surrogate to the hourly objective.
- There are no exceedances of the annual mean or short term AQS objectives for PM₁₀ at any of the receptor locations assessed. The maximum annual mean PM₁₀ concentration in the 2018 DS scenario was 15.1µg/m³, predicted on the first floor at locations D1, D2, D3 and D4. This represents 37.8% of the annual mean objective, and so it is unlikely that future residents will be exposed to elevated concentrations of PM₁₀.
- There are no exceedances of the annual mean AQS objective for PM_{2.5} at any of the receptor locations assessed. The maximum annual mean PM_{2.5} concentration in the 2018 DS scenario was 10.3µg/m³, also predicted on the first floor at locations D1, D2, D3 and D4. This represents 41.3% of the annual mean objective, and so it is unlikely that future residents will be exposed to elevated concentrations of PM₁₀.
- The predicted concentrations of NO₂, PM₁₀ and PM_{2.5} within the Site are well below both the annual mean and short term AQS objectives, therefore the future residents of the proposed development will not be exposed to any pollutant concentrations above the current AQS objectives.
- Best practice measures are recommended wherever possible to ensure adverse air quality impacts are avoided in the future. If ventilation systems are installed, it is recommended that clean air should be drawn from the rear façade of the building. Inlets should also be located as high up the building as possible due to pollutant concentrations worsening the closer to ground level receptors are located.

1 Introduction

Bureau Veritas UK Ltd has been commissioned by Manor Hayes Ltd to undertake an air quality assessment in support of an application for the conversion of an existing first floor residential property into eighteen new apartments spread across three floors at 128 Milton Road, Gravesend. It is understood that the development is currently midway through construction, with the main structure and roof construction completed.

Bureau Veritas prepared the original air quality impact assessment, which was issued in December 2007. Gravesham Borough Council (GBC) have since requested an updated assessment to take into consideration the changes in air quality in the area and the improvements to the dispersion modelling methodology since the original report was issued. Specific focus has been requested with regards to assessing potential exposure to poor air quality across the three floors of the building to help advise on ventilation options. The original report recommended that air intakes were installed at the rear of the building to ventilate the first and second floor roadside residential units. The updated assessment will confirm whether these recommendations are still applicable to the development.

The A226 One-way System Air Quality Management Area (AQMA) was designated for exceedances of annual mean NO₂ in 2005. It encompasses the main road links surrounding Gravesend town centre and extends along Milton Road to Cumberland Avenue. Therefore, the development site is located within the boundary of this AQMA.

1.1 Scope of Assessment

It is understood that Manor Hayes Ltd. require an air quality assessment to assess the air quality impact resulting from the current poor air quality in the surrounding area on future residents of the development.

The scope of this assessment is therefore to:

- Assess the air quality at selected locations (“receptors”) which are representative of worst-case exposure. The receptors will be located at the façade of the development across the three floors in order to determine concentrations of NO₂ and particulate matter (PM₁₀ and PM_{2.5}) at these locations, based on modelling of emissions from road traffic on the local road network for the baseline year 2017 and the predicted opening year of 2018;
- Compare the predicted air pollutant concentrations at future receptor locations with the objectives set out by the UK Government in The Air Quality Strategy (AQS)¹, and the Air Quality (England) Regulations 2000² and (Amended 2002 version³) for Local Air Quality Management (LAQM) purposes, in order to identify any issues pertinent to the exposure of residents to these pollutants; and
- Review options for mitigation for the operational phase, should poor air quality be predicted.

Bureau Veritas have not been made aware of any central energy generation associated with the development; therefore, emissions associated with any on-site energy generation during the operational phase has not been undertaken as part of this assessment.

¹ The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007), Published by Defra in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland.

² The Air Quality (England) Regulations 2000 (Statutory Instrument 928).

³ The Air Quality (England) (Amendments) Regulations 2002 (Statutory Instrument 3043).

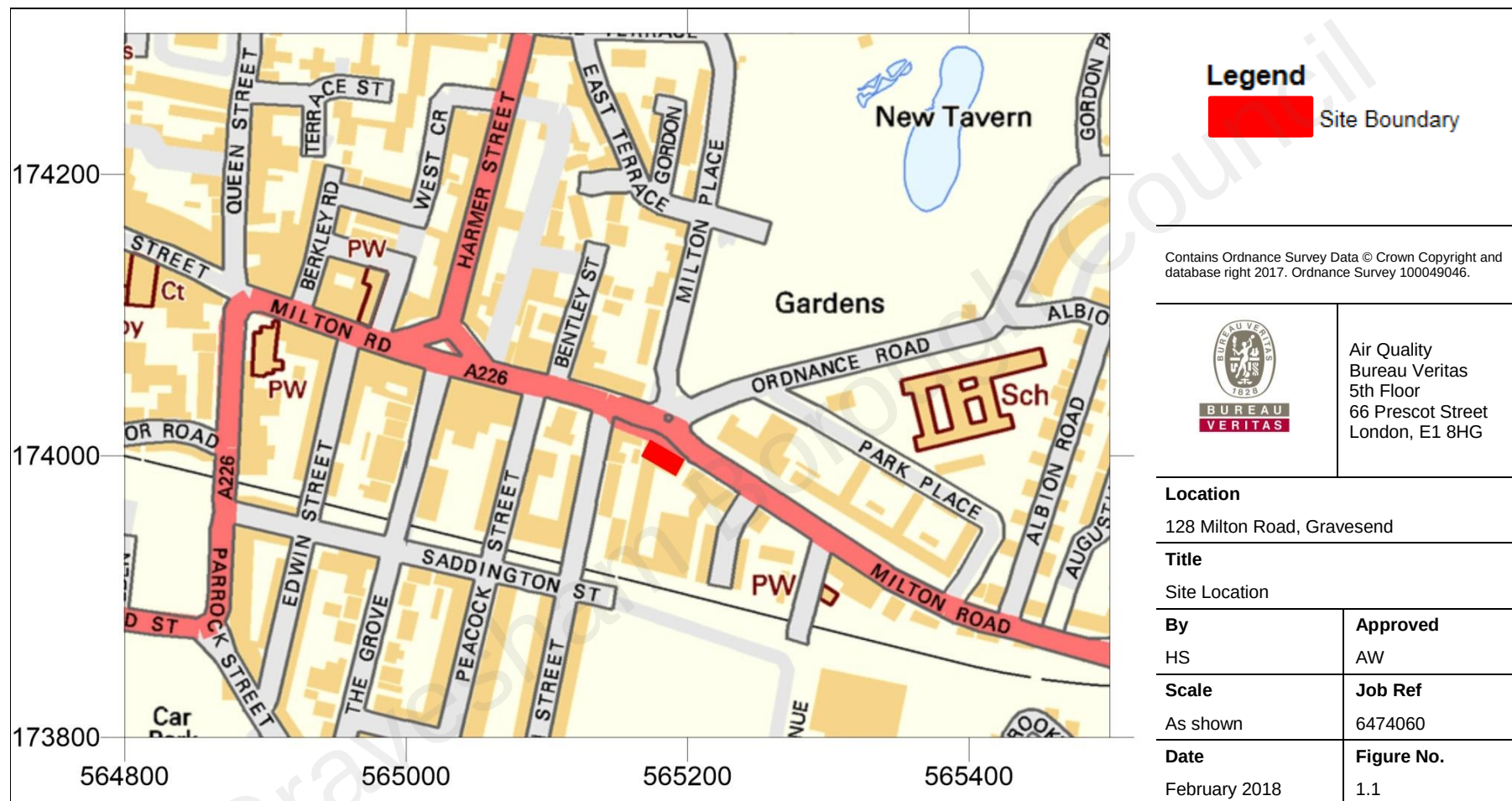
The approach adopted in this assessment to assess the impact of road traffic on air quality is based on using the Cambridge Environmental Research Consultants (CERC) ADMS-Roads™ dispersion model (version 4.0.1) with the latest vehicle emission factors released by the Department for Environment, Food and Rural Affairs (Defra) in 2017 (Emissions Factors Toolkit (EFT) version 8.0.1). The assessment will focus on NO₂ and particulate matter (PM₁₀ and PM_{2.5}). These pollutants are the main pollutants of concern associated with traffic emissions both nationally and within the Council's administrative area. The pollutant concentrations will be compared against the relevant AQS objectives. Further general information in relation to these pollutants and urban pollution is provided in Appendix 1.

In order to provide consistency with the Council's own work on air quality, the guiding principles for air quality assessments as set out in the latest guidance, and the tools provided by Defra for air quality assessments (LAQM.TG(16)⁴) have been used where relevant.

The Site location is illustrated in Figure 1.1.

⁴ LAQM Technical Guidance LAQM.TG(16) – April 2016. Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland.

Figure 1.1 – Site Location



2 Air Quality – Legislative Context

2.1 Air Quality Strategy

The importance of existing and future pollutant concentrations can be assessed in relation to the national air quality standards and objectives established by Government. The Air Quality Strategy¹ (AQS) provides the over-arching strategic framework for air quality management in the UK and contains national air quality standards and objectives established by the UK Government and Devolved Administrations to protect human health. The air quality objectives incorporated in the AQS and the UK Legislation are derived from Limit Values prescribed in the EU Directives transposed into national legislation by Member States.

The CAFE (Clean Air for Europe) programme was initiated in the late 1990s to draw together previous directives into a single EU Directive on air quality. The CAFE Directive⁵ has been adopted and replaces all previous air quality Directives, except the 4th Daughter Directive⁶. The Directive introduces new obligatory standards for PM_{2.5} for Government but places no statutory duty on local government to work towards achievement of these standards.

The Air Quality Standards (England) Regulations⁷ 2010 came into force on 11 June 2010 in order to align and bring together in one statutory instrument the Government's obligations to fulfil the requirements of the new CAFE Directive.

The objectives for ten pollutants – benzene (C₆H₆), 1,3-butadiene (C₄H₆), carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO₂), sulphur dioxide (SO₂), particulate matter (PM₁₀ and PM_{2.5}), ozone (O₃) and Polycyclic Aromatic Hydrocarbons (PAHs), have been prescribed within the AQS¹.

The EU Limit Values are considered to apply everywhere with the exception of the carriageway and central reservation of roads and any location where the public do not have access (e.g. industrial sites).

The AQS objectives apply at locations outside buildings or other natural or man-made structures above or below ground, where members of the public are regularly present and might reasonably be expected to be exposed to pollutant concentrations over the relevant averaging period. Typically these include residential properties and schools/care homes for long-term (i.e. annual mean) pollutant objectives and high streets for short-term (i.e. 1-hour) pollutant objectives.

Table 2.2 Table 2.1 taken from LAQM.TG(16)⁴ provides an indication of those locations that may or may not be relevant for each averaging period.

This assessment focuses on NO₂, PM₁₀ and PM_{2.5} as these are the pollutants of principal concern arising from road traffic, and it is from road traffic sources that potential impacts from the development may arise. The current AQMA designated by Gravesham Borough Council has been declared due to exceedances of the NO₂ annual mean AQS objective and have been attributed to emissions from nearby road sources. Moreover, as a result of traffic pollution the UK has failed to meet the EU Limit Values for NO₂ by the 2010 target date. The Government has subsequently had to submit time extension applications for compliance with the EU Limit Values. Continued failure to achieve these limits may lead to EU fines, and has already led to an infraction by Government. The AQS objectives for these pollutants are presented in Table 2.2.

In July 2017, the UK government published its plan for tackling roadside nitrogen dioxide⁸ concentrations, which are, in many places in the UK, in exceedance of the above objectives. This

⁵ Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.

⁶ Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic hydrocarbons in ambient air.

⁷ The Air Quality Standards Regulations (England) 2010, Statutory Instrument No 1001, The Stationary Office Limited.

sets out government policies for bringing NO₂ air pollution within statutory limits in the shortest possible time. Furthermore, a wider Clean Air Strategy is also set for publication in 2018 which will outline how the UK will meet international commitments to significantly reduce emissions of five damaging air pollutants by 2020 and 2030.

Table 2.1 – Examples of where the AQS Objectives should apply

Averaging Period	AQS Objectives should apply at:	AQS Objectives should generally not apply at:
Annual mean	All locations where members of the public might be regularly exposed Building facades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. 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. Gardens of residential properties ¹ .	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour mean	All locations where the annual mean and 24 and 8-hour mean objectives would apply. 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.	Kerbside sites where the public would not be expected to have regular access.
15-minute mean	All locations where members of the public might reasonably be expected to spend a period of 15 minutes or longer.	
Note: 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.		

Table 2.2 – Relevant AQS Objectives for the Assessed Pollutants in England

Pollutant	AQS Objective	Concentration Measured as:	Date for Achievement
Nitrogen dioxide (NO ₂)	200µg/m ³ not to be exceeded more than 18 times per year	1-hour mean	31st December 2005
	40µg/m ³	Annual mean	31st December 2005
Particles (PM ₁₀)	50µg/m ³ not to be exceeded more than 35 times per year	24-hour mean	31st December 2005
	40µg/m ³	Annual mean	31st December 2005
Particles (PM _{2.5})	25µg/m ³	Annual mean	2020
	Target of 15% reduction in concentrations at urban background	Annual Mean	2020

⁸ <https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017>

2.2 Local Air Quality Management (LAQM)

Part IV of the Environment Act 1995⁹ places a statutory duty on local authorities to periodically Review and Assess the current and future air quality within their area, and determine whether they are likely to meet the AQS objectives set down by Government for a number of pollutants – a process known as Local Air Quality Management (LAQM). The AQS objectives that apply to LAQM are defined for seven pollutants: benzene, 1,3-butadiene, carbon monoxide, lead, nitrogen dioxide, sulphur dioxide and particulate matter.

Where the results of the Review and Assessment process highlight that problems in the attainment of health-based objectives for air quality will arise, the authority is required to declare an AQMA – a geographic area defined by high concentrations of pollution and exceedances of health-based standards.

Where an authority has declared an AQMA, and development is proposed to take place either within or near the declared area, further deterioration to air quality resulting from a proposed development can be a potential barrier to gaining consent for the development proposal. Similarly, where a development would lead to an increase of the population within an AQMA, the protection of residents against the adverse long-term impacts of exposure to existing poor air quality can provide the barrier to consent. As such, after a high number of declarations across the UK, it has become standard practice for planning authorities to require an air quality assessment to be carried out for a proposed development (even where the size and nature of the development indicates that a formal Environmental Impact Assessment (EIA) is not required).

One of the objectives of the LAQM regime is for local authorities to enhance integration of air quality into the planning process. Current LAQM Policy Guidance¹⁰ clearly recognises land-use planning as having a significant role in terms of reducing population exposure to elevated pollutant concentrations. Generally, the decisions made on land-use allocation can play a major role in improving the health of the population, particularly at sensitive locations – such as schools, hospitals and dense residential areas.

2.3 National Planning Policy

The National Planning Policy Framework¹¹ (NPPF), published on 27 March 2012, states that the planning system should contribute to and enhance the natural and local environment, by preventing new development from contributing or being adversely affected by unacceptable concentrations of air pollution. In specific relation to the air quality policy, the document states:

“Planning policies should sustain compliance with, and contribute towards EU Limit Values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan”.

2.4 Local Planning Policy

The Gravesham Local Plan Core Strategy was adopted in September 2014. It sets out a long-term vision for the future of the borough to help guide the planning process to ensure future developments align with the overall commitment to support existing and future communities and ensure Gravesham remains an attractive place to live and work.

⁹ <http://www.legislation.gov.uk/ukpga/1995/25/part/IV>

¹⁰ LAQM Policy Guidance LAQM.PG(16) – April 2016. Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland.

¹¹ National Planning Policy Framework (2012). Available at: <https://www.gov.uk/government/publications/national-planning-policy-framework--2>

Air quality is a key part of the strategy and is addressed within several policies (CS01, CS11, CS10) throughout the strategy as well as within the following strategic objective:

“SO17: Increase accessibility, reduce the need to travel, minimise congestion and improve air quality through the improved provision of local public transport and the provision of local jobs and services.”

The air quality strategy for Gravesham Borough Council was published in 2006 and is designed to address wider air pollution issues in the Borough and prevent air quality deteriorating by taking action to improve air quality. It provides a framework for future air quality issues and a commitment to the following strategy policies:

“Policy 1: The Council will continue to fulfil its statutory duties under the Environmental Act 1995 Part IV Local Air Quality Management and meet the target deadlines for reporting as set by Defra.

Policy 2: The Council will implement the Council’s Sustainable Travel Plan measures and encourage uptake of sustainable modes of transport. The Council will periodically review the Travel Plan and assess progress with achieving the targets set.

Policy 3: The Council will ensure that the recommendations to further improve emissions from the Council fleet will be fully considered and developments reported within air quality strategy progress updates.

Policy 4: The Council will continue to address its own energy usage within Council buildings through adoption of efficient energy practices and use of the best available technology to deliver energy savings.

Policy 5: The Council, in partnership with the other Kent local authorities, will continue to fulfil its statutory duties with respect to waste management and build upon its current achievements to meet the recycling and composting targets. The Council will ensure that air quality is integrated into the waste management option appraisal process.

Policy 6: The Council will monitor its procurement to ensure that the Council’s Procurement Strategy aims are implemented and subsequent Procurement Plans Page 1 include appropriate consideration to environmental impacts and sustainability appraisal.

Policy 7: The Council will continue to work together with Kent County Council on sustainable transport issues within the Borough to secure necessary air quality improvements and encourage more sustainable transport modes to the car to prevent further deterioration in air quality.

Policy 8: The Council will ensure that the aims of the Air Quality Strategy are integrated into all relevant Council’s policies and strategies, (including the Local Development Framework, Community Strategy and Corporate Plan) and that air quality policies are adopted which ensure that future air quality is protected and enhanced through sustainable development.

Policy 9: The Council will regularly review its Code of Construction Practice to ensure that changes in guidance are taken into account and the recommendations represent best practice.

Policy 10: The Council will continue to work closely with businesses and industries within the Borough to secure necessary air quality improvements and encourage more sustainable practices through uptake of Travel Plans and awareness raising initiatives through the Local Business Partnership.

Policy 11: The Council will continue to work together with Kent County Council on work with schools within the Borough to secure air quality improvements through the development of school Travel Plans and encouragement of sustainable practices.

Policy 12: The Council will continue to work together with the Kent Energy Centre to promote and implement energy efficiency measures in Gravesham. Gravesham Borough Council will work in partnership with Kent County Council to implement the Kent Strategy sustainable energy policies.

Policy 13: The Council will continue to work together with the Primary Care Trusts to promote and implement health initiatives in Gravesham and help deliver environmental improvements to secure public health benefits. Subsequent reviews of the Public Health Strategy will emphasise the link between air quality and health to raise awareness of the impacts of poor air quality.

Policy 14: The Council will make details of the Air Quality Strategy policies and review and assessment reports available on the Website to ensure broad access to the consultation and implementation process.

Policy 15: The Council will continue to work together with the Kent and Medway Air Quality Partnership on promotional activities to raise the profile of air quality in Gravesham."

3 Review and Assessment of Air Quality Undertaken by the Council

3.1 Local Air Quality Management

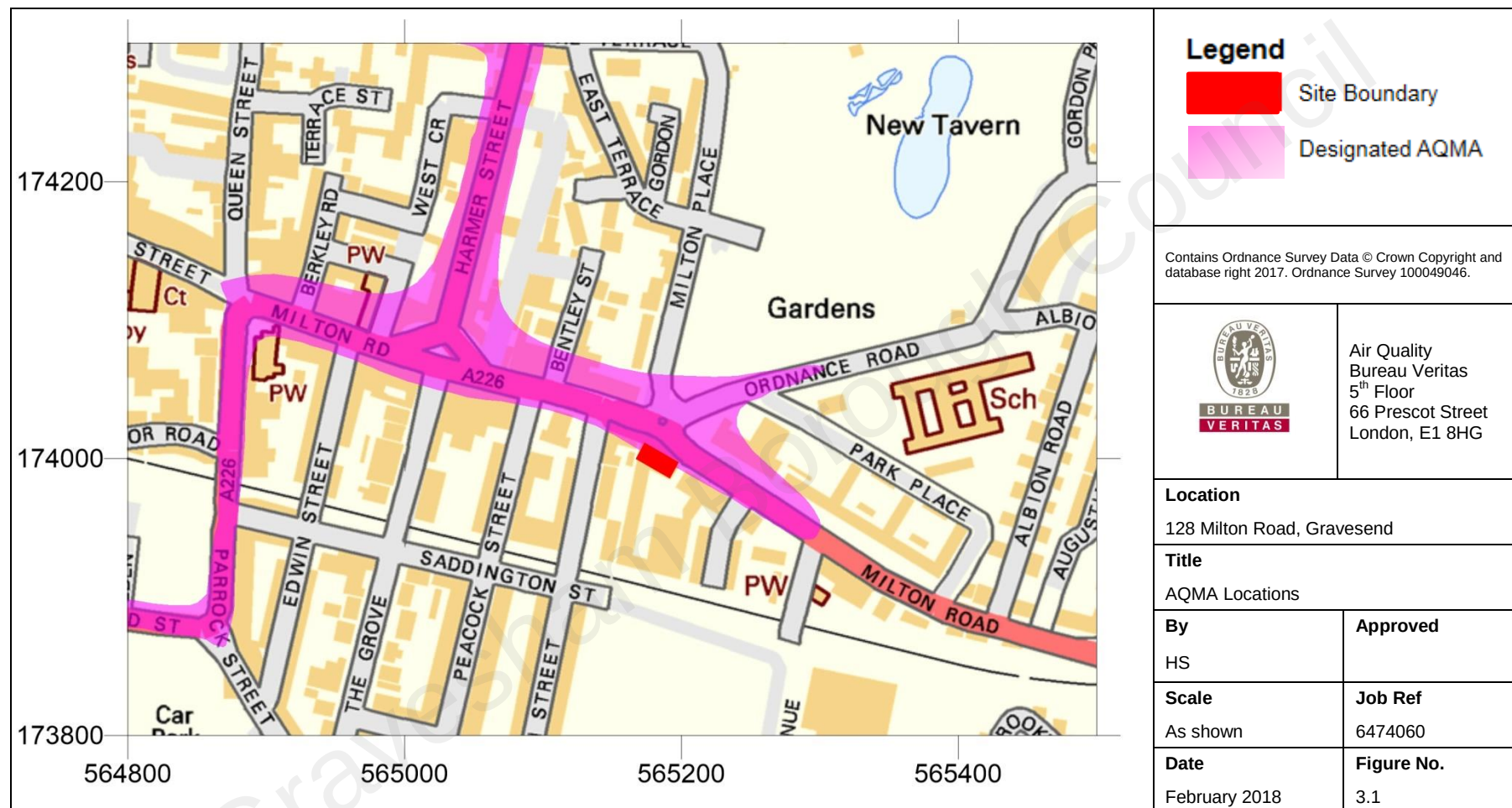
The Site is located on the south side of Milton Road in Gravesend within the jurisdiction of Gravesham Borough Council. There are no large scale point sources of pollution close to the site and therefore the main source of pollution in the area is from road traffic emissions from the surrounding road network, which will be explicitly modelled.

A total of seven AQMAs have been declared by the Council, six for exceedances of the annual mean NO₂ Air Quality Strategy (AQS) objective and one for exceedances of the 24-hour mean PM₁₀ AQS objective. The Council are currently reviewing the status of the declared AQMAs and looking into revoking several AQMAs which have shown improvements over the past 5 years. The site is located within the A226 One-way system in Gravesend AQMA, which is the largest AQMA in the borough and is not being considered for removal. Figure 3.1 shows the location of the site in relation to the AQMA.

The most recent LAQM report completed by the Council is the 2017 Annual Status Report (ASR), completed as part of the statutory annual Review and Assessment of air quality, which includes details of the monitoring data for 2016. Furthermore, the 2017 monitoring data has been published on the Kentair website¹² and will therefore be used within the assessment to represent the most up to date air quality conditions in the area.

¹² <http://www.kentair.org.uk/>

Figure 3.1 – AQMA Boundaries



3.2 Review of Air Quality Monitoring

3.2.1 Local Automatic Air Quality Monitoring

Automatic (continuous) monitoring is carried out at two locations within GBC. The Roadside site is located along the A2 and the Industrial Background site is located in the Northfleet Industrial Area. Both instruments measure NO₂ concentrations. Details of the monitoring stations are provided in Table 3.1.

Table 3.1 – Automatic Monitoring Stations

Site	Site Name	Site Type	OS Grid Ref	Annual Mean Concentration (µg/m ³)				
				2013	2014	2015	2016	2017*
ZG2	Gravesham A2 Roadside	Roadside	562589, 172076	31.4	30.9	30	29.6	31.6
ZG3	Gravesham Industrial Background	Industrial Background	562155, 174360	31.1	24.4	23.4	24.1	-

*Provisional data

Both instruments are over 2km from the development site and as a result have not been used for the model verification.

The Council operate a non-automatic monitoring network that in 2017 comprised of 67 diffusion tube monitoring locations, of which seven are within close proximity of the Site. The details of the monitoring locations are presented in Table 3.2 and illustrated in Figure 3.2. It can be seen that the NO₂ annual mean AQS objective was exceeded at 4 of the 7 monitoring locations and a further monitoring site (GR58) was within 10% of the objective.

The sites considered for the verification of the dispersion model are detailed in Appendix 2 – ADMS Model Verification. LAQM.TG(16)⁴ recommends only roadside sites be used to verify model performance at receptors adjacent to road sources.

Table 3.2 – Council Diffusion Tube Monitoring Locations

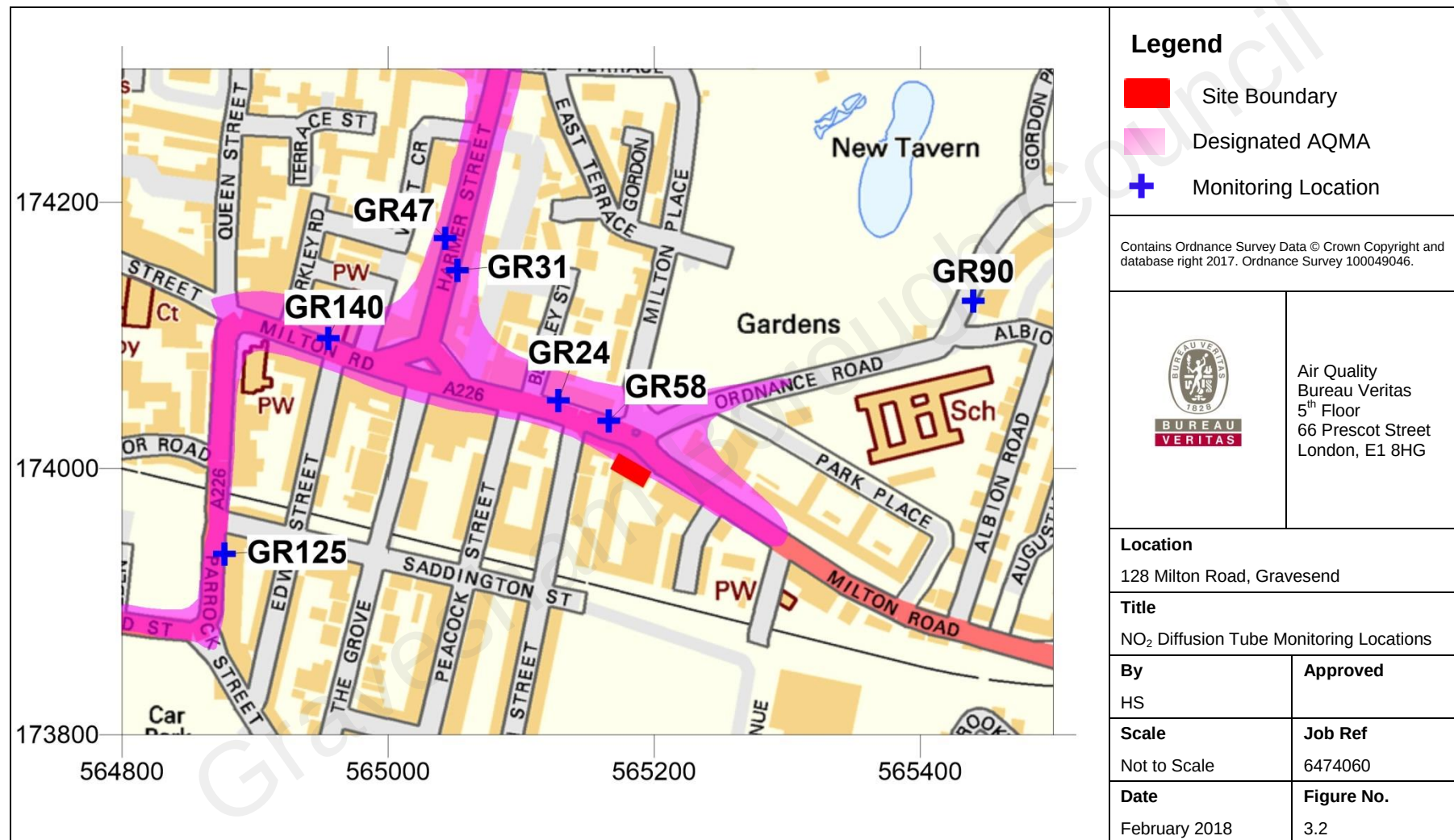
Site ID	Site Location	Site Type	OS Grid Ref (X)	OS Grid Ref (Y)	Approx. Distance to Site (m)	2015 Data Capture (%)	2017 Annual Mean NO ₂ Concentration (µg/m ³)
GR24	28- 29 Milton Road	R	565128	174051	56	100	42.4
GR31	32 Harmer Street	R	565052	174149	179	100	42.7
GR47	29-31 Harmer Street	R	565043	174173	204	100	41.3
GR58	The Venue, Milton Road	R	565166	174036	22	100	39.0
GR90	Canal Road	R	565440	174126	273	92	30.8
GR125	Café Taj, 170 Parrock Street	R	564877	173936	295	100	32.3
GR140	13-14 Milton Road	R	564955	174098	230	17*	42.5

The 2017 monitoring results have been derived from the Kentair website and bias adjusted using a national factor of 0.77
R = Roadside

Exceedances of the NO₂ annual mean AQS objective in bold

*Monitoring commenced in November 2017

Figure 3.2 – Local NO₂ Diffusion Tube Monitoring Locations



3.3 Defra Background Concentration Used in the Assessment

Defra maintains a nationwide model of existing and future background air quality concentrations at a 1km grid square resolution. The data sets include annual average concentration estimates for NO_x, NO₂, PM₁₀ and PM_{2.5}, using a base year of 2015. The model used is semi-empirical in nature; it uses the National Atmospheric Emissions Inventory (NAEI) emissions to model-predict the concentrations of pollutants at the centroid of each 1km grid square, but then calibrates these concentrations in relation to actual monitoring data.

Annual mean background concentrations have been obtained from the Defra published background maps¹³, based on the 1km grid squares which cover the modelled area and the affected road network. The Defra mapped background concentrations for the base year of 2017 and the predicted opening year of the development (2018) are presented in Table 3.3. The predicted annual mean road contributions are added to the relevant annual mean background concentration in order to predict the total pollutant concentration at each receptor location. The total pollutant concentration can then be compared against the relevant AQS objective to determine the event of an exceedance.

Table 3.3 – Defra Background Pollutant Concentrations

Grid Square (E,N)	2017 Annual Mean Background Concentration (µg/m ³)				2018 Annual Mean Background Concentration (µg/m ³)			
	NO _x	NO ₂	PM ₁₀	PM _{2.5}	NO _x	NO ₂	PM ₁₀	PM _{2.5}
565500, 174500	29.9	20.3	14.6	10.1	29.2	19.9	14.5	10.0
564500, 173500	22.8	16.3	14.8	10.0	21.9	15.7	14.7	9.8
565500, 173500	22.3	15.9	14.4	9.8	21.5	15.4	14.3	9.7
AQS objective	-	40	40	25	-	40	40	25

All of the mapped background concentrations presented are well below the respective annual mean AQS objectives.

¹³ Defra Background Maps (2015). <http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html>

4 Assessment Methodology

The approach applied to this assessment has been based on the following:

- Quantitative prediction of the ambient NO₂, PM₁₀ and PM_{2.5} concentrations to which new receptors may be exposed to upon completion of the development, based on modelling of emissions from road traffic on the local road network, and comparison with the relevant AQS objectives.

4.1 Operational Inputs

The following scenarios have been assessed relating to operational impacts from road traffic:

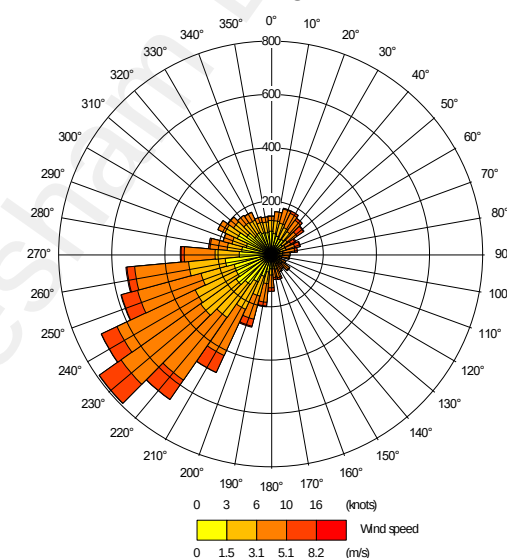
- 2017 Base Case (2017 BC) - Without development base flows for the year (2017), used for the purposes of model verification;
- 2018 Do Something (2018 DS) - With development for the proposed year of opening (2018);

A 2018 Base Case scenario was not required as there are no expected increases in traffic as a result of the development scheme. Therefore an impact assessment on existing receptors was not required.

4.1.1 Meteorological Data

Meteorological data from a representative station is required by the dispersion model. 2017 meteorological data from Gatwick Airport's Charlwood weather station, approximately 50km southwest from the Site, has been used in this assessment. A wind rose for the weather station for the year 2017 is shown in Figure 4.1.

Figure 4.1 – Wind rose for Charlwood Meteorological Data 2017



Most dispersion models do not use meteorological data if they relate to calm winds conditions, as dispersion of air pollutants is more difficult to calculate in these circumstances. ADMS-Roads treats calm wind conditions by setting the minimum wind speed to 0.75m/s. It is recommended in LAQM.TG(16)⁴ that the meteorological data file be tested within a dispersion model and the relevant output log file checked, to confirm the number of missing hours and calm hours that cannot be used by the dispersion model. This is important when considering predictions of high percentiles and the number of exceedances. LAQM.TG(16)⁴ recommends that meteorological

data should have a percentage of usable hours greater than 85%. If the data capture is less than 85% short-term concentration predictions should be expressed as percentiles rather than as numbers of exceedances. 2017 meteorological data from Charlwood includes 7,522 lines of usable hourly data out of the total 8,760 for the year, i.e. 86% usable data. This is therefore suitable for the dispersion modelling exercise.

4.1.2 Traffic Inputs

Assessing the air quality effects of a proposed development that affects local traffic flows is typically carried out by using an atmospheric dispersion model to calculate pollutant concentrations at sensitive human receptors, based on the calculated vehicle exhaust emissions, having due regard to their spatial distribution. Background pollutant concentrations are taken into account in the calculation of total pollutant concentrations. Where possible the performance of the dispersion model is evaluated by comparison against measured pollutant concentrations from the monitoring sites within the study area, through a process known as model verification. Future concentrations then can be predicted with and without the proposed development and compared with the relevant air quality standards and significance criteria.

The ADMS-Roads assessment incorporates numbers of road traffic vehicles, vehicle speeds on the local roads and the composition of the traffic fleet. As the development is assumed to be car-free there is not expected to be a significant increase in traffic on the road network as a result of the development. Therefore, the assessment will be based on the existing traffic conditions on the surrounding road network. The traffic data for this assessment has been derived from the Department for Transport (DFT) Traffic Counts website.

Traffic speeds were based on speed limits across the road network. However, where appropriate, the speeds have been reduced to simulate queues at junctions, traffic lights and other locations where queues are known to be an issue. Traffic speeds have been assumed to be consistent across all the modelled scenarios.

The Emissions Factor Toolkit (EFT) version 8.0.1 developed by Defra¹⁴ has then been used to determine vehicle emission factors for input into the ADMS-Roads model; these are based upon the traffic data inputs.

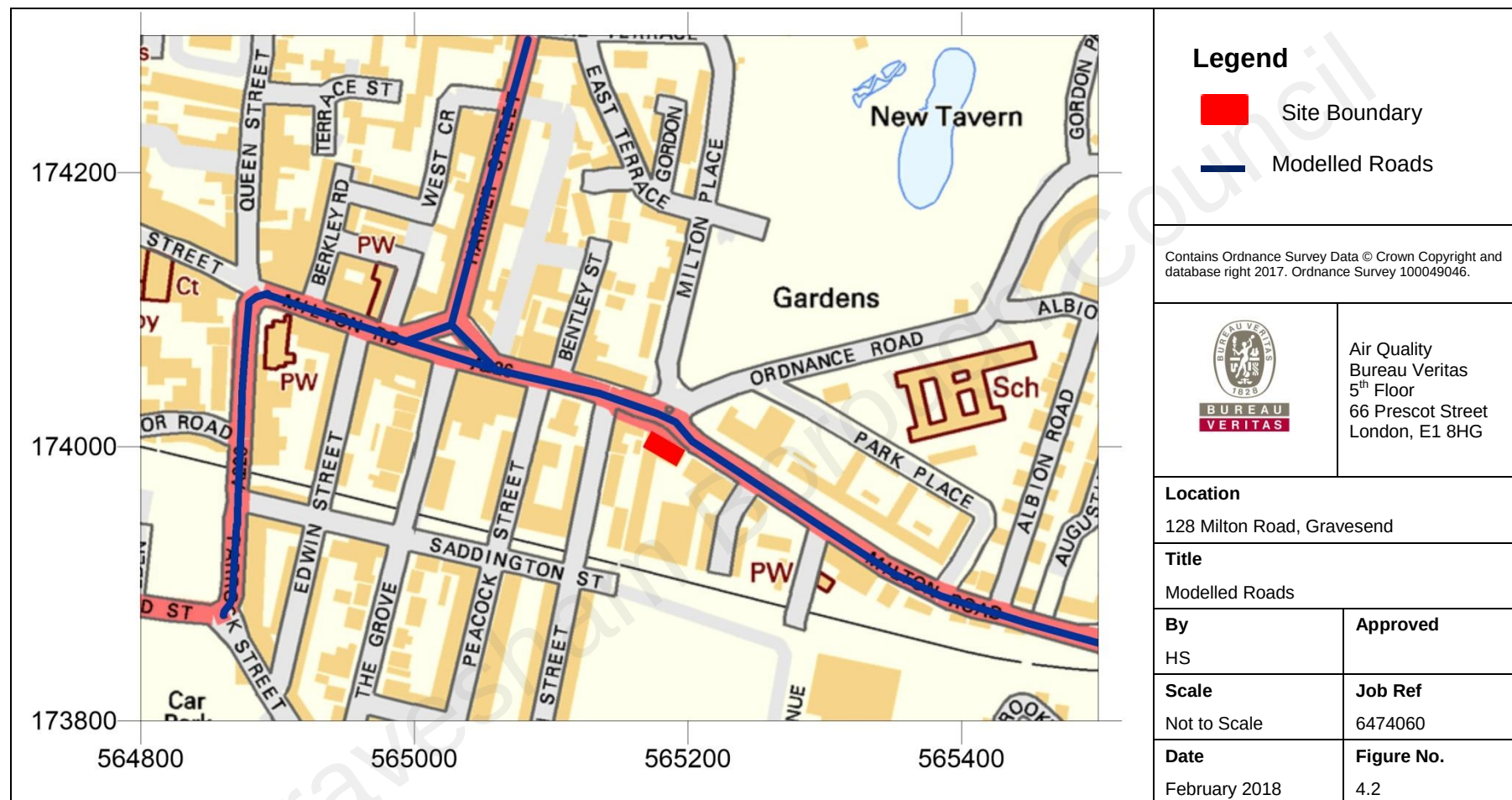
Details of the traffic flows used in this assessment are provided in Table 4.1 and the modelled roads in relation to the development site are presented in Figure 4.3.

Table 4.1 – Traffic Data used in ADMS-Roads Assessment

Link Name	2017 BC		2018 DS		Speed (kph)
	AADT	% HDV	AADT	% HDV	
Parrock Street	14262	5.2	14466	5.2	40
Harmer Street	12624	6.0	12805	6.0	40
Harmer Street Junction	6312	3.0	6403	3.0	16
Milton Road East of Harmer Street	15240	3.8	15458	3.8	40
Milton Road West of Harmer Street	14262	5.2	14466	5.2	40
Milton Road Junction	8927	3.8	9055	3.8	16
Note 1: Speeds have been reduced to simulate queues at junctions, traffic lights and other locations where queues are known to be an issue.					
Note 2: Traffic data was calculated using 2016 DfT derived traffic flows. A growth factor of 1.014 was applied for 2016 to 2017 and a growth factor of 1.029 applied for 2016 to 2018. Growth factors calculated using TEMPRO and RFT factors.					

¹⁴ Defra, Emission Factors Toolkit (2016). <http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html>

Figure 4.2 – Modelled Roads



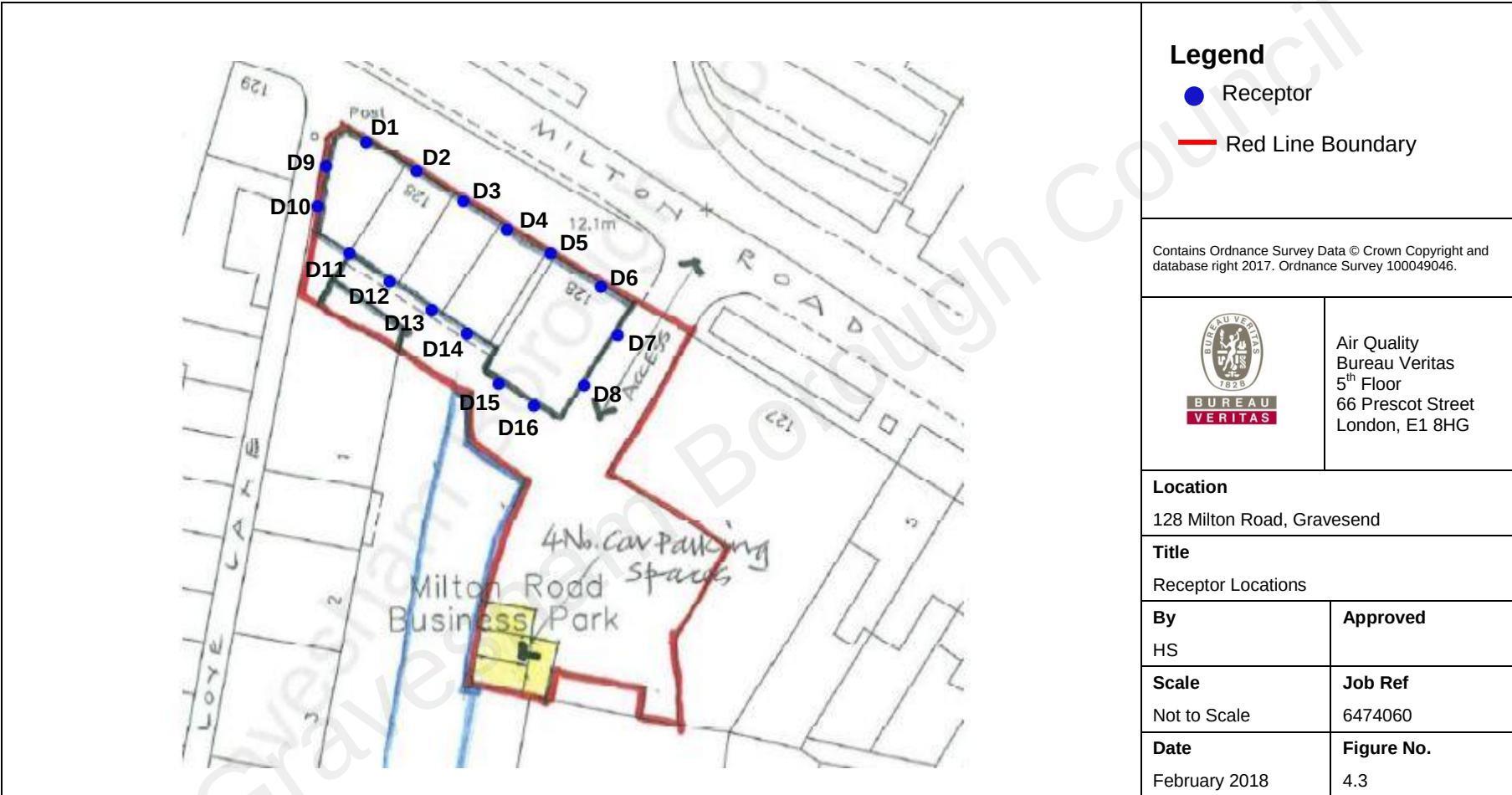
4.1.3 Sensitive Receptors

The future receptors considered in the assessment of emissions from road traffic are shown in Table 4.2 and their locations are illustrated in Figure 4.3. The receptors have been selected as the locations of worst-case exposure on the Site across the 3 floors allocated for residential use. The ground floor is to remain for commercial use only and therefore has not been assessed.

Table 4.2 – New Receptor Locations

ID	Coordinates		Height
	X	Y	
D1	565174.1	174009.4	All receptors assessed at 4.5, 8.5 and 10 meters to represent the first, second and third floor heights.
D2	565178.7	174007.3	
D3	565182.6	174004.8	
D4	565186.6	174002.2	
D5	565190.9	173999.6	
D6	565195.1	173997	
D7	565197.5	173991.9	
D8	565194.5	173987.3	
D9	565169.9	174006.4	
D10	565169	174001.4	
D11	565169.7	173997.8	
D12	565173	173995.6	
D13	565176.5	173993.4	
D14	565180	173991	
D15	565184.2	173988.6	
D16	565188.5	173986.6	

Figure 4.3 – Receptor Locations



4.1.4 Model Outputs

The background pollutant values discussed in the Section 3.3 have been used in the ADMS-Roads model to calculate predicted total annual mean concentrations of NO_x, NO₂, PM₁₀ and PM_{2.5}.

For the prediction of annual mean NO₂ concentrations for the modelled scenarios, the output of the ADMS-Roads modelled for road-NO_x has been converted to total NO₂ following the methodology in LAQM.TG(16)⁴ and using the NO_x to NO₂ conversion tool developed on behalf of Defra. This tool also utilises the total background NO_x and NO₂ concentrations. This assessment has used version 6.1 (October 2017) of the NO_x to NO₂ conversion tool¹⁵. The road contribution is then added to the appropriate NO₂ background concentration value to obtain an overall total NO₂ concentration.

For the prediction of short term NO₂ impacts, LAQM.TG(16)⁴ advises that it is valid to assume that exceedances of the 1-hour mean AQS objective for NO₂ are only likely to occur where the annual mean NO₂ concentration is 60µg/m³ or greater. This approach has thus been adopted for the purposes of this assessment.

Annual mean PM₁₀ and PM_{2.5} road contributions were also output from the model and processed in a similar manner, i.e. combined with the relevant background annual mean PM₁₀ concentrations to obtain an overall total PM₁₀ concentration.

For the prediction of short term PM₁₀, LAQM.TG(16)⁴ provides an empirical relationship between the annual mean and the number of exceedances of the 24-hour mean AQS objective for PM₁₀ that can be calculated as follows:

$$\text{Number of 24 hour Mean Exceedances} = -18.5 + 0.00145 * \text{annual mean}^3 + \frac{206}{\text{annual mean}}$$

This relationship has thus been adopted to determine whether exceedances of the short-term PM₁₀ AQS objective are likely in this assessment.

Verification of the ADMS-Roads assessment has been undertaken using local authority diffusion tube monitoring data. All results presented in the assessment are those calculated following the process of model verification, using a final adjustment factor of 1.72 derived from the methodology as detailed in Appendix 2 – ADMS Model Verification.

4.2 Uncertainty

Due to the number of inputs that are associated with the modelling of the study area there is a level of uncertainty that has to be taken into account when drawing conclusions from the predicted concentrations of NO₂, PM₁₀ and PM_{2.5}. The predicted concentrations are based upon the inputs of traffic data, background concentrations, emission factors, meteorological data, modelling terrain limitations and the availability of monitoring data from the assessment areas.

4.2.1 Uncertainty in NO_x and NO₂ Trends

Analysis of historical monitoring data within the UK has shown a disparity between measured concentration data and the projected decline in concentrations associated with emission forecasts for future years¹⁶. The report identifies that trends in ambient concentrations of NO_x and NO₂ in many urban areas of the UK have generally shown two characteristics; a decrease in

¹⁵ Defra NO_x to NO₂ Calculator (2016). <http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc>

¹⁶ Carslaw, D, Beevers, S, Westmoreland, E, Williams, M, Tate, J, Murrells, T, Steadman, J, Li, Y, Grice, S, Kent, A and Tsagatakis, I. 2011. Trends in NO_x and NO₂ emissions and ambient measurements in the UK. Prepared for Defra, 18th July 2011.

concentration from about 1996 to 2002-2004, followed by a period of more stable concentrations from 2002-2004 up until 2009. This trend of more stable recent years is expected to continue in future years. Trends in more rural, less densely trafficked areas, tend to show downward trend in either NO_x or NO₂, which are more in line with those expected.

The reason for this disparity is thought to be related to the actual on-road performance of vehicles, in particular diesel cars and vans, when compared with calculations based on the Euro emission standards. Preliminary studies suggest the following:

- NO_x emissions from petrol vehicles appear to be in line with current projections and have decreased by 96% since the introduction of 3-way catalysts in 1993;
- NO_x emissions from diesel cars, under urban driving conditions, do not appear to have declined substantially, up to and including Euro 5. There is limited evidence that the same pattern may occur for motorway driving conditions; and
- NO_x emissions from HDVs equipped with Selective Catalytic Reduction (SCR) are much higher than expected when driving at low speeds.

This disparity in the historical national data highlights the uncertainty of future year projections of both NO_x and NO₂.

Defra and the Devolved Administrations have investigated these issues and have since published an updated version of the Emissions Factor Toolkit (EFT Version 8.0.1) utilising COPERT 5 emission factors, which may go some way to addressing this disparity, but it is considered likely that a gap still remains. This assessment has utilised the latest EFT version 8.0.1¹⁴ and associated tools published Defra to help minimise any associated uncertainty when forming conclusions from this assessment.

5 Results

This assessment has considered emissions of NO₂, PM₁₀ and PM_{2.5} from road traffic at future receptor locations at the Site across the three floors allocated for residential use.

The results of the dispersion modelling are summarised below, for those receptor locations detailed in Table 4.2, and illustrated in Figure 4.3.

5.1 Assessment of Nitrogen Dioxide (NO₂)

Table 5.1 presents the annual mean NO₂ concentrations predicted at the proposed receptor locations surrounding the Site across the three floors allocated for residential use for 2017 BC and 2018 DS scenarios. A comparison against the 40µg/m³ annual mean AQS objective is also presented.

The maximum predicted annual mean NO₂ concentration for the base scenario (2017 BC) was on the first floor at locations D1 and D2. The model predicted a concentration of 24.3µg/m³ which is well below the 40µg/m³ annual mean AQS objective.

The maximum annual mean NO₂ concentration in the 2018 DS scenario was 23.7µg/m³, also predicted on the first floor at locations D1 and D2. This represents 59.2% of the annual mean objective, and so it is unlikely that future residents will be exposed to elevated concentrations of NO₂.

The empirical relationship given in LAQM.TG(16)⁴ states that exceedances of the 1-hour mean objective for NO₂ are only likely to occur where annual mean concentrations are 60µg/m³ or above. Annual mean NO₂ concentrations at all receptor locations are below this limit for all scenarios. Impacts associated with 1-hour mean NO₂ concentrations at all assessed receptor locations are therefore considered to be **not significant**.

Table 5.1 – Predicted Annual Mean NO₂ Concentrations

ID	Height (m)	Annual Mean NO ₂ (µg/m ³)			
		AQS Objective	2017 BC	2018 DS	% 2018 DS of AQS Objective
D1	4.5	40	24.3	23.7	59.2
	7.5		22.8	22.2	55.6
	10		22.0	21.5	53.8
D2	4.5	40	24.3	23.7	59.2
	7.5		22.8	22.2	55.5
	10		22.0	21.5	53.7
D3	4.5	40	24.2	23.6	59.0
	7.5		22.7	22.2	55.4
	10		22.0	21.5	53.6
D4	4.5	40	24.2	23.6	58.9
	7.5		22.7	22.1	55.3
	10		21.9	21.4	53.6
D5	4.5	40	19.9	19.2	47.9
	7.5		18.3	17.7	44.1
	10		17.5	16.9	42.4
D6	4.5	40	19.9	19.2	48.0
	7.5		18.3	17.6	44.1
	10		17.5	16.9	42.3
D7	4.5	40	19.6	18.9	47.2
	7.5		18.2	17.6	43.9
	10		17.5	16.9	42.2
D8	4.5	40	19.1	18.4	45.9
	7.5		18.1	17.4	43.6
	10		17.5	16.9	42.2
D9	4.5	40	23.9	23.2	58.1

ID	Height (m)	Annual Mean NO ₂ (µg/m ³)			
		AQS Objective	2017 BC	2018 DS	% 2018 DS of AQS Objective
D10	7.5	40	22.7	22.1	55.4
	10		22.0	21.5	53.7
	4.5		23.4	22.8	57.1
	7.5		22.6	22.0	55.0
	10		22.0	21.5	53.6
D11	4.5	40	18.9	18.2	45.5
	7.5		18.1	17.5	43.7
	10		17.6	17.0	42.4
D12	4.5	40	18.8	18.1	45.4
	7.5		18.1	17.4	43.6
	10		17.5	16.9	42.4
D13	4.5	40	18.8	18.1	45.3
	7.5		18.1	17.4	43.6
	10		17.5	16.9	42.3
D14	4.5	40	18.8	18.1	45.2
	7.5		18.0	17.4	43.5
	10		17.5	16.9	42.3
D15	4.5	40	18.8	18.1	45.2
	7.5		18.0	17.4	43.4
	10		17.5	16.9	42.2
D16	4.5	40	18.8	18.1	45.2
	7.5		18.0	17.4	43.4
	10		17.5	16.9	42.2

5.2 Assessment of Particulate Matter (PM₁₀)

Table 5.2 presents the annual mean PM₁₀ concentrations predicted at the proposed receptor locations surrounding the Site across the three floors allocated for residential use for 2017 BC and 2018 DS scenarios. A comparison against the 40µg/m³ annual mean AQS objective is also presented.

The maximum predicted annual mean PM₁₀ concentration for the base scenario (2017 BC) was on the first floor at locations D1, D2, D3 and D4. The model predicted a concentration of 15.3µg/m³ which is well below the 40µg/m³ annual mean AQS objective.

The maximum annual mean PM₁₀ concentration in the 2018 DS scenario was 15.1µg/m³, also predicted on the first floor at locations D1, D2, D3 and D4. This represents 37.8% of the annual mean objective, and so it is unlikely that future residents will be exposed to elevated concentrations of PM₁₀.

Table 5.2 – Predicted Annual Mean PM₁₀ Concentrations

ID	Height (m)	Annual Mean PM ₁₀ (µg/m ³)			
		AQS Objective	2017 BC	2018 DS	% 2018 DS of AQS Objective
D1	4.5	40	15.3	15.1	37.8
	7.5		15.0	14.9	37.2
	10		14.9	14.8	36.9
D2	4.5	40	15.3	15.1	37.8
	7.5		15.0	14.9	37.2
	10		14.9	14.8	36.9
D3	4.5	40	15.3	15.1	37.8
	7.5		15.0	14.9	37.2
	10		14.9	14.8	36.9
D4	4.5	40	15.3	15.1	37.8
	7.5		15.0	14.9	37.2
	10		14.9	14.8	36.9

ID	Height (m)	Annual Mean PM ₁₀ (µg/m ³)			
		AQS Objective	2017 BC	2018 DS	% 2018 DS of AQS Objective
D5	4.5	40	15.0	14.9	37.3
	7.5		14.8	14.7	36.7
	10		14.7	14.5	36.4
D6	4.5	40	15.1	14.9	37.3
	7.5		14.8	14.7	36.6
	10		14.7	14.5	36.3
D7	4.5	40	15.0	14.9	37.2
	7.5		14.8	14.6	36.6
	10		14.7	14.5	36.3
D8	4.5	40	14.9	14.8	37.0
	7.5		14.8	14.6	36.6
	10		14.7	14.5	36.3
D9	4.5	40	15.2	15.1	37.7
	7.5		15.0	14.9	37.2
	10		14.9	14.8	36.9
D10	4.5	40	15.1	15.0	37.5
	7.5		15.0	14.9	37.1
	10		14.9	14.8	36.9
D11	4.5	40	14.9	14.7	36.9
	7.5		14.8	14.6	36.6
	10		14.7	14.5	36.4
D12	4.5	40	14.9	14.7	36.9
	7.5		14.8	14.6	36.6
	10		14.7	14.5	36.4
D13	4.5	40	14.9	14.7	36.8
	7.5		14.7	14.6	36.6
	10		14.7	14.5	36.3
D14	4.5	40	14.9	14.7	36.8
	7.5		14.7	14.6	36.5
	10		14.7	14.5	36.3
D15	4.5	40	14.9	14.7	36.8
	7.5		14.7	14.6	36.5
	10		14.7	14.5	36.3
D16	4.5	40	14.9	14.7	36.8
	7.5		14.7	14.6	36.5
	10		14.7	14.5	36.3

Table 5.3 shows the number of predicted exceedances of the 24-hour PM₁₀ 50µg/m³ AQS objective predicted at all receptor locations, for the 2017 BC and 2018 DS scenarios.

The number of predicted concentrations above the 24-hour PM₁₀ 50µg/m³ AQS objective at all receptor locations in the 2017 BC and 2018 DS is no greater than 1 day. This is well below the 35 permitted exceedances, and so the site is considered suitable for the proposed residential use.

Table 5.3 – Predicted Number of Exceedances of 24-hour PM₁₀ 50µg/m³ AQS objective

ID	Height (m)	Number of Exceedances		
		Number of allowed exceedances of PM ₁₀ 50µg/m ³ AQO	2017 BC	2018 DS
D1	4.5	35	<1	<1
	7.5		<1	<1
	10		<1	<1
D2	4.5	35	<1	<1
	7.5		<1	<1
	10		<1	<1
D3	4.5	35	<1	<1

ID	Height (m)	Number of Exceedances		
		Number of allowed exceedances of PM ₁₀ 50µg/m ³ AQO	2017 BC	2018 DS
D4	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1
D5	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1
D6	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1
D7	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1
D8	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1
D9	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1
D10	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1
D11	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1
D12	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1
D13	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1
D14	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1
D15	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1
D16	7.5	35	<1	<1
	10		<1	<1
	4.5		<1	<1

5.3 Assessment of Particulate Matter (PM_{2.5})

Table 5.4 presents the annual mean PM_{2.5} concentrations predicted at the proposed receptor locations surrounding the Site across the three floors allocated for residential use for 2017 BC and 2018 DS scenarios. A comparison against the 25µg/m³ annual mean target AQS objective is also presented.

The maximum predicted annual mean PM_{2.5} concentration for the base scenario (2017 BC) was on the first floor at locations D1, D2, D3 and D4. The model predicted a concentration of 10.5µg/m³ which is well below the 25µg/m³ annual mean AQS objective.

The maximum annual mean PM_{2.5} concentration in the 2018 DS scenario was 10.3µg/m³, also predicted on the first floor at locations D1, D2, D3 and D4. This represents 41.3% of the annual

mean objective, and so it is unlikely that future residents will be exposed to elevated concentrations of PM₁₀.

Table 5.4 – Predicted Annual Mean PM_{2.5} Concentrations

ID	Height (m)	Annual Mean PM _{2.5} (µg/m ³)			
		AQS Objective	2017 BC	2018 DS	% 2018 DS of AQS Objective
D1	4.5	25	10.5	10.3	41.3
	7.5		10.3	10.2	40.8
	10		10.2	10.1	40.5
D2	4.5	25	10.5	10.3	41.3
	7.5		10.3	10.2	40.8
	10		10.2	10.1	40.5
D3	4.5	25	10.5	10.3	41.3
	7.5		10.3	10.2	40.7
	10		10.2	10.1	40.5
D4	4.5	25	10.5	10.3	41.3
	7.5		10.3	10.2	40.7
	10		10.2	10.1	40.5
D5	4.5	25	10.2	10.0	40.2
	7.5		10.0	9.9	39.6
	10		10.0	9.8	39.3
D6	4.5	25	10.2	10.1	40.2
	7.5		10.0	9.9	39.6
	10		9.9	9.8	39.3
D7	4.5	25	10.1	10.0	40.1
	7.5		10.0	9.9	39.6
	10		9.9	9.8	39.3
D8	4.5	25	10.1	10.0	39.9
	7.5		10.0	9.9	39.5
	10		9.9	9.8	39.3
D9	4.5	25	10.4	10.3	41.2
	7.5		10.3	10.2	40.7
	10		10.2	10.1	40.5
D10	4.5	25	10.4	10.3	41.0
	7.5		10.3	10.2	40.7
	10		10.2	10.1	40.5
D11	4.5	25	10.1	9.9	39.8
	7.5		10.0	9.9	39.5
	10		10.0	9.8	39.3
D12	4.5	25	10.1	9.9	39.8
	7.5		10.0	9.9	39.5
	10		10.0	9.8	39.3
D13	4.5	25	10.1	9.9	39.8
	7.5		10.0	9.9	39.5
	10		10.0	9.8	39.3
D14	4.5	25	10.1	9.9	39.8
	7.5		10.0	9.9	39.5
	10		9.9	9.8	39.3
D15	4.5	25	10.1	9.9	39.8
	7.5		10.0	9.9	39.5
	10		9.9	9.8	39.3
D16	4.5	25	10.1	9.9	39.8
	7.5		10.0	9.9	39.5
	10		9.9	9.8	39.3

6 Conclusions

Bureau Veritas UK Ltd has been commissioned by Manor Hayes Ltd to undertake an air quality assessment in support of an application for the conversion of an existing first floor residential property into eighteen new apartments spread across three floors at 128 Milton Road, Gravesend. It is understood that the development is currently midway through construction, with the main structure and roof construction completed.

Bureau Veritas prepared the original air quality impact assessment, which was issued in December 2007. Gravesham Borough Council (GBC) have since requested an updated assessment to take into consideration the changes in air quality in the area and the improvements to the dispersion modelling methodology since the original report was issued. Specific emphasis has been requested with regards to assessing potential exposure to poor air quality across the three floors of the building to help advise on ventilation options.

The assessment therefore focuses on the quantitative prediction of the ambient NO₂, PM₁₀ and PM_{2.5} concentrations to which new receptors may be exposed to upon completion of the development, based on modelling of emissions from road traffic on the local road network, and comparison with the relevant AQS objectives.

The ADMS-Roads dispersion model (version 4.0.1) has been used to determine the likely NO₂, PM₁₀ and PM_{2.5} concentrations at proposed receptor locations situated over the three floors allocated for residential use at the Site.

There are no exceedances of the NO₂ annual mean AQS objective at any of the assessed receptor locations. The maximum annual mean NO₂ concentration in the 2018 DS scenario was 23.7µg/m³, predicted on the first floor at locations D1 and D2. This represents 59.2% of the annual mean objective, and so it is unlikely that future residents will be exposed to elevated concentrations of NO₂.

Exceedances of the 1-hour NO₂ AQS objective are also considered to be unlikely at any of the receptor locations assessed. Impacts associated with 1-hour mean NO₂ concentrations at all assessed receptor locations are therefore considered to be not significant.

There are also no exceedances of the annual mean or short term AQS objectives for either PM₁₀ or PM_{2.5} at any of the receptor locations assessed. The maximum annual mean PM₁₀ concentration in the 2018 DS scenario was 15.1µg/m³, predicted on the first floor at locations D1, D2, D3 and D4. This represents 37.8% of the annual mean objective, and so it is unlikely that future residents will be exposed to elevated concentrations of PM₁₀. The maximum annual mean PM_{2.5} concentration in the 2018 DS scenario was 10.3µg/m³, also predicted on the first floor at locations D1, D2, D3 and D4. This represents 41.3% of the annual mean objective, and so it is unlikely that future residents will be exposed to elevated concentrations of PM₁₀.

The predicted concentrations of NO₂, PM₁₀ and PM_{2.5} within the Site are well below both the annual mean and short term AQS objectives, therefore the future residents of the proposed development will not be exposed to any pollutant concentrations above the current AQS objectives. The site is therefore considered to be suitable for the proposed use.

Based on the results of the modelling, it is unlikely that future residents will be exposed to poor air quality. However, best practice measures are recommended wherever possible to ensure adverse air quality impacts are avoided in the future. If ventilation systems are installed, clean air should be drawn from the rear façade of the building. Inlets should also be located as high up the building as possible due to pollutant concentrations worsening the closer to ground level receptors are located.

Appendices

Appendix 1 – Background to Air Quality

Emissions from road traffic contribute significantly to ambient pollutant concentrations in urban areas. The main constituents of vehicle exhaust emissions, produced by fuel combustion are carbon dioxide (CO₂) and water vapour (H₂O). However, combustion engines are not 100% efficient and partial combustion of fuel results in emissions of a number of other pollutants, including carbon monoxide (CO), particulate matter (PM), Volatile Organic Compounds (VOCs) and hydrocarbons (HC). For HC, the pollutants of most concern are 1,3 - butadiene (C₄H₆) and benzene (C₆H₆). In addition, some of the nitrogen (N) in the air is oxidised under the high temperature and pressure during combustion; resulting in emissions of oxides of nitrogen (NO_x). NO_x emissions from vehicles predominately consist of nitrogen oxide (NO), but also contain nitrogen dioxide (NO₂). Once emitted, NO can be oxidised in the atmosphere to produce further NO₂.

The quantities of each pollutant emitted depend upon a number of parameters; including the type and quantity of fuel used, the engine size, the vehicle speed, and the type of emissions abatement equipment fitted. Once emitted, these pollutants disperse in the air. Where there is no additional source of emission, pollutant concentrations generally decrease with distance from roads, until concentrations reach those of the background.

This air quality assessment focuses on NO₂, PM₁₀ and PM_{2.5} as these pollutants are associated with pollutant emissions from road sources. This has been confirmed over recent years by the outcome of the Local Air Quality Management (LAQM) regime. Recent statistics¹⁷ regarding Air Quality Management Areas (AQMA) show that approximately 650 AQMA are declared in the UK. The majority of existing AQMA have been declared in relation to road traffic emissions.

In line with these results, the reports produced by the Council under the LAQM regime have confirmed that road traffic within their administrative area is the main issue in relation to air quality.

An overview of this pollutant, describing briefly the sources and processes influencing the ambient concentrations, is presented below.

Nitrogen Oxides (NO_x)

NO and NO₂, collectively known as NO_x, are produced during the high temperature combustion processes involving the oxidation of N. Initially, NO_x are mainly emitted as NO, which then undergoes further oxidation in the atmosphere, particularly with ozone (O₃), to produce secondary NO₂. Production of secondary NO₂ could also be favoured due to a class of compounds, VOCs, typically present in urban environments, and under certain meteorological conditions, such as hot sunny days and stagnant anti-cyclonic winter conditions.

Of NO_x, it is NO₂ that is associated with health impacts. Exposure to NO₂ can bring about reversible effects on lung function and airway responsiveness. It may also increase reactivity to natural allergens, and exposure to NO₂ puts children at increased risk of respiratory infection and may lead to poorer lung function in later life.

In the UK, emissions of NO_x have decreased by 62% between 1990 and 2010. For 2010, NO_x (as NO₂) emissions were estimated to be 1,106kt. The transport sector remained the largest source of NO_x emissions with road transport contribution 34% to NO_x emissions in 2010.

Particulate Matter

Particulate matter is a mixture of solid and liquid particles suspended in the air. There are a number of ways in which airborne PM may be categorised. The most widely used categorisation is based on the size of particles such as PM_{2.5}, particles of aerodynamic diameter less than 2.5µm

¹⁷ Statistics from the UK AQMA website available at <http://aqma.defra.gov.uk> – Figures as of January 2017

(micrometre = 10^{-6} metre), and PM_{10} , particles of aerodynamic diameter less than $10\mu m$. Generically, particulate residing in low altitude air is referred to as Total Suspended Particulate (TSP) and comprises coarse and fine material including dust.

Particulate matter comprises a wide range of materials arising from a variety of sources. Examples of anthropogenic sources are carbon (C) particles from incomplete combustion, bonfire ash, recondensed metallic vapours and secondary particles (or aerosols) formed by chemical reactions in the atmosphere. As well as being emitted directly from combustion sources, man-made particles can arise from mining, quarrying, demolition and construction operations, from brake and tyre wear in motor vehicles and from road dust resuspension from moving traffic or strong winds. Natural sources of PM include wind-blown sand and dust, forest fires, sea salt and biological particles such as pollen and fungal spores.

The health impacts from PM depend upon size and chemical composition of the particles. For the purposes of the AQS objectives, PM_{10} or $PM_{2.5}$ is solely defined on size rather than chemical composition. This enables a uniform method of measurement and comparison. The short and long-term exposure to PM has been associated with increased risk of lung and heart diseases. PM may also carry surface-absorbed carcinogenic compounds. Smaller PM have a greater likelihood of penetrating the respiratory tract and reaching the lung to blood interface and causing the above adverse health effects.

In the UK, emissions of PM_{10} have declined significantly since 1980, and were estimated to be 114kt (kilotonne) in 2010¹⁸. Residential / public electricity and heat production and road transport are the largest sources of PM_{10} emissions. The road transport sector contributed 22% (25kt) of PM_{10} emissions in 2010. The main source within road transport is brake and tyre wear.

It is important to note that these estimates only refer to primary emissions, that is, the emissions directly resulting from sources and processes and do not include secondary particles. These secondary particles, which result from the interaction of various gaseous components in the air such as ammonia (NH_3), sulphur dioxide (SO_2) and NO_x , can come from further a field and impact on the air quality in the UK and vice versa.

¹⁸ National Atmospheric Emissions Inventory (NAEI) Summary Emission Estimate Datasets 2010. March 2012

Appendix 2 – ADMS Model Verification

The ADMS-Roads dispersion model has been widely validated for this type of assessment and is specifically listed in the Defra's LAQM.TG(16)⁴ guidance as an accepted dispersion model.

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

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

- Background concentration estimates;
- Source activity data such as traffic flows and emissions factors;
- 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;
- Distance between sources and monitoring as represented in the model;
- Speed estimates on roads;
- Background monitoring and background estimates; and
- Monitoring data.

The traffic data for this assessment has been collated from the Department for Transport (DfT), as outlined in Section 4.1.2.

For model verification, the diffusion tube data presented in Table 3.2 has been used. GR90 and GR140 have not been included in the verification process due to GR90 being located on a road where no traffic data was available and GR140 having a very low data capture for 2017. Furthermore, GR24 was scoped out due to it being positioned next to a bus stop. Emissions at the bus stop were not available and therefore have not been included in the model. As a result the predicted concentrations at this location were not representative of real world conditions.

Both PM₁₀ and PM_{2.5} results have been verified by applying the adjustment factor which was determined for NO_x/NO₂. This is considered valid as LAQM.TG(16)⁴ states the following:

'in the absence of any PM₁₀ data for verification, it may be appropriate to apply the road-NO_x adjustment to the modelled road-PM₁₀. If this identifies exceedances of the objective, then it would be appropriate to monitor PM₁₀ to confirm the findings.'

NO₂ Verification Calculations

The verification of the modelling output was performed in accordance with the guidance provided in Chapter 7 of LAQM.TG(16)⁴.

For the verification and adjustment of NO_x/NO₂, the annual mean concentrations for 2017 were used as presented in Table 3.2.

Table A1 below shows an initial comparison of the monitored and unverified modelled NO₂ results for the year 2017, in order to determine if verification and adjustment was required.

Table A1 – Comparison of Unverified Modelled and Monitored NO₂ Concentrations

Site ID	Background NO ₂ (µg/m ³)	Monitored total NO ₂ (µg/m ³)	Unverified Modelled total NO ₂ (µg/m ³)	% Difference (modelled vs. monitored)
GR125	16.3	32.3	24.3	-24.9
GR31	20.3	42.7	32.8	-23.3
GR47	20.3	41.3	35.0	-15.3
GR58	20.3	32.3	27.0	-16.5

The model was under predicting at all four locations and no further improvement of the modelled results could be obtained on this occasion. The modelled results were all within 25% of the monitored concentrations. According to LAQM.TG(16)⁴ if results are within 25% verification is not necessarily required. Nonetheless, model adjustment was still carried out to allow for further improvements in the results.

Model adjustment needs to be undertaken based on NO_x and not NO₂. NO_x concentrations were derived from the monitored NO₂ diffusion tube results used for verification. These calculations were undertaken using a spreadsheet tool available from the LAQM website. Table A2 provides the relevant data required to calculate the model adjustment based on regression of the modelled and monitored road source contribution to NO_x.

Table A2 – Data Required for Adjustment Factor Calculation

Site ID	Monitored total NO ₂ (µg/m ³)	Monitored total NO _x (µg/m ³)	Background NO ₂ (µg/m ³)	Background NO _x (µg/m ³)	Monitored road contribution NO ₂ (total - background) (µg/m ³)	Monitored road contribution NO _x (total - background) (µg/m ³)	Modelled road contribution NO _x (excludes background) (µg/m ³)
GR125	32.3	55.2	16.3	22.8	16.0	32.4	15.5
GR31	42.7	77.6	20.3	29.9	22.4	47.8	25.2
GR47	41.3	74.3	20.3	29.9	21.0	44.5	30.1
GR58	32.3	54.1	20.3	29.9	12.0	24.2	13.1

Figure A1 provides a comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x, and the equation of the trend line based on linear regression through zero. The equation of the trend lines presented in Figure A1 gives an adjustment factor for the modelled results of 1.72.

Figure A1 – Comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x

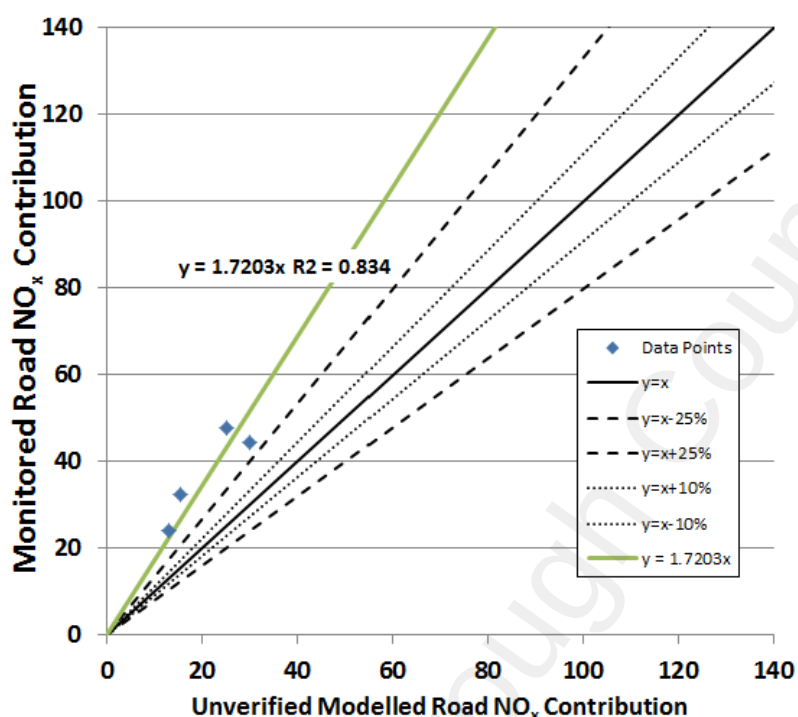
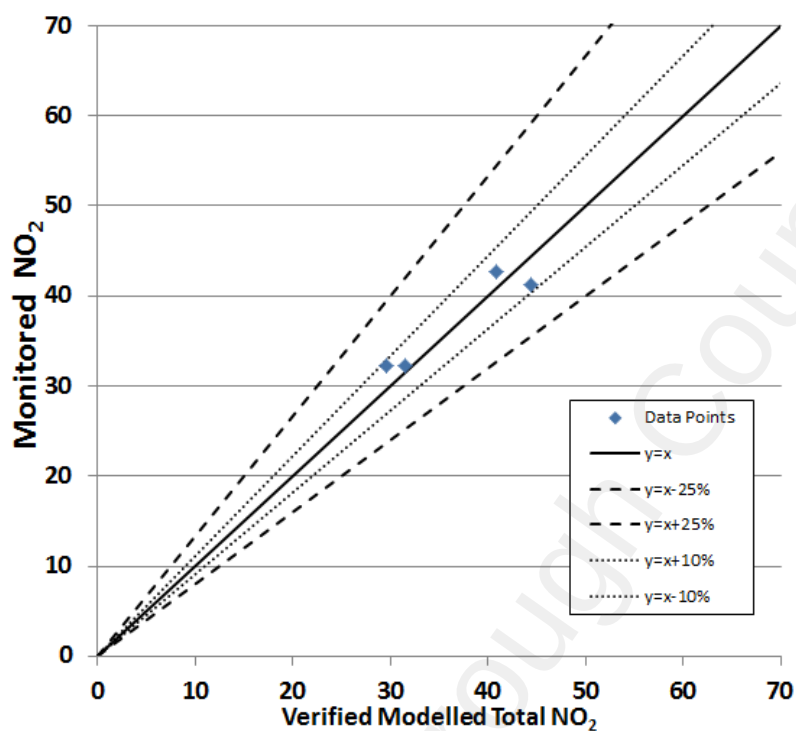


Table A3 and Figure A2 below illustrate the adjusted modelled NO₂ concentrations plotted against monitored NO₂ concentrations. All sites considered show acceptable agreement between the ratios of monitored and modelled NO₂ all being $\pm 10\%$. A verification factor of 1.72 was therefore used to adjust the model results. A factor of 1.72 reduces the Root Mean Square Error (RMSE) from a value of 7.606 to 2.261.

Table A3 – Adjustment Factor and Comparison of Verified Results Against Monitoring Results

Site ID	Ratio of monitored road contribution NO _x / modelled road contribution NO _x	Adjustment factor for modelled road contribution NO _x	Adjusted modelled road contribution NO _x (µg/m ³)	Adjusted modelled total NO _x (including background NO _x) (µg/m ³)	Modelled total NO ₂ (based upon empirical NO _x / NO ₂ relationship) (µg/m ³)	Monitored total NO ₂ (µg/m ³)	% Difference (adjusted modelled NO ₂ vs. monitored NO ₂)
GR125	2.09	1.720	26.7	49.5	29.7	32.3	-8.2
GR31	1.89		43.4	73.3	40.9	42.7	-4.3
GR47	1.48		51.8	81.7	44.4	41.3	7.4
GR58	1.85		22.5	52.4	31.5	32.3	-2.4

Figure A2 – Comparison of the Modelled NO_2 versus Monitored NO_2 for Motorway Contributions



The adjustment factor of 1.72 was applied to the road- NO_x concentrations predicted by the model to arrive at the final NO_2 concentrations. All NO_2 , PM_{10} and $\text{PM}_{2.5}$ results presented and discussed herein are those calculated following the process of model verification using an adjustment factor of 1.72.