

The background of the entire page is a photograph of a city street. In the foreground, there is a line of vehicles, including a dark SUV and several white vans, stopped at a traffic light. The road has white markings, including "AHEAD ONLY" and "STOP". In the background, there are tall buildings and trees with autumn foliage. The image has a warm, golden-brown tint.

Air Quality Assessment for the proposed development at Drake Way in Reading

**Report to Diageo Pension Trust
Ltd**

November 2020

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1 Introduction

Aether has been commissioned by Savills on behalf of Diageo Pension Trust Ltd to undertake an air quality assessment for the proposed development of a car park providing approximately 82 spaces, opposite the Circle Hospital in Reading. 10% of the spaces will be provided with electric vehicle charging points.

The development falls within Reading Borough Council, which suffers from elevated levels of air pollution, primarily due to high levels of traffic. It is therefore important to assess whether there will be a worsening of particulate matter (PM₁₀) or nitrogen dioxide (NO₂) concentrations as a result of the development at nearby locations where the public are regularly exposed. The assessment utilises ADMS-Roads, a comprehensive dispersion modelling tool for investigating air pollution problems due to small networks of roads and industrial sources.

The expected completion date of the proposed development is 2021. The assessment has therefore been completed for 2022, the expected first full year of occupation.

1.1 The Location of the Development

The proposed development is located on Drake Way in Reading (**Figure 1**).

Figure 1: Location of the development site



1.2 Assessment Criteria

A summary of the air quality objectives relevant to the Reading development, as set out in the UK Air Quality Strategy¹, is presented in **Table 1** below.

Table 1: UK Air Quality Objectives for NO₂ and PM₁₀

Pollutant	Concentration	Measured as
Nitrogen Dioxide (NO ₂)	40 µg/m ³	Annual mean
	200 µg/m ³	Hourly mean not to be exceeded more than 18 times per year (99.8th percentile)
Particulate Matter (PM ₁₀)	40 µg/m ³	Annual mean
	50 µg/m ³	24 hour mean not to be exceeded more than 35 times a year (90.4th percentile)

The oxides of nitrogen (NO_x) comprise principally of nitric oxide (NO) and nitrogen dioxide (NO₂). NO₂ is a reddish brown gas (at sufficiently high concentrations) and occurs as a result of the oxidation of NO, which in turn originates from the combination of atmospheric nitrogen and oxygen during combustion processes. NO₂ can also form in the atmosphere due to a chemical reaction between NO and ozone (O₃). Health based standards for NO_x generally relate to NO₂, where acute and long-term exposure may adversely affect the respiratory system.

Particulate matter is a term used to describe all suspended solid matter, sometimes referred to as Total Suspended Particulate matter (TSP). Sources of particles in the air include road transport, power stations, quarrying, mining and agriculture. Chemical processes in the atmosphere can also lead to the formation of particles. Particulate matter with an aerodynamic diameter of less than 10 µm is the subject of health concerns because of its ability to penetrate deep within the lungs and is known in its abbreviated form as PM₁₀.

A growing body of research has also pointed towards the smaller particles as a metric more closely associated with adverse health impacts. In particular, particulate matter with an aerodynamic diameter of less than 2.5 micrometres, known as PM_{2.5}. Local Authorities in England have a flexible role² in working towards reducing emissions and concentrations of PM_{2.5} as there is no specific objective for them. However, under EU Directive 2008/50/EC³, there is an annual mean limit of 25 µg/m³.

Further information on the health effects of air pollution can be found in the reports produced by the Committee on the Medical Effects of Air Pollutants⁴.

As defined by the regulations, the air quality objectives for the protection of human health are applicable:

- ➊ Outside of buildings or other natural or man-made structures above or below ground
- ➋ Where members of the public are regularly present.

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

² LAQM TG16 – paragraph 1.09

³ <https://ec.europa.eu/environment/air/quality/directive.htm>

⁴ <https://www.gov.uk/government/collections/comeap-reports>

Using these definitions, the annual mean objectives will apply at locations where members of the public might be regularly exposed such as building façades of residential properties, schools and hospitals and will not apply at the building façades of offices or other places of work, where members of the public do not have regular access. The 24-hour objective will apply at all locations where the annual mean objective would apply together with hotels. The hourly objective will apply at all locations where members of the public could reasonably be expected to spend that amount of time. Therefore, in this assessment:

- ➊ The annual mean objectives do not apply at the proposed car park, but will apply at nearby residential locations and at the Circle Hospital
- ➋ The 24-hour objective does not apply at the proposed car park, but will apply at nearby residential locations, the Circle Hospital and at the Hilton Hotel on Drake Way
- ➌ The hourly objective will apply at nearby residential locations, the Circle Hospital and the Hilton Hotel on Drake Way.

1.3 Local Air Quality Management

Local authorities are required to periodically review and assess the current and future quality of air in their areas. Where it is determined that an air quality objective is not likely to be met, the authority must designate an Air Quality Management Area (AQMA) and produce an Air Quality Action Plan (AQAP).

Reading Borough Council has declared one AQMA for exceedances of the annual mean NO₂ objective⁵. This covers Reading town centre, the main road routes into Reading and along railway lines where they pass through built up areas. An AQAP was published in 2009 with an update provided in 2016⁶. The proposed development is not located in the AQMA.

1.4 The ADMS-Roads Method

Local air quality has been assessed using ADMS-Roads, a comprehensive dispersion model that can be used to predict concentrations of pollutants in the vicinity of roads and small industrial sources. The model has been used for many years in support of planning applications for new residential/commercial developments.

ADMS-Roads is able to provide an estimate of air quality both before and after development, taking into account important input data such as background pollutant concentrations, meteorological data, traffic flows and on-site energy generation (if applicable). The model output can be verified against local monitoring data to increase the accuracy of the predicted pollutant concentrations and this approach has been followed in this assessment.

The use of dispersion modelling enables estimates of concentrations to be made at varying heights. As a result, suggestions for appropriate mitigation measures can be made where necessary, taking into consideration the identification of worst-case locations.

The most recent version of ADMS-Roads (v5) was issued in April 2020 and requires the following information to assess the impact at sensitive receptor locations:

- ➊ **Setup:** General site details and modelling options to be used
- ➋ **Source:** Source dimensions and locations, release conditions, emissions
- ➌ **Meteorology:** hourly meteorological data

⁵ https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=201

⁶ https://images.reading.gov.uk/2020/01/AQAP_Update_2016.pdf

- **Background:** Background concentration data
- **Grids:** Type and size of grid for output
- **Output:** Output required and sources/groups to include in the calculations.

2 Methodology

2.1 Local Pollutant Concentrations

It is good practice to include up-to-date local background pollutant concentrations in the assessment model, and also to verify modelled outputs against local monitoring data where available. This section provides an overview of the local data available for use in the assessment.

2.1.1 Local monitoring data

In 2019, Reading Borough Council had three automatic monitoring sites which measured nitrogen dioxide (NO₂) and particulate matter (PM₁₀) concentrations. Unfortunately, all these sites are located more than 3.5km from the development site and are therefore not discussed further as they are unlikely to be representative of the development site. NO₂ concentrations are also measured passively at diffusion tube sites across the Borough. Unfortunately, none are within close proximity of the site. The closest three however are provided in **Table 2**.

Monitoring results have been taken from the Council's latest Annual Status Report (ASR)⁷.

Table 2: Monitoring sites within 2.2 km of the Drake Way in Reading development

Site Name	Site Type	Pollutant	Grid Reference	Distance to Kerb (m)	Approx. Distance to development site (m)
Shinfield Rd / Whitley Wood Rd	R	NO ₂	473338, 170269	5	2,160
Shinfield Rd / Cedar Rd	K	NO ₂	473354, 170482	1	2,160
Exbourne Road	R	NO ₂	472341, 169731	5	1,400

Note: R = roadside, K = kerbside

The diffusion tubes were analysed by Gradko International Ltd, who participate in the Proficiency scheme⁸. Whilst diffusion tubes provide an indicative estimate of pollutant concentrations, they tend to under or over read. The data is therefore corrected using a bias adjustment factor. There are two types of bias adjustment factor – local and national. The local factor is derived from co-locating diffusion tubes (usually in triplicate) with automatic monitors, whereas the national factor is obtained from the average bias from all local authorities using the same laboratory. Reading Borough Council has applied a national bias adjustment factor (0.87) to their 2019 diffusion tube results.

Monitoring results are presented in **Table 3**. The data shows that the annual mean NO₂ objective was not exceeded at any of the monitoring sites shown between 2017 and 2019.

⁷ The 2020 ASR (containing data for 2019) was provided directly by Reading Borough Council. The previous 2019 report is available from: https://images.reading.gov.uk/2020/01/Reading_ASR_2019_v1.pdf

⁸ This is a national QA/QC scheme.

Diffusion tubes do not provide information on hourly exceedances, but research⁹ identified a relationship between the annual and 1 hour mean objective, such that exceedances of the latter were considered unlikely where the annual mean was below 60 µg/m³. Therefore, no exceedances of the hourly mean objectives are expected at the diffusion tube monitoring sites.

Table 3: Monitoring results for the three sites closest to the proposed car park site, 2017-2019

Objective	Site Name	2017	2018	2019
Annual mean NO ₂ (µg/m ³)	Shinfield Rd / Whitley Wood Rd	31	31	26
	Shinfield Rd / Cedar Rd	38	34	34
	Exbourne Road	N/A	N/A	15

N/A – data unavailable

2.1.2 Background mapped data

Background pollutant concentration maps are available from the Defra LAQM website¹⁰ and data has been extracted for Reading for this assessment. These 2018 baseline, 1 kilometre grid resolution maps are derived from a complex modelling exercise that takes into account emissions inventories and measurements of ambient air pollution from both automated and non-automated sites. The projections in the 2018 LAQM background maps are based on assumptions which were current before the Covid-19 outbreak in the UK. In consequence these maps do not reflect short or longer term impacts on emissions in 2020 and beyond resulting from behavioural change during the national or local lockdowns.

The estimated mapped background NO_x, NO₂ and PM₁₀ concentrations around the development site are 26.2 µg/m³, 18.3 µg/m³ and 15.2 µg/m³ respectively in 2019. For 2022 (the estimated first full year of occupation), the concentrations obtained for the same pollutants are 20.3 µg/m³, 16.6 µg/m³ and 14.6 µg/m³ respectively.

Due to the lack of a nearby urban background monitoring site, the 2019 mapped background concentrations have been used in this assessment. To provide a conservative estimate, the projected improvements in background air quality by 2022 have not been used in the dispersion modelling. This is in line with best practice to apply worst-case assumptions.

2.2 Model input data

Hourly meteorological data from Heathrow for 2019 has been used in the model. The wind-rose diagram (**Figure 2**) presents this below.

⁹ As described in Box 5.2 of LAQM Technical Guidance (TG16).

¹⁰ <http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html>

Figure 2: Wind-rose diagram for Heathrow meteorological data, 2019

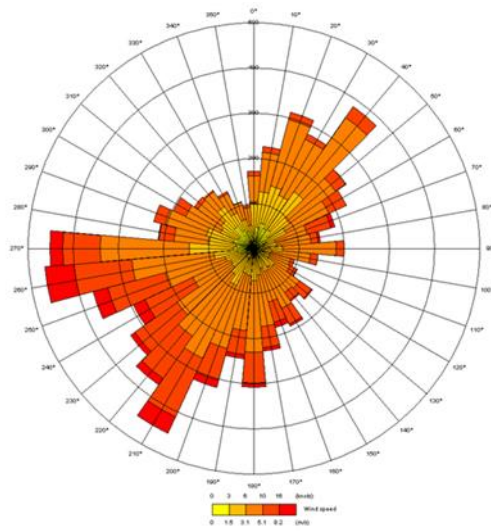
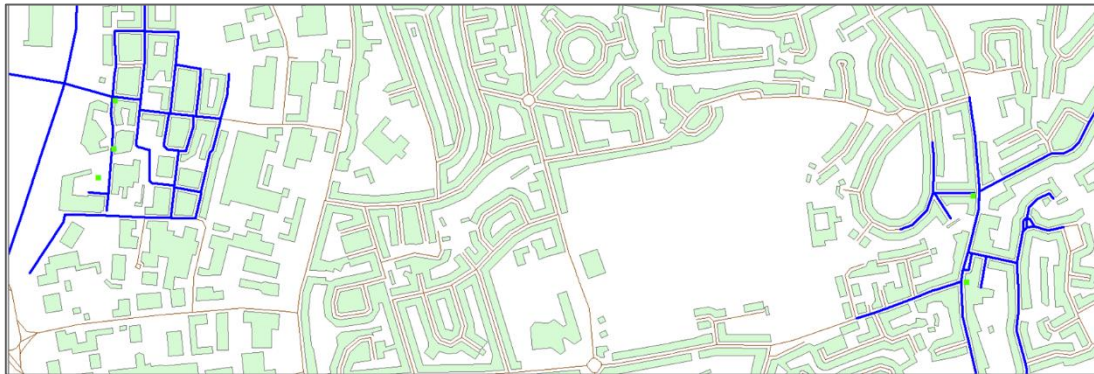


Figure 3: Road sources and receptors (around the development and verification sites).

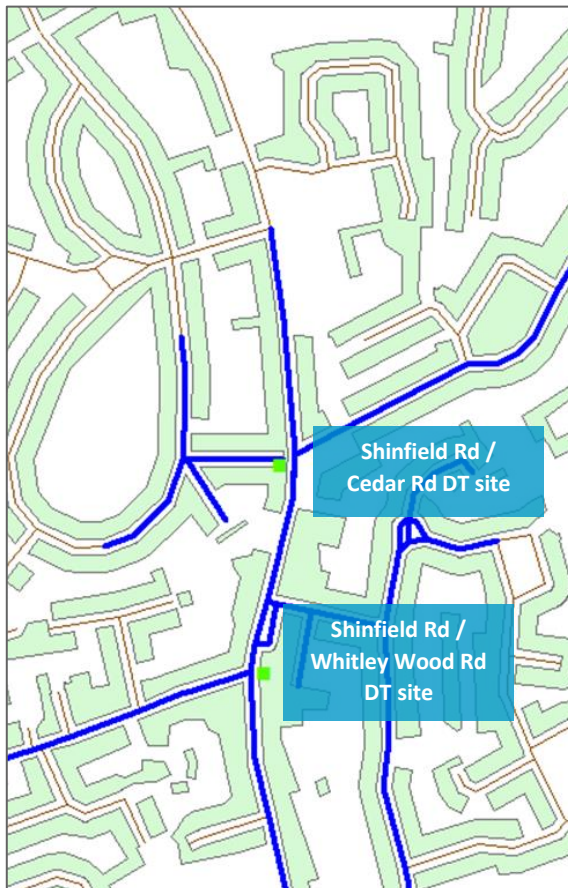


Contains Ordnance Survey data © Crown copyright and database right [2020]

Figure 4: Road sources and receptors near to the proposed Drake Way car park



Figure 4: Road sources and monitoring sites used for model verification



ArcMap software has been used to model the road source locations (blue lines) that are within 200 metres of the receptor locations (green squares). This data can then be automatically uploaded to ADMS-Roads. This generates an accurate representation of the surrounding area to be assessed in the model in terms of the length of roads and distances between sources and receptors. This is shown in **Figures 3, 4 and 5** above. It is assumed that the contribution of other sources to NO₂ and PM₁₀ is included in the background concentrations.

Six sensitive receptor locations have been selected for the assessment:

- ➊ In the centre of the proposed car park
- ➋ R1: Flats on Drake Way
- ➌ R2: Flats on Drake Way close to Lindisfarne Road
- ➍ Circle Hospital
- ➎ East side of the Hilton Hotel
- ➏ West side of the Hilton Hotel

These sites have been chosen to reflect the concentrations at the proposed car park and its impact on nearby residents / hospital patients / hotel guests.

2.3 Traffic data

Average annual daily traffic (AADT) count data for 2019 (the selected baseline year) has been obtained for Lindisfarne Way, Rose Kiln Lane, A33, B3031 (Basingstoke Road), Whitley Wood Road, Northumberland Avenue, Shinfield Road (A327) and Manor Farm Road from Department for Transport (DfT) Traffic Counts¹¹, which provides data for major roads. In the absence of any other data being available for the minor roads (including Drake Way), estimates are based upon average values for an 'urban minor road, south east' from the DfT National Road Traffic Survey, 2019¹². Therefore there will be uncertainty in the model input. A time variant factor was applied to all data based on the distribution on all roads by time of day and day of the week in Great Britain¹³. All roads within 200 metres of the modelled receptors have been included in the assessment. The values are shown in Appendix B.

For the purpose of this assessment, the RTF¹⁴ model has been utilised to project traffic growth. It has been assumed that traffic on local roads will increase by 3.8 % between 2019 and 2022.

The Transport Assessment¹⁵ concludes that the development will result in a maximum of 168 additional daily vehicular trips and predicted turning count data at the Lindisfarne Way / A33 junction (where receptor R2 is located) has been provided. The resulting estimated increase in daily car trips has been taken into account in the assessment for roads with direct access to the site with development. Although electric vehicle charging points are being provided, for the purposes of this modelling it has been assumed that all vehicles using the site are conventional fossil fuelled vehicles. This is therefore a worst-case scenario. Results (**Section 3** of this report) therefore refer to concentrations modelled in 2022 both without and with the proposed development.

¹¹ <http://www.dft.gov.uk/traffic-counts>

¹² <http://www.dft.gov.uk/statistics/series/traffic/>

¹³ <https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra>

¹⁴ <http://laqm.defra.gov.uk/documents/RTF-Automated-Traffic-Growth-Calculator-v3-1.xls>

¹⁵ Transport Assessment data provided by Hydrock on 5/11/2020

In the 'with' development scenario, the impact of the car park has been modelled as a volume source, assuming that each vehicle drives the equivalent of once around the car park¹⁶.

An average speed of 26.2 kph has been assumed on all surrounding roads, which is the average traffic speed for 'A' Roads in Reading in 2019¹⁷.

2.4 Conversion of NO_x to NO₂

Evidence shows that the proportion of primary NO₂ in vehicle exhaust has increased¹⁸. This means that the relationship between NO_x and NO₂ at the roadside has changed from that currently used in the ADMS model. A NO_x to NO₂ calculator (Published in April 2019)¹⁹ has therefore been developed and has been used in conjunction with the ADMS model to obtain a more accurate picture of NO₂ concentrations.

2.5 Model Verification

Model verification refers to checks that are carried out on model performance at a local level. This involves the comparison of predicted versus measured concentrations. Where there is a disparity, the first step is to check the input data and the model parameters in order to minimise the errors. If required, the second step will be to determine an appropriate adjustment factor that can be applied.

In the case of NO₂, the model should be verified for NO_x as the initial step and should be carried out separately for the background contribution and the source (i.e. road traffic). Once the NO_x has been verified and adjusted as necessary, a final check should be made against the measured NO₂ concentration.

For this project, modelled annual mean road-NO_x estimates have been verified against the concentrations measured at two of the diffusion tube sites – Shinfield Road / Whitley Wood Road and Shinfield Road / Cedar Road (see **Appendix A**). These sites were selected because they represent the monitoring sites closest to the proposed development. Exbourne Road was not utilised despite it being closer. This is because no traffic data is available for this road and therefore the modelling would be very uncertain. It is worth noting that both of the sites utilised are located more than 2 km from the proposed car park and therefore there will be uncertainty in the modelled results. Ideally three verification sites would have been used, but no other sites were deemed suitable due to their distance from the development site.

The adjustment factor determined for annual mean NO_x concentrations was also applied to the modelled annual mean PM₁₀ concentrations. This was done as no PM₁₀ monitoring data that is representative of the development site is available, and this approach was considered more appropriate than not applying any adjustment²⁰.

¹⁶ This is in accordance with LAQM TG16 (paragraphs 7.416 to 7.419)

¹⁷ Department for Transport Statistics. Road Congestion Statistics. Table CGN0501b. Average speed on local A roads by Local Authority in England for 2019.

¹⁸ <http://uk-air.defra.gov.uk/assets/documents/reports/ageg/primary-no-trends.pdf>

¹⁹ <https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOXNO2calc>

²⁰ Paragraph 7.529 of LAQM TG(16)

3 Results

3.1 Results of the Dispersion Modelling

Table 4 below provides the estimated pollutant concentrations in the development year (2022) without and with²¹ the development. Given the inherent uncertainties in the modelling, background pollutant concentrations and vehicle fleet emission factors have been maintained at 2019 levels in the development year scenarios to provide a worst case estimate. Traffic growth has been predicted using the RTF calculator.

²¹ 'With' development includes the impact of the additional traffic that will be generated with the car park.

Table 4: Estimated pollutant concentrations in 2022 without and with the development ($\mu\text{g}/\text{m}^3$)

Receptor	Annual mean NO ₂ concentration ($\mu\text{g}/\text{m}^3$)		Annual mean PM ₁₀ concentration ($\mu\text{g}/\text{m}^3$)		NO ₂ Change	PM ₁₀ change
	Without development	With development	Without development	With development		
Centre of Site	21.2	23.5	15.6	15.9	2.3	0.3
R1: Flats on Drake Road	22.4	22.6	15.8	15.9	0.2	<0.1
R2: Flats on Drake Road at junction with Lindisfarne Road	24.9	25.0	16.2	16.3	0.1	<0.1
Circle Hospital	21.8	22.6	15.7	15.8	0.8	0.1
Hilton Hotel – East	22.1	22.3	15.8	15.8	0.2	<0.1
Hilton Hotel - West	23.2	23.2	15.9	16.0	<0.1	<0.1

Note: The changes in NO₂ and PM₁₀ presented may not exactly equal the difference in the constituent parts shown due to rounding.

Nitrogen dioxide

In the without development scenario, the model predicts annual mean NO₂ concentrations to be below (by 38 %) the annual mean objective at all locations. The worst-case location is identified as receptor R2 (at the façade of the flats at the junction of Drake Way and Lindisfarne Road), where pollutant concentrations will be maximised.

The estimated annual mean NO₂ concentrations at the development site are reasonable when compared to the data collected at the nearby monitoring sites. Much higher concentrations are obtained at the Shinfield diffusion tube sites due to their proximity to busy roads.

The Guidance states that authorities may assume exceedances of the hourly mean objective are only likely to occur where annual mean concentrations are 60 µg/m³ or above. Therefore, it is considered highly unlikely that this objective will be exceeded at any of the receptors.

The model has also been run for a with development scenario taking into account predicted increases to traffic levels due to the development. The results indicate that annual mean NO₂ concentrations would increase by 2.3 µg/m³ in the centre of the car park and by 0.8 µg/m³ at the façade of the Circle Hospital, but by 0.2 µg/m³ or less at the other receptors modelled. It is worth noting however that the annual mean objective will not apply in the centre of the car park or the hotel and that this is for illustrative purposes only.

Although the results are subject to uncertainty, the low pollutant concentrations predicted give confidence that air quality will not be an issue in the locality with the construction of the car park.

Particulate matter

The model estimates no exceedance against the annual mean PM₁₀ objective. Potential exceedances of the daily mean PM₁₀ objective can be estimated based on the annual mean²², such that:

$$\begin{aligned} \text{No. 24 – hour mean exceedances} \\ = -18.5 + 0.00145 \times \text{Annual Mean}^3 + \left(\frac{206}{\text{Annual Mean}} \right) \end{aligned}$$

On this basis, it is estimated that in 2022 there will be no exceedances of the daily mean PM₁₀ limit value, regardless of whether the development takes place or not.

For estimating PM_{2.5} concentrations, where no appropriate sites measuring both PM₁₀ and PM_{2.5} are available, then a nationally derived correction ratio of 0.7 can be used²³. If this factor is used, then all locations in the modelling meet the EU Directive annual mean PM_{2.5} limit value of 25 µg/m³.

3.2 Significance

Professional judgement is an important part of the assessment of significance. However, there are various documents available that attempt to qualitatively or quantitatively provide ways of assessing the significance of a development on air quality. The most commonly applied is

²² Paragraph 7.92 of LAQM TG(16)

²³ LAQM: TG16, paragraph 7.109

Environmental Protection UK's Air Quality Guidance Document²⁴ which outlines how impacts may be assessed quantitatively. The assessment is made up of two steps – firstly to assess the magnitude of change in concentration (e.g. between with and without development) relative to the objective level, and secondly the percentage above/below the objective based upon the total modelled concentration at a given location or receptor. By combining these two values, you can obtain the impact descriptor. This method is presented in **Table 5** below.

Table 5: Significance of change description

Long term average concentration at receptor in assessment year	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75 % or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94 % of AQAL	Negligible	Slight	Moderate	Moderate
95-102 % of AQAL	Slight	Moderate	Moderate	Substantial
103-109 % of AQAL	Moderate	Moderate	Substantial	Substantial
110 % or more of AQAL	Moderate	Substantial	Substantial	Substantial

In addition to the criteria provided above, the Guidance document states that the table is intended to be used by rounding the change in percentage pollutant concentrations to whole numbers. Changes of 0 % i.e. less than 0.5 % are described as negligible.

The long-term average concentration at the Drake Way / Lindisfarne Road receptor in the assessment year is 62% of the Air Quality Assessment Level (AQAL) and the change in concentration relative to the AQAL is 0.25%.

The long-term average concentration at the Circle Hospital façade in the assessment year is estimated to be 55% of the AQAL and the change in concentration relative to the AQAL is 2%.

In applying the above results to Table 5 for the worst-case locations, it can be concluded that the impact of the development on local annual mean NO₂ concentrations is likely to be 'negligible'.

However, this is a fairly simplistic conclusion and other factors may also need to be considered in order to make transparent conclusions. Specific factors to consider may include:

1. Number of properties affected by the slight, moderate or major impacts and a judgement of the overall balance
2. Where new exposure is being introduced into an existing area of poor air quality, then the number of people exposed to levels above the objective or limit value will be relevant
3. The magnitude of the changes and descriptions of the impacts at the receptors
4. Whether or not an exceedance of an objective or limit value is predicted to arise in the study area where none existed before or an exceedance area is substantially increased
5. Whether or not the study area exceeds an objective or limit value and this exceedance is removed or the exceedance area is reduced
6. Uncertainty, including the extent to which worst case assumptions have been made

²⁴ <http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf>

7. The extent to which an objective or limit value is exceeded, for example an annual mean of $41 \mu\text{g}/\text{m}^3$ should attract less significance than an annual mean of $51 \mu\text{g}/\text{m}^3$.

In this case, uncertainty is an issue, but worst-case assumptions have been utilised and the predicted concentrations are substantially below the objective levels. This therefore suggests that there will be no concerns in terms of exposure to harmful pollutant concentrations across the study area.

3.3 Mitigation Measures

Based on the ADMS results, there is no specific requirement for mitigation as the air pollutant concentrations are expected to be substantially below the objective in both the without and with development scenario both at the car park site and at nearby relevant receptor locations.

However, in accordance with RBC's Local Plan 2019, 10% of the spaces will be provided with EV car charging points, which will reduce the emissions arising from the site. Additional ducting will also be installed for future connections; however, at the time of reporting the quantity is unknown.

4 Summary and Conclusions

An air quality assessment has been undertaken for a proposed car park at Drake Way in Reading. Reading Borough Council has declared one Air Quality Management Area (AQMA) due to the exceedance of the annual mean nitrogen dioxide (NO_2) objective. The proposed development is located outside the AQMA.

A conservative approach with regards to expected improvements to air quality has been taken in that no improvement in the pollutant background concentrations or road transport emission factors has been assumed between the base year (2019) and the first year of occupation (2022). With expected improvements to the traffic fleet, improvements in pollutant concentrations may however materialise. This is in line with best practice to apply worst-case assumptions.

The ADMS-Roads dispersion model has been used to determine the impact of emissions from road traffic on sensitive receptors. Predicted concentrations have been compared with the air quality objectives. The results of the assessment indicate that annual mean nitrogen dioxide (NO_2) concentrations are below the objective in the 'without' development scenario. Concentrations of particulate matter (PM_{10}) are also predicted to be below the annual mean objective in the 'without' development scenario. Based on the evidence it is estimated that there will be no exceedances of either short term objective for NO_2 or PM_{10} . The 'with' development scenario predicts that the development will cause annual mean NO_2 and PM_{10} concentrations to increase by approximately $0.8 \mu\text{g}/\text{m}^3$ at the façade of the hospital and by $< 0.2 \mu\text{g}/\text{m}^3$ at relevant nearby residential locations. Therefore, no mitigation is required as the air quality objectives are predicted to be met and the expected increase in pollutant concentrations is negligible.

Appendix A – Model Verification

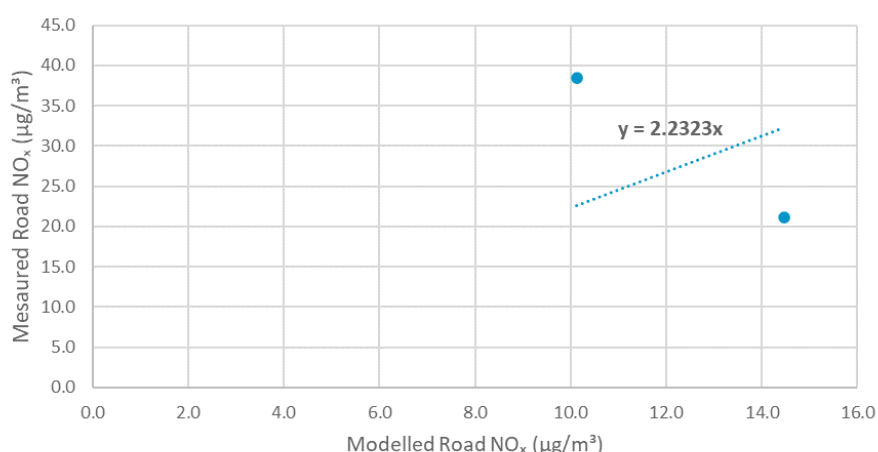
In order to verify modelled pollutant concentrations generated in the assessment, the model has been run to predict the annual mean road-NO_x concentration during 2019 at two of the diffusion tube sites (Shinfield Road / Whitley Wood Road, Shinfield Road / Cedar Road) described in **Table 2**.

The model output of road-NO_x has been compared with the 'measured' road-NO_x. Measured NO_x for the monitoring sites was calculated using the NO_x to NO₂ calculator¹⁹.

A primary adjustment factor was determined to convert between the 'measured' road contribution and the model derived road contribution (**Figure A.1**). This factor was then applied to the modelled road-NO_x concentration for each receptor to provide adjusted modelled road-NO_x concentrations. Total NO₂ concentrations were then determined by combining the adjusted modelled road-NO_x concentrations with the 2019 background NO₂ concentration.

The results imply that the model was under-predicting the road-NO_x contribution. This is a common experience with ADMS and most other models. It is worth noting that the verification sites are both located more than 2 km from the proposed car park and therefore there will be uncertainty in the modelled input.

Figure A.1: Comparison of Measured road-NO_x to unadjusted modelled road-NO_x concentrations



RMSE

The root mean square error (RMSE) is used to define the average error or uncertainty of the model. The following RMSE value has been calculated:

NO₂: 9.8

If the RMSE values are higher than ±25 % of the objective being assessed, it is recommended that the model inputs and verification should be revisited in order to make improvements. In this case the model is being assessed against the annual mean objective, which is 40 µg/m³ for NO₂. An RMSE value of less than 10 µg/m³ has been obtained. This is close to the limit as to whether it is acceptable or not. However, the low pollutant concentrations predicted (which

are expected due to the low traffic flows around the site) give confidence that there will be no air quality issues as a result of the car park being in operation.

Appendix B – Traffic Data

Table B.1: Traffic data for 2019 (and prediction for 2022 without development)

Development/ verification site	Road links	Annual Average Daily Traffic (AADT)	% Heavy Duty Vehicles (HDV)	Speed (kph)
Development site	Lindisfarne Way	4,601 (4,775)	2.2	26
	Rose Kiln Lane	18,791 (19,502)	2.2	26
	A33	46,167 (47,913)	4.3	26
	B3031 (Basingstoke Road)	12,867 (13,354)	4.7	26
Verification sites	Whitley Wood Road	3,422 (3,551)	1.3	26
	Northumberland Avenue	9,706 (10,073)	2	26
	Shinfield Road (A327)	10,649 (11,052)	2.8	26
	Manor Farm Road	2,901 (3,011)	4.5	26
Development / verification site	Urban minor road	2,600 (2,698)	2.2	26

Note: With development results in traffic increases on Lindisfarne Way, the A33 and Island Road junction. Data for this was obtained from Hydrock's Transport Statement.



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