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|-------------------------|-------------------------|----------|---|
| Be easy to Project name | Weldale Street          |          |   |
| Design note title       | Air Quality Strategy    |          |   |
| Document reference      | WDS-HYD-XX-ZZ-RP-Y-2001 |          |   |
| Author                  | M. Nichols              |          |   |
| Revision                | P02                     |          |   |
| Date                    | 22 June 2021            | Approved | ✓ |

## 1. INTRODUCTION

Hydrock have been commissioned by Henry Construction Projects Ltd to assist with the discharge of **Condition 15** of the Decision Notice (ref: 191974), for a residential development at Former Wickes Building Supplies Ltd, Weldale Street, Reading, RG1 7BW. Conditional Planning Permission was granted (ref: 170326) for the following:

*“Demolition of all existing buildings (including 3 retail units) and structures, and erection of new buildings ranging between lower ground & 4 storeys to lower ground & 11 storeys in height, providing 427 (233x1, 182x2 & 12x3-bed) residential units (Class C3) and 1 flexible ground floor retail shop (Class A1) or restaurant and cafe (Class A3) unit, together with new public realm, landscaping, accesses, parking and associated works (amended description).”*

A pre-occupation Replacement Condition (15) for an Air Quality Strategy was attached to the decision notice, as follows:

*“Prior to the first occupation of any residential unit hereby approved*

*(a) an overall air quality strategy demonstrating strategic mitigation principles shall be submitted to and approved in writing by the local planning authority. Prior to the first occupation of any residential unit within the relevant phase of development; and*

*(b) phase 2 - Block A1, c) phase 3 - Block A2, d) phase 4 - Block B2, e) phase 5 - Block B1, as per 3622\_0250 Rev D Phasing Plan, as received 14/02/2020) hereby approved a detailed scheme demonstrating sufficient mitigation to protect the occupants of the new dwellings hereby approved from poor air quality shall be submitted to and been approved in writing by the local planning authority. The scheme shall be implemented as approved prior to occupation of the relevant part of the development (associated with the relevant phase of development) and retained as approved at all times thereafter.*

**Reason:** *to protect the amenity / health of future occupants of the proposed development, in accordance with Policies CC8, EN15 and CR6, CS34 of the Reading Borough Local Plan 2019.”*

Based on the above, the Air Quality Strategy pursuant to Condition 15 is provided in Section 2 of this report. The supporting appendices provide further context and justification.

## 2. AIR QUALITY STRATEGY

### 2.1 Condition 15, Part (a) – Strategic Mitigation Principles

This section provides detail of the strategic mitigation principles which are designed into the scheme.

#### 2.1.1 *Transport Emissions*

A Framework Travel Plan (FTP) was prepared by Phil Jones Associates, which provides details of the sustainable travel initiatives to be adopted. Such measures will be effective as air quality mitigation, as they aim to reduce reliance on single occupancy car travel, and promote and encourage delivery of sustainable transport initiatives such as walking, cycling, and public transport. The key FTP measures include:

- Measures to Reduce Car Use by Occupants:
  - » The developer will facilitate home-working and shopping, by ensuring each household can connect to broadband services and ensure that the layout of the development can accommodate delivery vans;
  - » Residents and employees will not be eligible for parking permits for controlled roads in the vicinity of the development.
- Provision of Travel Information;
  - » Each household within the residential development will receive a Welcome Pack detailing sustainable travel options. Similar Welcome Packs will be provided to employees, with details of the commercial Travel Plan Coordinator (TPC) and how the employees can benefit from the Travel Plan;
  - » A Travel Plan information board will be located in a well-used communal area. It will include details as provided in the Welcome Packs, but this information will be regularly updated;
  - » Personalised travel planning whereby the TPC works with households, and provides them with individualised travel marketing and tailor-made information on sustainable travel, enabling people to walk, cycle, car share and use public transport more often;
  - » The sales staff will be trained by the TPC about the sustainable travel options in the surrounding area, and will be responsible for promoting these sustainable options to the prospective residents; and
  - » The Travel Plan will also be promoted alongside the promotion of key sustainable travel events. Supervised by the TPC, these events which will allow an opportunity for continued marketing of the aims of the strategy and enable wider engagement within the community.
- Measures to Promote and Facilitate Walking and Cycling;
  - » Five secure and covered cycle stores providing a total of 230 double-stacked spaces;
  - » Walking and cycling will also be encouraged through the inclusion of maps showing routes in the surrounding area within the welcome pack. Residents will be made aware of numerous Smartphone apps such as National Cycle Network, Walk it and MapMyRide. These apps can help plan/map out journeys via foot and cycle within the local area;
  - » Residents will also be provided with details regarding the BikeBudi (<https://bikebudi.liftshare.com>) and WalkBudi (<https://walkbudi.liftshare.com>) schemes which help users find others walking or cycling in the same direction; and

- » Negotiate discounts with local cycle shops and include details of discounts in the Welcome Pack.
- Measures to Promote and Facilitate Public Transport Use;
  - » Provide up-to-date public transport information including details on routes, services, timetables and fares. This will be easily accessible to all residents through materials contained within the Welcome Pack; and
  - » Journey planning tools such as <http://www.traveline.info/> and Smartphone apps will also be marketed, and the potential for discounted public transport for residents will be investigated.
- Car Sharing and Car Club;
  - » Details of car sharing schemes which operate locally will be provided to both residents and employees;
    - The site is situated within 10 minutes from two car club schemes (<https://www.carvenientclub.com> and <http://www.co-wheels.org.uk>). These car clubs will be promoted within the residents' Welcome Pack.

In addition to the FTP measures, the scheme will include the provision of Electric Vehicle Charging within the basement car park, comprising 12 car charging units. The scheme also includes electric cycle charging provision with 18 charging points across the Site.

## 2.1.2 Building emissions

Energy to the building will be supplied via a centralised boiler plant combined with a dynamic Combined Heat and Power (CHP) unit acting as the primary heating source. This CHP plant will provide efficient heating and hot water generation for all units on site, with Solar Photovoltaics (PV) supplying on-site electricity generation to supplement the Landlord's power supply.

### 2.1.2.1 Combined Heat and Power Emission Rates

The IAQM Land-Use Planning & Development Control: Planning for Air Quality<sup>11</sup> provides emission standards for CHP plant:

*"All gas-fired CHP plant to meet a minimum emissions standard of:*

*° Spark ignition engine<sup>22</sup>: 250 mgNO<sub>x</sub>/Nm<sup>3</sup>;*

*° Compression ignition engine<sup>23</sup>: 400 mgNO<sub>x</sub>/Nm<sup>3</sup>;*

*° Gas turbine<sup>24</sup>: 50 mgNO<sub>x</sub>/Nm<sup>3</sup>"*

Energy to the site shall be supplied via a centralised boiler plant combined with a dynamic CHP unit acting as the lead heating source. The CHP plant will be the EnergiMizer EM 33NG, which is a natural gas-fired plant. The specification datasheet for this model, provided at **Appendix B**, states that the exhaust gas emission rate for NO<sub>x</sub> will be less **<27.3mg/m<sup>3</sup>** which is well below the recommended emission standards for all plant types listed above. In addition, all exhaust stacks are located at roof level of each block. On this basis, there should be no additional requirement to mitigate emissions from the CHP plant as part of this Air Quality Strategy.

## 2.2 Condition 15, Parts (b)(c)(d)(e): Exposure to Poor Air Quality

The requirements for mitigation to address Condition 15, Parts (b)(c)(d)(e) – to reduce exposure to existing poor air quality - have been determined against the results of a dispersion modelling assessment, which supersedes

the data and conclusions provided in the Air Quality Assessment submitted<sup>1</sup> with the original planning application.

Table 1 provides a comparison between the model input parameters which were available when the planning application was originally submitted in 2017, and the latest iterations to justify the need for a revised assessment:

Table 1 – Reasons for re-assessment

| Input Parameter                           | Original Air Quality Assessment     | Revised Air Quality Assessment | Source                                 |
|-------------------------------------------|-------------------------------------|--------------------------------|----------------------------------------|
| ADMS software (version number)            | 4.0.1.0                             | 5.0.0.1                        | CERC                                   |
| Model Verification year                   | 2014 (no adjustment was undertaken) | 2019                           | RBC Monitoring Data <sup>19</sup>      |
| Baseline traffic data year                | 2014                                | 2019                           | Department for Transport <sup>15</sup> |
| Emissions Factor Toolkit (version number) | 6.0.1                               | 10.1                           | Defra                                  |
| Future Year Traffic Data                  | 2017                                | 2022                           | Department for Transport               |
| Meteorological data year                  | 2014                                | 2019                           | RAF Benson                             |

Based on the above, all input parameters used to assess exposure at the time of the planning application are superseded. On the basis that the condition is a pre-occupation condition, it is considered entirely reasonable to reassess the likely exposure at the Site in 2022, which is expected to be the earliest year of occupation of Phases 2 and 3.

Full details of the dispersion modelling methodology followed to inform the requirements for mitigation are provided in Appendix C. Full details of the model verification procedure are provided in Appendix D. Full results of the dispersion model are provided in Appendix E.

## 2.2.1 General Measures – Apartment Ventilation

Local MVHR (Mechanical Supply and Extract with Heat Recovery) will be provided at the high noise exposure road-facing façade dwellings for all phases. This will limit the need for windows to be opened, except for occasional purge ventilation. **This is also considered appropriate for this air quality strategy.**

For apartments where noise levels permit the use of trickle vents in the facade, Mechanical Extract Ventilation (MEV) units will be utilised. **This is also considered appropriate for this air quality strategy.**

**On apartments with air quality issues, as identified in section 2.2.5, mechanical ventilation will be provided with additional mitigation (Activated Carbon Filters) to reduce NO<sub>x</sub> emissions on the intake air supply.**

## 2.2.2 General Measures – Green Infrastructure

Green infrastructure offers benefits to public health by reducing exposure to the air pollution produced by vehicles<sup>14</sup>. Implementing appropriate Green Infrastructure design where air quality at street level is worse than above the surrounding buildings (i.e., within a street canyon), for instance the addition of green open space to one side (opening up the street canyon), can be beneficial in reducing air pollutants.

<sup>1</sup> Report reference: C16 1063-AQ-20160127 P02

As shown in 3622\_0250 Rev D Phasing Plan, **Phase 6 of the approved scheme includes 'Highways Land' which is designated as amenity green space.** Phase 6 avoids the creation of a narrow street canyon and increases the distance between the roadside and the building façades. Full details of the soft landscape can be found in 1903-MWA-00-XX-DR-L-1900-1904 and 2900-2903. In addition, the western façade of Block A1 will be a living green wall (which can reduce exposure<sup>14</sup>), as shown in 1903-MWA-00-XX-M-L-0001\_08.

### *2.2.3 Part (b) Phase 2, Block A1*

Based on the modelled concentrations in Table 6, there should be no requirement for additional mitigation on the MVHR supply air for roadside façade dwellings in Phase 2, as predicted annual mean NO<sub>2</sub> is not in exceedance of the NAQO, or within 10%. The same conclusions have been reached for PM<sub>10</sub> and PM<sub>2.5</sub>. Natural ventilation for façade dwellings set away from roadsides to the rear of Block A1 is considered appropriate.

### *2.2.4 Part (c) Phase 3, Block A2*

Based on the modelled concentrations in Table 7, there should be no requirement for additional mitigation on the MVHR supply air for Phase 3, as predicted annual mean NO<sub>2</sub> is not in exceedance of the NAQO, or within 10%. The same conclusions have been reached for PM<sub>10</sub> and PM<sub>2.5</sub>. Natural ventilation for façade dwellings set away from roadsides to the rear of Block A2 is considered appropriate.

### *2.2.5 Part (d) Phase 4, Block B2*

Based on the modelled concentrations in Table 8, additional mitigation should be installed on the MVHR supply air for façade dwellings in Phase 4, Block B2, as annual mean NO<sub>2</sub> is predicted to be within 10% of the NAQO (which indicates a risk of exceedance), due to proximity to emissions from the A329 Inner Distribution Road. Natural ventilation for façade dwellings set away from roadsides to the rear of Block B2 is considered appropriate.

**Targeted mitigation is required to reduce exposure to elevated NO<sub>2</sub> at lower ground and ground floor levels of Block B2. The MVHR should be installed with Activated Carbon Filters, which effectively reduce NO<sub>x</sub> concentrations on the air supply.**

### *2.2.6 Part (e) Phase 5, Block B1*

Based on the modelled concentrations in Table 9, there should be no requirement for additional mitigation on the MVHR supply air for Phase 5, as annual mean NO<sub>2</sub> is not in exceedance of the NAQO, or within 10%. The same conclusions have been reached for PM<sub>10</sub> and PM<sub>2.5</sub>. Natural ventilation for façade dwellings set away from roadsides to the rear of Block B1 is considered appropriate.

### 3. CONCLUSION AND RECOMMENDATIONS

Hydrock have been commissioned by Henry Construction Projects Ltd to assist with the discharge of **Condition 15** of the Decision Notice (ref: 191974), for a residential development at Former Wickes Building Supplies Ltd, Weldale Street, Reading, RG1 7BW.

A detailed Air Quality Strategy has been prepared, as outlined in Section 2. This demonstrates the overarching strategic mitigation principles which will be taken to ensure adverse impacts during operation will be reduced as far as reasonably possible to address Condition 15, Part (a).

In addition, the requirements for mitigation to address Condition 15, Part (b) – to reduce exposure to existing poor air quality – has been determined by providing the results of a dispersion modelling assessment using the latest available input parameters. As the condition is a pre-occupation condition, it is entirely reasonable to assess the likely exposure at the site in 2022, which is considered to be the first year of occupation of the development.

The principles of the Air Quality Strategy, as detailed in section 2, include:

#### Part (a)

- Measures to Reduce Car Use by Occupants;
- Provision of Travel Information;
- Measures to Promote and Facilitate Walking and Cycling;
- Measures to Promote and Facilitate Public Transport Use;
- Car Sharing and Car Club;
- Electric Vehicle Charging within the basement car park, comprising 12 car charging units;
- Cycle charging provision with 18 charging points across the site; and
- Natural Gas-fired CHP plant with NO<sub>x</sub> emissions <27.3mg/m<sup>3</sup>.

#### Parts (b)(c)(d)(e)

- Local MVHR will be provided to road-facing façade dwellings for all phases (purge ventilation via openable windows is still required);
- Road-facing façade dwellings in Phase 4, Block A2 will be provided with additional mitigation (Activated Carbon Filters) to reduce NO<sub>x</sub> emissions on the MVHR air supply at lower ground and ground floor levels. Local MVHR will be provided at higher floors (first floor and above) where pollutant levels are predicted to decline below the risk of NAQO exceedances;
- Rear facing façade dwellings will be provided with MEV, trickle vents for make-up air, and openable windows for prevention of overheating and purge ventilation;
- Phase 6 includes 'Highways Land' which is designated as amenity green space, avoiding the creation of a narrow street canyon and increasing the distance between the roadside and the building façades, and
- The western façade of Block A1 will be a living green wall.

On the basis of the evidence presented in this report, and provided that the principles of the air quality strategy are endorsed, full discharge of **Condition 15** is recommended, as the stated reasons (*to protect the amenity / health of future occupants of the proposed development, in accordance with Policies CC8, EN15 and CR6, CS34 of the Reading Borough Local Plan 2019*) have been addressed.

## Appendix A: Legislation, Policy and Guidance

### LEGISLATION, POLICY AND GUIDANCE

#### Legislation

##### EU

Whilst the UK has left the EU, the overarching EU directives relating to air quality still apply. The governing European Union Directive on ambient air quality and cleaner air for Europe (2008/50/EC)<sup>2</sup> came into force in 2008, and provides statutory guidance on air quality. This presents statutory requirements for the protection of human health and ecosystems through long and short-term limit values for: oxides of nitrogen (NO<sub>x</sub>), nitrogen dioxide (NO<sub>2</sub>), sulphur dioxide (SO<sub>2</sub>), particulate matter with a diameter of less than 10 microns (PM<sub>10</sub>), particulate matter with a diameter of less than 2.5 microns (PM<sub>2.5</sub>), carbon monoxide (CO), lead, benzene and ozone (O<sub>3</sub>). The above legislation replaces the EU's previous three daughter directives.

##### UK

The targets and limit values set within the 2008/50/EC directive were transposed into UK law through the Air Quality Standards Regulations 2010, as amended<sup>3</sup>. These set out how the government has interpreted the EU directives noted above. One of the main additions is the regulatory framework for PM<sub>2.5</sub>.

The Air Quality Strategy 2007 Volume 1<sup>4</sup> outlines the National Air Quality Standard (AQS) concentrations and National Air Quality Objectives (NAQOs) that should be achieved. A summary of the AQS concentrations and NAQOs of relevance to this assessment is provided below, in Table 2:

Table 2 - UK Air Quality Standards

| Pollutant                               | Units             | Averaging Period | Air Quality Standard (AQS) | National Air Quality Objectives (NAQO)           |
|-----------------------------------------|-------------------|------------------|----------------------------|--------------------------------------------------|
| Nitrogen dioxide (NO <sub>2</sub> )     | µg/m <sup>3</sup> | 1 Hour Mean      | 200 µg/m <sup>3</sup>      | Not to be exceeded more than 18 times in a year. |
|                                         |                   | Annual Mean      | 40 µg/m <sup>3</sup>       |                                                  |
| Particulate matter (PM <sub>10</sub> )  | µg/m <sup>3</sup> | 24 Hour Mean     | 50 µg/m <sup>3</sup>       | Not to be exceeded more than 35 times in a year. |
|                                         |                   | Annual Mean      | 40 µg/m <sup>3</sup>       |                                                  |
| Particulate matter (PM <sub>2.5</sub> ) | µg/m <sup>3</sup> | Annual Mean      | 25 µg/m <sup>3</sup>       | 25 µg/m <sup>3</sup>                             |

Both the annual mean and short term mean NAQOs apply at the residential properties when considering the exposure of new receptors at the site.

<sup>2</sup> EC, "Directive 2008/50/EC of the European Parliament and of the Council," May 21, 2008, 44.

<sup>3</sup> Parliament, "The Air Quality Standards Regulations 2010," June 11, 2010, [http://www.legislation.gov.uk/uksi/2010/1001/pdfs/ukxi\\_20101001\\_en.pdf](http://www.legislation.gov.uk/uksi/2010/1001/pdfs/ukxi_20101001_en.pdf).

<sup>4</sup> Defra, "The Air Quality Strategy for England, Scotland, Wales and Northern Ireland - Volume 1" (Department for Food, Environment and Rural Affairs (Defra), July 2007), [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/69336/pb12654-air-quality-strategy-vol1-070712.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69336/pb12654-air-quality-strategy-vol1-070712.pdf).

## Local Air Quality Management

Obligations under the Environment Act 1995<sup>5</sup> require local authorities to declare an Air Quality Management Area (AQMA) at sensitive receptor locations where an objective concentration has been predicted to be exceeded. In setting an AQMA, the local authority must then formulate an Air Quality Action Plan (AQAP) to seek to reduce pollution concentrations to values below NAQOs.

The Reading Town Centre and Major Radial Road routes AQMA was declared in 2001 for exceedances of the NO<sub>2</sub> annual mean NAQO. RBC released an AQAP update<sup>6</sup>, which states that the Council has reviewed its existing Air Quality Action Plan which has been in place since 2009, as some of the actions have either been completed or superseded. The revised Air Quality Action Plan contains measures to improve air quality across Reading, specifically targeting action on the key pollutants of concern.

## National Policy

### *National Planning Policy Framework*

The National Planning Policy Framework (NPPF)<sup>7</sup> sets out the Government's planning policy for England. At paragraph 103, it states that significant development should be focused on locations which are or can be made sustainable, which can help to reduce congestion and emissions, and improve air quality and public health.

The NPPF requires planning decisions for any new development to prevent new and existing development from contributing to, or being put at risk from, unacceptable levels of air pollution (paragraph 170). It also states that planning decisions should sustain and contribute towards compliance with relevant limit values or national objectives for air pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones (paragraph 181), and the cumulative impacts from other sites (paragraph 180).

Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. Furthermore, planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan.

### *Planning Practice Guidance*

Reference ID 32 (Air Quality) of the National Planning Practice Guidance (nPPG)<sup>8</sup> which was updated in November 2019, provides guiding principles on how planning can take account of the impact of new development on air quality. The PPG summarises the importance of air quality in planning and the key legislation relating to it.

## Local Policy

Relevant policies from the Reading Borough Local Plan (2019)<sup>9</sup> are summarised below:

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<sup>5</sup> Environment Agency, "Environment Act 1995" (The Environment Agency, 2002), <http://www.legislation.gov.uk/ukpga/1995/25/contents>.

<sup>6</sup> [https://images.reading.gov.uk/2020/01/AQAP\\_Update\\_2016.pdf](https://images.reading.gov.uk/2020/01/AQAP_Update_2016.pdf)

<sup>7</sup> Ministry of Housing, Communities and Local Government, "National Planning Policy Framework," July 2019, [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/740441/National\\_Planning\\_Policy\\_Framework\\_web\\_accessible\\_version.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/740441/National_Planning_Policy_Framework_web_accessible_version.pdf).

<sup>8</sup> Ministry of Housing, Communities & Local Government, "Reference ID (32) Air Quality" (Ministry of Housing, Communities & Local Government, 2019), <https://www.gov.uk/guidance/air-quality--3>.

<sup>9</sup> Reading Borough Council, Reading Borough Local Plan, Adopted November 2019 [https://images.reading.gov.uk/2019/12/Local\\_Plan\\_Adopted\\_November\\_2019.pdf](https://images.reading.gov.uk/2019/12/Local_Plan_Adopted_November_2019.pdf)

## **“CC8: SAFEGUARDING AMENITY**

*Development will not cause a detrimental impact on the living environment of existing residential properties or unacceptable living conditions for new residential properties, in terms of:*

*[...]*

- *Dust and fumes;*
- *Smell;*

*[...]*

*Where the proposals involve new development of more than 8 storeys. The position of habitable rooms, windows and outdoor living spaces will be particularly important. A back-to-back distance of 20 metres between dwellings is usually appropriate, although the circumstances on individual sites may enable dwellings to be closer without a detrimental effect on privacy.*

*As well as immediate impacts, other aspects to which this policy applies will include matters such as hours of operation of businesses, and effects of traffic movements, particularly of heavy goods vehicles (HGVs).*

*Proposals which would generate regular movements of HGVs on residential roads will not be acceptable. Where an otherwise acceptable development could change its character to a use that would have a greater impact on amenity without needing planning permission, conditions will be applied to restrict such changes.*

## **EN15: AIR QUALITY**

*Development should have regard to the need to improve air quality and reduce the effects of poor air quality.*

*i. Development that would detrimentally affect air quality will not be permitted unless the effect is to be mitigated. The following criteria should be taken into account:*

- *Whether the proposal, including when combined with the cumulative effect of other developments already permitted, would worsen air quality;*
- *Whether the development is within, or accessed via, an Air Quality Management Area; and*

*Whether it can be demonstrated that a local worsening in air quality that would not detrimentally affect human health or the environment would be offset by an overall improvement in air quality, for instance through reduction in the need to travel.*

*ii. Where a development would introduce sensitive uses (such as residential, schools and nurseries, hospitals, care facilities) into, or intensify such uses within, an Air Quality Management Area, detrimental effects on that use will be mitigated. Mitigation measures should be detailed in any planning application. If there are significant detrimental effects that cannot be mitigated, the application should be refused.*

*iii. Where required, planning obligations will be used to secure contributions to measures to tackle poor air quality or for air quality monitoring.*

## **CR6: LIVING IN CENTRAL READING**

*Proposals for residential development within the central area will be assessed against the following criteria:*

*[...]*

*ii) Proposals for new residential development within the central area will be required to demonstrate how the issue of potential noise disturbance from neighbouring land uses and other sources, and air quality*

*implications of residential development, have been considered and if necessary, mitigated. New residential development should not be located next to existing town centre uses where those uses would give rise to unacceptable levels of noise and disturbance to the occupiers of the new scheme, unless this can be mitigated.*

## **CS34: POLLUTION AND WATER RESOURCES**

*Development will only be permitted where it would not be damaging to the environment through air, land, noise or light pollution; where it would preserve or ideally enhance ground and surface water quality; and where existing water resources, sewerage and wastewater treatment infrastructure are adequate to support the proposed development.*

*Proposals for development that are sensitive to the effects of air, noise or light pollution will only be permitted in areas where they will not be subject to high levels of such pollution, unless adequate mitigation measures are provided to minimise the impact of such pollution.*

*Development will be permitted on land affected by contamination where it can be demonstrated, to the satisfaction of the LPA, that the contamination can be satisfactorily remediated so that it is suitable for the proposed end use.”*

## Guidance and Research

The following guidance and research documents have been referred to in preparation of this Air Quality Strategy:

- Defra’s Local Air Quality Management Technical Guidance (LAQM.TG (19))<sup>10</sup>
- IAQM: Land-Use Planning and Development Control: Planning for Air Quality<sup>11</sup>;
- Defra’s COVID-19 Supplementary LAQM Guidance<sup>12</sup>;
- City Air Quality at Height – Lessons for Developers<sup>13</sup>; and
- Using Green Infrastructure to Protect People from Air Pollution<sup>14</sup>.

<sup>10</sup> Local Air Quality Management Technical Guidance (TG16) <https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf>

<sup>11</sup> IAQM, “Land-Use Planning & Development Control: Planning for Air Quality” (Institute for Air Quality Management (IAQM), January 2017), <http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf>.

<sup>12</sup> <https://laqm.defra.gov.uk/documents/Covid-19%20-%20Supplementary%20Guidance%20for%20Local%20Air%20Quality%20Management%20Reporting%20in%202021%20v1.pdf>

<sup>13</sup> <https://www.camden.gov.uk/documents/20142/18667687/8-1+City+Air+Quality+at+Height.pdf/5cfb1877-c72c-869b-23e1-32f06a3cd642>

<sup>14</sup> [https://www.london.gov.uk/sites/default/files/green\\_infrastruture\\_air\\_pollution\\_may\\_19.pdf](https://www.london.gov.uk/sites/default/files/green_infrastruture_air_pollution_may_19.pdf)

## Appendix B: CHP Technical Specification



### NATURAL GAS FIRED EM 33NG

#### SPECIFICATION DATASHEET

|                                                    |                                               |
|----------------------------------------------------|-----------------------------------------------|
| Energy efficiency:                                 | A++                                           |
| Operational mode:                                  | Mains parallel operation                      |
| Fuel:                                              | Natural gas, LPG                              |
| Electrical output ( $P_{el}$ ):                    | 33kW(e) <sup>2)</sup> min 16.5 kW             |
| Thermal output ( $P_{th}$ ):                       | 67 kW <sup>2)</sup> min 43.5 kW               |
| Fuel consumption:                                  | 97.7 kW <sup>1)</sup> (nett) 109.2 kW (gross) |
| CHP coefficient:                                   | 0.46                                          |
| Efficiency:                                        | EN50465                                       |
| Total efficiency:                                  | 101.6% (nett) 91.5% (gross)                   |
| Electric efficiency:                               | 33.5% (nett) 30.2% (gross)                    |
| Thermal efficiency:                                | 68.1% (nett) 61.3% (gross)                    |
| Gas-connection pressure:                           | 20-50 mbar                                    |
| Gas-flow pressure:                                 | ≤16 mbar                                      |
| Flow rate with natural gas:                        | 9.9 Nm <sup>3</sup> /h                        |
| Flow temperature:                                  | max. 90 °C                                    |
| Return temperature:                                | max. 70 °C                                    |
| Max. system pressure:                              | 6 bar (heating side)                          |
| Combustion & cooling air requirement:              | min. 125 m <sup>3</sup> /h (85 kg/h)          |
| Ambient temperature:                               | 5°C to max. 35°C                              |
| Exhaust gas emissions:                             | at 5 Vol% remaining oxygen                    |
| CO (carbon monoxide):                              | < 40 mg/m <sup>3</sup> (50% TA-air)           |
| NOx (nitrogen oxide):                              | < 27.3 mg/m <sup>3</sup> (50% TA-air)         |
| Exhaust gas temperature:                           | - 50 °C <sup>2)</sup>                         |
| Exhaust gas volume flow:                           | - 125 m <sup>3</sup> /h                       |
| Exhaust gas mass flow dry:                         | - 135 kg/h                                    |
| Exhaust gas back pressure after CS <sup>4)</sup> : | max. 5 mbar                                   |
| Sound pressure level CHP:                          | - 48.5 dB(A) (1 m distance)                   |

#### CHP: Dimensions, weights and connections

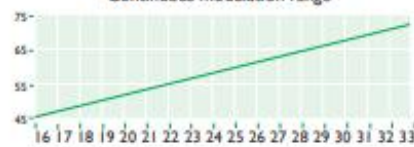
|                                           |                                        |
|-------------------------------------------|----------------------------------------|
| L x W x H CHP:                            | 1.59 x 0.91 x 1.105 m                  |
| Weight CHP, incl. oil and water:          | 1080 kg                                |
| x H CS <sup>4)</sup> :                    | 0.30 x 1.52 m (w/o flanges)            |
| Weight CS <sup>4)</sup> :                 | 30 kg                                  |
| Colour CHPP:                              | Pantone 5517C                          |
| Heating connections (VL):                 | R 1" Flow (warm)<br>R 1" Return (cold) |
| Exhaust gas connection CS <sup>4)</sup> : | DN100                                  |
| Gas connection:                           | R 3/4" NG<br>R 1/2" LPG                |

#### Motor

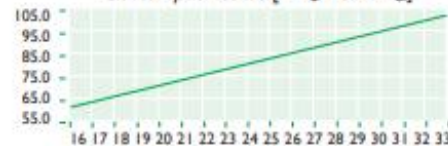
|                       |                          |
|-----------------------|--------------------------|
| Type:                 | K36                      |
| Operation:            | Straight line            |
| Cylinder:             | 4-stroke                 |
| Displacement:         | 4                        |
| Nominal engine speed: | 3.6 litres<br>1500 1/min |



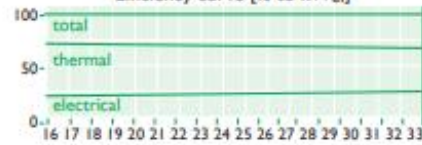
Output curve [kW<sub>th</sub> to kW<sub>el</sub>]  
Continuous modulation range



Consumption curve [NM<sup>3</sup>/h to kW<sub>el</sub>]



Efficiency curve [% to kW<sub>el</sub>]



Sound pressure level curve [dB(A) to Hz]<sup>5)</sup>



<sup>1)</sup> According to DIN ISO 3046-1, tolerance 5%

<sup>2)</sup> Return temperature 60°C

<sup>3)</sup> According to EU RL 2004/8/EG with 100% internal use

<sup>4)</sup> Combination silencer

<sup>5)</sup> Test stand measuring without liability

<sup>6)</sup> According to EN60959 2009



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## *Appendix C: Dispersion Modelling Methodology*

### Operational Phase Impact Assessment

It is understood from the original air quality assessment which accompanied the planning application<sup>1</sup>, vehicle movements associated with the Site will reduce as a result of the change-in-use from retail to residential-led. As a result, significant offsite impacts have not been assessed.

### Operational Phase Exposure Assessment

An updated assessment of exposure across the Site has been undertaken to inform the requirements for additional mitigation beyond the proposed MVHR system. The methodology is outlined below.

#### *ADMS-Urban Dispersion Modelling*

Emissions from road traffic travelling along the local road network have been assessed for exceedances of the NAQO for NO<sub>2</sub> at the Site using the latest version of ADMS-Urban (version 5.1), which was released in April 2020 by Cambridge Environmental Research Consultants (CERC). The model has been validated and approved by Defra for use as an assessment tool for calculating the dispersion of pollutants from traffic on UK roads.

The ADMS-Urban modelling has only been used to account for the road contribution to total receptor concentrations, therefore background concentrations from the Reading AURN station have been added to derive total concentrations.

#### *Modelled Roads and Receptors*

Receptors have been modelled at the roadside building façades of each block, in each phase according to 3622\_0250 Rev D Phasing Plan. Discrete model receptors were positioned at breathing height (assumed to be 1.5m) plus the relevant floor height (assumed to be 3m between each floor) up to the fourth floor.

These are considered worst-case locations, as pollutant concentrations would reasonably be expected to decline with increased distance from the roads and with height. Research suggests that the most significant reduction in pollutant concentrations occurs with height from ground to fourth floor<sup>13</sup>. Beyond the fourth floor the data indicates that there is no further significant reduction in NO<sub>2</sub> concentrations with height, which are expected to be comparable to background concentrations at this height. Accordingly, receptors have been modelled to fourth floor height only.

The modelled receptors are shown below, in Figure 1, which is overlain with 3622\_0250 Rev D Phasing Plan, for reference:

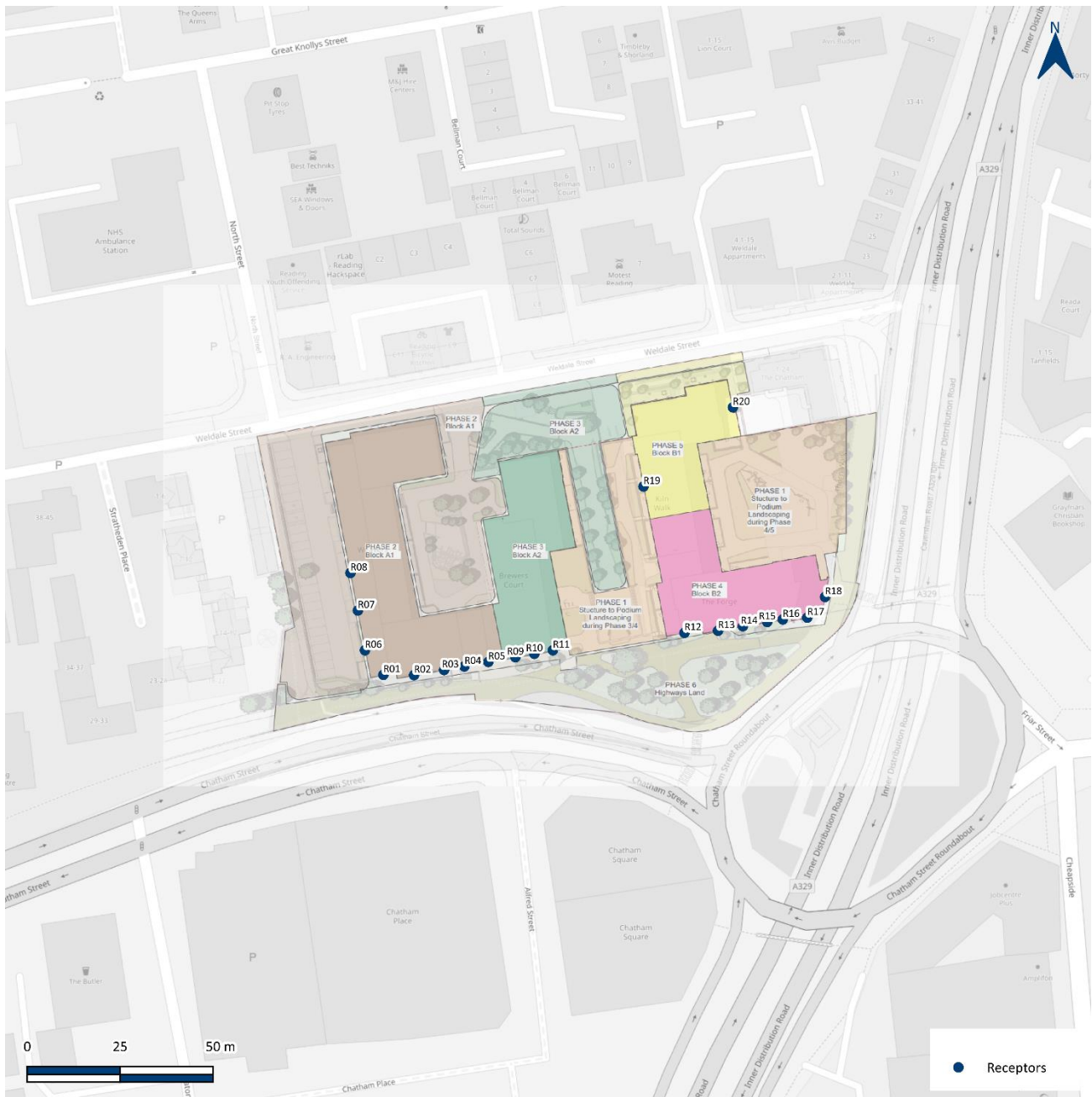


Figure 1 – Modelled Receptors

In addition, to illustrate the dispersion of annual mean NO<sub>2</sub> concentrations across the Site, isopleth contour plots were modelled. The contour plots were based on a modelled receptor grid at 1.5m breathing height (plus relevant floor height), originating at the grid reference 470929.33 (x), 173535.3 (y). The grid is made up of 84 × 56 receptor points at high resolution 2.5m spacing.

All roads in the immediate vicinity of the Site have been modelled. All modelled roads are shown below, in Figure 2:



Figure 2 – Modelled Roads

## Model Inputs

### Traffic Data

Traffic flows for the roads shown in Figure 2 have been derived from the latest available DfT road traffic statistics<sup>15</sup>, as follows:

- Chatham Street: DFT ID 48360
- Oxford Street: DFT ID 6924
- IDR South: DFT ID 27954
- IDR North: DFT ID 18632

<sup>15</sup> <https://roadtraffic.dft.gov.uk/#6/55.250/-1.000/basemap-regions-countpoints>

For all roads, 2019 data were available, and directional split by either East and West or North and South was also available. Data have been projected to 2022 to represent the opening year of the earliest phase using a local growth factor of 1.045 for Reading using TEMPro. The AADT traffic data used in the model are provided below, in Table 3:

Table 3 – AADT traffic data used in model

| Link # | Direction * | Link Name             | Verification 2019 |      |            |      | Opening Year 2022 |      |            |      |
|--------|-------------|-----------------------|-------------------|------|------------|------|-------------------|------|------------|------|
|        |             |                       | Flow (AADT)       |      | Total AADT | HDV% | Flow (AADT)       |      | Total AADT | HDV% |
|        |             |                       | LDV               | HDV  |            |      | LDV               | HDV  |            |      |
| L01    | E           | Chatham Street        | 8966              | 269  | 9235       | 2.9  | 9366              | 281  | 9647       | 2.9  |
| L02    | W           | Chatham Street        | 8364              | 235  | 8599       | 2.7  | 8738              | 245  | 8983       | 2.7  |
| L03    | E           | Oxford Road           | 6971              | 413  | 7384       | 5.6  | 7282              | 431  | 7714       | 5.6  |
| L04    | W           | Oxford Road           | 5897              | 441  | 6338       | 7.0  | 6160              | 461  | 6621       | 7.0  |
| L05    | TW          | Oxford Road           | 12868             | 853  | 13721      | 6.2  | 13443             | 891  | 14334      | 6.2  |
| L06    | N           | A329 South of Chatham | 21825             | 4819 | 26644      | 18.1 | 22800             | 5034 | 27834      | 18.1 |
| L07    | S           | A329 South of Chatham | 18040             | 3800 | 21840      | 17.4 | 18846             | 3970 | 22815      | 17.4 |
| L08    | N           | A329 North of Chatham | 17102             | 3474 | 20576      | 16.9 | 17866             | 3629 | 21495      | 16.9 |
| L09    | S           | A329 North of Chatham | 13327             | 2578 | 15905      | 16.2 | 13922             | 2693 | 16615      | 16.2 |
| L10    | N           | Slip 1(S)             | 13820             | 1440 | 15260      | 9.4  | 14438             | 1504 | 15942      | 9.4  |
| L11    | S           | Slip 2 (S)            | 4510              | 950  | 5460       | 17.4 | 4711              | 992  | 5704       | 17.4 |
| L12    | N           | Slip 3 (N)            | 13276             | 1104 | 14379      | 7.7  | 13868             | 1153 | 15021      | 7.7  |
| L13    | S           | Slip 4 (N)            | 3332              | 645  | 3976       | 16.2 | 3481              | 673  | 4154       | 16.2 |
| L14    | N           | Bedford Road          | 7969              | 341  | 8310       | 4.1  | 8324              | 356  | 8681       | 4.1  |
| L15    | S           | Bedford Road          | 7131              | 338  | 7469       | 4.5  | 7449              | 353  | 7802       | 4.5  |

- For Bedford Road, traffic flows have been assumed to be an average of Chatham Street and Oxford Road;
- For Slip Road 1, traffic flows have been assumed to be equal to 25% of L06 + 100% of L02;
- For Slip Road 2, traffic flows have been assumed to be equal to 25% of L07;
- For Slip Road 3, traffic flows have been assumed to be equal to 25% of L08 and 100% of L01, and
- For Slip Road 4, traffic flows have been assumed to be equal to 25% of L09.

No turning counts for the roundabout junction or traffic data for Friar Street were available. Accordingly, the above assumptions were considered to be reasonable and conservative.

## Emission Factors

Emission rates for NO<sub>x</sub>, PM<sub>10</sub> and PM<sub>2.5</sub> used for the dispersion modelling assessment were calculated from the latest Emissions Factor Toolkit (v.10.1) which was released in August 2020.

## Temporal Variation (diurnal traffic profile)

Temporal variation in traffic flows along roads has been included in the dispersion model to account for the realistic diurnal differences that would occur between weekdays and weekends. Accordingly, a time varying profile was included in the model.

The diurnal profile used in the model has been calculated based on DfT's Road traffic statistics (TRA) dataset. TRA0307 provides 'Motor vehicle traffic distribution by time of day and day of the week on all roads, Great Britain: 2019'<sup>16</sup>, which shows the average hourly traffic flow in each combination of weekday and hour, relative to the average hour across the whole year for main roads in England. Figure 3 shows the diurnal traffic profile included in the model:

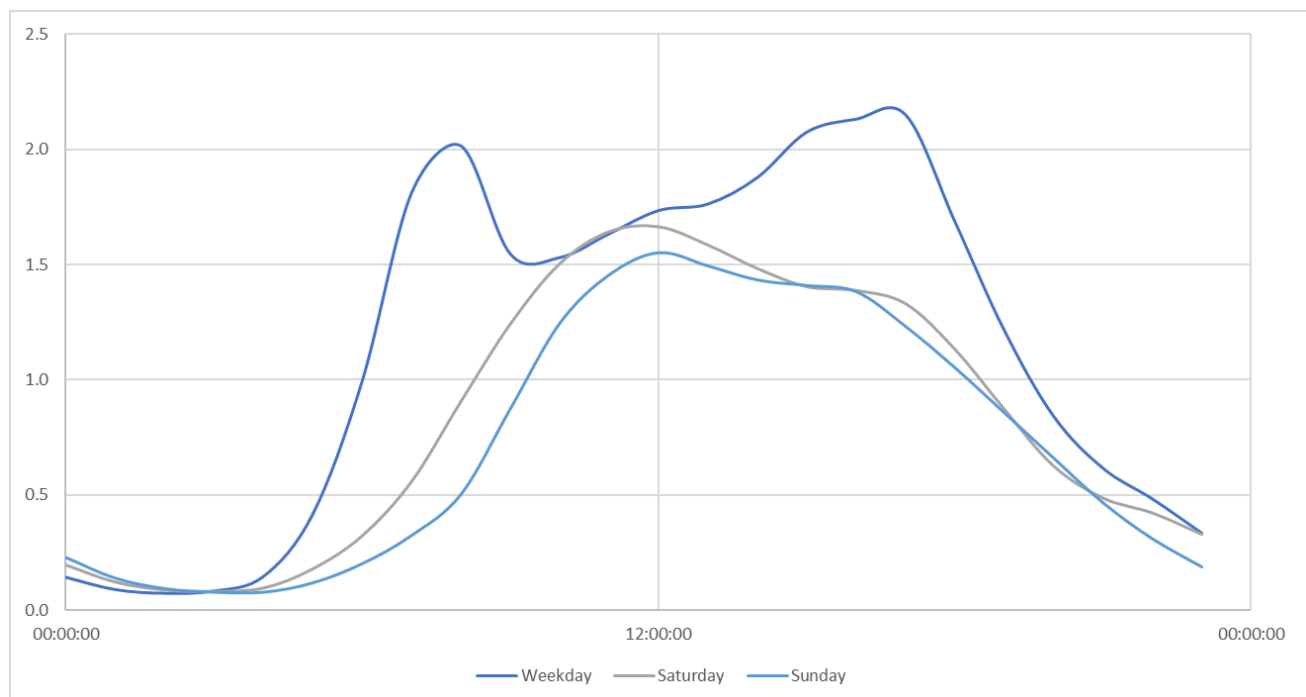


Figure 3 – Diurnal traffic profile included in the model

## Speed Data

For each link, vehicle speeds were derived from the sign posted speed limit for each road derived from the OpenStreet Browser v4.10<sup>17</sup>, which provides Max Speeds for most roads across the UK. Vehicle speeds were reduced by 10kph on approach to junctions (and on slip roads) relative to the speed limit to account for queuing and congestion in the average speed profile, in accordance with LAQM.TG (16).

## Meteorological Parameters

Detailed, hourly sequential meteorological data for the period 01/01/2019 to 31/12/2019 were obtained from RAF Benson measurement station, which is the closest to the Site, using the WorldMet R package<sup>18</sup>. Figure 4 shows the wind-rose:

<sup>16</sup> DfT, "Average Annual Daily Flow and Temporal Traffic Distributions (TRA03) - Statistical Data Sets - GOV.UK," 2015, <https://www.gov.uk/government/statistical-data-sets/tra03-motor-vehicle-flow>.

<sup>17</sup> [https://www.openstreetbrowser.org#map=15/53.7033/-1.2698&categories=car\\_maxspeed](https://www.openstreetbrowser.org#map=15/53.7033/-1.2698&categories=car_maxspeed)

<sup>18</sup> David Carslaw, NOAA Integrated Surface Database (ISD) Surface Meteorological Observations: Davidcarslaw/WorldMet, R, 2018, <https://github.com/davidcarslaw/worldmet>.

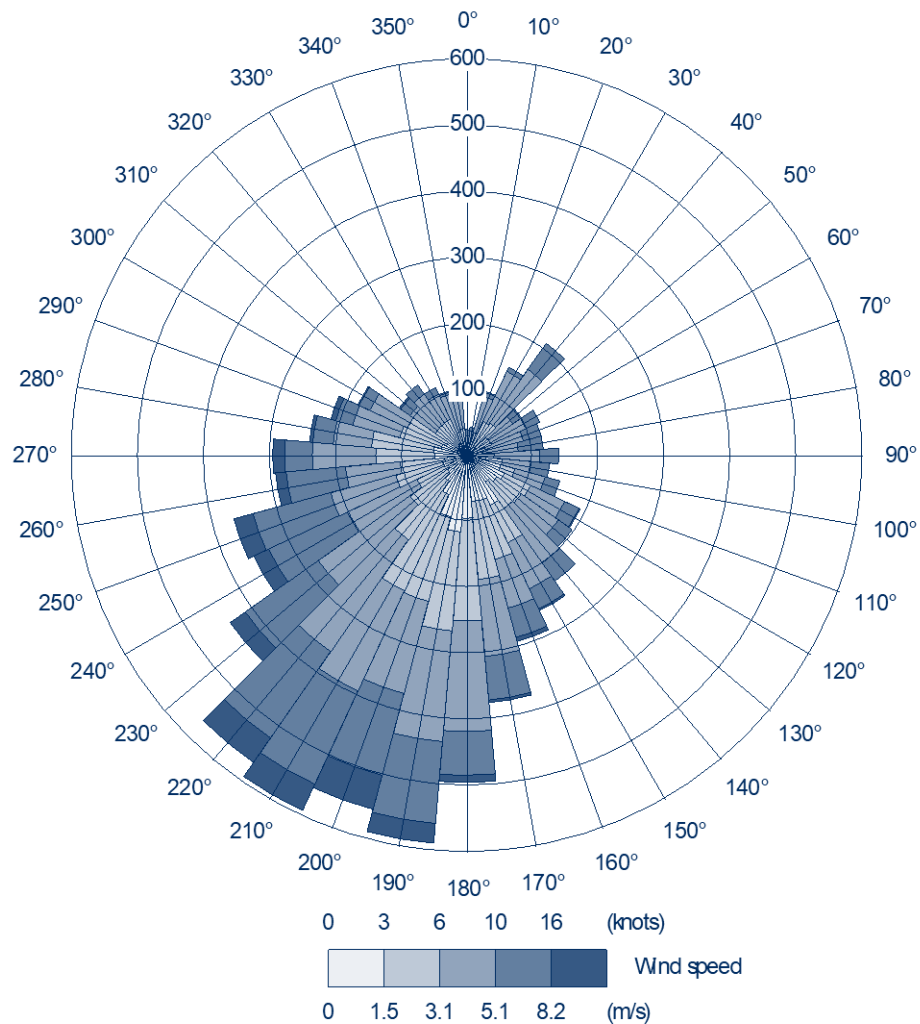


Figure 4 – 2019 Wind Rose for RAF Benson Meteorological Station

Data capture for the meteorological parameters included in the model were as follows:

- Wind speed: 100%;
- Wind direction: 100%;
- Temperature: 99.9%, and
- Cloud cover: 91.6%

## Surface Characteristics

The following surface roughness parameters have been applied in the model, which were obtained using the Corine land-use dataset:

- Dispersion site surface roughness = 1.07m;
- Met site surface roughness = 0.006m;

The following Minimum Monin-Obukhov (MO) lengths were applied:

- Dispersion site = 30m (pre-set for 'Cities and Large Towns'), and
- Met site = 10m (pre-set for 'Small Towns').

## *Elevation and Gradients*

CERC were contacted to seek advice on how to represent the elevation profile of the IDR road cutting beneath the roundabout junction. They provided the following advice:

*"The cutting will create a recirculation region where the air is well mixed and will allow concentrations to disperse out of the top in the upstream direction. As you are interested in receptor points outside of this recirculation region created by the cutting, where there is no flow directly beneath, it would be reasonable to model all road sources including the north/south road at ground level and the receptors at their relative height to ground level. This will be a conservative approach but will represent how the concentrations are dispersing out of the top of the road cutting."*

On this basis, no elevation or gradient profile has been applied to the model domain, and all roads have been modelled at 0m.

## *Street Canyons*

The principal effects of a street canyon on the dispersion of pollution from a road source are:

- pollution is channelled along the canyon;
- pollution is dispersed across the canyon by circulating flow at road height;
- pollutants are trapped in recirculation regions;
- pollutants leave the canyon through gaps between buildings;
- pollutants leave the canyon from the canyon top; and pollutants leave the canyon from the downstream end of the canyon.

In the ADMS street canyon module, each of these effects is modelled using a separate component source, with differing source geometry, source dispersion type, wind direction, region of influence and source strength.

The geometric profile of roads in the study area which meet the criteria for a street canyon have been modelled as 'Advanced Canyons' in the model. Canyon widths were estimated in Google Earth. For consistency with the original air quality assessment, the a-symmetric canyon profile introduced by the scheme on Chatham Street has been modelled at a height of 40m. A continuous canyon wall has been assumed – the impact of "porosity" is not represented in the model, which represents a conservative approach.

## *Background Concentrations*

The background annual mean NO<sub>2</sub>, PM<sub>10</sub> and PM<sub>2.5</sub> concentrations used in the modelling study were taken from the Reading AURN station, which is located approximately 2.km east of the site, and monitors urban background concentrations representative of Reading. The 2019 annual mean concentrations used in the study were:

- Annual mean NO<sub>2</sub>: 22 µg/m<sup>3</sup>;
- Annual mean PM<sub>10</sub>: 13 µg/m<sup>3</sup>, and
- Annual mean PM<sub>2.5</sub>: 8 µg/m<sup>3</sup>.

## *Model Verification*

A verification study has been undertaken using RBC's air quality monitoring data from 2019<sup>19</sup>. Full details of this study are included in Appendix D. The model was found to be under-predicting concentrations of NO<sub>x</sub> and NO<sub>2</sub>. Therefore, an adjustment factor of **1.128** was applied to the model results.

## *Limitations, Assumptions and Uncertainty*

To account for uncertainty in future emission factors and pollutant concentrations, the precautionary principle has been carried through the exposure assessment in accordance with the IAQM's position on Dealing with Uncertainty in Vehicle NO<sub>x</sub> Emissions<sup>20</sup>.

In addition to the above, in April 2021, Defra released the COVID-19: Supplementary Guidance for Local Air Quality Management Reporting in 2021<sup>12</sup>, which provides advice on uncertainty in air quality predictions associated with the pandemic. The guidance recommends that a 2019 verification scenario is undertaken, and that vehicle fleet emissions forecasts and background concentrations should be held constant (i.e., applying unadjusted data assumptions to the future assessment year being assessed). On this basis, the following assumptions have been applied:

- Emission Factors have been held at 2019 (no future improvements assumed);
- Background pollutant concentrations have been held at 2019 (no future improvements assumed);

Root Mean Square Error (RMSE) is used to define the average error or uncertainty of the model. According to LAQM.TG (16), the RMSE is acceptable where it is within 25%. The model verification process in Appendix D calculated a post-adjusted RMSE of **3.3 µg/m<sup>3</sup>**, which equates to **8.2%** of the annual mean NAQO for NO<sub>2</sub> and is therefore considered to be acceptable.

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<sup>19</sup> Provided via email by RBC on 20<sup>th</sup> May, 2021.

<sup>20</sup> [https://iaqm.co.uk/text/position\\_statements/uncertainty\\_vehicle\\_NOx\\_emissions.pdf](https://iaqm.co.uk/text/position_statements/uncertainty_vehicle_NOx_emissions.pdf)

## Appendix D: Model Verification Study

An important stage in the modelling process is model verification of the road traffic model, which involves comparing the model output with measured concentrations in order to increase confidence in modelled predictions. According to LAQM.TG (16), the difference between modelled results and monitored concentrations is acceptable where it is within 25% (10% is preferable).

### Monitoring Locations used for Verification:

The following RBC monitoring locations were selected for model verification, due to their close proximity to the Site:

- 281 Oxford Road;
- 10 Trinity Place;
- 165 Oxford Road;
- 33 Caversham Road, and
- Malcolm Place

### Model Verification

It is most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides ( $\text{NO}_x = \text{NO} + \text{NO}_2$ ). The model output of road- $\text{NO}_x$  (i.e., the component of total  $\text{NO}_x$  coming from road traffic) has been compared with the 'measured' road- $\text{NO}_x$ . Measured road- $\text{NO}_x$  has been calculated from the measured  $\text{NO}_2$  concentrations using the  $\text{NO}_x$  from  $\text{NO}_2$  calculator (Version 8.1) available on the Defra LAQM Support website<sup>21</sup>.

The pre-adjusted modelled and monitored verification results are given in Table 4.

Table 4 - 2019 Modelled and monitored results

| Diffusion Tube   | Modelled                 | Monitored                | % Difference $\text{NO}_x$ |
|------------------|--------------------------|--------------------------|----------------------------|
|                  | $\text{NO}_x$            | $\text{NO}_x$            |                            |
|                  | $\mu\text{g}/\text{m}^3$ | $\mu\text{g}/\text{m}^3$ |                            |
| 281 Oxford Road  | 28.4                     | 27.6                     | 2.9%                       |
| 10 Trinity Place | 11.1                     | 7.9                      | 41.7%                      |
| 165 Oxford Rd    | 14.1                     | 29.5                     | -52.0%                     |
| 33 Caversham Rd  | 27.3                     | 27.2                     | 0.3%                       |
| Malcolm Place    | 57.7                     | 66.6                     | -13.4%                     |

The data show that the road- $\text{NO}_x$  was underpredicted by more than 25% range at 165 Oxford Road, and underpredicted by more than 10% at Malcolm Place in the verification study. Accordingly, it was decided to proceed with adjustment. This step ensures a conservative approach to reduce uncertainty. An adjustment factor of **1.128** has been determined as the equation of the slope of the best-fit line between the 'measured' road contribution and the model derived road contribution of  $\text{NO}_x$ , as shown below:

<sup>21</sup> Defra, "NO<sub>x</sub> to NO<sub>2</sub> Calculator" (Defra, 2019), <http://laqm.defra.gov.uk/documents/NOx-NO2-Calculator-v7.1.xls>.

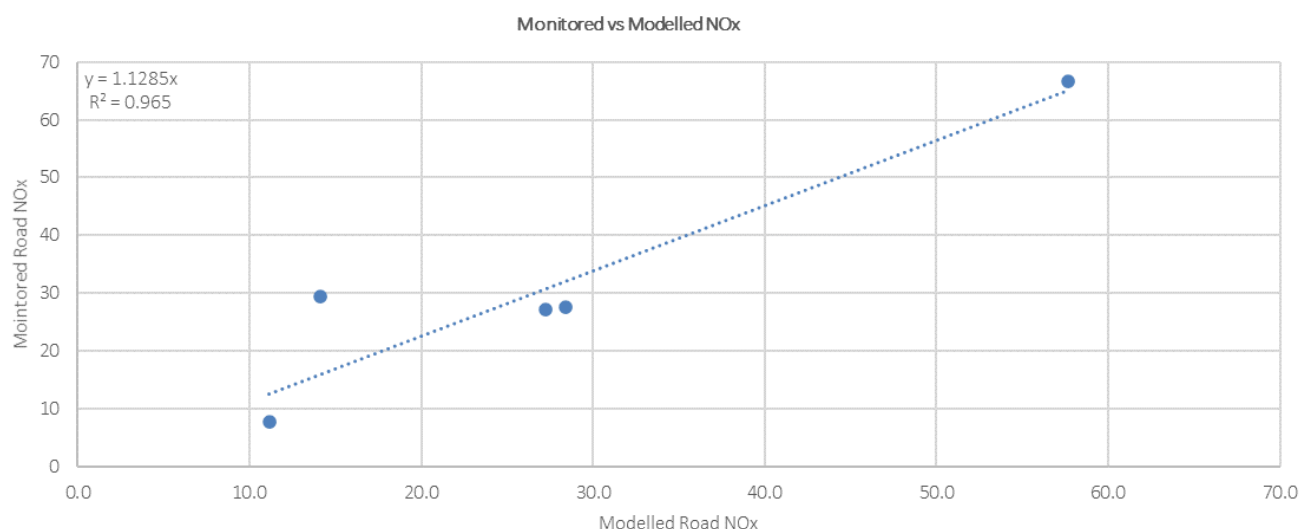


Figure 5 – Model Adjustment Factor (Monitored vs Modelled NO<sub>x</sub>)

Table 5 shows total monitored versus modelled NO<sub>2</sub> following the adjustment of the road contribution of NO<sub>x</sub> by this factor. The total NO<sub>2</sub> concentration was determined by adding the 2019 AURN background NO<sub>2</sub> concentration to the modelled road contribution.

Table 5 – post-adjusted 2019 Modelled and monitored results

| Diffusion Tube   | Adjusted Modelled | Monitored         | % Difference NO <sub>2</sub> |
|------------------|-------------------|-------------------|------------------------------|
|                  | NO <sub>2</sub>   | NO <sub>2</sub>   |                              |
|                  | µg/m <sup>3</sup> | µg/m <sup>3</sup> |                              |
| 281 Oxford Road  | 37.7              | 35.7              | 5.7%                         |
| 10 Trinity Place | 28.4              | 26.1              | 9.1%                         |
| 165 Oxford Rd    | 30.1              | 36.5              | -17.6%                       |
| 33 Caversham Rd  | 37.1              | 35.5              | 4.6%                         |
| Malcolm Place    | 51.8              | 52.4              | -1.1%                        |

Following adjustment of NO<sub>x</sub> by a factor of **1.128** all modelled concentrations of NO<sub>2</sub> were within the ideal 10% range of monitored concentrations at 4/5 monitoring locations included within the study, with 165 Oxford Road within the acceptable 25% range:

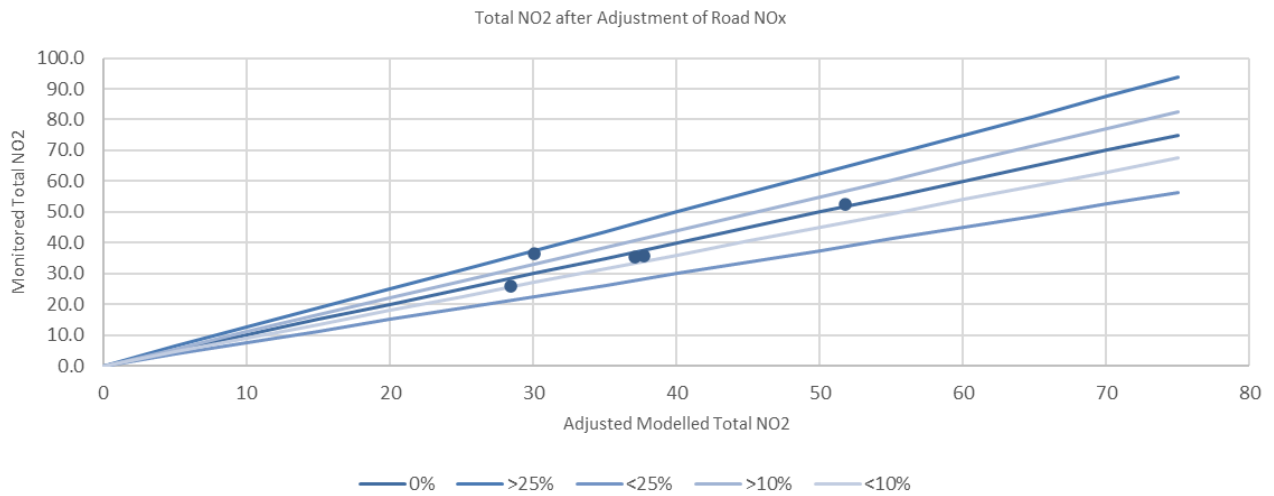


Figure 6 – Post-adjusted Monitored vs Modelled NO<sub>2</sub>

In addition, the overall post-adjusted uncertainty (RMSE) for annual mean NO<sub>2</sub> was 8.2%, which is well within the ideal 10% range of the NAQO. As such, the adjustment factor was considered to be acceptable and the final predictions are considered to be robust. The adjustment factor was also applied the modelled road-PM<sub>10</sub> and road-PM<sub>2.5</sub> in accordance with LAQM.TG (16).

## Appendix E: Dispersion Model Results

The results should be reviewed alongside the approved 3622\_0250 Rev D Phasing Plan.

### Phase 2, Block A1

Table 6 shows the model predicted annual mean NO<sub>2</sub> concentrations up to the fourth floor of Phase 2, Block A1, to determine requirements for mitigation:

Table 6 – Phase 2 Block A1 modelled concentrations

| Receptor     | Phase | Block | NAQO                 | Annual Mean NO <sub>2</sub> (µg/m <sup>3</sup> ) | Mitigation Required? (Y/N) |
|--------------|-------|-------|----------------------|--------------------------------------------------|----------------------------|
| Ground Floor |       |       |                      |                                                  |                            |
| R01_G        | 2     | A1    | 40 µg/m <sup>3</sup> | 29.4                                             | N                          |
| R02_G        | 2     | A1    | 40 µg/m <sup>3</sup> | 29.8                                             | N                          |
| R03_G        | 2     | A1    | 40 µg/m <sup>3</sup> | 29.9                                             | N                          |
| R04_G        | 2     | A1    | 40 µg/m <sup>3</sup> | 29.9                                             | N                          |
| R05_G        | 2     | A1    | 40 µg/m <sup>3</sup> | 29.9                                             | N                          |
| R06_G        | 2     | A1    | 40 µg/m <sup>3</sup> | 26.7                                             | N                          |
| R07_G        | 2     | A1    | 40 µg/m <sup>3</sup> | 26.0                                             | N                          |
| R08_G        | 2     | A1    | 40 µg/m <sup>3</sup> | 25.5                                             | N                          |
| First Floor  |       |       |                      |                                                  |                            |
| R01_1        | 2     | A1    | 40 µg/m <sup>3</sup> | 28.5                                             | N                          |
| R02_1        | 2     | A1    | 40 µg/m <sup>3</sup> | 28.8                                             | N                          |
| R03_1        | 2     | A1    | 40 µg/m <sup>3</sup> | 28.8                                             | N                          |
| R04_1        | 2     | A1    | 40 µg/m <sup>3</sup> | 28.9                                             | N                          |
| R05_1        | 2     | A1    | 40 µg/m <sup>3</sup> | 29.0                                             | N                          |
| R06_1        | 2     | A1    | 40 µg/m <sup>3</sup> | 26.2                                             | N                          |
| R07_1        | 2     | A1    | 40 µg/m <sup>3</sup> | 25.7                                             | N                          |
| R08_1        | 2     | A1    | 40 µg/m <sup>3</sup> | 25.3                                             | N                          |
| Second Floor |       |       |                      |                                                  |                            |
| R01_2        | 2     | A1    | 40 µg/m <sup>3</sup> | 27.3                                             | N                          |
| R02_2        | 2     | A1    | 40 µg/m <sup>3</sup> | 27.5                                             | N                          |
| R03_2        | 2     | A1    | 40 µg/m <sup>3</sup> | 27.6                                             | N                          |
| R04_2        | 2     | A1    | 40 µg/m <sup>3</sup> | 27.7                                             | N                          |
| R05_2        | 2     | A1    | 40 µg/m <sup>3</sup> | 27.8                                             | N                          |
| R06_2        | 2     | A1    | 40 µg/m <sup>3</sup> | 25.5                                             | N                          |
| R07_2        | 2     | A1    | 40 µg/m <sup>3</sup> | 25.2                                             | N                          |
| R08_2        | 2     | A1    | 40 µg/m <sup>3</sup> | 24.9                                             | N                          |
| Third Floor  |       |       |                      |                                                  |                            |
| R01_3        | 2     | A1    | 40 µg/m <sup>3</sup> | 26.4                                             | N                          |
| R02_3        | 2     | A1    | 40 µg/m <sup>3</sup> | 26.5                                             | N                          |

|                     |   |    |                      |      |   |
|---------------------|---|----|----------------------|------|---|
| R03_3               | 2 | A1 | 40 µg/m <sup>3</sup> | 26.6 | N |
| R04_3               | 2 | A1 | 40 µg/m <sup>3</sup> | 26.6 | N |
| R05_3               | 2 | A1 | 40 µg/m <sup>3</sup> | 26.7 | N |
| R06_3               | 2 | A1 | 40 µg/m <sup>3</sup> | 24.8 | N |
| R07_3               | 2 | A1 | 40 µg/m <sup>3</sup> | 24.7 | N |
| R08_3               | 2 | A1 | 40 µg/m <sup>3</sup> | 24.5 | N |
| <b>Fourth Floor</b> |   |    |                      |      |   |
| R01_4               | 2 | A1 | 40 µg/m <sup>3</sup> | 25.6 | N |
| R02_4               | 2 | A1 | 40 µg/m <sup>3</sup> | 25.7 | N |
| R03_4               | 2 | A1 | 40 µg/m <sup>3</sup> | 25.8 | N |
| R04_4               | 2 | A1 | 40 µg/m <sup>3</sup> | 25.8 | N |
| R05_4               | 2 | A1 | 40 µg/m <sup>3</sup> | 25.9 | N |
| R06_4               | 2 | A1 | 40 µg/m <sup>3</sup> | 24.2 | N |
| R07_4               | 2 | A1 | 40 µg/m <sup>3</sup> | 24.2 | N |
| R08_4               | 2 | A1 | 40 µg/m <sup>3</sup> | 24.1 | N |

In addition, the highest predicted annual mean PM<sub>10</sub> concentration was 14.5 µg/m<sup>3</sup> at R05\_G, and the highest predicted annual mean PM<sub>2.5</sub> concentration was 8.8 µg/m<sup>3</sup> at R03\_G – R05\_G, neither of which are in exceedance of the NAQOs.

## Phase 3, Block A2

Table 7 shows the model predicted annual mean NO<sub>2</sub> concentrations up to the fourth floor of Phase 3, Block A2, to determine requirements for mitigation:

Table 7 – Phase 3 Block A2 modelled concentrations

| Receptor            | Phase | Block | NAQO                 | Annual Mean NO <sub>2</sub><br>(µg/m <sup>3</sup> ) | Mitigation Required?<br>(Y/N) |
|---------------------|-------|-------|----------------------|-----------------------------------------------------|-------------------------------|
| <b>Ground Floor</b> |       |       |                      |                                                     |                               |
| R09_G               | 3     | A2    | 40 µg/m <sup>3</sup> | 28.3                                                | N                             |
| R10_G               | 3     | A2    | 40 µg/m <sup>3</sup> | 28.4                                                | N                             |
| R11_G               | 3     | A2    | 40 µg/m <sup>3</sup> | 28.4                                                | N                             |
| <b>First Floor</b>  |       |       |                      |                                                     |                               |
| R09_1               | 3     | A2    | 40 µg/m <sup>3</sup> | 27.5                                                | N                             |
| R10_1               | 3     | A2    | 40 µg/m <sup>3</sup> | 27.6                                                | N                             |
| R11_1               | 3     | A2    | 40 µg/m <sup>3</sup> | 27.7                                                | N                             |
| <b>Second Floor</b> |       |       |                      |                                                     |                               |
| R09_2               | 3     | A2    | 40 µg/m <sup>3</sup> | 26.4                                                | N                             |
| R10_2               | 3     | A2    | 40 µg/m <sup>3</sup> | 26.6                                                | N                             |
| R11_2               | 3     | A2    | 40 µg/m <sup>3</sup> | 26.7                                                | N                             |
| <b>Third Floor</b>  |       |       |                      |                                                     |                               |
| R09_3               | 3     | A2    | 40 µg/m <sup>3</sup> | 25.5                                                | N                             |

|              |   |    |                      |      |   |
|--------------|---|----|----------------------|------|---|
| R10_3        | 3 | A2 | 40 µg/m <sup>3</sup> | 25.6 | N |
| R11_3        | 3 | A2 | 40 µg/m <sup>3</sup> | 25.7 | N |
| Fourth Floor |   |    |                      |      |   |
| R09_3        | 3 | A2 | 40 µg/m <sup>3</sup> | 24.7 | N |
| R10_4        | 3 | A2 | 40 µg/m <sup>3</sup> | 24.8 | N |
| R11_4        | 3 | A2 | 40 µg/m <sup>3</sup> | 24.9 | N |

In addition, the highest predicted annual mean PM<sub>10</sub> concentration was 14.3 µg/m<sup>3</sup> at R11\_G, and the highest predicted annual mean PM<sub>2.5</sub> concentration was 8.7 µg/m<sup>3</sup> at R11\_G, neither of which are in exceedance of the NAQOs.

## Phase 4, Block B2

Table 8 shows the model predicted annual mean NO<sub>2</sub> concentrations up to the fourth floor of Phase 4, Block B2, to determine requirements for mitigation:

Table 8 – Phase 4 Block B2 modelled concentrations

| Receptor     | Phase | Block | NAQO                 | Annual Mean NO <sub>2</sub><br>(µg/m <sup>3</sup> ) | Mitigation Required?<br>(Y/N) |
|--------------|-------|-------|----------------------|-----------------------------------------------------|-------------------------------|
| Ground Floor |       |       |                      |                                                     |                               |
| R12_G        | 4     | B2    | 40 µg/m <sup>3</sup> | 30.4                                                | N                             |
| R13_G        | 4     | B2    | 40 µg/m <sup>3</sup> | 31.5                                                | N                             |
| R14_G        | 4     | B2    | 40 µg/m <sup>3</sup> | 32.5                                                | N                             |
| R15_G        | 4     | B2    | 40 µg/m <sup>3</sup> | 33.9                                                | N                             |
| R16_G        | 4     | B2    | 40 µg/m <sup>3</sup> | 35.0                                                | N                             |
| R17_G        | 4     | B2    | 40 µg/m <sup>3</sup> | <b>37.7</b>                                         | <b>Y</b>                      |
| R18_G        | 4     | B2    | 40 µg/m <sup>3</sup> | <b>39.5</b>                                         | <b>Y</b>                      |
| First Floor  |       |       |                      |                                                     |                               |
| R12_1        | 4     | B2    | 40 µg/m <sup>3</sup> | 29.4                                                | N                             |
| R13_1        | 4     | B2    | 40 µg/m <sup>3</sup> | 30.3                                                | N                             |
| R14_1        | 4     | B2    | 40 µg/m <sup>3</sup> | 31.0                                                | N                             |
| R15_1        | 4     | B2    | 40 µg/m <sup>3</sup> | 31.8                                                | N                             |
| R16_1        | 4     | B2    | 40 µg/m <sup>3</sup> | 32.5                                                | N                             |
| R17_1        | 4     | B2    | 40 µg/m <sup>3</sup> | 33.8                                                | N                             |
| R18_1        | 4     | B2    | 40 µg/m <sup>3</sup> | 34.3                                                | N                             |
| Second Floor |       |       |                      |                                                     |                               |
| R12_2        | 4     | B2    | 40 µg/m <sup>3</sup> | 28.0                                                | N                             |
| R13_2        | 4     | B2    | 40 µg/m <sup>3</sup> | 28.5                                                | N                             |
| R14_2        | 4     | B2    | 40 µg/m <sup>3</sup> | 28.9                                                | N                             |
| R15_2        | 4     | B2    | 40 µg/m <sup>3</sup> | 29.2                                                | N                             |
| R16_2        | 4     | B2    | 40 µg/m <sup>3</sup> | 29.4                                                | N                             |
| R17_2        | 4     | B2    | 40 µg/m <sup>3</sup> | 29.8                                                | N                             |

|              |   |    |                      |      |   |
|--------------|---|----|----------------------|------|---|
| R18_2        | 4 | B2 | 40 µg/m <sup>3</sup> | 29.8 | N |
| Third Floor  |   |    |                      |      |   |
| R12_3        | 4 | B2 | 40 µg/m <sup>3</sup> | 26.6 | N |
| R13_3        | 4 | B2 | 40 µg/m <sup>3</sup> | 26.8 | N |
| R14_3        | 4 | B2 | 40 µg/m <sup>3</sup> | 27.0 | N |
| R15_3        | 4 | B2 | 40 µg/m <sup>3</sup> | 27.1 | N |
| R16_3        | 4 | B2 | 40 µg/m <sup>3</sup> | 27.1 | N |
| R17_3        | 4 | B2 | 40 µg/m <sup>3</sup> | 27.2 | N |
| R18_3        | 4 | B2 | 40 µg/m <sup>3</sup> | 27.1 | N |
| Fourth Floor |   |    |                      |      |   |
| R12_4        | 4 | B2 | 40 µg/m <sup>3</sup> | 25.4 | N |
| R13_4        | 4 | B2 | 40 µg/m <sup>3</sup> | 25.5 | N |
| R14_4        | 4 | B2 | 40 µg/m <sup>3</sup> | 25.6 | N |
| R15_4        | 4 | B2 | 40 µg/m <sup>3</sup> | 25.6 | N |
| R16_4        | 4 | B2 | 40 µg/m <sup>3</sup> | 25.6 | N |
| R17_4        | 4 | B2 | 40 µg/m <sup>3</sup> | 25.6 | N |
| R18_4        | 4 | B2 | 40 µg/m <sup>3</sup> | 25.5 | N |

In addition, the highest predicted annual mean PM<sub>10</sub> concentration was 16.6 µg/m<sup>3</sup> at R18\_G, and the highest predicted annual mean PM<sub>2.5</sub> concentration was 10.1 µg/m<sup>3</sup> at R18\_G, neither of which are in exceedance of the NAQOs.

## Phase 5, Block B1

Table 9 shows the model predicted annual mean NO<sub>2</sub> concentrations up to the fourth floor of Phase 5, Block B1, to determine requirements for mitigation:

Table 9 – Phase 5 Block B1 modelled concentrations

| Receptor     | Phase | Block | NAQO                 | Annual Mean NO <sub>2</sub><br>(µg/m <sup>3</sup> ) | Mitigation Required?<br>(Y/N) |
|--------------|-------|-------|----------------------|-----------------------------------------------------|-------------------------------|
| Ground Floor |       |       |                      |                                                     |                               |
| R19_G        | 5     | B1    | 40 µg/m <sup>3</sup> | 27.2                                                | N                             |
| R20_G        | 5     | B1    | 40 µg/m <sup>3</sup> | 28.3                                                | N                             |
| First Floor  |       |       |                      |                                                     |                               |
| R19_1        | 5     | B1    | 40 µg/m <sup>3</sup> | 26.8                                                | N                             |
| R20_1        | 5     | B1    | 40 µg/m <sup>3</sup> | 27.8                                                | N                             |
| Second Floor |       |       |                      |                                                     |                               |
| R19_2        | 5     | B1    | 40 µg/m <sup>3</sup> | 26.3                                                | N                             |
| R20_2        | 5     | B1    | 40 µg/m <sup>3</sup> | 26.9                                                | N                             |
| Third Floor  |       |       |                      |                                                     |                               |
| R19_3        | 5     | B1    | 40 µg/m <sup>3</sup> | 25.6                                                | N                             |
| R20_3        | 5     | B1    | 40 µg/m <sup>3</sup> | 26.0                                                | N                             |

| Fourth Floor |   |    |                      |      |   |
|--------------|---|----|----------------------|------|---|
| R19_4        | 5 | B1 | 40 µg/m <sup>3</sup> | 24.9 | N |
| R20_4        | 5 | B1 | 40 µg/m <sup>3</sup> | 25.1 | N |

In addition, the highest predicted annual mean PM<sub>10</sub> concentration was 14.3 µg/m<sup>3</sup> at R20\_G, and the highest predicted annual mean PM<sub>2.5</sub> concentration was 8.7 µg/m<sup>3</sup> at R20\_Gs, neither of which are in exceedance of the NAQOs.

# AIR QUALITY STRATEGY

## Modelled Isopleth Contour Plots – Annual Mean NO<sub>2</sub>

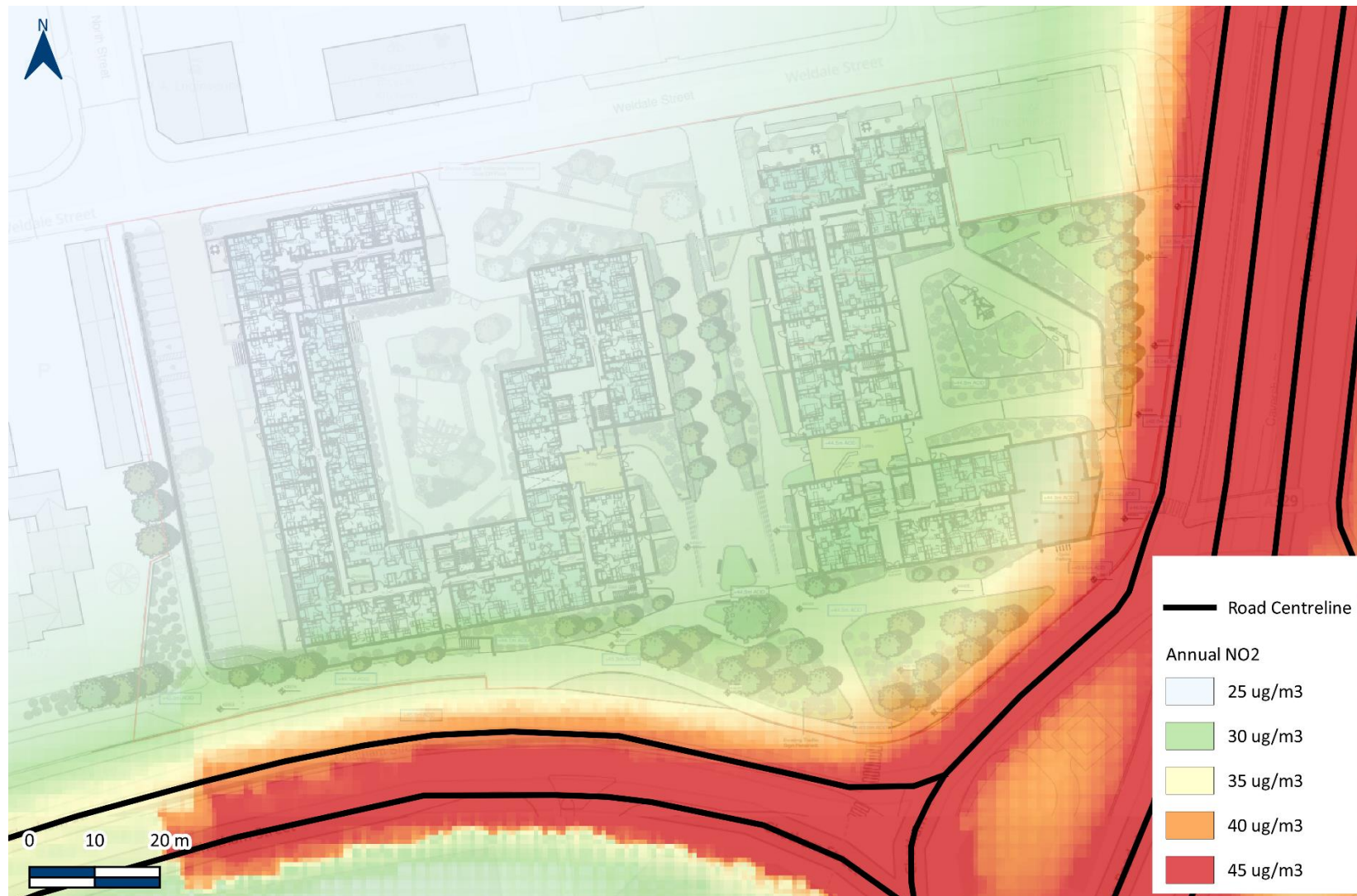


Figure 7 – Ground floor annual mean NO<sub>2</sub> Contour

# AIR QUALITY STRATEGY

As no modelled concentrations were within 10% of the annual mean NAQO for NO<sub>2</sub> above ground floor height, contours are not presented for higher floors.