Greggs Bakery / Twickenham

Air Quality Assessment

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London Square Developments Ltd.

GREGGS FACTORY, TWICKENHAM

Air Quality Assessment

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EXECUTIVE SUMMARY

WSP has been commissioned by London Square Developments Ltd to undertake an air quality assessment to support a planning application for the proposed redevelopment of the former Greggs Factory in Twickenham. The proposal includes 116 residential units and one B1 commercial unit with associated parking (117 spaces).

This report presents the findings of the assessment, which addresses the potential air quality impacts during both the construction and operational phases of the proposed development. For both phases the type, source and significance of potential impacts were identified, and the measures that should be employed to minimise these proposed. The methodology followed in this study was discussed and agreed with the Environmental Health Officer at London Borough of Richmond Upon Thames Council.

A qualitative assessment of the potential impacts on local air quality from construction activities has been carried out for this phase of the Proposed Development using the Institute of Air Quality Management (IAQM) methodology. This identified that there is a high to medium risk of dust soiling impacts and a medium to low risk of health impacts due to increases in particulate matter (PM_{10}) concentrations during construction. However, through good site practice and the implementation of suitable mitigation measures, the effect of dust and PM_{10} releases would be significantly reduced. The residual effects of dust and PM_{10} generated by construction activities on air quality are therefore considered to be negligible. The residual effect of emissions to air from construction vehicles and plant on local air quality is also considered to be negligible.

A quantitative assessment of the potential impacts during the operational phase was undertaken using ADMS-Roads to predict the changes in nitrogen dioxide (NO_2) and particulate matter (both PM_{10} and $PM_{2.5}$) concentrations that would occur due to traffic generated by the Proposed Development. The impacts of the operational phase on local quality are predicted to be negligible for all pollutants and the residual effect is not significant.

Predicted annual mean NO_2 and PM_{10} concentrations at all the new exposure locations are classified as APEC A in accordance with the London Councils Air Pollution Exposure Criteria. Compliance for annual mean $PM_{2.5}$ has also been predicted at all new receptors. As such, mitigation will not be required.

The proposed development is not air quality neutral for transport emissions, as such mitigation will therefore be required. A mitigation strategy has been proposed by the Project Transport Consultant which would offset emissions.

With the implementation of appropriate mitigation and offsetting of transport emissions, the development proposals will comply with national, regional and local planning policy for air quality.

1. INTRODUCTION

1.1.1. WSP has been commissioned by London Square Developments Ltd to carry out an assessment of the potential air quality impacts arising from the proposed development at the former Greggs Factory, Twickenham, hereafter referred to as the 'Proposed Development' or 'Application Site'.

1.1.2. The Application Site lies within the administrative boundary of the London Borough of Richmond Upon Thames (LBRT). The Application Site currently stands as a single industrial unit previously occupied by Greggs Bakery. Immediately north of the Application Site is River Crane and two residential terraced streets are located to the west and east by Crane Road and Norcutt Road respectively, the southern boundary is bordered by Edwin Road. The Application Site is shown in Figure 1.

1.1.3. The proposals are to provide 116 units of residential dwelling, a B1 commercial unit and 117 parking spaces. The heating and energy arrangement will also be supported by an electric heat pump system which is emission free.

1.1.4. This report presents the findings of an assessment of the potential air quality impacts of the Proposed Development during both the construction and operational phases. For both phases, the type, source and significance of potential impacts are identified, and the measures that should be employed to minimise these described.

1.1.5. This report also considers the potential exposure of future residents of the Proposed Development to local air pollution given the Application Site is located in the Richmond Air Quality Management Area (AQMA).

1.1.6. A glossary of terms used in this report is provided in Appendix A.

2. LEGISLATION, POLICY & GUIDANCE

2.1. AIR QUALITY LEGISLATION & POLICY

2.1.1. A summary of the relevant air quality legislation and policy is provided below.

UK AIR QUALITY STRATEGY

2.1.2. The Government's policy on air quality within the UK is set out in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS)[1]. The AQS provides a framework for reducing air pollution in the UK with the aim of meeting the requirements of European Union legislation.

2.1.3. The AQS also sets standards and objectives for nine key air pollutants to protect health, vegetation and ecosystems. These are benzene (C_6H_6), 1,3 butadiene (C_4H_6), carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), particulate matter (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2), ozone (O_3), and polycyclic aromatic hydrocarbons (PAHs). The standards and objectives for the pollutants considered in this assessment are given in Appendix B.

2.1.4. The air quality standards are levels recommended by the Expert Panel on Air Quality Standards (EPAQS) and the World Health Organisation (WHO) with regards to current scientific knowledge about the effects of each pollutant on health and the environment.

2.1.5. The air quality objectives are policy based targets set by the Government, which take into account economic efficiency, practicability, technical feasibility and timescale. Some objectives are equal to the EPAQS recommended standards or WHO guideline limits, whereas others involve a margin of tolerance, i.e. a limited number of permitted exceedances of the standard over a given period.

2.1.6. For the pollutants considered in this assessment, there are both long-term (annual mean) and short-term standards. In the case of NO_2, the short-term standard is for a 1-hour averaging period, whereas for PM_{10} it is for a 24-hour averaging period. These periods reflect the varying impacts on health of differing exposures to pollutants, for example temporary exposure on the pavement adjacent to a busy road, compared with the exposure of residential properties adjacent to a road.

2.1.7. The AQS contains a framework for considering the effects of a finer group of particles known as '$PM_{2.5}$' as there is increasing evidence that this size of particles can be more closely associated with observed adverse health effects than PM_{10}. Local Authorities are required to work towards reducing emissions/concentrations of particulate matter within their administrative area. However, there is no statutory objective given in the AQS for $PM_{2.5}$ at this time.

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[1] Department for Environment, Food and Rural Affairs (Defra) and the Devolved Administrations (2007). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volumes 1 and 2)

AIR QUALITY REGULATIONS

2.1.8. Many of the objectives in the AQS have been made statutory in England with the Air Quality (England) Regulations 2000[2] and the Air Quality (England) (Amendment) Regulations 2002[3] for the purpose of Local Air Quality Management (LAQM).

2.1.9. These Regulations require that likely exceedances of the AQS objectives are assessed in relation to:

"…the quality of air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present…"

2.1.10. The Air Quality Standards Regulations 2010[4] transpose the European Union Ambient Air Quality Directive (2008/50/EC) into law in England. This Directive sets legally binding limit values for concentrations in outdoor air of major air pollutants that impact public health such as PM_{10}, $PM_{2.5}$ and NO_2. The limit values for NO_2 and PM_{10} are the same concentration levels as the relevant. AQS objectives and the limit value for $PM_{2.5}$ is a concentration of 25µg/m^3.

ENVIRONMENTAL PROTECTION ACT 1990 - CONTROL OF DUST AND PARTICULATES ASSOCIATED WITH CONSTRUCTION

2.1.11. Section 79 of the Environmental Protection Act 1990 gives the following definitions of statutory nuisance relevant to dust and particles:

"Any dust, steam, smell or other effluvia arising from industrial, trade or business premises or smoke, fumes or gases emitted from premises so as to be prejudicial to health or a nuisance"; and

"Any accumulation or deposit which is prejudicial to health or a nuisance"

2.1.12. Following this, Section 80 says that where a statutory nuisance is shown to exist, the local authority must serve an abatement notice. Failure to comply with an abatement notice is an offence and if necessary, the local authority may abate the nuisance and recover expenses.

2.1.13. There are no statutory limit values for dust deposition above which 'nuisance' is deemed to exist. Nuisance is a subjective concept and its perception is highly dependent upon the existing conditions and the change which has occurred.

ENVIRONMENT ACT 1995

2.1.14. Under Part IV of the Environment Act 1995, local authorities must review and document local air quality within their area by way of staged appraisals and respond accordingly, with the aim of meeting the air quality objectives defined in the Regulations. Where the objectives are not likely to be achieved, an authority is required to designate an AQMA. For each AQMA the local authority is

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2 The Air Quality (England) Regulations 2000 - Statutory Instrument 2000 No.928

3 The Air Quality (England) (Amendment) Regulations 2002- Statutory Instrument 2002 No.3043

4 The Air Quality Standards Regulations 2010 - Statutory Instrument 2010 No. 1001

required to draw up an Air Quality Action Plan (AQAP) to secure improvements in air quality and show how it intends to work towards achieving air quality standards in the future.

CLEAN AIR STRATEGY

2.1.15. Defra published an updated Clean Air Strategy in 2019[5], and this is aimed out tackling all sources of air pollution, making air healthier to breathe, protecting nature and boosting the economy. The strategy also sits alongside three other UK government strategies: our Industrial Strategy, our Clean Growth Strategy and our 25 Year Environment Plan.

2.1.16. FThe strategy proposes tough new goals to cut public exposure to particulate matter pollution, as per the recommendation by the World Health Organisation. Comprehensive action is required from all parts of government and society to participate in order to meet these goals. In particular, the Clean Air Strategy states:

"New legislation will create a stronger and a more coherent framework for action to tackle air pollution. This will be underpinned by new England-wide powers to control major sources of air pollution, in line with the risk they pose to public health and the environment, plus new local powers to take action in areas with an air pollution problem. These will support the creation of Clean Air Zones to lower emissions from all sources of air pollution, backed up with clear enforcement mechanism."

2.2. PLANNING POLICY

2.2.1. A summary of the national, regional and local planning policy relevant to the Proposed Development and air quality is provided below.

NATIONAL PLANNING POLICY

National Planning Policy Framework

2.2.2. The Government's overall planning policies for England are described in the National Planning Policy Framework[6]. The core underpinning principle of the Framework is the presumption in favour of sustainable development, defined as:

- *'… meeting the needs of the present without compromising the ability of future generations to meet their own needs*

2.2.3. One of the three overarching objectives of the NPPF is that planning should:

- *'to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.'*

2.2.4. In relation to air quality, the following paragraphs in the document are relevant:

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[5] Defra (2019). Clean Air Strategy 2019.

[6] Ministry of Housing, Communities and Local Government (2018). National Planning Policy Framework.

- Paragraph 54, which states '*Local planning authorities should consider whether otherwise unacceptable development could be made acceptable through the use of conditions or planning obligations. Planning obligations should only be used where it is not possible to address unacceptable impacts through a planning condition.*'
- Paragraph 103, which states '*Significant development should be focused on locations which are or can be made sustainable, through limiting the need to travel and offering a genuine choice of transport modes. This can help to reduce congestion and emissions, and improve air quality and public health.*;
- Paragraph 170, which states '*Planning policies and decisions should contribute to and enhance the natural and local environment by: …e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans.*;
- Paragraph 180, which states '*Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development.*'
- Paragraph 181, which states '*Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. 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*.';
- Paragraph 183, which states '*The focus of planning policies and decisions should be on whether proposed development is an acceptable use of land, rather than the control of processes or emissions (where these are subject to separate pollution control regimes). Planning decisions should assume that these regimes will operate effectively. Equally, where a planning decision has been made on a particular development, the planning issues should not be revisited through the permitting regimes operated by pollution control authorities.*'

REGIONAL PLANNING POLICY

London Environment Strategy

2.2.5. The Mayor's London Environment Strategy[7] details a range of actions to improve the environment.. Within the Strategy, air quality is one of the main areas identified as requiring improvement and the objectives of the strategy are summarised below:

- Support and empower London and its communities, particularly the most disadvantaged and those in priority locations, to reduce their exposure to poor air quality;
- Achieve legal compliance with UK and EU limits as soon as possible, including mobilising action from London Boroughs, Government and other partners; and
- Establish and achieve new, tighter air quality targets for a cleaner London by transitioning to a zero emission London by 2050, and meeting World Health Organisation health based guidance for air quality.

The London Plan: Spatial Development Strategy for Greater London (consolidated with alterations since 2011)

2.2.6. Policy 7.14 of the London Plan[8] is specific to the improvement of air quality and states that development proposals should:

- *'Minimise increased exposure to existing poor air quality and make provision to address local problems of air quality';*
- *'Promote sustainable design and construction in order to reduce emissions from the demolition and construction of buildings following the best practice guidance in the GLA and London Councils' 'The control of dust and emissions from construction and demolition'';*
- *'Be at least 'air quality neutral' and not lead to further deterioration of existing poor air quality';*
- *'Ensure that where provision needs to be made to reduce emissions from a development, this is usually made on site'; and*
- *'Where the development requires a detailed air quality assessment and biomass boilers are included, the assessment should forecast pollutant concentrations. Permission should only be granted if no adverse air quality impacts from the biomass boiler are identified.'*

2.2.7. A consultation draft of a new London Plan was published last year by the GLA/Mayor of London[9]. Within this document, Policy SI1 Improving air quality says that *'London's air quality should be significantly improved and exposure to poor air quality, especially for vulnerable people, should be reduced:*

1) Development proposals should not:

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[7] Greater London Authority (2018). London Environment Strategy.

[8] Mayor of London (March 2016) The London Plan: Spatial Development Strategy for Greater London Consolidated with alterations since 2011.

[9] Draft London Plan for consultation (GLA/Mayor of London, December 2017) https://www.london.gov.uk/what-we-do/planning/london-plan/new-london-plan/download-draft-london-plan-0

a) lead to further deterioration of existing poor air quality.

b) create any new areas that exceed air quality limits, or delay the date at which compliance will be achieved in areas that are currently in exceedance of legal limits.

c) reduce air quality benefits that result from the Mayor's or boroughs' activities to improve air quality.

d) create unacceptable risk of high levels of exposure to poor air quality.

2) Development proposals should use design solutions to prevent or minimise increased exposure to existing air pollution and make provision to address local problems of air quality. Particular care should be taken with developments that are in Air Quality Focus Areas or that are likely to be used by large numbers of people particularly vulnerable to poor air quality, such as children or older people.

3) The development of large-scale redevelopment areas, such as Opportunity Areas and those subject to an Environmental Impact Assessment should propose methods of achieving an Air Quality Positive approach through the new development. All other developments should be at least Air Quality Neutral.

4) Development proposals must demonstrate how they plan to comply with the Non-Road Mobile Machinery Low Emission Zone and reduce emissions from the demolition and construction of buildings following best practice guidance.

5) Air Quality Assessments (AQAs) should be submitted with all major developments, unless they can demonstrate that transport and building emissions will be less than the previous or existing use.

6) Development proposals should ensure that where emissions need to be reduced, this is done on-site. Where it can be demonstrated that on-site provision is impractical or inappropriate, off-site measures to improve local air quality may be acceptable, provided that equivalent air quality benefits can be demonstrated.'

2.2.8. Policy SI3 Energy infrastructure also states that *'Major development proposals within Heat Network Priority Areas should have a communal heating system. 1) the heat source for the communal heating system should be selected in accordance with the following heating hierarchy:….*

a) use fuel cells (if using natural gas in areas where legal air quality limits are exceeded all development proposals must provide evidence to show that any emissions related to energy generation will be equivalent or lower than those of an ultra-low NO_x gas boiler);

b) use low emission combined heat and power (CHP) (in areas where legal air quality limits are exceeded all development proposals must provide evidence to show that any emissions related to energy generation will be equivalent or lower than those of an ultra-low NO_x gas boiler);

c) use ultra-low NO_x gas boilers.

2) CHP and ultra-low NO_x gas boiler communal or district heating systems should be designed to ensure that there is no significant impact on local air quality.'

LOCAL PLANNING POLICY

Local Plan

2.2.9. The Local Plan[10] was adopted by the council on 3rd July 2018, and it incorporates the main modifications recommended by the Inspector and additional modifications made by the Council.

Policy LP10, Local Environment Impacts, Pollution and Land Contamination states that:

"The Council promotes good air quality design and new technologies. Developers should secure at least 'Emissions Neutral' development. To consider the impact of introducing new developments in areas already subject to poor air quality, the following will be required:

1) an air quality impact assessment, including where necessary, modelled data.

2) mitigation measures to reduce the development's impact upon air quality, including the type of equipment installed, thermal insulation and ducting abatement technology.

3) measures to protect the occupiers of new developments from existing sources.

4) strict mitigation for developments to be used by sensitive receptors such as schools, hospitals and care homes in areas of existing poor air quality; this also applies to proposals close to developments used by sensitive receptors.

2.2.10. The Council requires submission of a Construction Management Statement (CMS) for developments outlined in the policy above. In addition, the Council will also request through planning conditions, that the GLA Regulation relating to Non-Road Mobile Machinery (NRMM) is imposed where necessary.

2.2.11. The Council will be preparing SPDs and/or Advice Notes to provide additional guidance on local environmental impacts, pollution, air quality, noise and construction management, which will contain further guidance and clear requirements, including methodologies, for the various assessments that may need to be submitted as part of certain types of planning applications.

2.2.12. Policy LP 44 – Sustainable Travel Choices states that:

"The Council will work in partnership to promote safe, sustainable and accessible transport solutions, which minimise the impacts of development including in relation to congestion, air pollution and carbon dioxide emissions ".

2.2.13. The Policy seeks to promote more sustainable modes of transport, such as walking, cycling and public transport, as well as supporting the retention and use of river transport, and efficient, safe and sustainable freight transport. The Council's aim is to minimise impacts of developments in relation to congestion and air pollution.

2.3. GUIDANCE

2.3.1. A summary of the publications referred to in the undertaking of this assessment is provided below.

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[10] London Borough of Richmond upon Thames (2018). Adopted Local Plan.

LONDON LOCAL AIR QUALITY MANAGEMENT TECHNICAL GUIDANCE

2.3.2. The Mayor of London has published guidance for use by the London Boroughs in their review and assessment work[11]. This guidance, referred to in this document as LLAQM.TG (16), has been used where appropriate in the assessment presented herein.

LOCAL AIR QUALITY MANAGEMENT REVIEW AND ASSESSMENT TECHNICAL GUIDANCE

2.3.3. The Department for Environment, Food and Rural Affairs (Defra) has published technical guidance for use by local authorities outside of their London Boroughs in their review and assessment work[12]. This guidance, referred to in this document as LAQM.TG (16), has been used to assess operational phase effects because LLAQM.TG (16) does not include suitable guidance.

LAND-USE PLANNING & DEVELOPMENT CONTROL: PLANNING FOR AIR QUALITY

2.3.4. Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM) have published guidance[13] that offers comprehensive advice on: when an air quality assessment may be required; what should be included in an assessment; how to determine the significance of any air quality impacts associated with a development; and the possible mitigation measures that may be implemented to minimise these impacts.

GUIDANCE ON THE ASSESSMENT OF DUST FROM DEMOLITION AND CONSTRUCTION

2.3.5. This document[14] published by the IAQM was produced to provide guidance to developers, consultants and environmental health officers on how to assess the impacts arising from construction activities. The emphasis of the methodology is on classifying sites according to the risk of impacts (in terms of dust nuisance, PM_{10} impacts on public exposure and impact upon sensitive ecological receptors) and to identify mitigation measures appropriate to the level of risk identified.

NATIONAL PLANNING PRACTICE GUIDANCE – AIR QUALITY

2.3.6. This guidance[15] provides a number of guiding principles on how the planning process can take into account the impact of new development on air quality, and explains how much detail air quality assessments need to include for proposed developments, and how impacts on air quality can be mitigated. It also provides information on how air quality is taken into account by Local Authorities in

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11 Mayor of London (May 2016) London Local Air Quality Management (LLAQM) Technical Guidance (LLAQM.TG (16))

12 Defra (2018) Part IV The Environment Act 1995 and Environment (Northern Ireland) Order 2002 Part III, Local Air Quality Management Technical Guidance LAQM.TG (16)

13 Environmental Protection UK and Institute of Air Quality Management (Version 1.2 Updated January 2017). Land Use Planning & Development Control: Planning for Air Quality

14 Institute of Air Quality Management (Version 1.1 Updated June 2016). Guidance on the Assessment of Dust from Demolition and Construction

15 Department of Communities and Local Government (DCLG) (2014). National Planning Practice Guidance

both the wider planning context of Local Plans and neighbourhood planning, and in individual cases where air quality is a consideration in a planning decision.

LONDON COUNCILS GUIDANCE FOR AIR QUALITY ASSESSMENTS

2.3.7. The London Councils have published guidance[16] for undertaking air quality assessments in the London Boroughs, the majority of which have declared AQMAs. The guidance sets out suggested methods for undertaking such an assessment within London and provides a methodology to assist in determining the impacts of a development proposal on air quality. The focus of the document isthe difference in air quality as a result of the proposed development.

MAYOR OF LONDON'S SUPPLEMENTARY PLANNING GUIDANCE FOR THE CONTROL OF DUST AND EMISSIONS DURING CONSTRUCTION AND DEMOLITION

2.3.8. This Supplementary Planning Guidance[17] (SPG) builds on the voluntary guidance published in 2006 by the London Councils to establish best practice in mitigating impacts on air quality during construction and demolition work. The SPG incorporates more detailed guidance and best practice, and seeks to address emissions from NRMM through the use of a Low Emission Zone, which was introduced in September 2015.

2.3.9. The SPG provides a methodology for assessing the potential impact of construction and demolition activities on air quality following the same procedure as set out in the IAQM guidance. It then identifies the relevant controls and mitigation measures that should be put in place to minimise any adverse impacts. These are set out in draftin an air quality assessment report submitted with the planning application, and are then formalised post submission as an Air Quality and Dust Management Plan. Details of site air quality monitoring protocols are also provided with varying requirements depending on the size of the site and the potential risk of adverse impacts.

GREATER LONDON AUTHORITY: SUSTAINABLE DESIGN AND CONSTRUCTION SUPPLEMENTARY PLANNING GUIDANCE

2.3.10. Section 4.3 of this SPG provides guidance on when a developer will be required to undertake an air quality assessment, how design and transport measures can be used to minimise emissions to air, and sets out emissions standards for combustion plant.

2.3.11. The SPG also contains guidance on assessing the air quality neutrality of a proposed development in order to comply with the London Plan and the Mayor's Air Quality Strategy. Air Quality neutral benchmarks for both transport and buildings NO_x and PM_{10} emissions are provided within the SPG.

2.3.12. Developments that do not exceed these benchmarks (considered separately) will be considered to be 'air quality neutral', whilst developments that exceed the benchmarks after appropriate on-site mitigation measures have been incorporated will be required to off-set any excess in emissions off site. This can be achieved by providing NO_x and PM abatement measures in the vicinity of the

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16 London Councils (January 2007): Air Quality and Planning Guidance – Revised version

17 Mayor of London (July 2014): The control of dust and emissions during construction and demolition – Supplementary Planning Guidance.

development, such as: green planting/walls and screens, with special consideration given to planting that absorbs or supresses pollutants; upgrade or abatement work to combustion plant; retro-fitting abatement technology for vehicles and flues; and exposure reduction. These measures can be secured by condition or Section 106 contribution. Air quality monitoring is not eligible for funding as it is not considered to contribute to actual air quality improvements.

AIR QUALITY NEUTRAL PLANNING SUPPORT GUIDANCE

2.3.13. The Air Quality Neutral Planning Support guidance[18] provides a methodology for assessing the air quality neutrality of proposed developments in London.

[18] AQC and ENVIRON UK Ltd (2014). Air Quality Neutral Planning Support.

3. SCOPE & METHODOLOGY

3.1. SCOPE

3.1.1. The scope of the assessment has been determined in the following way:

- Consultation with the Environmental Health Officer (EHO) at LBRT Council to agree the scope of the assessment and the methodology;
- Review of LBRT's latest review and assessment reports[19] and air quality data for the area surrounding the Application Site, including data from LBRT, Defra[20] and the London Air websites[21];
- Desk study to confirm the locations of nearby existing receptors that may be sensitive to changes in local air quality, and a review of the masterplan for the Proposed Development to establish the location of new sensitive receptors; and
- Review of the traffic data provided by the Project Transport Consultant (WSP).

3.1.2. The scope of the assessment includes consideration of the potential impacts on local air quality resulting from:

- Dust and particulate matter generated by on-site activities during the construction phase;
- Increases in pollutant concentrations as a result of exhaust emissions arising from construction traffic and plant; and
- Increases in pollutant concentrations as a result of exhaust emissions arising from traffic generated by the Proposed Development once operational.

3.1.3. In addition, the potential exposure of future residents of the Proposed Development to poor air quality will also be considered.

3.1.4. The assessment results and conclusions will be used to inform a judgement as to compliance with national, regional and local planning policy.

3.2. METHODOLOGY

CONSTRUCTION PHASE

3.2.1. Dust comprises particles typically in the size range 1-75 micrometres (μm) in aerodynamic diameter and is created through the action of crushing and abrasive forces on materials. The larger dust particles fall out of the atmosphere quickly after initial release and therefore tend to be deposited in close proximity to the source of emission. Dust therefore, is unlikely to cause long-term or widespread changes to local air quality; however, its deposition on property and cars can cause

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19 London Borough of Richmond upon Thames (2018). Air Quality Annual Status Report for 2017. SR London Borough of Richmond upon

20 Defra Local Air Quality Management (LAQM) Support Pages. Available at: http://laqm.defra.gov.uk/ Accessed on 23/01/2019

21 London Air Website. Available at: http://www.londonair.org.uk/LondonAir/Default.aspx. Accessed on 23/01/2019.

‘soiling’ and discolouration. This may result in complaints of nuisance through amenity loss or perceived damage caused, which is usually temporary.

3.2.2. The smaller particles of dust (less than 10µm in aerodynamic diameter) are known as particulate matter (PM_{10}) and represent only a small proportion of total dust released; this includes a finer fraction, known as $PM_{2.5}$ (with an aerodynamic diameter less than 2.5µm). As these particles are at the smaller end of the size range of dust particles they remain suspended in the atmosphere for a longer period of time than the larger dust particles, and can therefore be transported by wind over a wider area. PM_{10} and $PM_{2.5}$ are small enough to be drawn into the lungs during breathing, which in sensitive members of the public could have a potential impact on health.

3.2.3. An assessment of the likely significant impacts on local air quality due to the generation and dispersion of dust and PM_{10} during the construction phase has been undertaken with reference to: the Mayor of London’s SPG for the control of dust and emissions during construction and demolition; the available information for this phase of the Proposed Development provided by the Client and Project Team; and professional judgement.

3.2.4. The Mayor of London’s SPG requires a Dusk Risk Assessment to be undertaken following the methodology published by the IAQM, which assesses the risk of potential dust and PM_{10} impacts from the following four sources: demolition; earthworks; general construction activities and track-out[22]. It considers the nature and scale of the activities undertaken for each source and the sensitivity of the area to an increase in dust and PM_{10} levels to assign a level of risk. Risks are described in terms of there being a low, medium or high risk of dust impacts. Once the level of risk has been ascertained, then site specific mitigation proportionate to the level of risk is identified, and the significance of residual effects determined. A summary of the IAQM assessment methodology is provided in Appendix C.

3.2.5. In addition to impacts on local air quality due to on-site construction activities, exhaust emissions from construction vehicles and plant may have an impact on local air quality adjacent to the routes used by these vehicles to access the Application Site and in the vicinity of the Application Site itself. As information on the number of vehicles and plant associated with the construction phase was not available at the time of writing, a qualitative assessment of their impact on local air quality has been undertaken using professional judgement and by considering the following:

- The number and type of construction traffic and plant likely to be generated by this phase of the Development;
- The number and proximity of sensitive receptors to the Application Site and along the likely routes to be used by construction vehicles; and
- The likely duration of the construction phase and the nature of the construction activities undertaken.

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22 Track-out is defined as the transport of dust and dirt from the construction/ demolition site onto the public road network, where it may deposit and then re-suspended by vehicles using the network. This arises when heavy duty vehicles (HDVs) leave the construction/ demolition site with dusty material, which may then spill onto the road, and/or when HDVs transfer dust and dirt onto the road having travelled over muddy ground on site.

OPERATIONAL PHASE

3.2.6. Of the pollutants included in the AQS, concentrations of NO_2, PM_{10} and $PM_{2.5}$ have been considered in this assessment as road traffic is a major source of these pollutants. Concentrations of these pollutants tend to be close to, or in exceedance of, the objectives in urban locations.

3.2.7. For the prediction of impacts due to emissions arising from road traffic during the operation of the Proposed Development, the dispersion model ADMS-Roads (version 4.1.1.0) has been used. This model uses detailed information regarding traffic flows on the local road network, surface roughness, and local meteorological conditions to predict pollutant concentrations at specific receptor locations.

3.2.8. Meteorological data, such as wind speed and direction, is used by the model to determine pollutant transportation and levels of dilution by the wind. Meteorological data used in the model was obtained from the Met Office observing station at Heathrow for 2017. This station is considered to provide representative data for the assessment. The wind rose and other modelling parameters are presented in Appendix F.

3.2.9. A summary of the traffic data and pollutant emission factors used in the assessment can be found in Appendix D. It includes details of the Annual Average Daily Traffic (AADT) flows, vehicle speeds (km/h) and the percentage of Heavy Duty Vehicles (HDVs) for the local road network in all assessment years considered. Traffic speeds were reduced at junctions in line with guidance provided in LAQM.TG (16), and using professional judgement. The road network is also presented in Figure 1.

3.2.10. For the assessment, three scenarios were modelled, as follows:

- 2017 – Model Verification and Baseline;
- 2022 – Without Development; and
- 2022 – With Development.

3.2.11. 2017 is the most recent year for which monitoring data and meteorological data are available to enable verification of the model results, and so this year has been used as the baseline year for this assessment. 2022 is the anticipated opening year of the Proposed Development.

3.2.12. The traffic flows for the 'without development' scenarios include flows for committed developments in the locality of the Application Site but do not include any contribution to road traffic from the Proposed Development itself. The traffic flows for the 'with development' scenarios include contributions to road traffic from the Proposed Development itself and the nearby committed developments.

3.2.13. Committed developments have been accounted for in the future scenarios in 2022, as the future traffic flows are determined by using Trip End Model Presentation Program (TEMPro) factors. These figures were provided by the Project Transport Consultant.

Vehicle Emission Factors

3.2.14. Vehicle emission factors for use in the assessment have been obtained using the Emission Factor Toolkit (EFT) version 8.0.1 (published in December 2017) available on the Defra website. The EFT allows for the calculation of emission factors arising from road traffic for all years between 2015 and 2030. For the predictions of future year emissions, the toolkit considers factors such as anticipated advances in vehicle technology and changes in vehicle fleet composition, such that vehicle emissions are assumed to reduce over time. However, there is currently some uncertainty over how representative the future predictions are. To address this uncertainty, emission rates calculated by Air Quality Consultants (AQC) Ltd's 'Calculator Using Realistic Emissions for Diesels (CURED) V3A[23] have also been used. The CURED tool has been developed to address the uncertainties associated with future vehicle emissions. Table 1 provides a summary of the how the emission factors were derived in the assessment.

Table 1 – Derivation of Vehicle Emission Factors in the Assessment

Modelling Scenarios	Vehicle Emission Factors
2017 – Model Verification and Baseline	Defra's EFT for all modelled pollutants
2022 – Without and With Development	CURED for NO_x Defra's EFT for PM_{10} and $PM_{2.5}$

3.2.15. Table 1 shows that the 2017 vehicle emission factors have not been calculated using the AQC's methodology because the latest CURED emission factors show no deviation in NO_x emission rates between the years 2016 and 2019 in comparison to the Defra's EFT. Deviations can only be observed from the year 2020 onwards therefore CURED is applied to NO_x emissions for opening year 2022.

3.2.16. The methodology above has been agreed with the EHO at LBRT.

Selection of background concentrations

3.2.17. Background pollutant concentrations used in the assessment have been taken from the national maps provided on the Defra website[24], where background concentrations of those pollutants included within the AQS have been mapped at a grid resolution of 1x1km for the whole of the UK. Estimated concentrations are available for all years between 2015 and 2030. The maps assume that background concentrations will improve (i.e. reduce) over time, in line with the predicted reduction in vehicle emissions and emissions from other sources. Background concentrations for 2017 have been utilised in the '2017 – model verification and baseline' scenario, whilst background concentrations for 2022 have been used to represent the opening year, both without and with development.

3.2.18. The Defra backgrounds for NO_2 have been adjusted as per AQC's methodology[25]. This allows the user to derive more realistic future background concentrations of NO_2 for using with the CURED emission factors. AQC produced this methodology as they found that Defra background maps tend to under-predict concentrations of NO_x and NO_2 as a result of disparity relating to the on-road emission performance of modelled diesel vehicles. The methodology also calibrates the background concentrations against more recent monitoring data for Automatic Urban and Rural Network sites, to

23 Air Quality Consultants (2018). Development of the CURED V3A Emissions Model.

24 https://uk-air.defra.gov.uk/data/laqm-background-home

25 Air Quality Consultants (2019). Deriving Background Concentrations of NO_x to NO_2 for Use in 'CURED 3A'.

provide more realist indications of background concentrations, as opposed to the optimistic Defra mapped background.

3.2.19. The above approach has been agreed in consultation with the EHO at LBRT.

3.2.20. Further details on the background concentrations are provided in Section 4 of this report.

MODEL VERIFICATION AND PROCESSING OF RESULTS

3.2.21. The ADMS-Roads dispersion model has been widely validated for this type of assessment and is considered fit for purpose. Model validation undertaken by the software developer will not have included validation in the vicinity of the Application Site.

3.2.22. To determine the performance of the model at a local level, a comparison of modelled results with the results of monitoring carried out within the study area was undertaken. This process of verification aims to minimise modelling uncertainty and systematic error by correcting modelled road-NO_x results by an adjustment factor to increase confidence in the results. This was completed following the methodology specified in Chapter 7, Section 4, of LAQM.TG (16).

3.2.23. Details of the verification factor calculations are presented in Appendix E. An adjustment factor of 3.0 was obtained during the verification process, which indicated that the model was under-predicting. This factor was applied to the model road-NO_x outputs prior to conversion to annual mean NO_2 concentrations utilising the NO_x to NO_2 calculator (version 6.1, released November 2017) provided by Defra[26].

3.2.24. In the absence of relevant local monitoring of PM_{10} and $PM_{2.5}$ the modelled concentrations of these pollutants have been adjusted by the same factor as for road-NO_x. The total concentrations are then determined by adding the adjusted modelled concentrations and relevant background concentrations. The number of days with PM_{10} concentrations greater than 50µg/m^3 was then estimated using the relationship with the annual mean concentration described in LLAQM.TG (16).

3.2.25. Once processed, the predicted concentrations were compared against the relevant AQS objectives for NO_2, PM_{10} and $PM_{2.5}$ set out in Appendix B.

Selection of Sensitive Receptors

3.2.26. Sensitive locations are places where the public or sensitive ecological habitats may be exposed to pollutants resulting from activities associated with the Proposed Development. These will include locations sensitive to an increase in dust deposition and PM_{10} exposure as a result of on-site construction activities, and locations sensitive to exposure to gaseous pollutants emitted from the exhausts of construction and operational traffic associated with the Proposed Development

CONSTRUCTION PHASE

3.2.27. The IAQM assessment is undertaken where there are:

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[26] Defra NO_x to NO_2 Calculator. Available at: http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxsector [Accessed: 23.1.19].

- 'human receptors' within 350m of the site boundary, or within 50m of the route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s); and/or
- 'ecological receptors' within 50m of the site boundary, or within 50m of the route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s).

3.2.28. It is within these distances that the impacts of dust soiling and increased particulate matter in the ambient air will have the greatest impact on local air quality at sensitive receptors.

OPERATIONAL PHASE

3.2.29. Locations that are sensitive to pollutants emitted from engine exhausts, include places where members of the public are likely to be regularly present over the period of time prescribed in the AQS. For instance, on a footpath where exposure will be transient (for the duration of passage along that path) comparison with a short-term standard (i.e. 15-minute mean or 1-hour mean) may be relevant. At a school or adjacent to a private dwelling, where exposure may be for longer periods, comparison with a long-term standard (such as 24-hour mean or annual mean) may be more appropriate. Box 1.1 of LLAQM.TG (16) provides examples of the locations where the air quality objectives should/should not apply.

3.2.30. To complete the assessment of operational phase impacts, a number of 'receptors' representative of locations of relevant public exposure were identified at which pollution concentrations were predicted. Receptors have been located adjacent to the roads that are likely to experience the greatest change in traffic flows or composition, and therefore NO_2 and particulate matter concentrations, as a result of the Proposed Development. In addition, there are no designated ecological receptors near the Application Site, hence, further assessment is not required.

3.2.31. To complete the exposure assessment, pollution concentrations were also predicted at a number of locations within the Application Site. The receptors have been selected to be representative at each façade of the Proposed Development.

3.2.32. The locations of the assessment receptors are shown on Figure 1 and listed in **Table 2** below.

Table 2 - Receptor Locations Used in the Assessment

Receptor	Description/ Address	Grid Reference		Height above Ground Level (m)
		X	Y	
E1	Residential property on Edwin Road	515342	173211	1.5
E2	Residential property on Colne Road	515312	173152	1.5
E3	Residential property on Gould Road	515246	173327	1.5
E4	Residential property on Crane Road	515270	173326	1.5
E5	Residential property on Crane Road	515292	173194	1.5
E6	Residential property on May Road	515206	173282	1.5
E7	Residential property on May Road	515234	173151	1.5

Receptor	Description/ Address	Grid Reference		Height above Ground Level (m)
		X	Y	
E8	Residential property on May Road	515262	173131	1.5
E9	Residential property on May Road	515302	173039	1.5
E10	Residential property on Andover Road	514869	173054	1.5
E11	Residential property on Meadway	514909	172949	1.5
E12	Residential property on Staines Road (first floor)	514979	172977	4.5
E13	Residential property on Health Road	515461	173070	1.5
E14	Residential property on Health Road (first floor)	515774	173141	4.5
E15	Residential property on Kings Street (first floor)	516188	173161	4.5
E16	Residential property on Kings Street	516170	173088	1.5
E17	Residential property on York Street (first floor)	516296	173338	4.5
E18	Residential property on London Road (first floor)	516251	173334	4.5
E19	Residential property on London Road	516040	173737	1.5
E20	Residential property on The Green	515490	173058	1.5
E21	Trafalgar Infant School	514741	173070	1.5
E22	Twickenham Primary Academy	515478	173076	1.5
E23	Archdeacon Cambridge's CoE Primary School	515290	172804	1.5
N1	New receptor within the Proposed Development	515344	173227	1.5
N2	New receptor within the Proposed Development	515349	173292	1.5
N3	New receptor within the Proposed Development	515371	173212	1.5
N4	New receptor within the Proposed Development	515254	173329	1.5
N5	New receptor within the Proposed Development	515221	173338	1.5
N6	New receptor within the Proposed Development	515322	173362	1.5

3.3. SIGNIFICANCE CRITERIA

CONSTRUCTION PHASE

3.3.1. The IAQM assessment methodology recommends that significance criteria are only assigned to the identified risk of dust impacts occurring from a construction activity with appropriate mitigation measures in place. For almost all construction activities, the application of effective mitigation should prevent any significant effects occurring to sensitive receptors and therefore the residual effect will normally be negligible.

3.3.2. For the assessment of the impact of exhaust emissions from plant used on-site and construction vehicles accessing and leaving the Site on local concentrations of NO_2 and particulate matter, the significance of residual effects have been determined using professional judgement and the principles outlined in the EPUK/IAQM guidance, which are described below.

3.3.3. A quantitative assessment for the construction phase has not been made, as it is anticipated that the number of construction vehicles will not exceed the threshold[27] detailed in the EPUK/ IAQM guidance. Hence the overall impact is not considered to be significant and further assessment is not be required.

OPERATIONAL PHASE

3.3.4. The approach provided in the EPUK/IAQM guidance has been used within this assessment to assist in describing the air quality effects of additional emissions from traffic generated by the Proposed Development once operational.

3.3.5. This guidance recommends that the degree of an impact is described by expressing the magnitude of incremental change in pollution concentration as a proportion of the relevant assessment level and examining this change in the context of the new total concentration and its relationship with the assessment criterion, as summarised in Table 3.

Table 3 - Impact Descriptors for Individual Receptors

Long term average concentration at receptors 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% 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
Notes				

[27] The EPUK/IAQM guidance document Planning for Air Quality provides criteria which can be used to determine if a detailed assessment of air quality is required. For on-road construction vehicles (HGVs), a detailed assessment is not required if there is likely to be a permanent change of less than 25 AADT within or adjacent to an AQMA. In the absence of detailed construction information, HGV flows are estimated to be in the region of 10-50 AADT, however, this will be for the duration of the construction works only.

AQAL = Air Quality Assessment Level, which for this assessment related to the UK Air Quality Strategy objectives. Where the %change in concentrations is <0.5%, the change is described as 'Negligible' regardless of the concentration. When defining the concentration as a percentage of the AQAL, 'without scheme' concentration should be used where there is a decrease in pollutant concentration and the 'with scheme;' concentration where there is an increase. Where concentrations increase, the impact is described as adverse, and where it decreases as beneficial.

3.3.6. The EPUK/IAQM guidance notes that the criteria in Table 3 should be used to describe impacts at individual receptors and should be considered as a starting point to make a judgement on significance of effects, as other influences may need to be accounted for. The EPUK/IAQM guidance states that the assessment of overall significance should be based on professional judgement, considering several factors, including:

- The existing and future air quality in the absence of the development;
- The extent of current and future population exposure to the impacts; and
- The influence and validity of any assumptions adopted when undertaking the prediction of impacts.

3.3.7. The EPUK/IAQM guidance states that for most road transport related emissions, long-term average concentrations are the most useful for evaluating the impacts. The guidance does not include criteria for determining the significance of the effect on hourly mean NO_2 concentrations or daily mean PM_{10} concentrations. The significance of effects of hourly mean NO_2 and daily mean PM_{10} concentrations arising from the operational phase have therefore been determined qualitatively using professional judgement and the principles described above.

3.3.8. The EPUK/IAQM guidance says that 'Where the air quality is such that an air quality objective at the building facade is not met, the effect on residents or occupants will be judged as significant, unless provision is made to reduce their exposure by some means. For people working at new developments in this situation, the same will not be true as occupational exposure standards are different, although any assessment may wish to draw attention to the undesirability of the exposure.'

3.3.9. In addition to these criteria, the flow chart method for determining the significance of the predicted air quality impacts of a proposed development and published in the London Councils guidance for air quality assessments has been used. A summary of the flow chart for determining significance is shown below in Table 4.

Table 4 - Summary of the London Councils flow chart method for assessing the significance of air quality impacts

Effect of Development	Outcome
Will development interfere with or prevent implementation of measures in the AQAP	Air Quality is an overriding consideration.
Is development likely to cause a worsening of air quality or introduce new exposure into the AQMA?	Air Quality is a highly significant consideration.

Effect of Development	Outcome
Would the development contribute to air quality exceedances or lead to the designation of a new AQMA?	Air Quality is a highly significant consideration.
Is the development likely to increase emissions of or increase/introduce new exposure to PM_{10}	Air Quality is a significant consideration.
None of the above.	Air Quality is not a significant consideration but mitigation measures may still need to be considered.

3.3.10. In determining both the significance of new exposure to air pollution and the levels of mitigation required within the Proposed Development Site, consideration was given to the Air Pollution Exposure Criteria (APEC) published in the London Councils guidance for air quality assessments and shown in Table 5.

Table 5 - London Councils Air Pollution Exposure Criteria

APEC Level	Applicable Range Annual average NO_2	Applicable Range PM_{10}	Recommendation
A	> 5% below national objective	Annual Mean > 5% below national objective 24 hour mean > 1 day less than the national objective	No air quality grounds for refusal; however mitigation of any emissions should be considered.
B	Between 5% below or above national objective	Annual Mean Between 5% below or above national objective 24 hour mean Between 1 day above or below the national objective	May not be sufficient air quality grounds for refusal, however appropriate mitigation must be considered e.g., maximise distance from pollution source, proven ventilation systems, parking considerations, winter gardens, internal layout considered and internal pollutant emissions minimised.
C	> 5% above national objective	Annual Mean > 5% above national objective 24 hour mean > 1 day more than the national objective	Refusal on air quality grounds should be anticipated, unless the Local Authority has a specific policy enabling such land use and ensure best endeavours to reduce exposure are

APEC Level	Applicable Range Annual average NO_2	Applicable Range PM_{10}	Recommendation
			incorporated. Worker exposure in commercial/industrial land uses should be considered further. Mitigation measures must be presented with air quality assessment, detailing anticipated outcomes of mitigation measures.

MAYOR OF LONDON'S AIR QUALITY NEUTRAL POLICY

3.3.11. The air quality neutral assessment has been undertaken using the Gross Internal Area (GIA) and anticipated development trip rates of each proposed use once operational to calculate the NO_x and PM_{10} emissions from the transport elements of the Proposed Development.

3.3.12. No combustion sources will be installed within the Proposed Development because the heating and energy arrangement will be supported by a heat pump system. Therefore, building emissions and associated benchmarks have not been considered further.

3.3.13. Data for the Proposed Development air quality neutral assessment, calculated from information provided by the Project Team, are presented in Table 6.

Table 6 - Parameters used in the Air Quality Neutral Assessment

Land Use Class	GIA (m^2)	Annual two-way trips
B1	175	1,895
C3	11,740	71,633

3.3.14. The results were compared to the benchmarks set out in the SPG, which are shown in Table 7 below.

Table 7 - Emission Benchmarks

Land Use Class	Benchmark Category	NO_x Benchmark	PM_{10} Benchmark
B1	Transport emissions	12.0	2.1
C3		180.1	31.0

3.4. LIMITATIONS & ASSUMPTIONS

3.4.1. As suitable information for the construction phase of the Proposed Development was not available professional judgement has been used in the completion of this part of the assessment. For instance, the extent and demolition and earthworks were assumed using Google Earth and plans provided by the Project Architect respectively.

3.4.2. There are uncertainties associated with both measured and predicted concentrations. The model (ADMS-Roads) used in this assessment relies on input data (including predicted traffic flows), which also have uncertainties associated with them. The model itself simplifies complex physical systems into a range of algorithms. In addition, local micro-climatic conditions may affect the concentrations of pollutants that the ADMS-Roads model will not take into account.

3.4.3. To reduce the uncertainty associated with predicted concentrations, model verification has been carried out following guidance set out in LAQM.TG (16). As the model has been verified against local monitoring data and adjusted accordingly, there can be reasonable confidence in the predicted concentrations.In order to demonstrate the increase in certainty, the Root Mean Square Error (RMSE) was 14.6μg/m^3 and 2.0μg/m^3 before and after the verification process respectively.

3.4.4. The traffic data are obtained from both Automatic Traffic Counters (ATC) and Department for Transport (DfT)'s traffic count. Average spends from the ATC and speed limits have been used in the assessment. The traffic flows for the future years were determined by using the TEMpro factors. The traffic data were provided by the Project Transport Consultant and it has assumed that the data are correct.

4. BASELINE CONDITIONS

4.1. LBRT'S REVIEW & ASSESSMENT OF AIR QUALITY

4.1.1. The LBRT has designated a borough wide AQMA as a consequence of their Review and Assessment work. The Application Site lies within this AQMA designated due to exceedances of the AQS objectives for annual mean NO_2 and 24-hour mean PM_{10} concentrations.

4.1.2. LBRT has a draft Air Quality Action Plan[28] (AQAP) published in 2017. It details a number of measures proposed to reduce concentrations of NO_2 and PM_{10} in the AQMA. These measures include:

- Include air quality as a key standalone measure in the Borough's Local Plan[29].
- Adoption of AQ Supplementary Planning Guidance to ensure emissions from new development is minimised and effective mitigation is integrated in scheme design.
- Promotion and increased use of Love Clean Air website (south London cluster).
- Lobby for Cleaner buses in areas of poor air quality

4.2. LOCAL EMISSION SOURCES

4.2.1. The Application Site is located in an area where air quality is mainly influenced by emissions from road transport using Gould Road, May Road, Crane Road, Edwin Road and Norcutt Road.

4.2.2. Review of the Environment Agency's Public Register[30] indicates that there are no industrial pollution sources in the immediate vicinity of the site that will influence the local air quality.

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[28] London Borough of Richmond Upon Thames (2017) Air Quality Action Plan 2017-2022.

[29] London Borough of Richmond Upon Thames (2018). Adopted Local Plan.

[30] Environment Agency. Public Registers website. Available at https//environment.data.gov.uk/public-register/view/index.

4.3. DEFRA BACKGROUND AIR QUALITY DATA

Table 8 – Defra Background Concentrations for 2017 and 2022 ($\mu g/m^3$)

Grid Square (centre on O.S. Grid Reference)		2017			2022		
X	Y	CURED NO_2 ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	CURED NO_2 ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
514500	172500	22.0	15.1	9.8	18.5	14.7	9.4
514500	173500	24.0	15.7	10.2	20.3	15.3	9.7
515500	172500	21.7	15.1	9.9	18.3	14.7	9.4
515500	173500	24.1	15.7	10.2	20.3	15.2	9.7
516500	173500	24.1	16.0	10.3	20.1	15.4	9.8

4.3.1. Table 8 summarises the background pollutant concentrations of NO_2, PM_{10} and $PM_{2.5}$ for 2017 that were utilised in the assessment. All the annual mean background concentrations are well below the relevant objectives.

4.4. LOCAL AUTHORITY AIR QUALITY MONITORING DATA

Annual mean NO_2 Concentrations

4.4.1. Annual mean NO_2 concentrations measured at monitoring locations by LBRT within 1km of the Application Site are provided in Table 9 and shown in Figure 2.

Table 9 – LBRT Air Quality Monitoring Data for 2013-2017

Site ID	Site Name	Site Type	Annual Mean NO_2 Concentration ($\mu g/m^3$)				
			2013	2014	2015	2016	2017
RHG	Mobile Air Quality Unit, Chertsey Rd, TW2	Automatic Roadside	**43**	**42**	-	-	37
9	Hampton Road	Kerbside	**49**	**48**	**42**	**45**	**40**
13	Whitton Road	Kerbside	**48**	**47**	**42**	**42**	**40**
14	Cross Deep	Kerbside	**46**	**45**	39	**40**	36
31	A316 (near Chudleigh Rd)	Roadside	**61**	**<u>62</u>**	**54**	**54**	**52**

Site ID	Site Name	Site Type	Annual Mean NO_2 Concentration ($\mu g/m^3$)				
			2013	2014	2015	2016	2017
32	Kings Street	Roadside	**<u>74</u>**	**<u>73</u>**	**<u>62</u>**	**<u>64</u>**	**59**
33	Heath Road	Roadside	**<u>62</u>**	**<u>69</u>**	**<u>61</u>**	**<u>61</u>**	**53**
58	London Road	Kerbside	**58**	**50**	**46**	**50**	**47**
59	Whitton Road	Kerbside	**46**	**42**	**40**	**44**	39
61	London Road	Roadside	**58**	**54**	**48**	**49**	**45**
65	York Street	Kerbside	-	-	-	**<u>75</u>**	**<u>68</u>**
Rut 01	Civic Centre, York St	Automatic Roadside	**<u>60</u>**	**56**	45	**50**	**51**

Note: Data in **bold** indicates exceedance of the NO_2 annual mean AQO of 40 $\mu g/m^3$.
Data in **<u>bold and underlined</u>** indicates NO_2 annual means in excess of 60 $\mu g/m^3$, indicating a potential exceedance of the NO_2 hourly mean AQS objective.
- indicates no data available
Source: London Borough of Richmond upon Thames ASR 2018.

4.4.2. The monitoring data above show that the majority of monitoring locations recorded exceedances of the annual mean NO_2 objective of 40µg/m^3 between 2013 and 2017. Sporadic compliance has been recorded at monitoring locations RHG, 14 and 59 in the past 5 years. As the majority of monitoring locations are located adjacent to heavily trafficked roads, these locations are not considered to be representative of the Application Site due to its urban background location.

4.4.3. Trend analysis indicates no clear pattern in annual mean NO_2 reduction for majority of the monitoring sites in LBRT. However, some improvement in annual mean NO_2 is evident at site Rut 01.

Hourly mean NO_2 concentrations

4.4.4. Monitoring location RHG recorded compliance for hourly mean NO_2 concentrations in the last 5 years, and this the nearest monitor with available information. Monitoring data for site Rut 01 are not available.

PM_{10} Concentrations

4.4.5. The nearest PM_{10} monitoring is undertaken at location RHG, and compliance for annual mean and 24-hour mean PM_{10} concentrations has been recorded in 2013 and 2017.

4.5. LAEI BACKGROUND AIR QUALITY DATA

4.5.1. The LAEI includes detailed map of annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations across London in 2013 and 2020. As 2022 is the opening year for the Proposed Development, it is reasonable to use the 2020 mapping data to provide a good indication of the potential future baseline pollutant levels in the vicinity of the Application Site.

4.5.2. There are no exceedances of the annual mean objectives for NO_2, PM_{10} and $PM_{2.5}$ indicated by the 2020 LAEI data.

4.5.3. The 2020 LAEI maps for annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations are presented in Figures 3 to 5.

5. ASSESSMENT OF IMPACTS

5.1. CONSTRUCTION PHASE

DUST AND PM_{10} ARISING FROM ON-SITE ACTIVITIES

5.1.1. Construction activities that have the potential to generate and/or re-suspend dust and PM_{10} include:

- Site clearance and preparation including demolition activities;
- Preparation of temporary access/egress to the Application Site and haulage routes;
- Earthworks;
- Materials handling, storage, stockpiling, spillage and disposal;
- Movement of vehicles and construction traffic within the Application Site (including excavators and dumper trucks);
- Use of crushing and screening equipment/plant;
- Exhaust emissions from site plant, especially when used at the extremes of their capacity and during mechanical breakdown;
- Construction of buildings, roads and areas of hardstanding alongside fabrication processes;
- Internal and external finishing and refurbishment; and
- Site landscaping after completion.

5.1.2. The majority of the releases are likely to occur during the 'working week'. However, for some potential release sources (e.g. exposed soil produced from significant earthwork activities) in the absence of dust control mitigation measures, dust generation has the potential to occur 24 hours per day over the period during which such activities are to take place.

ASSESSMENT OF POTENTIAL DUST EMISSION MAGNITUDE

5.1.3. The IAQM assessment methodology has been used to determine the potential dust emission magnitude for the following four different dust and PM_{10} sources: demolition; earthworks; construction; and, trackout. The findings of the assessment are presented below.

Demolition

5.1.4. The total volume of buildings to be demolished on site is more than 50,000m^3, with potentially dusty construction material (e.g. concrete), on-site crushing and screening, and with demolition activities occurring more than 20m above ground level. Therefore, the potential dust emission magnitude is considered to be large for demolition activities.

Earthworks

5.1.5. The total area of the Application Site is more than 10,000m^2, the soil type is clay and therefore potentially dusty when moisture content is low, and the total material that will be moved is estimated to be more than 100,000 tonnes. It is also estimated that more than 10 heavy earth moving vehicles will be active at any one time, and that the formation of bunds higher than 8m will occur. Therefore, the potential dust emission magnitude is considered to be large for earthwork activities

Construction

5.1.6. The total volume of buildings to be constructed on the Application Site will be approximately 90,000m^3 (which lies between the IAQM range of 25,000m^3 and 100,000m^3) with potentially dusty construction materials being used. In addition, on site concrete batching will occur. Therefore, the potential dust emission magnitude is considered to be medium for construction activities.

Trackout

5.1.7. In the absence of construction traffic data, it has been estimated that between 10 and 50 HDV (>3.5t) outward movements in any one day travelling on moderately dusty surface materials. Due to the size of the site, it is also assumed that the length of unpaved roads within Application Site will be between 50 and 100m. Therefore, the potential dust emission magnitude is considered to be medium for trackout.

5.1.8. Table 10 provides a summary of the potential dust emission magnitude determined for each construction activity considered.

Table 10 - Potential Dust Emission Magnitude

Activity	Dust Emission Magnitude
Demolition	Large
Earthworks	Large
Construction Activities	Medium
Trackout	Medium

ASSESSMENT OF SENSITIVITY OF THE STUDY AREA

5.1.9. A windrose generated using the meteorological data used for the dispersion modelling of operational phases impacts is provided in Appendix F. This shows that the prevailing wind direction is from the west and south west. Therefore, receptors located on Norcutt Road (downwind locations east and north east of the Application Site) are more likely to be affected by dust and particulate matter emitted and re-suspended during the construction phase.

5.1.10. Under low wind speed conditions, it is likely that the majority of dust would be deposited in the area immediately surrounding the source. Within 50m from the Application Site, there are 10 to 100 residential units located in the immediate boundary. The annual mean PM_{10} background concentration in the vicinity of the Application site is 15.5µg/m^3 [31]. As such, this area is of high sensitivity to dust soiling and human health effects due to increase in ambient PM_{10} concentrations. Gould Road and Edwin Road are the main routes that construction vehicles will use, so residential receptors along these links are likely to be affected by dust trackout.

5.1.11. There are no designated ecological receptors near the Application Site.

[31] 2019 Defra background obtained from grid square 515500, 173500.

5.1.12. Taking the above into account and following the IAQM assessment methodology, the sensitivity of the area to changes in dust and PM_{10} has been derived for each of the construction activities considered. The results are shown in Table 11.

Table 11 - Sensitivity of the Study Area

Potential Impact	Sensitivity of the Surrounding Area			
	Demolition	Earthworks	Construction	Trackout
Dust Soiling	High	High	High	High
Human Health	Low	Low	Low	Low

Risk of Impacts

5.1.13. The predicted dust emission magnitude has been combined with the defined sensitivity of the area to determine the risk of impacts during the construction phase, prior to mitigation. Table 12 below provides a summary of the risk of dust impacts for the Proposed Development. The risk category identified for each construction activity has been used to determine the level of mitigation required.

Table 12 - Summary Dust Risk Table to Define Site Specific Mitigation

Potential Impact	Risk			
	Demolition	Earthworks	Construction	Trackout
Dust Soiling	High Risk	High Risk	Medium Risk	Medium Risk
Human Health	Medium Risk	Low Risk	Low Risk	Low Risk

CONSTRUCTION VEHICLES & PLANT

5.1.14. The greatest impact on air quality due to emissions from vehicles and plant associated with the construction phase will be in the areas immediately adjacent to the site access. It is anticipated that construction traffic will access the site via Gould Road and Edwin Road. Due to the size of the Application Site, it is considered likely that the construction traffic will be low to medium risk of dust Trackout in comparison to the existing traffic flows on these roads.

5.1.15. Final details of the exact plant and equipment likely to be used will be determined by the appointed contractor, it is considered likely to comprise dump trucks, tracked excavators, diesel generators, asphalt spreaders, rollers, compressors and trucks. The number of plant and their location within the Application Site are likely to be variable over the construction period.

5.1.16. Based on the current local air quality in the area, the close proximity of sensitive receptors to the roads likely to be used by construction vehicles, and the likely numbers of construction vehicles and plant that will be used, the impacts are therefore considered to be of moderate to slight adverse significance according to the assessment significance criteria before the implementation of mitigation measures. This is determined following the criteria detailed in section 3.2.5.

5.2. OPERATIONAL PHASE

5.2.1. Full results of the dispersion modelling are presented in Appendix G and a summary is provided below.

ANNUAL MEAN NO_2 CONCENTRATIONS

5.2.2. The AQS objective for annual mean NO_2 concentrations is 40µg/m^3. In the 2017 baseline scenario, NO_2 concentrations at 6 out of 23 existing receptors exceed the AQS objective. The highest concentration is 47.2µg/m^3 predicted at Receptor E15 (first floor residential receptor on King Street).

5.2.3. In 2022, concentrations predicted at all existing receptors are below the AQS objective both without and with the Proposed Development. The highest concentration is predicted 35.8µg/m^3 predicted at Receptor E16 (ground floor residential receptor on Kings Street) when the Proposed Development is operational.

5.2.4. The greatest predicted change in annual mean NO_2 concentration in 2022 due to the Proposed Development is 0.2µg/m^3, predicted at Receptor E11 (ground floor residential property on Meadway); and this is less than 1% of the relevant AQS objective. Therefore, in accordance with the EPUK/ IAQM guidance, the impacts on annual mean NO_2 concentrations are negligible at all existing receptors. The Proposed Development is also not predicted to cause any new exceedances of the AQS objective (even by taking the RMSE of 2µg/m^3 into consideration).

5.2.5. The results indicate that concentrations at the new exposure locations will meet the AQS objectives and are therefore classified as APEC Level A (no mitigation required).

HOURLY MEAN NO_2 CONCENTRATIONS

5.2.6. The annual mean NO_2 concentrations at all receptors predicted by the model are all below 60µg/m^3, and therefore hourly mean NO_2 concentrations are unlikely to cause a breach of the hourly mean AQS objective. The impact of the Proposed Development on hourly mean NO_2 concentrations at existing sensitive receptors is considered to be negligible.

ANNUAL MEAN PM_{10} CONCENTRATIONS

5.2.7. Predicted PM_{10} concentrations are well below the annual mean objective of 40µg/m^3 at all existing receptors within all modelled scenarios.

5.2.8. The highest concentration is 19.4µg/m^3 predicted at Receptor E16 when the Proposed Development is operational. The greatest change in annual mean PM_{10} is 0.04µg/m^3, and this is less than 1% of the AQS objective. Therefore, the resulting impact is negligible at all existing receptors for annual mean PM_{10} concentrations.

5.2.9. The predicted annual mean PM_{10} concentrations at the new exposure locations are all well below the AQS objective and are therefore classified as APEC A (no mitigation required).

DAILY MEAN PM_{10} CONCENTRATIONS

5.2.10. The AQS objective for daily mean PM_{10} concentrations is 50µg/m^3 to be exceeded no more than 35 times a year. The results indicate that both existing and future receptors will not be exposed to daily mean PM_{10} concentrations which are in breach of this objective. The impacts on daily mean PM_{10} concentrations at all existing receptors are negligible.

ANNUAL MEAN $PM_{2.5}$ CONCENTRATIONS

5.2.11. Predicted annual mean concentrations of $PM_{2.5}$ are all well below AQS objective of 25µg/m^3 in all modelled scenarios.

5.2.12. In 2022, the greatest predicted change in annual mean $PM_{2.5}$ concentrations due to the Proposed Development is less than 0.02µg/m^3 across all existing receptors. The impacts on annual mean $PM_{2.5}$ concentration for all existing receptors are negligible in accordance to the EPUK/ IAQM guidance.

AIR QUALITY NEUTRAL ASSESSMENT

5.2.13. A summary of the findings of the air quality neutral assessment is presented in Table 13.

Table 13 - Summary of Air Quality Neutral Assessments

Category	Benchmark	NO_x (kg/annum)	PM_{10} (kg/annum)
Transport Emissions	192.1	295.5	103.4
	33.0	50.7	17.7

5.2.14. The transport emissions for NO_x and PM_{10} are above the benchmark values and as such, the Proposed Development is not air quality neutral and mitigation measures will be required to address these. Further details on these are given in Section 6.2.

6. MITIGATION & RESIDUAL EFFECTS

6.1. CONSTRUCTION PHASE

6.1.1. Based on the assessment results, in which high dust risks have been identified for construction phase activities associated with the Proposed Development, recommended mitigation measured are given below.

General Communication

- A stakeholder communications plan that includes community engagement before work commences on site should be developed and implemented.
- The name and contact details of person(s) accountable for air quality and dust issues should be displayed on the site boundary. This may be the environment manager/engineer or the site manager. The head or regional office contact information should also be displayed.

General Dust Management

- A Dust Management Plan (DMP), which may include measures to control other emissions, in addition to the dust and PM_{10} mitigation measures given in this report, should be developed and implemented, and approved by the Local Authority. In London, additional measures may be required to ensure compliance with the Mayor of London's guidance. The DMP may include a requirement for monitoring of dust deposition, dust flux, real-time PM_{10} continuous monitoring and/or visual inspections.

Site Management

- All dust and air quality complaints should be recorded and causes identified. Appropriate remedial action should be taken in a timely manner with a record kept of actions taken including of any additional measures put in-place to avoid reoccurrence
- The complaints log should be made available to the local authority on request.
- Any exceptional incidents that cause dust and/or air emissions, either on- or offsite should be recorded, and then the action taken to resolve the situation recorded in the log book.
- Regular liaison meetings with other high-risk construction sites within 500m of the site boundary should be held, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/ deliveries which might be using the same strategic road network routes.

Monitoring

- Daily on-site and off-site inspections should be undertaken, where receptors (including roads) are nearby to monitor dust. The inspection results should be recorded and made available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary, with cleaning to be provided if necessary.
- Regular site inspections to monitor compliance with the DMP should be carried out, inspection results recorded, and an inspection log made available to the local authority when asked.
- The frequency of site inspections should be increased when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.

- Dust deposition, dust flux, or real-time PM_{10} continuous monitoring locations should be agreed with the Local Authority. Where possible baseline monitoring should start at least three months before work commences on site or, if it a large site, before work on a phase commences.

Preparing and maintaining the site

- Plan the site layout so that machinery and dust causing activities are located away from receptors, as far as is practicable.
- Where practicable, erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site.
- Where practicable, fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.
- Avoid site runoff of water or mud.
- Keep site fencing, barriers and scaffolding clean using wet methods.
- Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover appropriately.
- Where practicable, cover, seed or fence stockpiles to prevent wind whipping.

Operating vehicle/machinery and sustainable travel

- Ensure all on-road vehicles comply with the requirements of the London Low Emission Zone and the London NRMM standards, where applicable.
- Ensure all vehicle operators switch off engines when stationary - no idling vehicles.
- Avoid the use of diesel or petrol-powered generators and use mains electricity or battery powered equipment where practicable.
- A maximum-speed-limit of 15 mph on surfaced and 10 mph on unsurfaced haul roads and work areas should be imposed (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate).
- A Construction Logistics Plan should be produced to manage the sustainable delivery of goods and materials.
- A Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing) should be considered.

Operations

- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.
- Use enclosed chutes and conveyors and covered skips.
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.
- Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.

Waste management

- Avoid bonfires and burning of waste materials.

Measures Specific to Demolition

- Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).
- Ensure effective water suppression is used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.
- Avoid explosive blasting, using appropriate manual or mechanical alternatives.
- Bag and remove any biological debris or damp down such material before demolition.

Measures Specific to Earthworks

- Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.
- Use Hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.
- Where practicable, only remove the cover in small areas during work and not all at once.
- Stockpile surface areas should be minimised (subject to health and safety and visual constraints regarding slope gradients and visual intrusion) to reduce area of surfaces exposed to wind pick-up.
- Where practicable, windbreak netting/screening should be positioned around material stockpiles and vehicle loading/unloading areas, as well as exposed excavation and material handling operations, to provide a physical barrier between the Application Site and the surroundings.
- Where practicable, stockpiles of soils and materials should be located as far as possible from sensitive properties, taking account of the prevailing wind direction.
- During dry or windy weather, material stockpiles and exposed surfaces should be dampened down using a water spray to minimise the potential for wind pick-up.

Measures Specific to Construction

- Avoid scabbling (roughening of concrete surfaces) if possible.
- Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
- Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.
- For smaller supplies of fine powder materials ensure bags are sealed after use and stored appropriately to prevent dust *(desirable)*.
- All construction plant and equipment should be maintained in good working order and not left running when not in use.

Measures Specific to Trackout

- Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site. This may require the sweeper being in frequent use.
- Avoid dry sweeping of large areas.
- Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.

- Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.
- Record all inspections of haul routes and any subsequent action in a site log book.
- Where practicable, hard surfaced haul routes should be installed, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.
- Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).
- Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.
- Access gates to be located at least 10m from receptors where possible.

6.1.2. Detailed mitigation measures to control construction traffic should be discussed with LBRT to establish the most suitable access and haul routes for the site traffic. The most effective mitigation will be achieved by ensuring that construction traffic does not pass along sensitive roads (for example residential roads such as Crane Road, Edwin Road and May Road , congested roads, or via unsuitable junctions, etc.) where possible, and that vehicles are kept clean (through the use of wheel washers, etc.) and sheeted when on public highways. Timing of large-scale vehicle movements to avoid peak hours on the local road network will also be beneficial.

RESIDUAL EFFECTS

6.1.3. The residual effects of dust and PM_{10} generated by construction activities following the application of the mitigation measures described above and good site practice is considered to be negligible.

6.1.4. The residual effects of emissions to air from construction vehicles and plant on local air quality is considered to be not significant.

6.2. OPERATIONAL PHASE

MITIGATION

6.2.1. The change in pollutant concentrations attributable to traffic emissions during the operational phase of the Proposed Development (i.e. impacts on local air quality) are negligible for all pollutants, and therefore, no mitigation is required.

6.2.2. Predicted annual NO_2 and PM_{10} concentrations at all the new exposure locations are classified as APEC A. Compliance for annual mean $PM_{2.5}$ has also been predicted at all new receptors. As such, mitigation will not be required.

6.2.3. The Proposed Development is not air quality neutral in terms of transport emissions, as such mitigation will be required to offset the emissions. The following mitigation strategy has been proposed by the Project Transport Consultant:

- Electric car charging outlets for a minimum of 20% of the parking spaces with the potential to provide 100% (electric vehicle) EV chargers for all the parking spaces at a later stage if required;
- The applicant will be providing a contribution to a new car club on Edwin Road; and
- Provision of travel plan incentives such as free car club membership for the future residents.

RESIDUAL EFFECTS

6.2.4. The Proposed Development is predicted to cause a very marginal increase in NO_2, PM_{10} and $PM_{2.5}$ concentrations and the new receptors will comply with the relevant objectives. On this basis, the residual effects of the Proposed Development on all relevant pollutants are not significant.

7. CONCLUSIONS

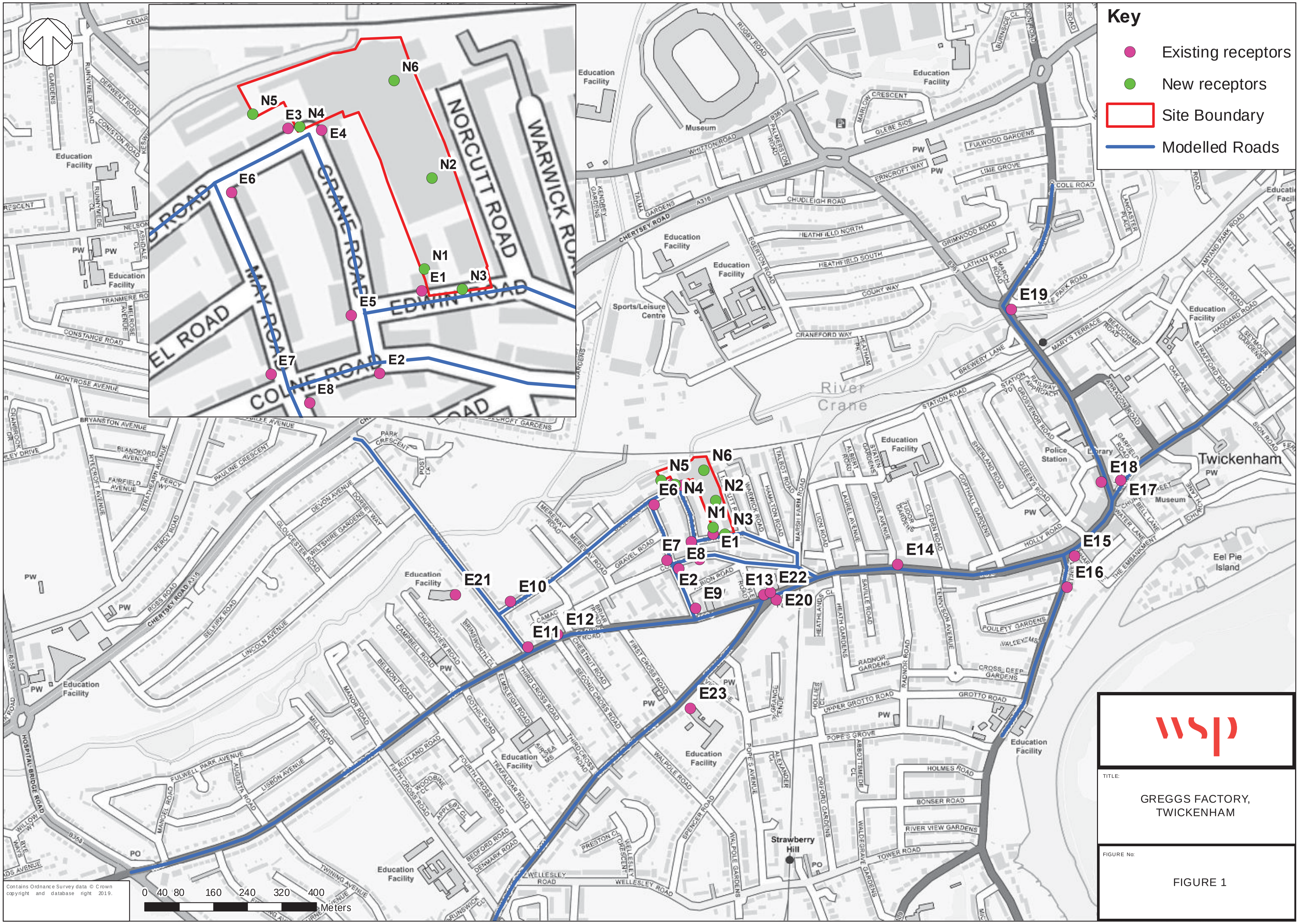
7.1.1. A qualitative assessment of the potential impacts on local air quality from construction activities has been carried out for this phase of the Proposed Development using the IAQM methodology. This identified that there is a high to medium risk of dust soiling impacts and a medium to low risk of increases in particulate matter concentrations due to construction activities. However, through good site practice and the implementation of suitable mitigation measures, the effect of dust and PM_{10} releases would be significantly reduced. The residual effects of dust and PM_{10} generated by construction activities on air quality are therefore considered to be negligible. The residual effects of emissions to air from construction vehicles and plant on local air quality is considered to be not significant.

7.1.2. A quantitative assessment of the potential impacts during the operational phase was undertaken using ADMS-Roads to predict the changes in NO_2, PM_{10} and $PM_{2.5}$ concentrations that would occur due to traffic generated by the Proposed Development. A conservative approach was taken to the assessment, and to increase confidence in the results, measures were taken to minimise uncertainty in the modelling process. The impacts of the operational phase on local quality were predicted to be negligible for all pollutants and the residual effect was assessed asnot significant.

7.1.3. Predicted annual NO_2 and PM_{10} concentrations at all the new exposure locations are classified as APEC A in accordance with the London Councils Air Pollution Exposure Criteria. Compliance for annual mean $PM_{2.5}$ has also been predicted at all new receptors. As such, mitigation will not be required.

7.1.4. The Proposed Development is not air quality neutral for transport emissions, as such mitigation will therefore be required. A mitigation strategy has been proposed by the Project Transport Consultant which would offset emissions.

7.1.5. It is considered that the development proposals will comply with national, regional and local policy for air quality with the application of appropriate mitigation.

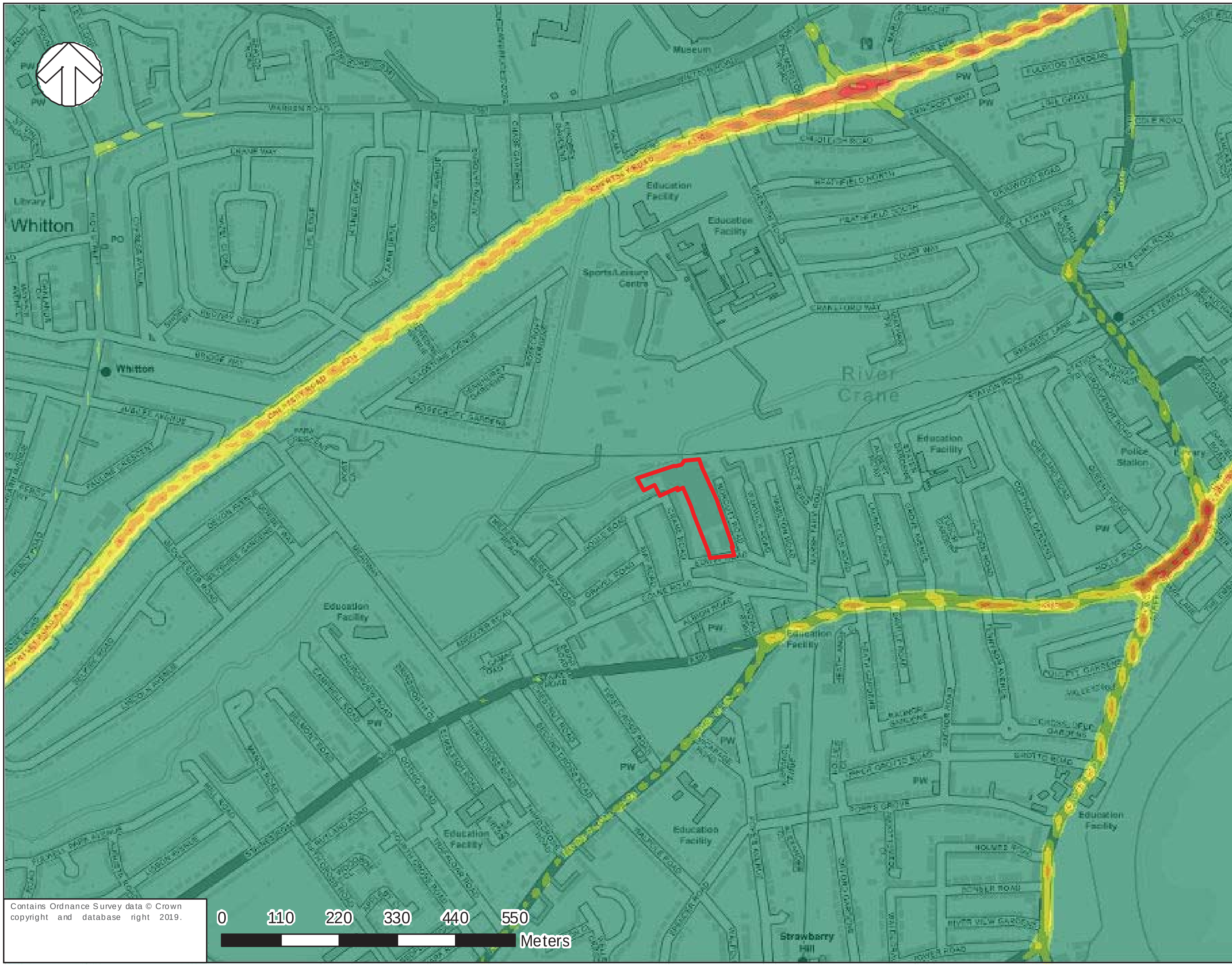

Key
Existing receptors
New receptors
Site Boundary
Modelled Roads
E1
E2
E3
E4
E5
E6
E7
E8
E9
E10
E11
E12
E13
E14
E15
E16
E17
E18
E19
E20
E21
E22
E23
N1
N2
N3
N4
N5
N6
NORCUTT ROAD
WARWICK ROAD
EDWIN ROAD
CRANE ROAD
MAY ROAD
COLNE ROAD
Twickenham
River Crane
Eel Pie Island
Strawberry Hill
0 40 80 160 240 320 400 Meters
Contains Ordnance Survey data © Crown copyright and database right 2019.
wsp
TITLE:
GREGGS FACTORY, TWICKENHAM
FIGURE No:
FIGURE 1

TITLE:

GREGGS FACTORY, TWICKENHAM

FIGURE No:

FIGURE 2



Key

2020 LAEI Baseline

Annual mean NO_2 (µg/m^3)

- >60
- 55-60
- 40-55
- 45-50
- 40-45
- 35-40
- <35
- Site Boundary

TITLE:

GREGGS FACTORY, TWICKENHAM

FIGURE No:

FIGURE 3


Key
2020 LAEI Baseline
Annual mean NO2 (µg/m3)
>40
35-40
<35
Site Boundary
Twickenham
Whitton
River Crane
Eel Pie Island
Strawberry Hill
0 110 220 330 440 550 Meters
Contains Ordnance Survey data © Crown copyright and database right 2019.
wsp
TITLE:
GREGGS FACTORY, TWICKENHAM
FIGURE No:
FIGURE 4

TITLE:

GREGGS FACTORY, TWICKENHAM

FIGURE No:

FIGURE 5

Appendix A

GLOSSARY

Term	Definition
AADT Annual Average Daily Traffic	A daily total traffic flow (24 hrs), expressed as a mean daily flow across all 365 days of the year.
Adjustment	Application of a correction factor to modelled results to account for uncertainties in the model
Air quality objective	Policy target generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedances within a specific timescale (see also air quality standard).
Air quality standard	The concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on the assessment of the effects of each pollutant on human health including the effects on sensitive sub groups (see also air quality objective).
Ambient air	Outdoor air in the troposphere, excluding workplace air.
Annual mean	The average (mean) of the concentrations measured for each pollutant for one year.
AQMA	Air Quality Management Area.
Defra	Department for Environment, Food and Rural Affairs.
DfT	Department for Transport.
Dust	Dust comprises particles typically in the size range 1-75 micrometres (µm) in aerodynamic diameter and is created through the action of crushing and abrasive forces on materials
Emission rate	The quantity of a pollutant released from a source over a given period of time.
Exceedance	A period of time where the concentrations of a pollutant is greater than the appropriate air quality standard.
HDV/HGV	Heavy Duty Vehicle/Heavy Goods Vehicle.
LAQM	Local Air Quality Management.
LBRT	London Borough of Richmond upon Thames
NO_2	Nitrogen dioxide.
NO_x	Nitrogen oxides.
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 micrometres.

Term	Definition
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 2.5 micrometres.
Road link	A length of road which is considered to have the same flow of traffic along it. Usually, a link is the road from one junction to the next.
Trackout	The transport of dust and dirt from the construction / demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network. This arises when heavy duty vehicles (HDVs) leave the construction / demolition site with dusty materials, which may then spill onto the road, and/or when HDVs transfer dust and dirt onto the road having travelled over muddy ground on site.
microgram per cubic metre ($\mu g/m^3$)	A measure of concentration in terms of mass per unit volume. A concentration of $1ug/m^3$ means that one cubic metre of air contains one microgram (millionth of a gram) of pollutant.
Uncertainty	A measure, associated with the result of a measurement, which characterizes the range of values within which the true value is expected to lie. Uncertainty is usually expressed as the range within which the true value is expected to lie with a 95% probability, where standard statistical and other procedures have been used to evaluate this figure. Uncertainty is more clearly defined than the closely related parameter 'accuracy', and has replaced it on recent European legislation.
Validation (modelling)	Refers to the general comparison of modelled results against monitoring data carried out by model developers.
Verification (modelling)	Comparison of modelled results versus any local monitoring data at relevant locations.

Appendix B

RELEVANT UK AIR QUALITY STRATEGY OBJECTIVES

National Air Quality Objectives and European Directive Limit Values for the protection of human health						
Pollutant	**Applies to**	**Objective**	**Measured as**	**Date to be achieved by and maintained thereafter**	**European Obligations**	**Date to be achieved by and maintained thereafter**
Nitrogen dioxide (NO_2)	UK	200µg/m^3 not to be exceeded more than 18 times a year	1 hour mean	31.12.2005	200µg/m^3 not to be exceeded more than 18 times a year	01.01.2010
	UK	40µg/m^3	annual mean	31.12.2005	40µg/m^3	01.01.2010
Particulate Matter (PM_{10}) (gravimetric)[A]	UK (except Scotland)	40µg/m^3	annual mean	31.12.2004	40µg/m^3	01.01.2005
	UK (except Scotland)	50µg/m^3 not to be exceeded more than 35 times a year	24 hour mean	31.12.2004	50µg/m^3 not to be exceeded more than 35 times a year	01.01.2005
Particulate Matter ($PM_{2.5}$)	UK (except Scotland)	25µg/m^3	annual mean	2020	Target value 25µg/m^3	2010

[A] Measured using the European gravimetric transfer sampler or equivalent
µg/m^3= microgram per cubic metre

Appendix C

IAQM CONSTRUCTION ASSESSMENT METHODOLOGY

STEP 1 – SCREENING THE NEED FOR A DETAILED ASSESSMENT

An assessment will normally be required where there are:

- 'Human receptors' within 350m of the site boundary; or within 50m of the route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s); and/or
- 'Ecological receptors' within 50m of the site boundary; or within 50m of the route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s).

Where the need for a more detailed assessment is screened out, it can be concluded that the level of risk is "negligible".

STEP 2A – DEFINE THE POTENTIAL DUST EMISSION MAGNITUDE

The following are examples of how the potential dust emission magnitude for different activities can be defined. (Note that not all the criteria need to be met for a particular class). Other criteria may be used if justified in the assessment.

Table 2A: Examples of Human Receptor Sensitivity to Construction Phase Impacts

Dust Emission Magnitude	Activity
Large	**Demolition** >50,000m^3 building demolished, dusty material (e.g. concrete), on-site crushing/screening, demolition >20m above ground level
	Earthworks >10,000m^2 site area, dusty soil type (e.g. clay), >10 earth moving vehicles active simultaneously, >8m high bunds formed, >100,000 tonnes material moved
	Construction >100,000m^3 building volume, on site concrete batching, sandblasting
	Trackout >50 HDVs out / day, dusty surface material (e.g. clay), >100m unpaved roads
Medium	**Demolition** 20,000 - 50,000m^3 building demolished, dusty material (e.g. concrete) 10-20m above ground level
	Earthworks 2,500 - 10,000m^2 site area, moderately dusty soil (e.g. silt), 5-10 earth moving vehicles active simultaneously, 4m - 8m high bunds, 20,000 -100,000 tonnes material moved
	Construction 25,000 - 100,000m^3 building volume, dusty material e.g. concrete, on site concrete batching

Dust Emission Magnitude	Activity
	Trackout 10 - 50 HDVs out / day, moderately dusty surface material (e.g. clay), 50 -100m unpaved roads
Small	Demolition <20,000m^3 building demolished, non-dusty material (e.g metal cladding), <10m above ground level, work during wetter months
	Earthworks <2,500m^2 site area, soil with large grain size (e.g. sand), <5 earth moving vehicles active simultaneously, <4m high bunds, <20,000 tonnes material moved, earthworks during wetter months
	Construction <25,000m^3, non-dusty material (e.g. metal cladding or timber)
	Trackout <10 HDVs out / day, non-dusty soil, < 50m unpaved roads

STEP 2B – DEFINE THE SENSITIVITY OF THE AREA

The tables below present the IAQM assessment methodology to determine the sensitivity of the area to dust soiling, human health and ecological impacts respectively. The IAQM guidance provides guidance to allow the sensitivity of individual receptors to dust soiling and health effects to assist in the assessment of the overall sensitivity of the study area.

Table 2Ba: Sensitivity of the Area to Dust Soiling Effects

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Table 2Bb: Sensitivity of the Area to Human Health Impacts

Receptor Sensitivity	Annual Mean PM_{10} Concentration (μg/m³)	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
High	>32	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	24-28	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>32	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	28-32	>10	Medium	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	24-28	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<24	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Table 2Bc: Sensitivity of the Area to Ecological Impacts

Receptor Sensitivity	Distance from the Sources (m)	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

STEP 2C – DEFINE THE RISK OF IMPACTS

The dust emissions magnitude determined at Step 2A should be combined with the sensitivity of the area determined at Step 2B to determine the risk of impacts without mitigation applied. For those cases where the risk category is 'negligible' no mitigation measures beyond those required by legislation will be required.

Table 2C: Risk of Dust Impacts

Sensitivity of surrounding area	Dust Emission Magnitude		
	Large	Medium	Small
Demolition			
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible
Earthworks and Construction			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible
Trackout			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

STEP 3 –SITE SPECIFIC MITIGATION

Having determined the risk categories for each of the four activities it is possible to determine the site-specific measures to be adopted. These measures will be related to whether the site is considered to be a low, medium or high-risk site. The IAQM guidance details the mitigation measures required for high, medium and low risk sites as determined in Step 2C.

STEP 4 – DETERMINE SIGNIFICANT EFFECTS

Once the risk of dust impacts has been determined in Step 2C and the appropriate dust mitigation measures identified in Step 3, the final step is to determine whether there are significant effects arising from the construction phase. For almost all construction activities, the application of effective mitigation should prevent any significant effects occurring to sensitive receptors and therefore the residual effect will normally be negligible.

Appendix D

TRAFFIC DATA

2017 BASELINE

Road Link	Description	Speed (kph)	AADT	% HDV	NO_x Emission Rate (g/km/s)	PM_{10} Emission Rate (g/km/s)	$PM_{2.5}$ Emission Rate (g/km/s)
0	Gould Road	30	339	1.4	0.00182	0.00015	0.00009
1	May Road	16	224	1.7	0.00158	0.00010	0.00007
2	Edwin Road	30	278	3.5	0.00169	0.00013	0.00008
3	Colne Road	30	958	0.7	0.00490	0.00041	0.00025
4	A305, York Street	48	13898	8.1	0.08051	0.00693	0.00413
5	A305, Staines Road	48	11184	5.4	0.05838	0.00523	0.00313
6	Cross Deep	48	21397	3.6	0.10340	0.00956	0.00573
7	Crane Road	30	358	3.3	0.00215	0.00016	0.00010
8	Meadway	30	3533	2.4	0.02015	0.00159	0.00097
9	A310, London Road	48	11266	5.0	0.05776	0.00521	0.00312
10	A305, Heath Road	48	14856	7.3	0.08361	0.00728	0.00434
11	A311, The Green	48	9094	9.6	0.05557	0.00469	0.00279
12	A305, Kings Street	16	28650	6.7	0.28867	0.01522	0.00958
13	Colne Road	16	958	0.7	0.00620	0.00043	0.00027
14	Colne Road	16	958	0.7	0.00620	0.00043	0.00027
15	Edwin Road	16	278	3.5	0.00227	0.00014	0.00009
16	Edwin Road	30	278	3.5	0.00169	0.00013	0.00008
17	Gould Road	16	339	1.4	0.00234	0.00016	0.00010
18	Crane Road	16	358	3.3	0.00287	0.00017	0.00011
19	Gould Road	16	339	1.4	0.00234	0.00016	0.00010
20	May Road	16	224	1.7	0.00158	0.00010	0.00007
21	May Road	30	224	1.7	0.00122	0.00010	0.00006
22	May Road	16	224	1.7	0.00158	0.00010	0.00007
23	May Road	16	224	1.7	0.00158	0.00010	0.00007

Road Link	Description	Speed (kph)	AADT	% HDV	NO_x Emission Rate (g/km/s)	PM_{10} Emission Rate (g/km/s)	$PM_{2.5}$ Emission Rate (g/km/s)
24	May Road	30	224	1.7	0.00122	0.00010	0.00006
25	Crane Road	16	358	3.3	0.00287	0.00017	0.00011
26	Meadway	16	3533	2.4	0.02649	0.00167	0.00105
27	A305, Staines Road	16	11184	5.4	0.10381	0.00574	0.00361
28	A305, Staines Road	48	11184	5.4	0.05838	0.00523	0.00313
29	A305, Staines Road	48	11184	5.4	0.05838	0.00523	0.00313
30	A305, Staines Road	16	11184	5.4	0.10381	0.00574	0.00361
31	A305, Staines Road	48	11184	5.4	0.05838	0.00523	0.00313
32	A305, Staines Road	16	11184	5.4	0.10381	0.00574	0.00361
33	A305, Staines Road	48	11184	5.4	0.05838	0.00523	0.00313
34	A305, Staines Road	16	11184	5.4	0.10381	0.00574	0.00361
35	A305, Staines Road	16	11184	5.4	0.10381	0.00574	0.00361
36	A305, Heath Road	16	14856	7.3	0.15490	0.00801	0.00504
37	A305, Heath Road	48	14856	7.3	0.08361	0.00728	0.00434
38	A305, Heath Road	48	14856	7.3	0.08361	0.00728	0.00434
39	A305, Heath Road	16	14856	7.3	0.15490	0.00801	0.00504
40	A305, Heath Road	48	14856	7.3	0.08361	0.00728	0.00434
41	A305, Heath Road	16	14856	7.3	0.15490	0.00801	0.00504
42	A305, Heath Road	16	14856	7.3	0.15490	0.00801	0.00504
43	A305, Heath Road	48	14856	7.3	0.08361	0.00728	0.00434
44	A305, Heath Road	16	14856	7.3	0.15490	0.00801	0.00504
45	A305, Kings Street	16	28650	6.7	0.28867	0.01522	0.00958
46	A305, Kings Street	32	28650	6.7	0.19787	0.01428	0.00869
47	A305, York Street	16	13898	8.1	0.15136	0.00764	0.00480
48	A305, York Street	48	13898	8.1	0.08051	0.00693	0.00413

Road Link	Description	Speed (kph)	AADT	% HDV	NO_x Emission Rate (g/km/s)	PM_{10} Emission Rate (g/km/s)	$PM_{2.5}$ Emission Rate (g/km/s)
49	A305, York Street	16	13898	8.1	0.15136	0.00764	0.00480
50	A305, York Street	48	13898	8.1	0.08051	0.00693	0.00413
51	A305, York Street	16	13898	8.1	0.15136	0.00764	0.00480
52	Cross Deep	16	21397	3.6	0.17530	0.01046	0.00659
53	Cross Deep	48	21397	3.6	0.10340	0.00956	0.00573
54	Cross Deep	16	21397	3.6	0.17530	0.01046	0.00659
55	A311, The Green	48	9094	9.6	0.05557	0.00469	0.00279
56	A311, The Green	16	9094	9.6	0.10715	0.00518	0.00326
57	A311, The Green	16	9094	9.6	0.10715	0.00518	0.00326
58	A311, The Green	48	9094	9.6	0.05557	0.00469	0.00279
59	A311, The Green	16	9094	9.6	0.10715	0.00518	0.00326
60	A310, London Road	16	11266	5.0	0.10162	0.00572	0.00360
61	A310, London Road	16	11266	5.0	0.10162	0.00572	0.00360
62	A310, London Road	48	11266	5.0	0.05776	0.00521	0.00312
63	A310, London Road	48	11266	5.0	0.05776	0.00521	0.00312
64	A310, London Road	16	11266	5.0	0.10162	0.00572	0.00360
65	A310, London Road	16	11266	5.0	0.10162	0.00572	0.00360
66	A310, London Road	48	11266	5.0	0.05776	0.00521	0.00312
67	A310, London Road	16	11266	5.0	0.10162	0.00572	0.00360
68	A310, London Road	16	11266	5.0	0.10162	0.00572	0.00360
69	A311, The Green	16	9094	9.6	0.10715	0.00518	0.00326

2022 WITHOUT DEVELOPMENT

Road Link	Description	Speed (kph)	AADT	% HDV	CURED NO_x Emission Rate (g/km/s)	PM_{10} Emission Rate (g/km/s)	$PM_{2.5}$ Emission Rate (g/km/s)
0	Gould Road	30	357	1.4	0.00135	0.00014	0.00008
1	May Road	16	236	1.7	0.00110	0.00010	0.00006
2	Edwin Road	30	293	3.5	0.00110	0.00012	0.00007
3	Colne Road	30	1010	0.7	0.00380	0.00039	0.00022
4	A305, York Street	48	14645	8.1	0.04611	0.00666	0.00374
5	A305, Staines Road	48	11785	5.4	0.03708	0.00502	0.00283
6	Cross Deep	48	22547	3.6	0.07091	0.00917	0.00518
7	Crane Road	30	377	3.3	0.00142	0.00016	0.00009
8	Meadway	30	3723	2.4	0.01402	0.00150	0.00086
9	A310, London Road	48	11872	5.0	0.03735	0.00500	0.00282
10	A305, Heath Road	48	15655	7.3	0.04928	0.00699	0.00393
11	A311, The Green	48	9583	9.6	0.03018	0.00451	0.00253
12	A305, Kings Street	16	30190	6.7	0.14144	0.01401	0.00816
13	Colne Road	16	1010	0.7	0.00471	0.00040	0.00023
14	Colne Road	16	1010	0.7	0.00471	0.00040	0.00023
15	Edwin Road	16	293	3.5	0.00137	0.00012	0.00007
16	Edwin Road	30	293	3.5	0.00110	0.00012	0.00007
17	Gould Road	16	357	1.4	0.00167	0.00014	0.00008
18	Crane Road	16	377	3.3	0.00176	0.00016	0.00009
19	Gould Road	16	357	1.4	0.00167	0.00014	0.00008
20	May Road	16	236	1.7	0.00110	0.00010	0.00006
21	May Road	30	236	1.7	0.00089	0.00009	0.00005
22	May Road	16	236	1.7	0.00110	0.00010	0.00006
23	May Road	16	236	1.7	0.00110	0.00010	0.00006

Road Link	Description	Speed (kph)	AADT	% HDV	CURED NO_x Emission Rate (g/km/s)	PM_{10} Emission Rate (g/km/s)	$PM_{2.5}$ Emission Rate (g/km/s)
24	May Road	30	236	1.7	0.00089	0.00009	0.00005
25	Crane Road	16	377	3.3	0.00176	0.00016	0.00009
26	Meadway	16	3723	2.4	0.01740	0.00154	0.00090
27	A305, Staines Road	16	11785	5.4	0.05517	0.00529	0.00308
28	A305, Staines Road	48	11785	5.4	0.03708	0.00502	0.00283
29	A305, Staines Road	48	11785	5.4	0.03708	0.00502	0.00283
30	A305, Staines Road	16	11785	5.4	0.05517	0.00529	0.00308
31	A305, Staines Road	48	11785	5.4	0.03708	0.00502	0.00283
32	A305, Staines Road	16	11785	5.4	0.05517	0.00529	0.00308
33	A305, Staines Road	48	11785	5.4	0.03708	0.00502	0.00283
34	A305, Staines Road	16	11785	5.4	0.05517	0.00529	0.00308
35	A305, Staines Road	16	11785	5.4	0.05517	0.00529	0.00308
36	A305, Heath Road	16	15655	7.3	0.07336	0.00737	0.00429
37	A305, Heath Road	48	15655	7.3	0.04928	0.00699	0.00393
38	A305, Heath Road	48	15655	7.3	0.04928	0.00699	0.00393
39	A305, Heath Road	16	15655	7.3	0.07336	0.00737	0.00429
40	A305, Heath Road	48	15655	7.3	0.04928	0.00699	0.00393
41	A305, Heath Road	16	15655	7.3	0.07336	0.00737	0.00429
42	A305, Heath Road	16	15655	7.3	0.07336	0.00737	0.00429
43	A305, Heath Road	48	15655	7.3	0.04928	0.00699	0.00393
44	A305, Heath Road	16	15655	7.3	0.07336	0.00737	0.00429
45	A305, Kings Street	16	30190	6.7	0.14144	0.01401	0.00816
46	A305, Kings Street	32	30190	6.7	0.11099	0.01352	0.00769
47	A305, York Street	16	14645	8.1	0.06866	0.00703	0.00409
48	A305, York Street	48	14645	8.1	0.04611	0.00666	0.00374

Road Link	Description	Speed (kph)	AADT	% HDV	CURED NO_x Emission Rate (g/km/s)	PM_{10} Emission Rate (g/km/s)	$PM_{2.5}$ Emission Rate (g/km/s)
49	A305, York Street	16	14645	8.1	0.06866	0.00703	0.00409
50	A305, York Street	48	14645	8.1	0.04611	0.00666	0.00374
51	A305, York Street	16	14645	8.1	0.06866	0.00703	0.00409
52	Cross Deep	16	22547	3.6	0.10544	0.00963	0.00562
53	Cross Deep	48	22547	3.6	0.07091	0.00917	0.00518
54	Cross Deep	16	22547	3.6	0.10544	0.00963	0.00562
55	A311, The Green	48	9583	9.6	0.03018	0.00451	0.00253
56	A311, The Green	16	9583	9.6	0.04497	0.00477	0.00277
57	A311, The Green	16	9583	9.6	0.04497	0.00477	0.00277
58	A311, The Green	48	9583	9.6	0.03018	0.00451	0.00253
59	A311, The Green	16	9583	9.6	0.04497	0.00477	0.00277
60	A310, London Road	16	11872	5.0	0.05556	0.00526	0.00307
61	A310, London Road	16	11872	5.0	0.05556	0.00526	0.00307
62	A310, London Road	48	11872	5.0	0.03735	0.00500	0.00282
63	A310, London Road	48	11872	5.0	0.03735	0.00500	0.00282
64	A310, London Road	16	11872	5.0	0.05556	0.00526	0.00307
65	A310, London Road	16	11872	5.0	0.05556	0.00526	0.00307
66	A310, London Road	48	11872	5.0	0.03735	0.00500	0.00282
67	A310, London Road	16	11872	5.0	0.05556	0.00526	0.00307
68	A310, London Road	16	11872	5.0	0.05556	0.00526	0.00307
69	A311, The Green	16	9583	9.6	0.04497	0.00477	0.00277

2022 WITH DEVELOPMENT

Road Link	Description	Speed (kph)	AADT	% HDV	CURED NO_x Emission Rate (g/km/s)	PM_{10} Emission Rate (g/km/s)	$PM_{2.5}$ Emission Rate (g/km/s)
0	Gould Road	30	604	0.7	0.00227	0.00023	0.00013
1	May Road	16	236	1.7	0.00110	0.00010	0.00006
2	Edwin Road	30	373	2.7	0.00141	0.00015	0.00009
3	Colne Road	30	1091	0.6	0.00410	0.00042	0.00024
4	A305, York Street	48	14685	8.1	0.04624	0.00667	0.00375
5	A305, Staines Road	48	11909	5.3	0.03747	0.00507	0.00286
6	Cross Deep	48	22553	3.6	0.07093	0.00917	0.00518
7	Crane Road	30	458	2.8	0.00172	0.00019	0.00011
8	Meadway	30	3969	2.3	0.01495	0.00159	0.00091
9	A310, London Road	48	11900	4.9	0.03744	0.00501	0.00283
10	A305, Heath Road	48	15729	7.3	0.04952	0.00702	0.00394
11	A311, The Green	48	9589	9.6	0.03020	0.00451	0.00253
12	A305, Kings Street	16	30259	6.7	0.14176	0.01404	0.00818
13	Colne Road	16	1091	0.6	0.00509	0.00043	0.00025
14	Colne Road	16	1091	0.6	0.00509	0.00043	0.00025
15	Edwin Road	16	373	2.7	0.00175	0.00016	0.00009
16	Edwin Road	30	373	2.7	0.00141	0.00015	0.00009
17	Gould Road	16	604	0.7	0.00282	0.00024	0.00014
18	Crane Road	16	458	2.8	0.00214	0.00019	0.00011
19	Gould Road	16	604	0.7	0.00282	0.00024	0.00014
20	May Road	16	236	1.7	0.00110	0.00010	0.00006
21	May Road	30	236	1.7	0.00089	0.00009	0.00005
22	May Road	16	236	1.7	0.00110	0.00010	0.00006
23	May Road	16	236	1.7	0.00110	0.00010	0.00006

Road Link	Description	Speed (kph)	AADT	% HDV	CURED NO_x Emission Rate (g/km/s)	PM_{10} Emission Rate (g/km/s)	$PM_{2.5}$ Emission Rate (g/km/s)
24	May Road	30	236	1.7	0.00089	0.00009	0.00005
25	Crane Road	16	458	2.8	0.00214	0.00019	0.00011
26	Meadway	16	3969	2.3	0.01855	0.00164	0.00095
27	A305, Staines Road	16	11909	5.3	0.05575	0.00533	0.00311
28	A305, Staines Road	48	11909	5.3	0.03747	0.00507	0.00286
29	A305, Staines Road	48	11909	5.3	0.03747	0.00507	0.00286
30	A305, Staines Road	16	11909	5.3	0.05575	0.00533	0.00311
31	A305, Staines Road	48	11909	5.3	0.03747	0.00507	0.00286
32	A305, Staines Road	16	11909	5.3	0.05575	0.00533	0.00311
33	A305, Staines Road	48	11909	5.3	0.03747	0.00507	0.00286
34	A305, Staines Road	16	11909	5.3	0.05575	0.00533	0.00311
35	A305, Staines Road	16	11909	5.3	0.05575	0.00533	0.00311
36	A305, Heath Road	16	15729	7.3	0.07371	0.00740	0.00431
37	A305, Heath Road	48	15729	7.3	0.04952	0.00702	0.00394
38	A305, Heath Road	48	15729	7.3	0.04952	0.00702	0.00394
39	A305, Heath Road	16	15729	7.3	0.07371	0.00740	0.00431
40	A305, Heath Road	48	15729	7.3	0.04952	0.00702	0.00394
41	A305, Heath Road	16	15729	7.3	0.07371	0.00740	0.00431
42	A305, Heath Road	16	15729	7.3	0.07371	0.00740	0.00431
43	A305, Heath Road	48	15729	7.3	0.04952	0.00702	0.00394
44	A305, Heath Road	16	15729	7.3	0.07371	0.00740	0.00431
45	A305, Kings Street	16	30259	6.7	0.14176	0.01404	0.00818
46	A305, Kings Street	32	30259	6.7	0.11124	0.01354	0.00771
47	A305, York Street	16	14685	8.1	0.06885	0.00704	0.00410
48	A305, York Street	48	14685	8.1	0.04624	0.00667	0.00375

Road Link	Description	Speed (kph)	AADT	% HDV	CURED NO_x Emission Rate (g/km/s)	PM_{10} Emission Rate (g/km/s)	$PM_{2.5}$ Emission Rate (g/km/s)
49	A305, York Street	16	14685	8.1	0.06885	0.00704	0.00410
50	A305, York Street	48	14685	8.1	0.04624	0.00667	0.00375
51	A305, York Street	16	14685	8.1	0.06885	0.00704	0.00410
52	Cross Deep	16	22553	3.6	0.10546	0.00964	0.00562
53	Cross Deep	48	22553	3.6	0.07093	0.00917	0.00518
54	Cross Deep	16	22553	3.6	0.10546	0.00964	0.00562
55	A311, The Green	48	9589	9.6	0.03020	0.00451	0.00253
56	A311, The Green	16	9589	9.6	0.04499	0.00477	0.00277
57	A311, The Green	16	9589	9.6	0.04499	0.00477	0.00277
58	A311, The Green	48	9589	9.6	0.03020	0.00451	0.00253
59	A311, The Green	16	9589	9.6	0.04499	0.00477	0.00277
60	A310, London Road	16	11900	4.9	0.05569	0.00528	0.00308
61	A310, London Road	16	11900	4.9	0.05569	0.00528	0.00308
62	A310, London Road	48	11900	4.9	0.03744	0.00501	0.00283
63	A310, London Road	48	11900	4.9	0.03744	0.00501	0.00283
64	A310, London Road	16	11900	4.9	0.05569	0.00528	0.00308
65	A310, London Road	16	11900	4.9	0.05569	0.00528	0.00308
66	A310, London Road	48	11900	4.9	0.03744	0.00501	0.00283
67	A310, London Road	16	11900	4.9	0.05569	0.00528	0.00308
68	A310, London Road	16	11900	4.9	0.05569	0.00528	0.00308
69	A311,The Green	16	9589	9.6	0.04499	0.00477	0.00277

Appendix E

MODEL VERIFICATION

The comparison of modelled concentrations with local monitored concentrations is a process termed 'verification'. Model verification investigates the discrepancies between modelled and measured concentrations, which can arise due to the presence of inaccuracies and/or uncertainties in model input data, modelling and monitoring data assumptions. The following are examples of potential causes of such discrepancy:

a) Estimates of background pollutant concentrations;

b) Meteorological data uncertainties;

c) Traffic data uncertainties;

d) Model input parameters, such as 'roughness length'; and

e) Overall limitations of the dispersion model.

NITROGEN DIOXIDE

Most nitrogen dioxide is produced in the atmosphere by the reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of the primary pollutant emissions of nitrogen oxides (NO_x = NO + NO_2), in line with the guidance provided within LAQM.TG(16).

The model has been run to predict the 2017 annual mean road-NO_x contribution at five roadside diffusion tubes within the modelled road network. The model outputs of road-NO_x have been compared with the 'measured' road-NO_x, which was determined from the NO_2 concentrations measured using diffusion tubes at the monitoring locations, utilising the NO_x from NO_2 calculator provided by Defra and the adjusted NO_2 background concentration following AQC's CURED methodology.

The table and figure below present:

- Total monitored and modelled NO_2 before adjustment;
- Data used in the verification and
- results after verification.

Table E1 – Total monitored and modelled NO_2 before adjustment

Monitoring Site	2017 Background NO_2 (µg/m^3)	2017 Measured Annual Mean NO_2 Concentration (µg/m^3)	Total Annual Mean NO_2 Concentration before adjustment (µg/m^3)	Difference between monitored and modelled NO_2 (µg/m^3)	% Difference between monitored and modelled NO_2
9	22.0	40.0	27.3	-12.7	-31.9
14	24.1	36.0	28.3	-7.7	-21.5
32	24.1	59.0	38.3	-20.7	-35.1
58	24.1	47.0	32.3	-14.7	-31.2
61	24.1	45.0	30.7	-14.3	-31.8

Table E2 – Data used in model verification

Monitoring Site	2017 Measured Annual Mean NO_2 Concentration ($\mu g/m^3$)	2017 Background NO_2 ($\mu g/m^3$)	Measured Road-NO_x ($\mu g/m^3$) (from NO_x to NO_2 calculator)	Modelled Road-NO_x ($\mu g/m^3$)	Ratio
9	40.0	22.0	40.2	10.9	3.7
14	36.0	24.1	26	8.8	3.0
32	59.0	24.1	88.5	31.5	2.8
58	47.0	24.1	53.7	17.6	3.1
61	45.0	24.1	48.3	13.9	3.5

The road-NO_x adjustment factor of 3.0 was determined as the slope of the best fit line between the 'measured' road contribution and the model derived road contribution, forced through zero (Figure E1). This factor was then applied to the modelled road-NO_x concentration for each monitoring site to provide adjusted modelled road-NO_x concentrations. The total nitrogen dioxide concentrations were then determined by inputting the adjusted modelled road-NO_x concentrations and the background NO_2 concentration into the NO_x to NO_2 calculator.

Figure E1: Comparison of Measured Road-NO_x with Unadjusted Modelled Road-NO_x

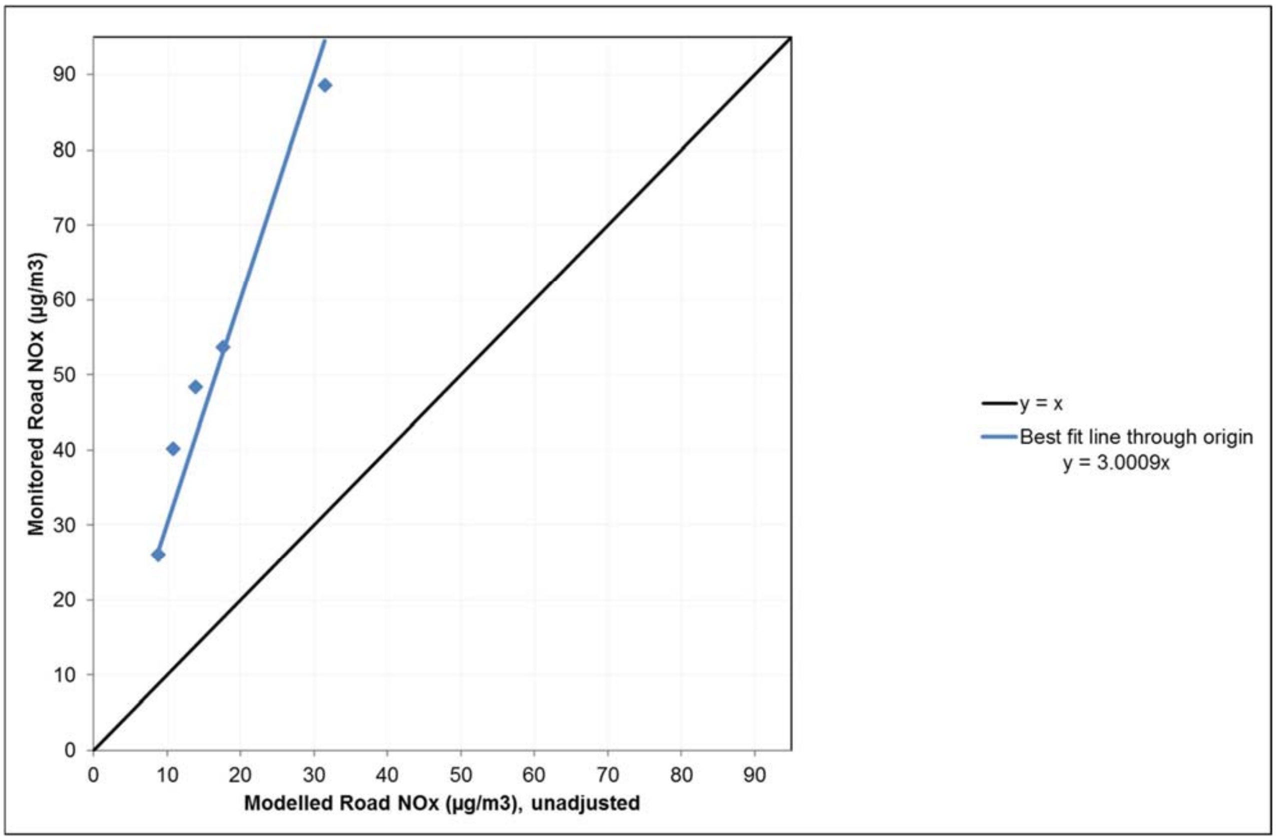
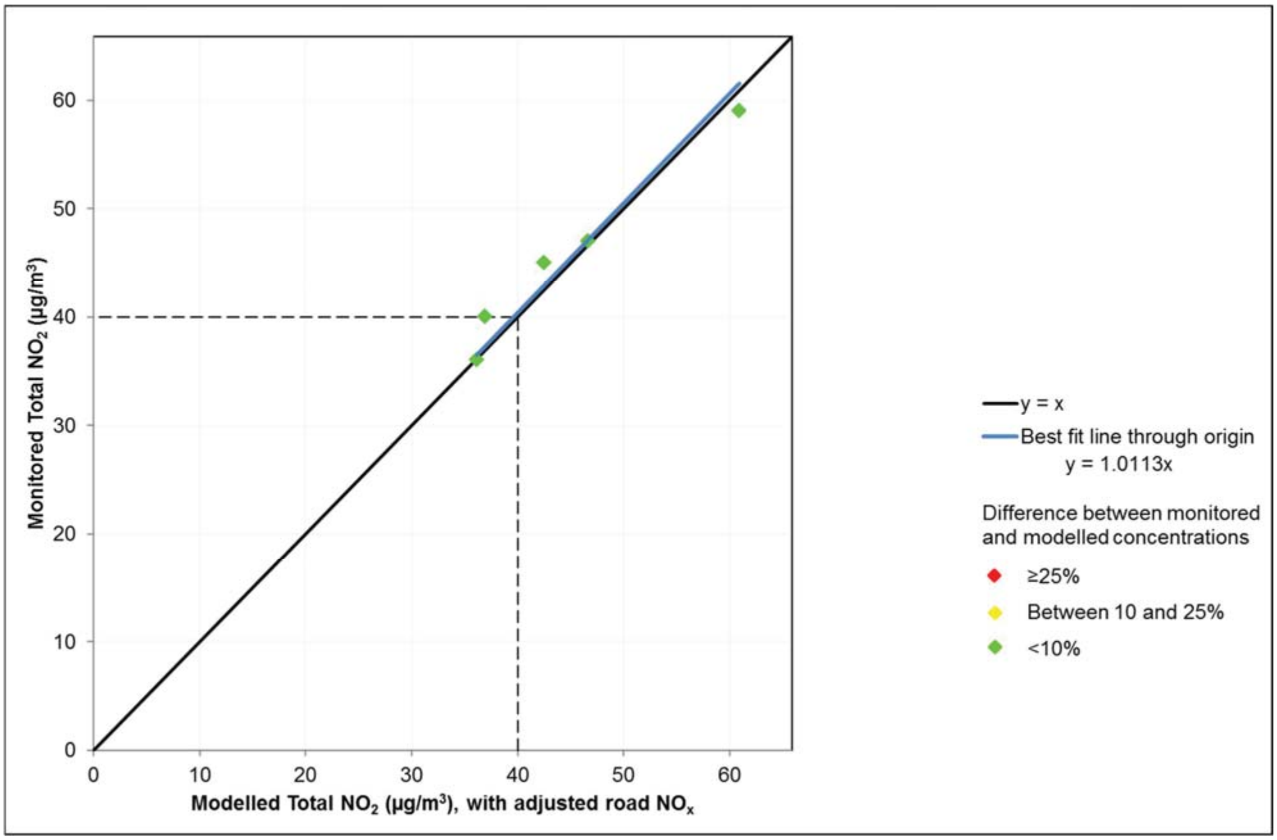


Table E3 – Total NO_2 after verification

Monitoring Site	2017 Measured Annual Mean NO_2 Concentration ($\mu g/m^3$)	2017 Background NO_2 ($\mu g/m^3$)	Modelled NO_2 after Verification	Difference between monitored and modelled NO_2 ($\mu g/m^3$)	% Difference between monitored and modelled NO_2
9	40.0	22.0	36.9	-3.1	-7.8
14	36.0	24.1	36.1	0.1	0.3
32	59.0	24.1	60.9	1.9	3.2
58	47.0	24.1	46.7	-0.3	-0.7
61	45.0	24.1	42.5	-2.5	-5.6

Figure E2 - Comparison of Measured Road-NOx with Adjusted Modelled Road-NO_x



PM_{10} AND $PM_{2.5}$

There are no local PM_{10} or $PM_{2.5}$ monitoring data against which the model could be verified. Consequently, the verification factor determined above for adjusting the road-NO_x contribution has been applied to the predicted road-PM_{10} and road-$PM_{2.5}$ contributions, consistent with guidance set out in LAQM.TG (16).

MODEL UNCERTAINTY

An evaluation of model performance has been undertaken to establish confidence in model results. LAQM.TG (16) identifies a number of statistical procedures that are appropriate to evaluate model performance and assess the uncertainty. These include:

a) Root mean square error (RMSE);

b) Fractional bias (FB); and

c) Correlation coefficient (CC).

These parameters estimate how the model results agree or diverge from the observations. These calculations can be carried out prior to, and after adjustment, or based on different options for adjustment, and can provide useful information on model improvement. A brief for explanation of each statistic is provided in Table E2, and further details can be found in Box 7.17 of LAQM.TG(16).

Table E4 – Methods for describing model uncertainty

Statistical Parameter	Comments	Value
RMSE	RMSE is used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared. 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. For example, if the model predictions are for the annual mean NO_2 objective of 40µg/m^3, if an RMSE of 10µg/m^3 or above is determined for a model it is advised to revisit the model parameters and model verification. Ideally an RMSE within 10% of the air quality objective would be derived, which equates to 4µg/m^3 for the annual mean NO_2 objective.	2.0µg/m^3 14.6µg/m^3 (before verification)
Fractional Bias	It is used to identify if the model shows a systematic tendency to over or under predict. FB values vary between +2 and -2 and has an ideal value of zero. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.	0.017
Correlation Coefficient	It is used to measure the linear relationship between predicted and observed data. A value of zero means no relationship and a value of 1 means absolute relationship.	1.00

Statistical Parameter	Comments	Value
	This statistic can be particularly useful when comparing a large number of model and observed data points.	

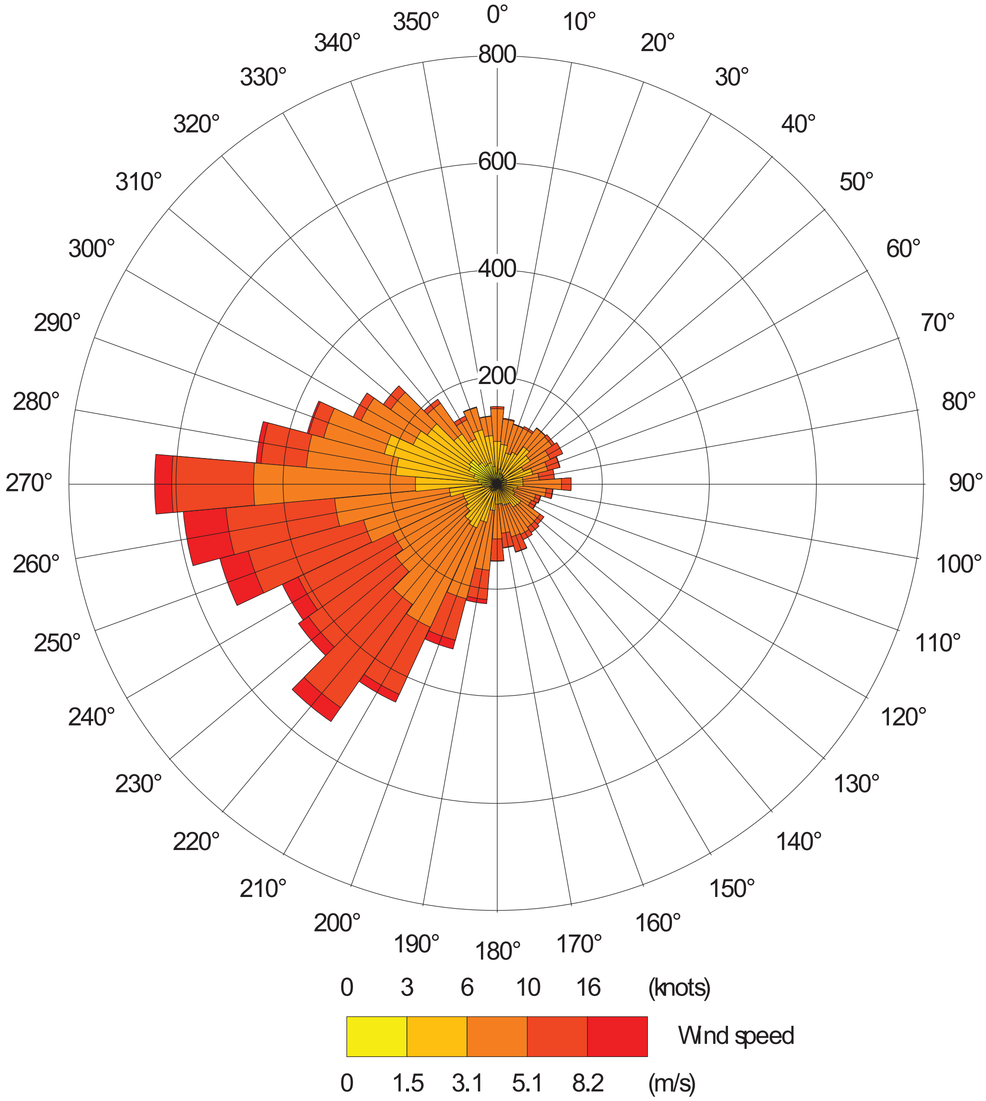
To assess the uncertainty of a model, the RMSE is the simplest parameter to calculate providing an estimate of the average error of the model in the same units as the modelled predictions. It is also often easier to interpret the RMSE than the other statistical parameters and therefore it has been calculated in this assessment to understand the model uncertainty.

The RMSE value calculated after verification was 2.0 and therefore the final predictions are considered to be robust.

Appendix F

METEOROLOGICAL DATA

WIND ROSE FOR 2017 HEATHROW AIRPORT



OTHER PARAMETERS

Parameters	Value
Latitude (º)	51.4
Surface roughness for dispersion site (m)	1
Minimum Monin-Obukhov for dispersion site (m)	30
Surface roughness for met. measurement site (m)	0.5
Minimum Monin-Obukhov for met. measurement site (m)	30

Appendix G

MODEL RESULTS

ANNUAL MEAN NO_2 CONCENTRATIONS (µg/m^3)

Receptor ID	Height (m)	Annual Mean NO_2 Concentrations (µg/m^3)					
		2017 Baseline	2022 Without Development	2022 With Development	Change (µg/m^3)	% Change Relative to Objective	Impact/ APEC
E1	1.5	25.8	21.3	21.4	0.1	<0.1	Negligible
E2	1.5	26.7	22.0	22.1	0.1	<0.1	Negligible
E3	1.5	25.0	20.9	21.0	0.1	<0.1	Negligible
E4	1.5	25.2	21.0	21.1	0.1	<0.1	Negligible
E5	1.5	25.7	21.3	21.3	<0.1	<0.1	Negligible
E6	1.5	25.4	21.1	21.3	0.2	<0.1	Negligible
E7	1.5	25.7	21.3	21.3	<0.1	<0.1	Negligible
E8	1.5	26.3	21.7	21.8	0.1	<0.1	Negligible
E9	1.5	29.3	23.6	23.6	0.0	<0.1	Negligible
E10	1.5	26.3	21.8	21.9	0.1	<0.1	Negligible
E11	1.5	31.5	24.9	25.1	0.2	1.0	Negligible
E12	4.5	28.7	22.5	22.6	0.1	<0.1	Negligible
E13	1.5	43.4	30.7	30.7	<0.1	<0.1	Negligible
E14	4.5	34.3	25.8	25.9	0.1	<0.1	Negligible
E15	4.5	47.2	33.6	33.6	<0.1	<0.1	Negligible
E16	1.5	46.8	35.8	35.8	<0.1	<0.1	Negligible
E17	4.5	37.8	27.8	27.8	<0.1	<0.1	Negligible
E18	4.5	32.9	25.1	25.1	<0.1	<0.1	Negligible
E19	1.5	40.0	29.6	29.6	<0.1	<0.1	Negligible
E20	1.5	43.8	30.9	31.0	0.1	<0.1	Negligible
E21	1.5	25.1	20.9	21.0	0.1	<0.1	Negligible
E22	1.5	42.3	30.0	30.0	<0.1	<0.1	Negligible
E23	1.5	29.2	21.9	21.9	<0.1	<0.1	Negligible
N1	1.5	-	-	21.2	-	-	APEC A

Receptor ID	Height (m)	Annual Mean NO_2 Concentrations (µg/m^3)					
		2017 Baseline	2022 Without Development	2022 With Development	Change (µg/m^3)	% Change Relative to Objective	Impact/ APEC
N2	1.5	-	-	20.9	-	-	APEC A
N3	1.5	-	-	21.5	-	-	APEC A
N4	1.5	-	-	21.0	-	-	APEC A
N5	1.5	-	-	20.8	-	-	APEC A
N6	1.5	-	-	20.7	-	-	APEC A

Results rounded to 1.d.p

ANNUAL MEAN PM_{10} CONCENTRATIONS (µg/m^3)

Receptor ID	Height (m)	Annual Mean PM_{10} Concentrations (µg/m^3)					
		2017 Baseline	2022 Without Development	2022 With Development	Change (µg/m^3)	% Change Relative to Objective	Impact/ APEC
E1	1.5	16.0	15.5	15.5	<0.1	<0.1	Negligible
E2	1.5	16.1	15.6	15.6	<0.1	<0.1	Negligible
E3	1.5	15.9	15.4	15.4	<0.1	<0.1	Negligible
E4	1.5	15.9	15.4	15.4	<0.1	<0.1	Negligible
E5	1.5	16.0	15.5	15.5	<0.1	<0.1	Negligible
E6	1.5	15.9	15.4	15.5	<0.1	<0.1	Negligible
E7	1.5	16.0	15.5	15.5	<0.1	<0.1	Negligible
E8	1.5	16.1	15.6	15.6	<0.1	<0.1	Negligible
E9	1.5	16.6	16.1	16.1	<0.1	<0.1	Negligible
E10	1.5	16.1	15.6	15.6	<0.1	<0.1	Negligible
E11	1.5	16.7	16.1	16.2	<0.1	<0.1	Negligible
E12	4.5	16.1	15.6	15.6	<0.1	<0.1	Negligible
E13	1.5	18.2	17.5	17.5	<0.1	<0.1	Negligible
E14	4.5	17.1	16.6	16.6	<0.1	<0.1	Negligible
E15	4.5	19.0	18.3	18.3	<0.1	<0.1	Negligible
E16	1.5	20.2	19.4	19.4	<0.1	<0.1	Negligible
E17	4.5	17.8	17.2	17.2	<0.1	<0.1	Negligible
E18	4.5	17.1	16.5	16.5	<0.1	<0.1	Negligible
E19	1.5	18.0	17.4	17.4	<0.1	<0.1	Negligible
E20	1.5	18.3	17.6	17.6	<0.1	<0.1	Negligible
E21	1.5	15.9	15.4	15.4	<0.1	<0.1	Negligible
E22	1.5	18.0	17.4	17.4	<0.1	<0.1	Negligible
E23	1.5	16.0	15.5	15.5	<0.1	<0.1	Negligible
N1	1.5	-	-	15.4	-	-	APEC A

Receptor ID	Height (m)	Annual Mean PM_{10} Concentrations (µg/m³)					
		2017 Baseline	2022 Without Development	2022 With Development	Change (µg/m³)	% Change Relative to Objective	Impact/ APEC
N2	1.5	-	-	15.4	-	-	APEC A
N3	1.5	-	-	15.5	-	-	APEC A
N4	1.5	-	-	15.4	-	-	APEC A
N5	1.5	-	-	15.4	-	-	APEC A
N6	1.5	-	-	15.3	-	-	APEC A

Results rounded to 1.d.p

DAILY MEAN PM_{10} (NO. OF DAYS OF EXCEEDANCE)

Receptor ID	Height (m)	Days with PM_{10} Concentrations >50µg/m³				
		2017 Baseline	2022 Without Development	2022 With Development	Change (days)	Impact
E1	1.5	0	0	0	0	Negligible
E2	1.5	0	0	0	0	Negligible
E3	1.5	0	0	0	0	Negligible
E4	1.5	0	0	0	0	Negligible
E5	1.5	0	0	0	0	Negligible
E6	1.5	0	0	0	0	Negligible
E7	1.5	0	0	0	0	Negligible
E8	1.5	0	0	0	0	Negligible
E9	1.5	1	0	0	0.	Negligible
E10	1.5	0	0	0	0	Negligible
E11	1.5	1	0	0	0	Negligible
E12	4.5	0	0	0	0	Negligible
E13	1.5	2	1	1	0	Negligible
E14	4.5	1	1	1	0	Negligible
E15	4.5	2	2	2	0	Negligible
E16	1.5	4	3	3	0	Negligible
E17	4.5	1	1	1	0	Negligible
E18	4.5	1	1	1	0	Negligible
E19	1.5	1	1	1	0	Negligible
E20	1.5	2	1	1	0	Negligible
E21	1.5	0	0	0	0	Negligible
E22	1.5	1	1	1	0	Negligible
E23	1.5	0	0	0	0	Negligible
N1	1.5	-	-	0	-	-

Receptor ID	Height (m)	Days with PM_{10} Concentrations >50µg/m^3				
		2017 Baseline	2022 Without Development	2022 With Development	Change (days)	Impact
N2	1.5	-	-	0	-	-
N3	1.5	-	-	0	-	-
N4	1.5	-	-	0	-	-
N5	1.5	-	-	0	-	-
N6	1.5	-	-	0	-	-

ANNUAL MEAN $PM_{2.5}$ CONCENTRATIONS (µg/m^3)

Receptor ID	Height (m)	Annual Mean $PM_{2.5}$ Concentrations (µg/m^3)					
		2017 Baseline	2022 Without Development	2022 With Development	Change (µg/m^3)	% Change Relative to Objective	Impact
E1	1.5	10.3	9.8	9.8	<0.1	<0.1	Negligible
E2	1.5	10.4	9.9	9.9	<0.1	<0.1	Negligible
E3	1.5	10.3	9.8	9.8	<0.1	<0.1	Negligible
E4	1.5	10.3	9.8	9.8	<0.1	<0.1	Negligible
E5	1.5	10.3	9.8	9.8	<0.1	<0.1	Negligible
E6	1.5	10.3	9.8	9.8	<0.1	<0.1	Negligible
E7	1.5	10.3	9.8	9.8	<0.1	<0.1	Negligible
E8	1.5	10.4	9.9	9.9	<0.1	<0.1	Negligible
E9	1.5	10.7	10.2	10.2	<0.1	<0.1	Negligible
E10	1.5	10.4	9.9	9.9	<0.1	<0.1	Negligible
E11	1.5	10.8	10.2	10.2	<0.1	<0.1	Negligible
E12	4.5	10.4	9.9	9.9	<0.1	<0.1	Negligible
E13	1.5	11.7	11.0	11.0	<0.1	<0.1	Negligible
E14	4.5	11.0	10.4	10.4	<0.1	<0.1	Negligible
E15	4.5	12.2	11.5	11.5	<0.1	<0.1	Negligible
E16	1.5	12.9	12.1	12.1	<0.1	<0.1	Negligible
E17	4.5	11.5	10.8	10.8	<0.1	<0.1	Negligible
E18	4.5	11.0	10.4	10.4	<0.1	<0.1	Negligible
E19	1.5	11.6	10.9	10.9	<0.1	<0.1	Negligible
E20	1.5	11.8	11.1	11.1	<0.1	<0.1	Negligible
E21	1.5	10.3	9.8	9.8	<0.1	<0.1	Negligible
E22	1.5	11.6	10.9	10.9	<0.1	<0.1	Negligible
E23	1.5	10.4	9.9	9.9	<0.1	<0.1	Negligible
N1	1.5	-	-	9.8	-	-	-

Receptor ID	Height (m)	Annual Mean $PM_{2.5}$ Concentrations (µg/m³)					
		2017 Baseline	2022 Without Development	2022 With Development	Change (µg/m³)	% Change Relative to Objective	Impact
N2	1.5	-	-	9.8	-	-	-
N3	1.5	-	-	9.8	-	-	-
N4	1.5	-	-	9.8	-	-	-
N5	1.5	-	-	9.7	-	-	-
N6	1.5	-	-	9.7	-	-	-

Results rounded to 1.d.p

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