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Kirklees Council

HECKMONDWIKE BUS HUB

Air Quality Assessment



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Air Quality Assessment

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EXECUTIVE SUMMARY

WSP has been commissioned by Kirklees Council to undertake an air quality assessment to support the planning application for the proposed redevelopment of the existing Heckmondwike bus station. The proposals include the revamping of the existing bus station and increasing the number of bus stands from 4 to 6, thereby increasing capacity from a maximum of 48 to 52 buses per hour.

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 assessment of construction phase impacts associated with fugitive dust and fine particulate matter (PM₁₀ and PM_{2.5}) emissions has been undertaken in line with the relevant Institute of Air Quality Management guidance. This identified that there is a **Low Risk** of dust soiling amenity impacts and a **Negligible Risk** of health impacts from 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 particulate matter releases would be significantly reduced. The residual effects of the construction phase on air quality are assessed as **negligible**.

The assessment of the potential air quality impacts associated with traffic generated by the operational phase of the proposed development has been completed with reference to published methodologies and technical guidance. The pollutants considered in this part of the assessment were nitrogen dioxide (NO₂), PM₁₀ and PM_{2.5} which have been assessed using detailed dispersion modelling. The results of the dispersion modelling study demonstrate that pollutant concentrations at all receptors are predicted to be under the health-based air quality objectives with the Proposed Development in operation in the proposed opening year (2023), with all impacts relative to the 'without development' scenario in 2023 being **negligible**. Therefore, the overall effect of the Proposed Development operation on local air quality is **not significant**.

Results of the air quality damage cost assessment, completed in accordance with relevant West Yorkshire Technical Planning Guidance and based on the maximum trip generation, show that the total five-year exposure damage cost value associated with the Proposed Development is between a minimum of a minimum of £32,551 (low sensitivity) and maximum of £698,658 (high sensitivity), with a central present value of £204,195. These values are conservative given that they do not include the associated modal shift away from private vehicles as a result of increased bus provision, which would offset the damage costs through a reduction in private vehicle emissions

However, given that the Proposed Development is itself a qualifying default mitigation type as defined in the relevant West Yorkshire Technical Planning Guidance, and will bring forward other air quality mitigation inherent to the design (e.g. improved public transport and infrastructure, provision of new public transport services, improved pedestrian links to bus stops, green infrastructure), the calculated damage costs would effectively be wholly offset by the investment required to support the implementation of the Proposed Development.

Based on the assessment results, the Proposed Development site is suitable for its proposed land use and will comply with policies included in the National Planning Policy Framework and the Kirklees Local Plan, with no air quality constraints identified.

1. INTRODUCTION

- 1.1.1. WSP has been commissioned by Kirklees Council to carry out an assessment of the potential air quality impacts arising from the proposed redevelopment of the existing Heckmondwike bus station, which is located adjacent to the A638 in the town of Heckmondwike (hereafter referred to as the 'Application Site'). The Application Site lies within the administrative boundaries of Kirklees Council (KC).
- 1.1.2. The proposals at the Application Site include the revamping of the existing bus station and increasing the number of bus stands from 4 to 6 (hereafter referred to as the 'Proposed Development'). Increasing the number of bus stands will facilitate an increase in capacity from a maximum of 48 to 52 buses per hour. A site location plan is shown in **Figure 1**.
- 1.1.3. This report provides a review of existing air quality conditions at and in proximity to the Application Site and an assessment of the potential impacts of the Proposed Development on local air quality during the construction and operational phases. The assessment was undertaken in accordance with current technical guidance published by the West Yorkshire Combined Authority (WYCA), the Department of Environment, Food and Rural Affairs (Defra) and other relevant guidance published by the Institute of Air Quality Management (IAQM).
- 1.1.4. Air pollution in urban areas and adjacent to major roads is dominated by emissions from road vehicles. The main pollutants of health concern from road traffic exhaust releases are nitrogen dioxide (NO₂) and fine particulate matter of mean aerodynamic diameter less than 10 and 2.5 micrometres (PM₁₀ and PM_{2.5}, respectively). These pollutant concentrations are likely to be higher in proximity to major roads and in congested urbanised areas. As such, NO₂, PM₁₀ and PM_{2.5} emissions associated with the Proposed Development form the focus of this assessment.
- 1.1.5. This report is supported by four technical appendices:
- Appendix A – Glossary;
 - Appendix B – IAQM Construction Assessment Methodology;
 - Appendix C – Dispersion Model Approach & Verification; and
 - Appendix D – Atmospheric Dispersion Modelling Results.

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 legislation².
- 2.1.3. The AQS also sets standards and objectives for nine key air pollutants to protect health, vegetation and ecosystems. These are benzene (C₆H₆), 1,3 butadiene (C₄H₆), carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO₂), particulate matter (PM₁₀ and PM_{2.5}), sulphur dioxide (SO₂), ozone (O₃), and polycyclic aromatic hydrocarbons (PAHs). The standards and objectives for the pollutants considered in this assessment are given in **Table 1**.
- 2.1.4. The air quality standards are concentrations recorded over a given time period, which are considered to be acceptable in terms of what is scientifically known about the effects of each pollutant on health and on the environment. They can also be used as a benchmark to indicate whether air pollution is getting better or worse.
- 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 air quality standards, 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 NO₂, the short-term standard is for a 1-hour averaging period, whereas for PM₁₀ 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 PM₁₀.

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)

² The UK formally left the EU on 31st January 2020 and new air quality legislation for the UK will be brought forward in due course. The Air Quality (Miscellaneous Amendment and Revocation of Retained Direct EU Legislation) (EU Exit) Regulations 2018 (SI 2018/1407) (see Regulation 5) makes changes to retained direct EU legislation relating to air quality, to ensure that it continues to operate effectively.

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 2000³ and the Air Quality (England) (Amendment) Regulations 2002⁴ 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 2010⁵ 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 PM₁₀, PM_{2.5} and NO₂. The limit values for NO₂ and PM₁₀ are the same concentration levels as the relevant AQS objectives and the limit value for PM_{2.5} is a concentration of 25µg/m³. However, Regulation 2 of the Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020⁶ updates the Air Quality Standards Regulations 2010 to include a limit value for PM_{2.5} from 2020. At the time that the Air Quality Standards Regulations 2010 were made the limit value for this pollutant was under review by the European Commission.

2.2. RELEVANT UK AIR QUALITY OBJECTIVES

- 2.2.1. The national air quality objectives that the UK must comply with, specifically for traffic-related pollutants NO₂, PM₁₀ and PM_{2.5}, are presented in **Table 1**. The respective UK objective concentration standards and averaging periods are numerically identical for each pollutant, based on air quality standards set for the protection of human health.

Table 1 – National (England) Air Quality Objectives Set for the Protection of Human Health

Pollutant	Applies to	Objective	Measured as	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
	UK	40µg/m ³	annual mean	31.12.2005

³ The Air Quality (England) Regulations 2000 - Statutory Instrument 2000 No.928

⁴ The Air Quality (England) (Amendment) Regulations 2002- Statutory Instrument 2002 No.3043

⁵ The Air Quality Standards Regulations 2010 - Statutory Instrument 2010 No. 1001

⁶ The Environmental (Miscellaneous Amendments) (EU Exit) Regulations 2020 - Statutory Instrument 2020 No.000

Pollutant	Applies to	Objective	Measured as	Date to be achieved by and maintained thereafter
Particulate Matter (PM ₁₀) (gravimetric) ^A	UK (except Scotland)	50µg/m ³	24 hour mean	31.12.2004
	UK (except Scotland)	40µg/m ³	annual mean	31.12.2004
Particulate Matter (PM _{2.5})	UK (except Scotland)	20µg/m ³	annual mean	1.1.2020

CLEAN AIR STRATEGY

- 2.2.2. Defra published the Government’s Clean Air Strategy in 2019⁷. This sets out measures, which aim to reduce emissions from all sources of air pollution, making air healthier to breathe, protecting nature and boosting the economy. The Strategy also proposes tough new goals to cut public exposure to airborne particulate matter, as per the recommendation made by the WHO.
- 2.2.3. Furthermore, the Strategy confirms that the Government will set new legislation to ‘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.’ New enforcement powers will also be given at a national and local level, across all sectors of society.

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

- 2.2.4. 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”.*
- 2.2.5. 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.

⁷ Defra (January, 2019). Clean Air Strategy 2019.

- 2.2.6. 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

- 2.2.7. 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 Air Quality Management Area (AQMA). For each AQMA the local authority is 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 objectives in the future.

ENVIRONMENT ACT 2021

- 2.2.8. The Environment Act 2021⁸, published in November 2021, provides a new framework for environmental protection within the UK. It aims to ensure that environmental standards are maintained and that improvements are achieved (specifically in relation to air quality, water, waste and resources, nature and biodiversity) and bridges the gaps in legislation resulting from the UK’s departure from the EU. The Environment Act 2021 does not replace the Environment Act 1995, but it does make amendments in order to strengthen environmental protections.
- 2.2.9. In relation to air quality, the Environment Act 2021 includes a legally binding duty on Government to bring forward at least two new air quality targets for PM_{2.5} into secondary legislation by 31 October 2022.
- 2.2.10. Target objectives under consideration for air quality include:
- Reducing the annual mean concentrations of PM_{2.5} in ambient air; and
 - Reducing population exposure to PM_{2.5}.

2.3. PLANNING POLICY

- 2.3.1. A summary of the national and local planning policy relevant to the Proposed Development and air quality is provided below.

NATIONAL PLANNING POLICY

National Planning Policy Framework

- 2.3.2. The Government’s overall planning policies for England are described in the National Planning Policy Framework⁹. The core underpinning principle of the Framework is the presumption in favour of sustainable development, defined as:

⁸ UK Government (1995) Environment Act 1995. [Online] <https://www.legislation.gov.uk/ukpga/1995/25/contents>

⁹ Ministry of Housing, Communities and Local Government (July 2021) *National Planning Policy Framework*.

- *‘... meeting the needs of the present without compromising the ability of future generations to meet their own needs’.*

2.3.3. One of the three overarching objectives of the NPPF is that the planning system should seek *‘to protect and enhance our natural, built and historic environment; including making effective use of land, improving biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.’*

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

- Paragraph 55, 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 104, which relates to the need to consider transport related issues at the earliest stages of plan making and development proposals, so that *‘...c) opportunities to promote walking, cycling and public transport use are identified and pursued; d) the environmental impacts of traffic and transport infrastructure can be identified, assessed and taken into account – including appropriate opportunities for avoiding and mitigating any adverse effects, and for net environmental gains...’;*
- Paragraph 105, 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 174, 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 185, 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 186, 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.’;* and
- Paragraph 188, 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.'

LOCAL PLANNING POLICY

Kirklees Local Plan

2.3.5. The Local Plan¹⁰ is KC's primary planning document which directs planning permission in the district. The Local Plan includes the following policy specifically related to local air quality:

"Policy LP51

Protection and improvement of local air quality

- 1. Development will be expected to demonstrate that it is not likely to result, directly or indirectly, in an increase in air pollution which would have an unacceptable impact on the natural and built environment or to people.*
- 2. Proposals that have the potential to increase local air pollution either individually or cumulatively must be accompanied by evidence to show that the impact of the development has been assessed in accordance with the relevant guidance. Development which has the potential to cause levels of local air pollution to increase must incorporate sustainable mitigation measures that reduce the level of this impact. If sustainable measures cannot be introduced the development will not be permitted.*
- 3. Where the development introduces new receptors into Air Quality Management Areas or Areas of Concern or near other areas of relatively poor air quality, for example near roads or junctions, the development must incorporate sustainable mitigation measures that protect the new receptors from unacceptable levels of air pollution. Where sustainable mitigation measures cannot be introduced which prevent receptors from being exposed to unsafe levels of air pollution, development will not be permitted."*

¹⁰ Kirklees Council. Kirklees Local Plan Allocations and Designations. Adopted February 2019

3. SCOPE & METHODOLOGY

3.1.1. This section of the air quality assessment provides details of the data and information supplied for the purposes of the assessment. It also describes the adopted methodology for assessing and appraising the potential air quality impacts associated with the Proposed Development.

3.2. KEY DATA & RESOURCES

3.2.1. An index of the key data and resources used within the assessment is presented in Table 3-1 below.

Table 2 – Key Data & Resources

Data/Resource	Summary	Source/Reference
Annual Mean NO ₂ monitoring data	Data obtained for the study area required to facilitate baseline air quality review and air quality model verification	KC 2020 Air Quality Annual Status Report ¹¹
Defra national background pollutant mapping data	Background 1km x 1km grid pollutant data obtained for the respective grid squares encompassing the study area	Defra Background Pollutant Maps, 2018 Reference Year ¹²
DEFRA Local Air Quality Management (LAQM) Tools	A suite of tools to enable collation of vehicle emissions inventory data, background pollutant adjustment, and conversion of NO _x to NO ₂	All LAQM tools sourced from DEFRA: https://laqm.defra.gov.uk/review-and-assessment/tools/tools.html
Atmospheric dispersion modelling system for roads (ADMS-Roads)	Dispersion model capable of predicting dispersion of vehicle emissions from the assessed road network and calculating pollutant concentrations at identified receptors	ADMS-Roads v5.0 developed by Cambridge Environmental Research Consultants (CERC) Ltd
Baseline and future years traffic data for all model scenarios	Traffic data provided in appropriate format to enable air pollutant emissions inventory (NO _x , PM ₁₀ , PM _{2.5}) databases to be generated prior to dispersion modelling	Traffic data supplied by project transport consultant (WSP) (see Appendix C)
Meteorological Data	Emley Moor 2019	See Appendix C
LAQM Technical Air Quality Guidance	Guidance document, including information on dispersion modelling and model verification / adjustment	DEFRA (2016) Local Air Quality Management Technical Guidance TG16 ¹³

¹¹ Kirklees Council. 2021 Air Quality Annual Status Report, June 2021

¹² Defra 2018 background mapping [online] <https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018>

¹³ DEFRA (2018) Part IV The Environment Act 1995 and Environment (Northern Ireland) Order 2002 Part III, Local Air Quality Management Technical Guidance LAQM.TG16

Land Use Planning & Development Control Guidance	Joint guidance provided by Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM) that includes air quality impact descriptor criteria	Document published by EPUK/IAQM (2017) Land-Use Planning & Development Control ¹⁴
West Yorkshire Low Emissions Strategy (WYLES)	Joint guidance development by West Yorkshire local authorities which outlines what the key challenges are in relation to air quality within West Yorkshire.	Document published through collaboration between the West Yorkshire Local authorities ¹⁵
West Yorkshire Technical Planning Guidance	Part of the WYLES which provides a methodology for undertaking damage cost assessments for qualifying developments.	Technical Planning Guidance published as part of the WYLES ¹⁶
IAQM Construction Guidance	Guidance provided by IAQM on the appropriate assessment of construction impacts	Document published by IAQM (2016), Guidance on the assessment of dust from demolition and construction ¹⁷

3.3. BASELINE AIR QUALITY REVIEW

- 3.3.1. The 2021 Air Quality Annual Status (ASR)¹¹ published by KC has been reviewed to establish baseline air quality conditions within the immediate vicinity of the Application Site. The ASR provides the monitored annual mean NO₂ levels for the previous five years (2016 – 2020) near to the Application Site.
- 3.3.2. Background NO₂, PM₁₀ and PM_{2.5} pollutant concentrations corresponding to the 1km² grid squares covering the associated link roads and identified sensitive receptor locations were obtained from Defra’s published national pollutant mapping data¹² for use in the air quality assessment.
- 3.3.3. The Defra mapped background concentrations were selected to represent air quality at the Application Site instead of urban background monitoring. This approach was taken to enable a variable and representative background levels to be applied at each receptor location.

3.4. CONSTRUCTION PHASE METHODOLOGY

- 3.4.1. A construction phase impact assessment was undertaken using the relevant Construction Guidance¹⁷, LAQM TG16¹³, information provided by the Client and Project Team, and professional judgement.
- 3.4.2. The Construction Guidance¹⁷ methodology determines the risk of potential impacts from the following four sources of dust and PM₁₀ emissions: demolition; earthworks; general construction activities and track-out. The level of risk associated with dust soiling, human health and ecological health is based on the magnitude of impact, which considers the nature and scale of activities for

¹⁴ EPUK/IAQM (2017) Land-Use Planning & Development Control: Planning For Air Quality

¹⁵ West Yorkshire Low Emissions Strategy 2016 - 2021

¹⁶ Air Quality & Emissions. Technical Planning Guidance, Part of the West Yorkshire Low Emissions Strategy

¹⁷ Institute of Air Quality Management (Version 1.1 Updated June 2016). Guidance on the Assessment of Dust from Demolition and Construction

each source, and the sensitivity of the receiving environment to increased dust and PM₁₀ levels. The overall level of risk is described as low, medium or high based on the source associated with highest risk. Once the level of risk is ascertained, site-specific mitigation proportionate to the level of risk is identified, and the significance of residual effects determined. An overview of the Construction Guidance methodology is provided in **Appendix B**.

- 3.4.3. Additionally, the impacts of exhaust emissions from construction vehicles, non-road mobile machinery (NRMM) and plant were assessed in line with the Construction Guidance¹⁷, Land Use Planning Guidance¹⁴ and LAQM TG16¹³.

3.5. OPERATIONAL PHASE METHODOLOGY

ATMOSPHERIC DISPERSION MODELING

- 3.5.1. The operational phase assessment focussed on the following scenarios, for which traffic data were provided to facilitate atmospheric dispersion modelling of vehicle emissions using Cambridge Environmental Research Consultants'(CERC) Atmospheric Dispersion Modelling System (ADMS)-Roads v5.0 model:
- Baseline & Model Verification Year (2019);
 - Without Proposed Development (2023); and
 - With Proposed Development (2023).

TRAFFIC DATA

- 3.5.2. Traffic flows for the Proposed Development were produced by the project's transport consultant (WSP) for the above scenarios. The extent of the modelled road traffic network is shown in **Figure 2**.
- 3.5.3. The traffic data include details of the Annual Average Daily Traffic (AADT) flows, speed limits (km/h) and the percentage of Heavy-Duty Vehicles (HDVs) applicable to the local road network in all assessment years considered. The traffic data is segmented at major junctions to account for changes in speeds, which aligns with guidance provided in LAQM.TG16¹³.
- 3.5.4. The traffic flows for the without Proposed Development scenario represent 2023 baseline flows, based on 2019 traffic count data and using growth factors taken from the Cleckheaton-Kirklees Strategic Transport Model to account for expected future development in the local area, but excludes any contribution to road traffic from the Proposed Development itself. The traffic flows for the with Proposed Development scenario account for the baseline flows in addition to the change in vehicle flows arising from the operation of the Proposed Development. Further details on the traffic data are included in **Appendix C**.

VEHICLE EMISSION FACTORS

- 3.5.5. The traffic data were used to develop emissions inventory databases for each pollutant (NO_x, PM₁₀, and PM_{2.5}) and scenario using the Defra Emissions Factors Toolkit (EFT) version 11.0¹⁸. This accounts for traffic flow characteristics, including:
- Road type (e.g. urban, rural, motorway);
 - Total vehicle flow by link (AADT);
 - Percentage of HDV per link; and
 - Average link speed (km/h)
- 3.5.6. The emissions database outputs for each respective scenario provided road link-specific pollutant emission rates (g/km/s), which were input to the ADMS-Roads model to enable prediction of pollutant concentrations at identified sensitive receptor locations. In addition, the following model inputs were required:
- Geometry of each affected road link;
 - Road gradients;
 - Identified street canyons;
 - Hourly sequential meteorological data obtained from Emley Moor for 2019; and,
 - Coordinates of each identified sensitive receptor at which the model calculated pollutant concentrations (see **Section 3.6**).
- 3.5.7. Further detailed information of the modelling process and input data used for this assessment is presented in **Appendix C**.

BACKGROUND CONCENTRATIONS

- 3.5.8. Due to the resolution of the Defra background mapping (1km resolution) it is possible that artificial step changes are possible between receptors in one grid square and those close by but in an adjacent square, which can be evident when a small area with few receptors is modelled. To reduce this and to improve the reliability of results the model prediction, background concentrations have been interpolated using bilinear interpolation which takes into account the four Defra background squares nearest to the receptor. The interpolation uses the standard geometry of the square to provide a relative weighting for any point between the four Defra mapped points, assuming that the 1km average concentration can be assigned to the centre of the 1km x 1km grid cell.

MODEL VERIFICATION

- 3.5.9. Verification of the ADMS-Roads model outputs has been undertaken through comparing the annual mean NO₂ base year (2019) model outputs with KC NO₂ monitoring data at the respective monitoring locations. This enabled appropriate model adjustment factors, derived with reference to LAQM.TG16¹³, to be applied to model outputs to ensure the performance of the dispersion model was suitable within the context of the available monitoring data.

¹⁸ Defra Emission Factor Toolkit v11.0 [online] <https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html>

3.5.10. Verification of PM₁₀ and PM_{2.5} has been completed using the same factor determined through verification of NO₂ concentrations, in accordance with LAQM.TG16 technical guidance, which states “...In the absence of any PM₁₀ data for verification, it may be appropriate to apply the road-NO_x adjustment to the modelled road-PM₁₀.”

3.5.11. Further detailed information in regard to the model verification and adjustment procedure is presented in **Appendix C**.

DAMAGE COST ASSESSMENT

3.5.12. With reference to the West Yorkshire Technical Planning Guidance¹⁶, published as part of the WYLES, the Proposed Development is classified as a ‘major development’ due to the level of vehicle (bus) trips being generated. As such, a damage cost assessment is required to inform the level of mitigation required to negate any potential impacts, defined under ‘Type 3 Mitigation’ as per the WYLES guidance for a ‘major development’.

3.5.13. A damage cost assessment aims to identify the environmental damage costs associated with a proposed development and determine the cost (monetary value) of mitigation that is expected to be spent on impact control measures. The calculation utilises Defra’s most recent Emission Factor Toolkit (EFT) v11.0¹⁸ to estimate the change in pollutant emissions associated with a proposed development and the latest Defra Air Quality Appraisal: Damage Cost Guidance¹⁹ for the specific pollutants of interest, to calculate the resultant damage cost. The Defra ‘damage costs’ are a set of pre-calculated values, expressed in cost per tonne (£/tonne) of emissions, to enable proportionate analysis when assessing relatively small impacts on air quality.

3.5.14. The damage cost calculation process includes:

- Maximum trip rates generated by the Proposed Development (based on information provided in the associated traffic data; see **Appendix C**);
- The pollutant emissions of concern (PM_{2.5} and NO_x) calculated from the Defra EFT v11.0¹⁸;
- The air quality damage costs calculation for the specific pollutant emissions (PM₁₀ assessed in terms of PM_{2.5} based on the Defra Damage Cost Appraisal Toolkit²⁰); and
- The West Yorkshire Technical Planning Guidance¹⁶ recommends that the result is totalled for a five-year period to enable mitigation implementation. This provides a five-year exposure cost value, which is the total monetary value expected to be spent on mitigation measures.
- With the Proposed Development opening year expected to be 2023, annual vehicle pollutant emissions and associated emissions mitigation costs were calculated for the period 2023 – 2027 inclusive, to provide a five-year exposure cost value.

3.5.15. It should be noted that the default ‘Type 3 Mitigation’ included in the WYLES guidance¹⁶ includes measures such as supporting improved public transport, which lists “*provision of new or enhanced*

¹⁹ Defra (2020) Air Quality Appraisal: Damage Cost Guidance [online] <https://www.gov.uk/government/publications/assess-the-impact-of-air-quality/air-quality-appraisal-damage-cost-guidance>

²⁰ Defra (2021) Air Quality Appraisal: Damage Costs Toolkit [online] <https://www.gov.uk/government/publications/assess-the-impact-of-air-quality>

public transport services to the site”, “*support improving information systems for public transport*”, and “*promoting low emission bus service provision*” among its examples. Therefore, the Proposed Development is a form of Type 3 Mitigation in itself and any damage costs calculated via the above methodology would effectively be wholly offset by the investment required to support the implementation of the Proposed Development.

3.6. IDENTIFIED DISCRETE RECEPTORS

3.6.1. 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 include locations sensitive to an increase in dust deposition and PM₁₀ exposure as a result of on-site construction activities, and locations sensitive to exposure to fine particulate and gaseous pollutants emitted from the exhausts of construction and operational traffic associated with the Proposed Development. For the purposes of this assessment, we are assessing human health and ecological receptors.

CONSTRUCTION PHASE

3.6.2. The IAQM Construction Guidance¹⁷ focusses on the following sensitive locations:

- ‘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).

3.6.3. 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. There were no ecologically sensitive locations identified within 50m of the Application Site boundary and thus were scoped out of the assessment.

OPERATIONAL PHASE

3.6.4. In terms of locations that are sensitive to pollutants emitted from engine exhausts, these will 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 LAQM.TG(16) provides examples of the locations where the air quality objectives should/should not apply.

3.6.5. 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 NO₂ and particulate matter concentrations, as a result of the Proposed Development.

3.6.6. The locations of the assessment receptors are shown on **Figure 2** and listed in **Table 3** below. The majority of modelled receptors are located at residential dwellings which are considered to be of high sensitivity. Several lower sensitive receptors, including a public house, dentist and a park, have also been included in the model.

3.6.7. The majority of receptors were modelled at “breathing height” (1.5 m above ground level, m agl). Two of the modelled receptors are located at 1st floor residential units. As such, these have been modelled at 4.5 m agl (floor height + breathing height).

Table 3 - Receptor Locations Used in the Assessment

Receptor	Description/ Address	Grid Reference		Height above Ground Level (m)
		X	Y	
R1	Healds Avenue - Residential	420674	423983	1.5
R2	439 Bradford Road - Residential	420784	423857	1.5
R3	48 Leeds Road - Residential	420966	423956	1.5
R4	45 Leeds Road – Residential	420823	423855	1.5
R5	Malthouse Court - Residential	420537	423784	1.5
R6	7 Halifax Road - Residential	420667	423707	1.5
R7	6 Huddersfield Road - Residential	420689	423657	1.5
R8	Shine Bright Day care & Out of School Club	420763	423773	1.5
R9	463 Bradford Road - Residential	420838	423782	1.5
R10	29 Bank Street - Residential	420916	423727	1.5
R11	141 A638 - Residential	421139	423642	1.5
R12	19 Westgate - Residential (flat above row of shops)	421440	423513	4.5
R13	Bupa Dental Care	421557	423546	1.5
R14	23 Northgate - Residential	421392	423700	1.5
R15	3 Cemetery Road - Residential	421560	423497	1.5
R16	Heckmondwike Grammar School	421933	423570	1.5
R17	Public House	421646	423469	1.5
R18	Heckmondwike The Green - Park and Garden	421470	423524	1.5
R19	45 High Street - Residential	421830	423554	1.5
R20	Firth Park Playground	421322	423552	1.5
R21	34A Market Street (flat above shops)	421602	423409	4.5

3.6.8. In terms of ecological receptors, paragraph 2.25 in guidance published by National Highways²¹ defines the type of designated habitats that require consideration and when, which depends on whether or not they lie within 200m of the affected road network specific to the Proposed Development. As there are no designated sites located within 200 m of the affected road network, assessment of air quality impacts at ecological receptors is scoped out of this assessment.

3.7. SIGNIFICANCE CRITERIA

CONSTRUCTION PHASE

3.7.1. The IAQM Construction Guidance¹⁷ 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.

3.7.2. For the assessment of the impact of exhaust emissions from plant used on-site and construction vehicles accessing and leaving the Application Site on local concentrations of NO₂ and particulate matter, the significance of residual effects has been determined using professional judgement and the principles outlined in the Land Use Planning Guidance¹⁴, which are described below.

OPERATIONAL PHASE

3.7.3. The approach provided in the Land Use Planning Guidance¹⁴ 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.

3.7.4. 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 4**.

Table 4 - 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

²¹ LA105 Air Quality Revision 0, Sustainability & Environment Appraisal, Design Manual for Roads and Bridges, November 2019

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
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

Notes

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.

3.7.5. The EPUK/IAQM guidance notes that the criteria in **Table 4** 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 Land Use Planning Guidance¹⁴ states that the assessment of overall significance should be based on professional judgement, taking into account 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.

3.7.6. The Land Use Planning Guidance¹⁴ 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 NO₂ concentrations or daily mean PM₁₀ concentrations. The significance of effects of hourly mean NO₂ and daily mean PM₁₀ concentrations arising from the operational phase has therefore been determined qualitatively using professional judgement and the principles described above.

3.8. LIMITATIONS & ASSUMPTIONS

3.8.1. With respect to the operational phase assessment and completion of atmospheric dispersion modelling, 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.

- 3.8.2. In order to reduce the uncertainty associated with predicted concentrations, model verification has been carried out following guidance set out in LAQM.TG16¹³. As the model has been verified against local monitoring data and adjusted accordingly, there can be reasonable confidence in the predicted concentrations. See **Appendix C** for more detail on the model verification completed for this study.
- 3.8.3. The average uncertainty (derived as the root mean square error) calculated in the model verification equates to 2.4 $\mu\text{g}/\text{m}^3$ for annual mean NO_2 . As such, the modelled receptors that are predicted to experience NO_2 concentrations between 37.6 $\mu\text{g}/\text{m}^3$ and 42.4 $\mu\text{g}/\text{m}^3$ are considered to be at potential risk of exceeding the annual mean objective of 40 $\mu\text{g}/\text{m}^3$. Of the 21 modelled receptor locations included in the assessment, none are predicted to be within this range in the opening year of assessment (2023).

4. BASELINE CONDITIONS

4.1. KC REVIEW & ASSESSMENT OF AIR QUALITY

- 4.1.1. KC has designated ten AQMA's within their administrative area as a consequence of their local air quality review and assessment work. AQMA No. 7, which is located approximately 0.6 km to the northwest of the Application Site, is the closest AQMA.
- 4.1.2. This AQMA is located at a crossroads between the A632 and the A62. The AQMA was declared in 2017 for exceedances of the annual mean NO₂ objective. Exceedances in the AQMA are no longer ongoing¹¹. KC's AQMA No. 7 is within the modelled road network, thus the potential impacts of the Proposed Development on this AQMA have been considered in this assessment.

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 the local road network, in particular; the A638 (Westgate) and Northgate. Air quality at the Application Site will also be influenced by bus movements within the bus depot.
- 4.2.2. With reference to the Environment Agency's Pollution Inventory²², there are no industrial pollution sources identified within 1 km of the Application Site that would influence local air quality.

4.3. BACKGROUND AIR QUALITY DATA

- 4.3.1. Background pollutant concentrations for NO₂, PM₁₀ and PM_{2.5} were obtained from Defra's national background maps¹² for the 1km x 1km grid square encompassing the Application Site.
- 4.3.2. Data were obtained for the baseline year (2019), current year (2022) and proposed opening year (2023), as summarised in **Table 5**. All of the annual mean background concentrations are well below the relevant objectives. Furthermore, the data shows a reduction in pollutant concentrations from 2019 to 2023 with the greatest observed for annual mean NO₂. The greater rate of reduction in annual mean NO₂ is expected as a result of continued improvements in vehicle emissions technologies and targeted policies to reduce ambient NO₂ concentrations.

Table 5 - Defra Background Concentrations (µg/m³)

Grid Square (centre on O.S. Grid Reference)	NO ₂			PM ₁₀			PM _{2.5}		
	2019	2022	2023	2019	2022	2023	2019	2022	2023
421500, 423500	17.4	15.6	15.2	13.0	12.5	12.4	9.1	8.8	8.7
Air Quality Objective	40µg/m³			40µg/m³			20µg/m³		

²² Environmental Agency 2020 Pollution Inventory [online] <https://data.gov.uk/dataset/cfd94301-a2f2-48a2-9915-e477ca6d8b7e/pollution-inventory>

4.4. LOCAL AUTHORITY AIR QUALITY MONITORING DATA

CONTINUOUS MONITORING

4.4.1. KC operates two continuous automatic monitoring locations within its jurisdiction; however, neither of these are located within 5 km of the Application Site. As such, they are not considered to be representative of air quality conditions at the Proposed Development and have not been included in this assessment.

PASSIVE MONITORING

4.4.2. KC carries out passive diffusion tube monitoring of NO₂ at various locations throughout the borough. Annual mean concentrations of NO₂ for those locations situated within 1 km of the Application Site are provided in **Table 6**.

Table 6 – KC Passive Diffusion Tube Annual Mean NO₂ Concentrations (µg/m³) – 2018 to 2020

Site ID - Location	Site Type	Distance from Application Site (km)	Annual Mean NO ₂ Concentration (µg/m ³)		
			2018	2019	2020
K51 – High Street, Heckmondwike	Roadside	0.4	38.9	34.5	28.6
K48 – Flush, Liversedge	Roadside	0.5	36.1	36.1	38.1
K34 – Frost Hill, Liversedge	Roadside	0.7	38.4	33.6	29.9
K35 – Leeds Road, Liversedge	Roadside	0.7	44.4	45.3	39.7
K33 – Wakefield Road/Huddersfield Road	Roadside	0.8	34.3	31.1	26.8
Annual Mean Objective			40		

4.4.3. The data from **Table 6** shows that exceedances have been recorded at one diffusion tube (K35) within 1 km of the Application Site between 2018 and 2020. The most recent exceedance was recorded at monitor K35 in 2019. Concentrations at this monitor dropped below the annual mean objective in 2020, likely as a result of travel restrictions associated with the Covid-19 pandemic.

4.4.4. Of the monitors listed in **Table 6**, K51 is considered to be the most representative of air quality conditions at the Application Site, given that it is the closest diffusion tube to the Proposed Development and is located adjacent to the A638 (like the Application Site). The most recent results from this monitor recorded annual mean NO₂ concentrations of 28.6 µg/m³ (2020; influenced by traffic restrictions) and 34.5 µg/m³ (2019; pre-pandemic), both of which were below the respective objective.

4.5. SUMMARY

4.5.1. The Proposed Development is not located within an AQMA. The closest AQMA to the Application Site (AQMA No. 7) is located approximately 0.6 km to the northwest. Defra's background pollutant data (**Table 5**) show that pollutant concentrations within the Application Site are all well below their respective annual mean objectives.

- 4.5.2. Monitoring data from **Table 6** indicates that there is one diffusion tube within 1 km of the Application Site that has recorded exceedances of the annual mean NO₂ objective in recent years (2018 and 2019). However, concentrations in the most recent year (2020) are all below the annual mean objective, which is likely due to the effect of travel restrictions linked to the Covid-19 pandemic.
- 4.5.3. Local monitoring site K51 is located closest to the Application Site and is considered to be most representative of current air quality conditions at the Application Site. The most recent recorded concentrations from this monitor were below the annual mean NO₂ objective.

5. ASSESSMENT OF IMPACTS

5.1. CONSTRUCTION PHASE

DUST AND PM₁₀ ARISING FROM ON-SITE ACTIVITIES

- 5.1.1. Construction activities that have the potential to generate and/or re-suspend dust and PM₁₀ 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;
 - 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.
- 5.1.3. Enabling works for the Proposed Development are expected to commence in October 2022 and last until January 2023. The main construction works will commence in January 2023 and are expected to be completed by September 2023.

ASSESSMENT OF POTENTIAL DUST EMISSION MAGNITUDE

- 5.1.4. The IAQM assessment methodology has been used to determine the potential dust emission magnitude for the following four different dust and PM₁₀ sources: demolition; earthworks; construction; and, trackout. The findings of the assessment are presented below.

Demolition

- 5.1.5. Demolition of the existing bus shelters and breakup, and removal, of old foundations are planned at the Application Site. The total volume of this demolition is expected to be less than 20,000m³, which the Construction Guidance¹⁷ classes as being a small potential for dust release. Any demolition activities will occur below 10m above ground level. Therefore, the potential dust emission magnitude is considered to be **small** for demolition activities.

Earthworks

- 5.1.6. The total area of the Application Site is less than 2,500m² and the total amount of material that will be moved is estimated to be less than 20,000 tonnes. It is also estimated that less than 5 heavy earth moving vehicles will be active at any one time, and that the formation of bunds with a height of less than 4m is likely to occur. Therefore, the potential dust emission magnitude is considered to be **small** for earthwork activities.

Construction

- 5.1.7. The Proposed Development includes the construction of a pod (which will include a waiting area, toilets and a driver’s mess) and a canopy. The total volume of construction at the Application Site will be less than 25,000m³. It is assumed that no sandblasting will occur at the Application Site. Therefore, the potential dust emission magnitude is considered to be **small** for construction activities.

Trackout

- 5.1.8. Based on the traffic information provided by the transport consultants (WSP) there will be less than 10 HDV (>3.5t) outward movements in any one day travelling on surface materials with low potential for dust release. Furthermore, there will be no unpaved roads within Application Site. Therefore, the potential dust emission magnitude is considered to be **small** for trackout.
- 5.1.9. **Table 7** provides a summary of the potential dust emission magnitude determined for each construction activity considered.

Table 7 - Potential Dust Emission Magnitude

Activity	Dust Emission Magnitude
Demolition	Small
Earthworks	Small
Construction Activities	Small
Trackout	Small

ASSESSMENT OF SENSITIVITY OF THE STUDY AREA

- 5.1.10. A wind rose generated using 2019 meteorological data from Emley Moor (**Appendix C**) shows that the prevailing wind at Application Site is from the west. Therefore, receptors primarily located to the east of the Application Site are more likely to be affected by dust and particulate matter emitted and re-suspended during the construction phase. The land to the east of the Application Site is mixed use in nature and includes medium sensitive receptors within 20 m of the boundary (with reference to the Construction Guidance¹⁷), including retail and commercial developments off Cemetery Road and the A638. There are also some high sensitive receptors located approximately 40 m to the east of the Application Site off Cemetery Road.
- 5.1.11. Given the nature of construction phase emissions, it is likely that the majority of dust would be deposited in proximity to the source. Being located in a town centre, the majority of receptors in proximity to the Application Site are retail and commercial developments. The closest high sensitive receptors to the Application Site are the residential dwellings off Cemetery Road and the A638, the closest of which fall within 50m of the Application Site boundary.
- 5.1.12. With reference to **Table 5**, Defra background concentrations of PM₁₀ at and near to the Application Site are all well below the annual mean objective. In the current year (2022) an annual mean background concentration of 12.5 µg/m³ is predicted at the Application Site, which is below the

annual mean objective by 27.5 µg/m³. Considering the above, and with reference to the Construction Guidance¹⁷, the sensitivity of the area to human health impacts is considered to be low.

- 5.1.13. The areas most sensitive to construction dust deposition are highlighted in **Figure 3**, which depicts 20m, 50m, 100m and 350m distance bands (buffer zones) around the Proposed Development.
- 5.1.14. Taking the above into account and following the Construction Guidance¹⁷ assessment methodology, the sensitivity of the area to changes in dust and PM₁₀ has been derived for each of the construction activities considered. The results are shown in **Table 8**.

Table 8 - Sensitivity of the Study Area

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

RISK OF IMPACTS

- 5.1.15. 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 9** 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. Overall, there is a **Low Risk** of dust impacts relating to the expected construction phase activities, prior to mitigation being applied.

Table 9 - Summary Dust Risk Table to Define Site Specific Mitigation

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

CONSTRUCTION VEHICLES & PLANT

- 5.1.16. The greatest impact from vehicles and plant emissions will be in the areas immediately adjacent to the site access. Construction traffic will access the site via Westgate (A638) and Northgate (B6117). The total baseline flows (2019) on these road links are 8,929 and 5,713 respectively (**see Appendix C**). The number of HDV's accessing the Application Site each is expected to be less than 10 AADT per day. This makes up just 0.1% of the existing baseline flows on Westgate and 0.2% of the baseline flows on Northgate. All construction traffic movements will be temporary, lasting for the duration of the construction period only, which is expected to be completed within one year from commencement.
- 5.1.17. In terms of construction plant and NRMM, the LAQM.TG16 guidance¹³ states that:

“Experience of assessing the exhaust emissions from on-site plant (NRMM) and site traffic suggests that, with suitable controls and site management, they are unlikely to make a significant impact on

local air quality. In the vast majority of cases, they will not need to be quantitatively assessed – qualitative consideration to the above points will likely provide sufficient screening.”

- 5.1.18. Final details of the exact plant and equipment likely to be used at the Application Site will be determined by the appointed contractor, but may comprise dump trucks, tracked excavators, diesel generators and trucks. The number of plant and their location within the Application Site are likely to be variable over the construction period. Furthermore, the operational patterns of such equipment are usually variable and intermittent over the construction period, limiting the release of total emissions at any given time.
- 5.1.19. Therefore, based on the available information, current air quality baseline conditions and professional judgement, the local air quality impacts associated with emissions from construction vehicles and plant are expected to be **negligible**.

5.2. OPERATION PHASE

- 5.2.1. The predicted pollutant concentrations for all scenarios at each of the modelled discrete sensitive receptor locations included in the atmospheric dispersion modelling study are tabulated in **Appendix D**. The below provides a summary of these results, focussed on each of the assessed air pollutants (NO₂, PM₁₀, and PM_{2.5}) within the context of the respective objectives set for the protection of human health (**Table 1**) and the air quality assessment significance criteria (**Table 4**).

ANNUAL MEAN NO₂ CONCENTRATIONS

- 5.2.2. The objective for annual mean NO₂ concentrations is 40 µg/m³. The results of the assessment show that in the 2019 baseline scenario, concentrations do not exceed the annual mean objective at any of the modelled receptors. The highest modelled concentration is 28.4 µg/m³ at receptor R12, which consists of mixed business/residential premises on Westgate (A638) west of the Northgate controlled junction.
- 5.2.3. For the Proposed Development opening year (2023), both the ‘with’ and ‘without’ development scenarios predict no exceedances of the annual mean NO₂ objective. The highest annual mean concentrations are predicted to occur at receptor R12, where the predicted concentrations are 19.9 µg/m³ in the ‘without development’ scenario and 21.6 µg/m³ in the ‘with development’ scenario.
- 5.2.4. The largest improvement in concentrations is predicted to occur at receptor R7, which is the location of residential and community premises on Huddersfield Road, and is 0.2 µg/m³. The ‘without development’ and ‘with development’ concentrations are predicted to be 16.1 µg/m³ and 16.0 µg/m³ respectively.
- 5.2.5. The greatest deterioration in annual mean NO₂ concentrations in 2023 as a result of the Proposed Development being in operation is predicted to occur at receptor R13, which is predicted to experience a 6.1 µg/m³ deterioration. This magnitude of increase equates to a *moderate* impact on local air quality with reference to the Land Use Planning Guidance¹⁴. However, the annual mean impact predicted at R13 does not constitute a significant local air quality effect for the following reasons:
- The associated total annual mean NO₂ concentration at this receptor in the ‘with development’ scenario (17.2 µg/m³) remains well below the objective (40 µg/m³).

- Receptor R13 (Bupa Dental Care) does not represent a sensitive receptor with respect to the annual mean objective, with the respective short-term hourly NO₂ objective being more applicable to the potential periods of exposure by users of the building.

5.2.6. Notwithstanding the result at R13, 19 of the remaining 20 modelled receptors are expected to experience *negligible* impacts and one slight adverse impact (R18, which is a park area and, similarly to R13, is not representative of long-term exposure).

5.2.7. Given the above, the overall impact of the Proposed Development is predicted to be **negligible** and **not significant** with respect to annual mean NO₂ impacts.

HOURLY MEAN NO₂ CONCENTRATIONS

5.2.8. LAQM.TG16¹³ advises that exceedances of the 1-hour mean NO₂ objective are unlikely to occur where annual mean concentrations are below 60 µg/m³. The annual mean NO₂ concentrations predicted by the model were all below 60 µg/m³, and therefore hourly mean NO₂ concentrations are unlikely to cause a breach of the hourly mean AQS objective.

5.2.9. The impact of the Proposed Development on hourly mean NO₂ concentrations at existing sensitive receptors are **negligible**, which is **not significant**.

ANNUAL MEAN PM₁₀ CONCENTRATIONS

5.2.10. The objective for annual mean PM₁₀ concentrations is 40µg/m³. The results of the assessment show that in the 2019 baseline scenario, concentrations are below the annual mean objective at all of the modelled receptors. The highest modelled concentration is 17.1 µg/m³ at receptor R21.

5.2.11. PM₁₀ concentrations predicted in the opening year (2023) are well below the annual mean objective at all receptors in both the 'without' and 'with' Proposed Development scenarios. The highest annual mean concentrations are predicted to occur at receptor R21, where the predicted concentrations are 16.3 µg/m³ in the 'without development' scenario and 16.4 µg/m³ in the 'with development' scenario.

5.2.12. The greatest deterioration in annual mean PM₁₀ concentrations, as a result of the Proposed Development being in operation, is predicted to occur at receptor R18 with a 0.5 µg/m³ deterioration. This magnitude of increase equates to a negligible impact on local air quality with reference to the Land Use Planning Guidance¹⁴ and this receptor (park area) is not representative of long-term exposure (i.e. over an annual averaged period).

5.2.13. There are no receptors predicted to experience an improvement in concentrations of PM₁₀.

5.2.14. Overall, the predicted impact of the changes in vehicle emissions associated with the operation of the Proposed Development on annual mean PM₁₀ concentrations, at existing sensitive receptors, are **negligible**, which is **not significant**.

DAILY MEAN PM₁₀ CONCENTRATIONS

5.2.15. The Land Use Planning¹⁴ and LAQM.TG16¹³ guidance provides an approach to assessing the relationship between annual mean and 24-hour mean concentrations of PM₁₀. The guidance states that potential exceedances of the 24-hour objective are unlikely where the annual mean concentration is below 32 µg/m³.

5.2.16. Given that all predicted annual mean PM₁₀ values are well below this level, exceedances of the 24-hour objective are very unlikely. The impact on daily mean PM₁₀ concentrations are predicted to be **negligible**, which is **not significant**.

ANNUAL MEAN PM_{2.5} CONCENTRATIONS

- 5.2.17. The objective for annual mean PM_{2.5} is 20 µg/m³. The results of the assessment show that in the 2019 baseline scenario, concentrations are below the annual mean objective at all of the modelled receptors. The highest modelled concentration is 10.7 µg/m³ at receptor R12.
- 5.2.18. PM_{2.5} concentrations predicted in the opening year (2023) are well below the annual mean objective at all receptors in both the ‘without’ and ‘with’ Proposed Development scenarios. The highest annual mean concentrations are predicted to occur at receptor R12, where the predicted concentrations are 10.1 µg/m³ in the ‘without development’ scenario and 10.2 µg/m³ in the ‘with development’ scenario.
- 5.2.19. The greatest deterioration in annual mean PM_{2.5} concentrations, as a result of the Proposed Development being in operation, is predicted to occur at receptors R13 and R18 with a 0.2 µg/m³ deterioration. This magnitude of increase equates to a *negligible* impact on local air quality with reference to the Land Use Planning Guidance¹⁴.
- 5.2.20. Overall, the predicted impact of the changes in vehicle emissions associated with the operation of the Proposed Development on annual mean PM_{2.5} concentrations, at existing sensitive receptors, are **negligible**, which is **not significant**.

DAMAGE COST ASSESSMENT

- 5.2.21. A damage cost assessment has been undertaken following the methodology detailed within the West Yorkshire Technical Planning Guidance¹⁶ and the Defra Air Quality Appraisal: Damage Cost Guidance¹⁹.
- 5.2.22. The calculated change in pollutant emissions, associated with the Proposed Development, are shown in Table 10 below.

Table 10 – Calculated Change in Emissions Associated with the Proposed Development

Operational Years	Trip Generation ¹	Annual Emissions (tonnes/year) ²		
		NO _x	PM ₁₀	PM _{2.5} ³
2023	1,108	3.71	0.51	0.32
2024		3.05	0.50	0.32
2025		2.48	0.49	0.31
2026		2.09	0.48	0.31
2027		1.79	0.48	0.30

¹Trip generation taken from maximum increase on road links as a result of the Proposed Development (see Appendix C)

²Values rounded to 2 decimal places

³PM_{2.5} emissions calculated by applying DEFRA’s transport conversion factor of 0.635 to PM₁₀ emissions

- 5.2.23. The emissions data presented in **Table 10** demonstrate that annual emissions for all pollutants are predicted to decrease from 2023 to 2027. This is expected as the Defra EFT v11.0¹⁸ projects that pollutant emissions from vehicles will gradually decrease for future years with the increased uptake of cleaner, lower and zero emission vehicles.

5.2.24. The damage cost for the Proposed Development was calculated using the data in **Table 10** and the Defra Air Quality Appraisal: Damage Costs Toolkit²⁰. The resultant five-year exposure cost value is provided in **Table 11** below.

Table 11 – Five-Year Damage Cost Values

Pollutant Name	Low Sensitivity Present Value	Central Sensitivity Present Value	High Sensitivity Present Value
NO _x (Road Transport)	£9,546	£99,285	£375,571
PM _{2.5} (Road Transport)	£23,005	£104,910	£323,088
Total	£32,551	£204,195	£698,658

5.2.25. **Table 11** shows that the five-year exposure damage cost associated with the Proposed Development is estimated to be **£204,195** based on central present values.

5.2.26. The calculated emissions mitigation costs should be treated as preliminary and conservative, subject to the following assumptions and limitations, with further discussions provided in **Section 6.2**:

- All generated vehicle trips were assumed to only comprise buses;
- No account was taken for any modal shift away from private vehicles as a result of increased bus provision, which would offset the above damage costs through a reduction in private vehicle emissions;
- All generated trip distances were assumed to be 10 km based on the National Transport Statistics UK average and in line with the West Yorkshire Technical Planning Guidance¹⁶;
- The speed travelled was assumed to be 50 km/hour as an estimated average speed; and
- Particulate matter (PM) impacts are potentially overestimated through the damage cost appraisal. This is because air pollutants are typically emitted in mixtures, which causes a degree of overlap between NO_x and PM_{2.5}¹⁹. While the NO_x damage costs are adjusted for this within the damage cost values, there is no such adjustment factor available for PM emissions¹⁹. Therefore, the PM damage costs do not account for the potential confounding effect of other correlated pollutants¹⁹.

6. MITIGATION & RESIDUAL EFFECTS

6.1. CONSTRUCTION PHASE

MITIGATION

- 6.1.1. Based on the construction phase air quality assessment results, there is a **low risk** of dust impacts occurring at identified sensitive receptors throughout the construction phase. Appropriate mitigation is required to further prevent or minimise the release of dust entering the atmosphere and/or being deposited on nearby receptors. Attention should be paid to operations that unavoidably take place in the immediate vicinity of sensitive receptors.
- 6.1.2. The following mitigation measures are typical for a development of this nature and are consistent with the Construction Guidance¹⁷.

General Communication

- 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

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.

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.
- 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.

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.
- Avoid site runoff of water or mud.

Operating vehicle/machinery and sustainable travel

- 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 Construction Logistics Plan should be produced to manage the sustainable delivery of goods and materials.

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.

Waste management

- Avoid bonfires and burning of waste materials.

Measures Specific to Demolition

- 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

- 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.
- 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.
- Record all inspections of haul routes and any subsequent action in a site log book.
- Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).

6.1.3. Detailed mitigation measures to control construction traffic should be discussed with KC 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 (residential roads, congested roads, 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

- 6.1.4. The residual effect of dust and PM₁₀ generated by construction activities following the application of the mitigation measures described above and good site practice is considered to be negligible.
- 6.1.5. The residual effect of emissions to air from construction vehicles and plant on local air quality is considered to be negligible.

6.2. OPERATIONAL PHASE

MITIGATION

- 6.2.1. The impacts on local air quality attributable to traffic emissions associated with the operation phase of the Proposed Development are negligible and do not equate to a significant air quality effect, thus do not necessitate the need for mitigation. As stated in paragraph 3.5.15, the Proposed Development is a form of Type 3 Mitigation (as defined by WLES guidance¹⁶) in itself and the calculated damage costs (see **Section 5.2**) would effectively be wholly offset by the investment required to support the implementation of the Proposed Development.
- 6.2.2. Furthermore, in January 2022 the WYCA submitted a Full Business Case funding bid for the Zero Emission Bus Regional Area (ZEBRA) programme to government to enable the introduction of 111 zero-emission buses throughout the region, ensuring that 10% of the bus fleet are zero emission and some of the most polluting buses are taken off the region's roads. The ZEBRA funding bid is to bring about sustainable change towards reducing emissions from bus movements in the West Yorkshire area and align with relevant Kirklees Council transport and climate strategies. If successful, the ZEBRA funding bid will further enable the Proposed Development to align with the aims of the WYLES.
- 6.2.3. The WYLES technical air quality guidance¹⁶ also promotes public transport use and infrastructure such as "*improved pedestrian links to public transport stops*" and "*provision of new bus stops infrastructure*" among its Type 2 Mitigation, which are inherent to the Proposed Development. Marginal air quality improvements may also be realised through the green infrastructure included as part of the Proposed Development such as planting, a green wall, and green roof design.
- 6.2.4. The residual effects of the Proposed Development on air quality are considered to be **negligible** for all pollutants considered within the assessment, based on the assessment results and criteria provided by the Land Use Planning Guidance¹⁴. Further, given the nature of the Proposed



Development and the associated alignment with the WYLES and Kirklees Council transport and climate strategies, the calculated damage costs (see Section 5.2) will effectively be offset.

7. CONCLUSIONS

- 7.1.1. This report presents the outcomes of a detailed air quality impact assessment for the proposed redevelopment of the existing Heckmondwike bus station.
- 7.1.2. The assessment has considered to potential local air quality impacts associated with both the construction phase and operational phase of the Proposed Development. A review of baseline air quality information and monitoring data at and near to the Application Site concluded that, in the most recent monitored year (2020), there were no exceedances of the annual mean NO₂ objective from diffusion tubes located within 1 km of the Application Site. However, one monitoring site within 1 km of the Application Site did record an exceedance of the objective in both 2018 and 2019. Any monitoring from 2020 should be taken with caution due to the effects of the Covid-19 pandemic travel restrictions.
- 7.1.3. Defra's background pollutant data show that pollutant concentrations within and near to the Application Site are all well below the respective annual mean objectives.
- 7.1.4. 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 Construction Guidance¹⁷. This identified that there is a **Low Risk** of dust soiling impacts and a **Negligible Risk** of increases in particulate matter concentrations due to construction activities. Through good site practice and the implementation of suitable mitigation measures, the effect of dust and PM₁₀ releases would be significantly reduced. The residual effects of dust and PM₁₀ generated by construction activities on air quality, including emissions to air from construction vehicles and plant, are expected to be **negligible**.
- 7.1.5. A quantitative assessment of the potential impacts attributed to the operational phase of the Proposed Development was undertaken using dispersion modelling to predict the changes in annual mean NO₂, PM₁₀ and PM_{2.5} concentrations that would occur due to the generation of additional bus trips associated with the Proposed Development. The results of the assessment have demonstrated that the operation of the Proposed Development would not cause any exceedance of the statutory air quality objectives, with impacts predicted to be **negligible** at all receptors where exposure is representative of the averaging periods assigned to the relevant air quality objectives. Therefore, the overall effect of the Proposed Development operation on local air quality is **not significant**.
- 7.1.6. A damage cost assessment has been undertaken in line with the West Yorkshire Technical Planning Guidance¹⁶, with reference to the Defra Air Quality Appraisal: Damage Cost Guidance¹⁹. Based on the maximum trip generation, the total five-year exposure damage cost associated with the Proposed Development was predicted to be between a minimum of £32,551 (low sensitivity) and maximum of £698,658 (high sensitivity), with a central present value of £204,195.
- 7.1.7. However, given that the Proposed Development is itself a Type 3 Mitigation, as defined by the Planning Guidance¹⁶, and will bring forward other air quality mitigation inherent to the design (e.g. improved public transport and infrastructure, provision of new public transport services, improved pedestrian links to bus stops, green infrastructure), as well as aligning with Kirklees Council's transport and climate strategies, the calculated damage costs would effectively be wholly offset by the investment required to support the implementation of the Proposed Development.



- 7.1.8. Based on the assessment results, the Proposed Development site is suitable for its proposed land use and will comply with policies included in the National Planning Policy Framework and Kirklees Local Plan, with no identified air quality constraints.

Figure 1 – Application Site Location & Local Authority Monitoring Locations

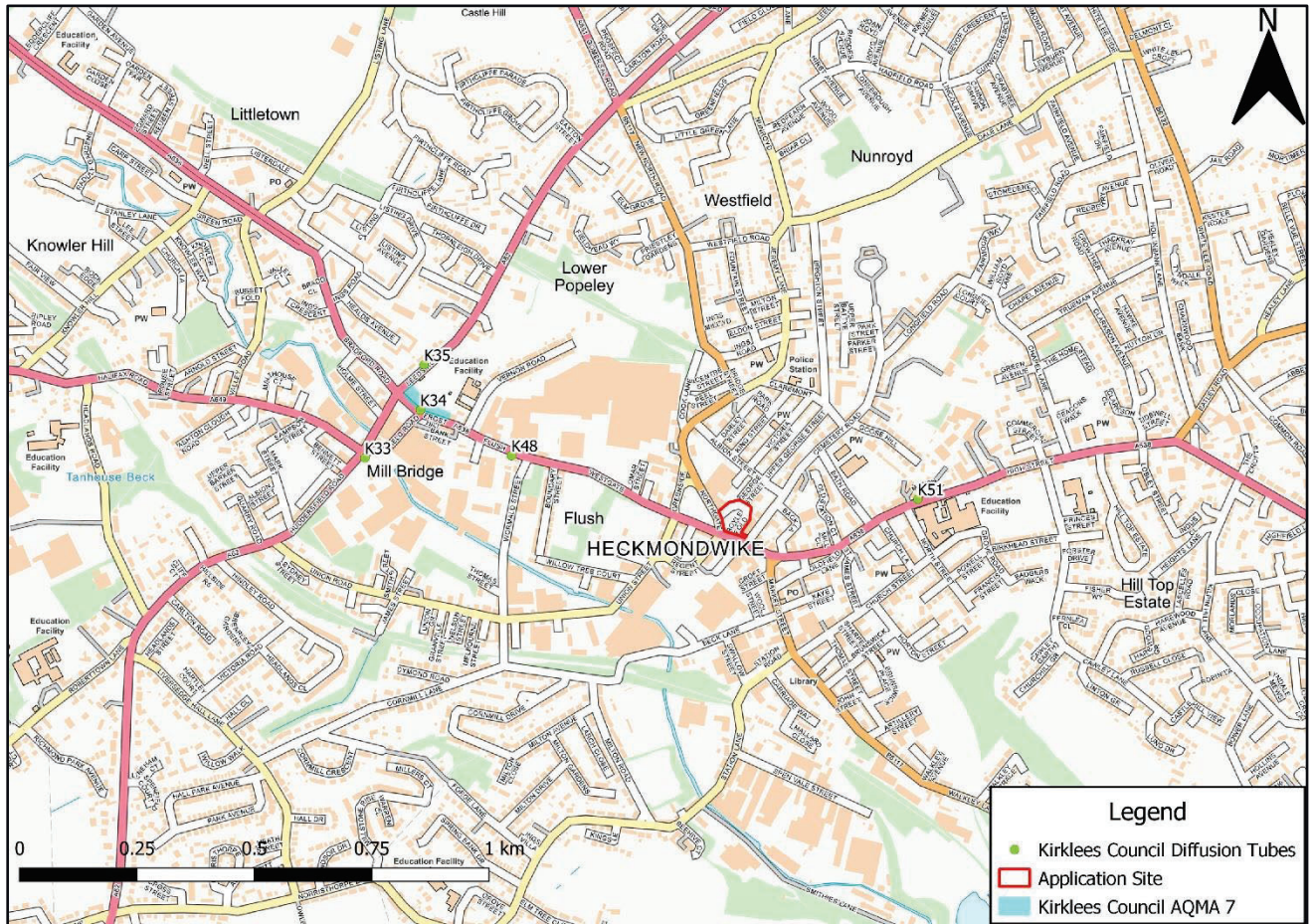


Figure 2 – Operation Phase Modelled Sensitive Receptors & Modelled Road Network Extent

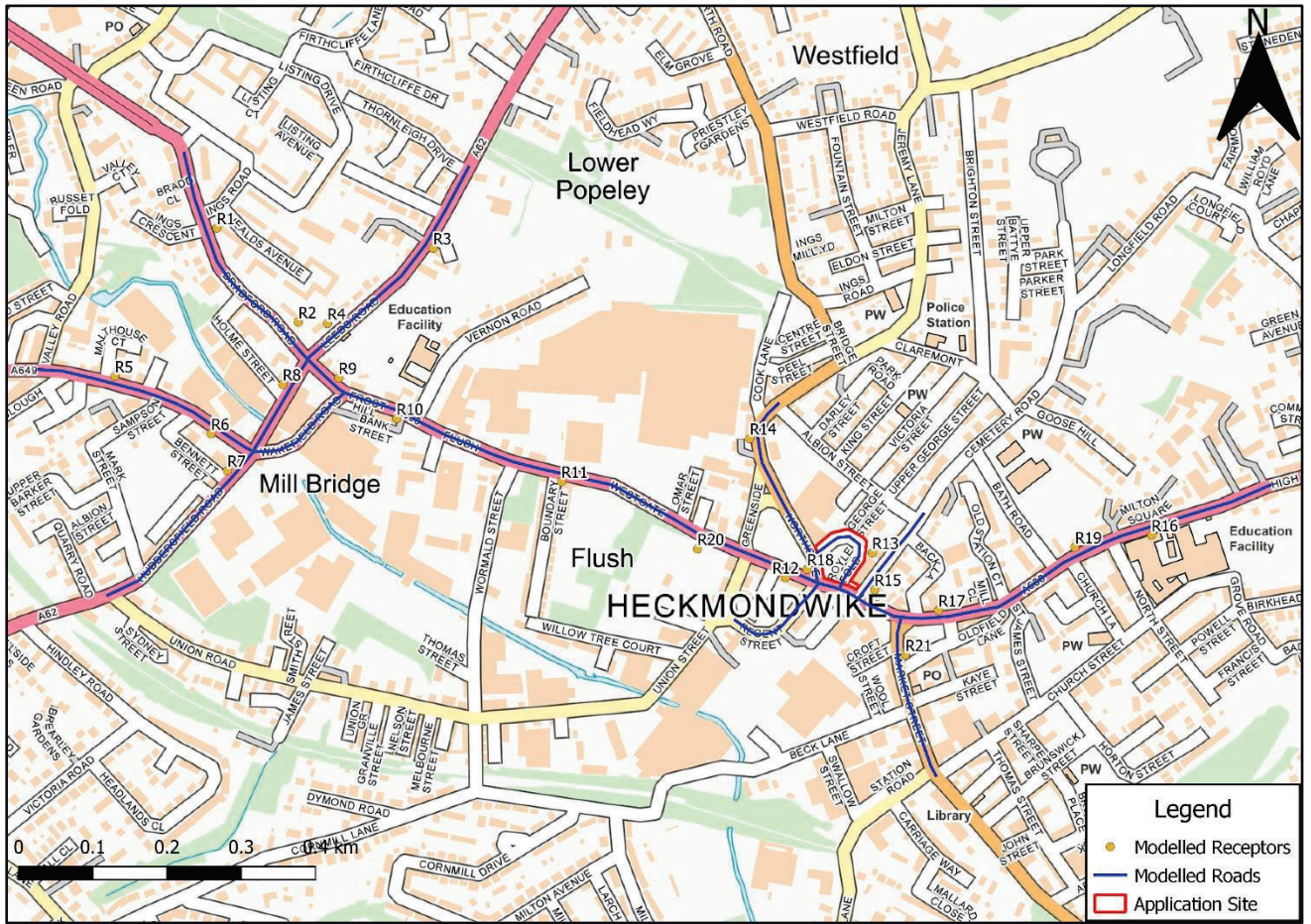


Figure 3 – Construction Phase Dust Assessment Buffer Zones

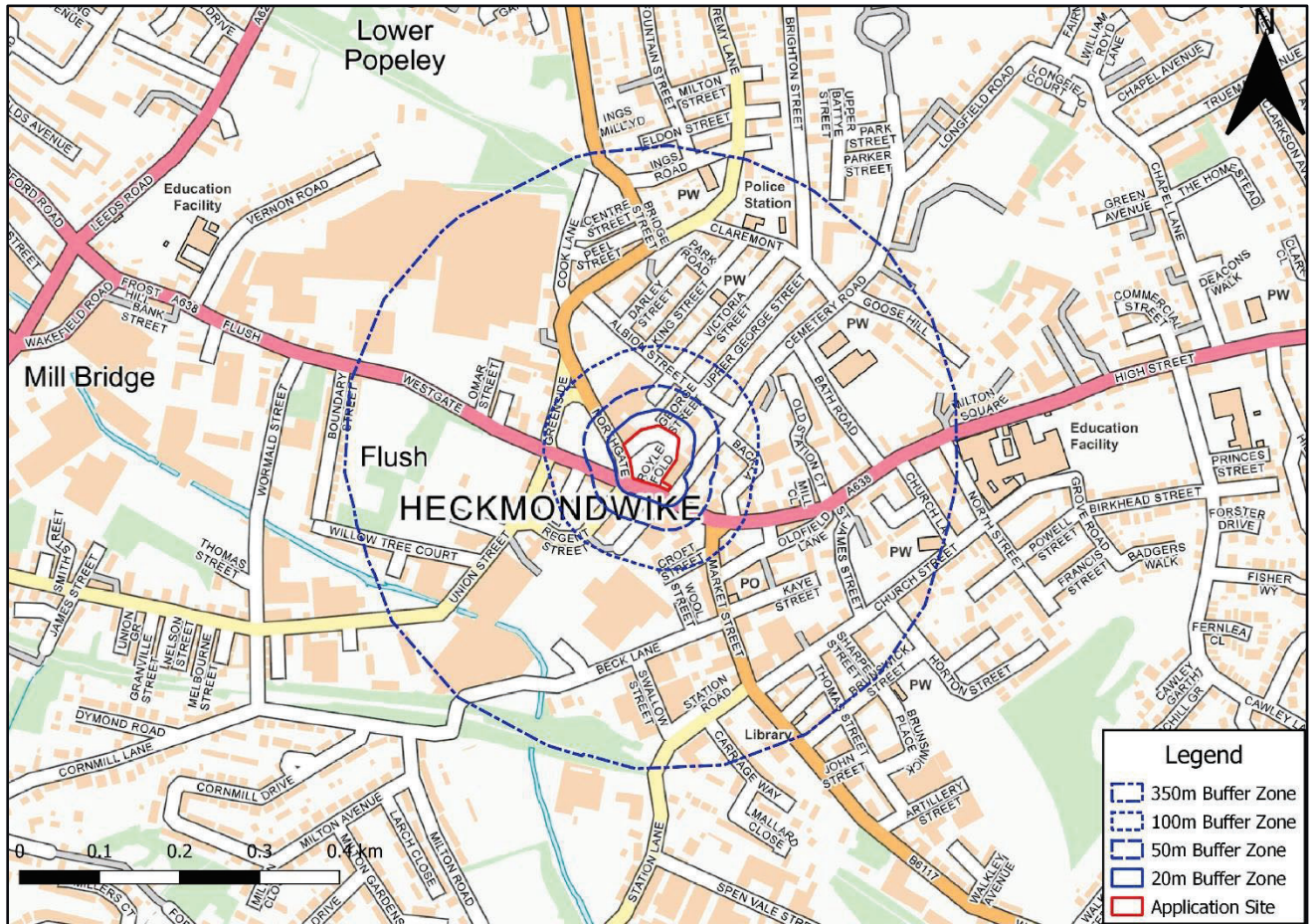
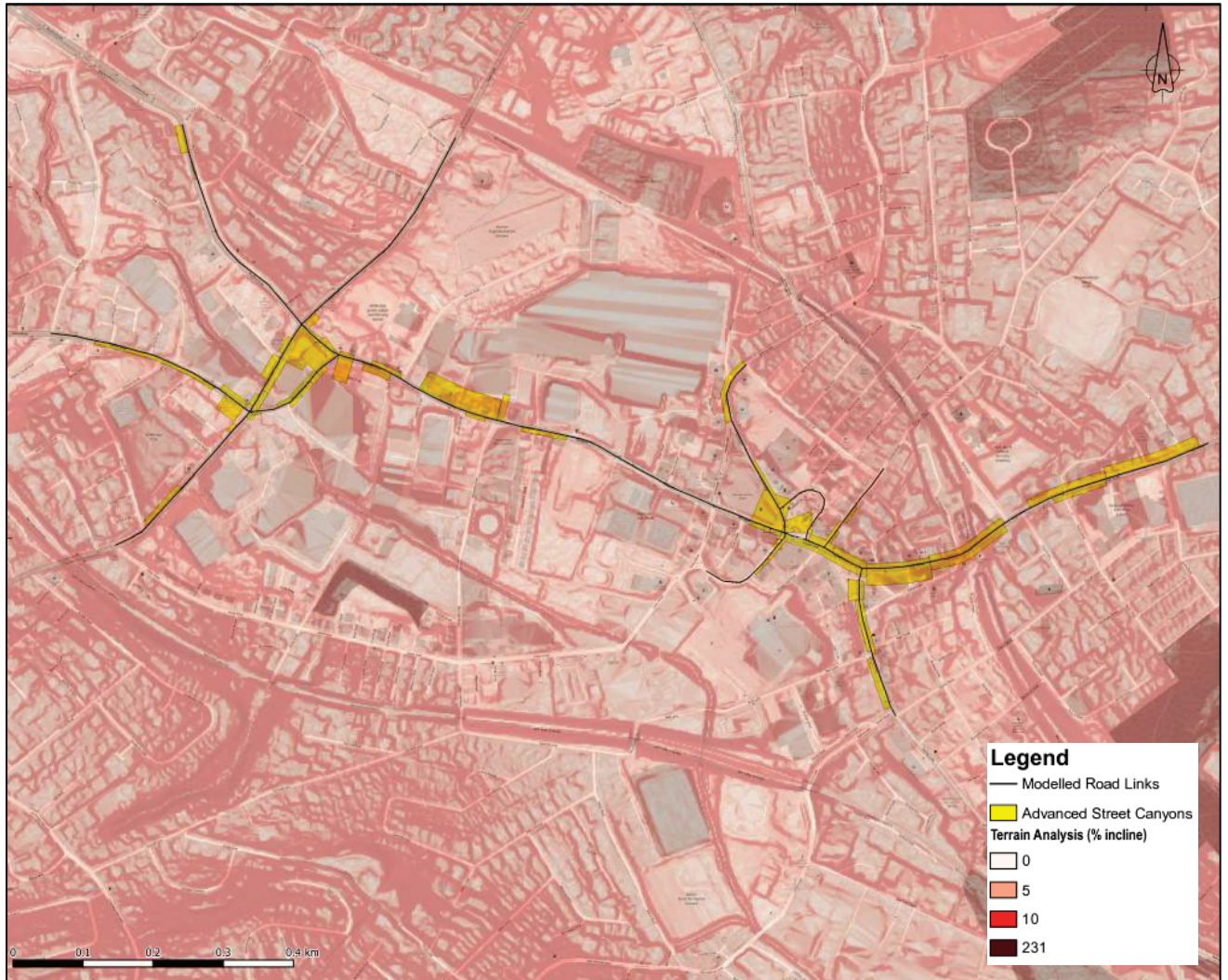


Figure 4 - Modelled Canyons and Gradients



Appendix A

GLOSSARY



Table A1: Glossary

Term	Definition
Annual Average Daily Traffic (AADT)	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
Accuracy	A measure of how well a set of data fits the true value.
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.
Conservative	Tending to over-predict the impact rather than under-predict.
Data capture	The percentage of all the possible measurements for a given period that were validly measured.
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.
Minor roads	Non-A roads of Motorways.
Model adjustment	Following model verification, the process by which modelled results are amended. This corrects for systematic error.
NO ₂	Nitrogen dioxide.
NO _x	Nitrogen oxides.

Term	Definition
PM ₁₀	Particulate matter with an aerodynamic diameter of less than 10 micrometres.
PM _{2.5}	Particulate matter with an aerodynamic diameter of less than 2.5 micrometres.
Ratification (Monitoring)	Involves a critical review of all information relating to a data set, in order to amend or reject the data. When the data have been ratified they represent the final data to be used (see also validation).
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.
µg/m ³ microgrammes per cubic metre	A measure of concentration in terms of mass per unit volume. A concentration of 1µg/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.
Validation (monitoring)	Screening monitoring data by visual examination to check for spurious and unusual measurements (see also ratification).
Verification (modelling)	Comparison of modelled results versus any local monitoring data at relevant locations.

Appendix B

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 B1: Definitions of Dust Emission Magnitudes

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
	Trackout 10 - 50 HDVs out / day, moderately dusty surface material (e.g. clay), 50 -100m unpaved roads

Dust Emission Magnitude	Activity
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 B2: 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 B3: Sensitivity of the Area to Human Health Impacts

Receptor Sensitivity	Annual Mean PM ₁₀ Concentration (µg/m ³)	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
High	>32	>100	High	High	High	Medium	Low

	28-32	10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
		>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
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 B4: 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 B5: 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 C

DISPERSION MODELLING APPROACH & VERIFICATION



INTRODUCTION

Air pollution in urban areas is dominated by emissions from road vehicles. The main pollutants of concern from road traffic are oxides of nitrogen (NO_x/NO_2) and fine particulate matter (PM_{10} & $\text{PM}_{2.5}$), since these pollutants are most likely to approach their relevant air quality objectives in proximity to major road links.

The introduction of the Proposed Development has the potential to change the total flow, distribution and characteristics of traffic movements on the affected road links, which would result in changes to emissions of the aforementioned pollutants. The local air quality assessment was completed to predict the potential impacts of these changes on ambient pollutant concentrations at identified sensitive receptors within proximity to affected roads.

The changes in local traffic related pollution levels predicted at the receptor locations were assessed by comparing the predicted concentrations of NO_2 , PM_{10} and $\text{PM}_{2.5}$ with the current air quality objectives and considering the change (improvement or worsening) between the 'without' and 'with' development scenarios.

ATMOSPHERIC DISPERSION MODEL SELECTION

The predicted impacts on local air quality associated with changes to vehicle emissions as a result of the operation of the scheme were assessed using Cambridge Environmental Research Consultants (CERC) atmospheric dispersion modelling system for roads (ADMS-Roads v5).

ADMS-Roads applies advanced algorithms for the height-dependence of wind speed, turbulence and stability to produce improved predictions of air pollutant concentrations within the given model domain. It can predict long-term and short-term concentrations, as well as calculations of percentile concentrations.

ADMS-Roads is a validated model, developed in the UK by CERC. The model validation process includes comparisons with data from the UK's Automatic Urban Rural Network (AURN) and specific verification exercises using standard field, laboratory and numerical data sets. CERC is also involved in European programmes on model harmonisation, and their models were compared favourably against other EU and U.S. EPA systems. Further information in relation to this is available from the CERC web site at <http://www.cerc.co.uk/environmental-software/model-validation.html>.

ATMOSPHERIC DISPERSION MODELLING PROCESS

The procedures involved in undertaking the dispersion modelling assessment are outlined below:

- Collation of input data – traffic data (flows, speeds, percentage of Heavy-Duty Vehicles (HDVs)), road network mapping, sensitive receptor coordinates and meteorological data;
- Input of data in to the ADMS-Roads model for the scenarios to be modelled;
- Development of emissions inventories for each pollutant to be assessed, using Defra's emission factor toolkit (EFT v11.0¹⁸);
- Running the ADMS-Roads model for each considered scenario;
- Conversion of modelled NO_x concentrations to NO_2 concentrations using Defra's NO_x - NO_2 calculator v8.1;
- Addition of Defra background concentrations¹² to the modelled concentrations;

- Verification and adjustment of modelled road-NO_x contributions from the assessed road network through analysing the ADMS-Roads modelled road-NO_x outputs versus scheme specific monitored road-NO_x for the base year scenario (2019);
- Comparison of predicted NO₂, PM₁₀ and PM_{2.5} concentrations at all receptors to the relevant air quality objectives in each scenario; and
- Analysis of changes in pollutant concentrations between the ‘without Proposed Development’ and ‘With Proposed Development’ scenarios to assess the significance of impacts associated with the Proposed Development on local air quality.

TRAFFIC DATA

Traffic flow data comprising Annual Average Daily Traffic (AADT) flows, traffic composition (percentage HDVs) and average link speeds (km/h) were used in the modelling as provided by the projects transport consultant (WSP) for the assessed road network. The traffic data was undertaken from traffic counts collected in 2019, which did not include committed development but flows were calculated for future years by using growth factors taken from the Cleckheaton-Kirklees Strategic Transport Model. Appropriate assumptions were made with respect to traffic speeds on approach to and progress through junctions (i.e. lower speeds on approach and progress through junction).

Table C1 – 2019 Baseline Flows

Road Link ID - Name	AADT	HDV%	Free Flow Speed (kph)
1 - A638 Bradford Road West	10,106	3.4%	20
2 - A62 Leeds Road	13,364	2.2%	20
3 - A638 Bradford Road	7,980	4.7%	20
4 - A649 Wakefield Road	4,517	5.9%	20
5 - A62 Huddersfield Road	11,576	3.3%	20
6 - A649 Halifax Road	5,758	3.3%	20
7 - A62 Leeds Road	12,050	2.6%	20
8 - A638 (Between Union Street / Greenside and A649 Wakefield Road)	12,132	5.1%	20
9 - B6117 Northgate (West of South George Street)	5,713	4.7%	20
10a - Royle Fold	306	80.6%	5
10b - South George Street	301	81.2%	5
11 - Cemetery Road	319	2.2%	20
12 - A638 Westgate (Between Regent Street and Market Street)	8,929	3.6%	20
13 - Regent Street	3,308	2.5%	20
14 - B6117 Northgate (East of South George Street)	5,713	4.7%	20

Road Link ID - Name	AADT	HDV%	Free Flow Speed (kph)
15 - A638 High Street	10,216	4.2%	20
16 - Market Place	6,762	6.7%	20

Table C2 – 2023 Without Proposed Development Flows

Road Link ID - Name	AADT	HDV%	Free Flow Speed (kph)
1 - A638 Bradford Road West	10,414	3.4%	20
2 - A62 Leeds Road	13,771	2.2%	20
3 - A638 Bradford Road	8,223	4.7%	20
4 - A649 Wakefield Road	4,654	5.9%	20
5 - A62 Huddersfield Road	11,928	3.3%	20
6 - A649 Halifax Road	5,933	3.3%	20
7 - A62 Leeds Road	12,417	2.6%	20
8 - A638 (Between Union Street / Greenside and A649 Wakefield Road)	12,501	5.1%	20
9 - B6117 Northgate (West of South George Street)	5,886	4.7%	20
10a - Royle Fold	315	80.6%	5
10b - South George Street	310	81.2%	5
11 - Cemetery Road	329	2.2%	20
12 - A638 Westgate (Between Regent Street and Market Street)	9,201	3.6%	20
13 - Regent Street	3,409	2.5%	20
14 - B6117 Northgate (East of South George Street)	5,886	4.7%	20
15 - A638 High Street	10,527	4.2%	20
16 - Market Place	6,968	6.7%	20

Table C3 – 2023 With Proposed Development Flows

Road Link ID - Name	AADT	HDV%	Free Flow Speed (kph)
1 - A638 Bradford Road West	10,688	4.4%	20
2 - A62 Leeds Road	13,771	1.9%	20
3 - A638 Bradford Road	8,497	5.9%	20
4 - A649 Wakefield Road	4,845	7.3%	20
5 - A62 Huddersfield Road	11,928	2.9%	20
6 - A649 Halifax Road	6,124	4.8%	20
7 - A62 Leeds Road	12,417	2.2%	20
8 - A638 (Between Union Street / Greenside and A649 Wakefield Road)	12,967	6.4%	20
9 - B6117 Northgate (West of South George Street)	6,189	6.9%	20
10a - Royle Fold	717	82.0%	5
10b - South George Street	713	82.6%	5
11 - Cemetery Road	329	1.9%	20
12 - A638 Westgate (Between Regent Street and Market Street)	9,766	5.2%	20
13 - Regent Street	3,537	4.3%	20
14 - B6117 Northgate (East of South George Street)	6,994	14.2%	20
15 - A638 High Street	10,948	5.7%	20
16 - Market Place	7,112	6.9%	20

In order to appropriately account for the emissions of buses for the scheme, data were adjusted using the above data as an input and the national traffic fleet mix from the National Atmospheric Emissions Inventory for the appropriate year to derive inputs for the Defra EFT 'Detailed Option 3'. The flows on links 10a and 10b were further modified to remove all the light and heavy goods vehicles and the flows for these categories applied to the buses and coaches category.

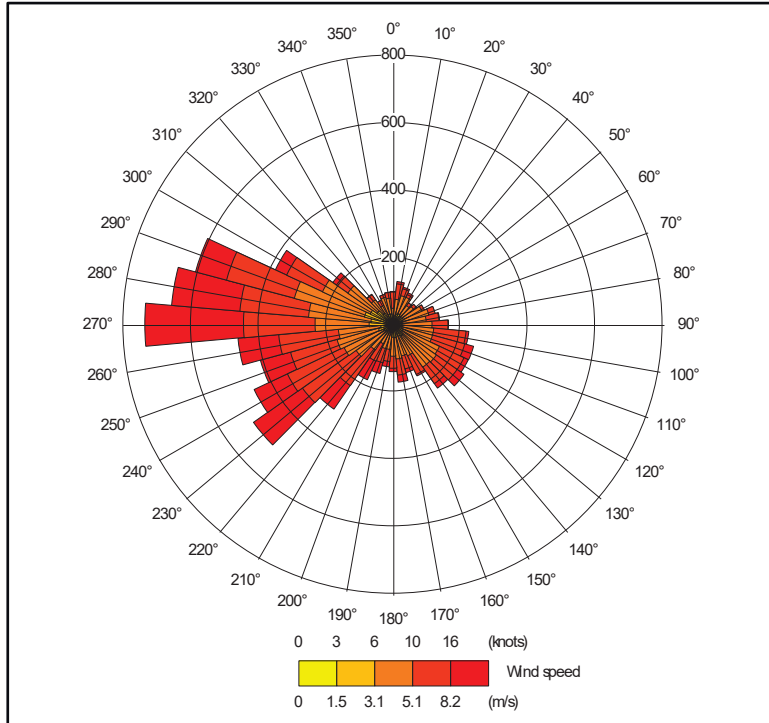
METEOROLOGICAL DATA

ADMS-Roads utilises hourly sequential meteorological data; including wind direction, wind speed, temperature, precipitation and cloud cover, to facilitate the prediction of pollution dispersion between source and receptor.

Meteorological data input to the model were obtained from the closest meteorological station, Emley Moor, for the year 2019. The 2019 data was used to be consistent with the base/verification traffic

year and were applied to the remaining scenarios for the local air quality assessment. The 2019 wind rose is presented as **Figure C1**.

Figure C1 - 2019 Wind Rose for Emley Moor



CONVERSION OF NO_x TO NO₂

NO_x concentrations were predicted using the ADMS-Roads model. The modelled road contribution of NO_x at the modelled receptor locations was then converted to NO₂ using the NO_x to NO₂ calculator (v8.1), in accordance with Defra guidance.

STREET CANYONS

Advanced street canyons created within ArcGIS using the ADMS python tool as shown in **Figure 4** were included within the model to accurately reflect air quality conditions influenced by buildings either side of the streets.

ROAD GRADIENTS

Road gradients were calculated using the Lidar (Light detection and ranging) tool and included in the model to assess the impact of gradients on air quality concentrations. These are shown in **Figure 4**.

MODEL VALIDATION

The ADMS-Roads dispersion model has been validated for road traffic assessments and is considered to be fit for purpose. Model validation undertaken by the software developer, CERC, is unlikely to have included validation in the vicinity of the scheme considered in this assessment. It is therefore necessary to perform a comparison of model results with local monitoring data at relevant locations.

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:

- Estimates of background pollutant concentrations;
- Meteorological data uncertainties;
- Traffic data uncertainties;
- Model input parameters such as ‘roughness length; and
- Overall limitations of the dispersion model

Full details of the model verification process specific to the Proposed Development modelling assessment are provided in the ‘Assessment Verification Methodology’ section below.

MODEL PRECISION

Residual uncertainty may remain after systematic error or ‘model accuracy’ has been accounted for in the final predictions. Residual uncertainty may be considered synonymous with the ‘precision’ of the model predictions, i.e. how wide the scatter or residual variability of the predicted values compare with the monitored true value, once systematic error has been allowed for. The quantification of model precision provides an estimate of how the final predictions may deviate from true (monitored) values at the same location over the same period. Suitable local monitoring data for the purpose of verification is used for model verification.

An evaluation of model performance has been undertaken to establish confidence in model results. LAQM.TG16¹³ identifies a number of statistical procedures that are appropriate to evaluate model performance and assess the uncertainty. The statistical parameters used in this assessment are:

- Root mean square error (RMSE);
- Fractional bias (FB); and
- Correlation coefficient (CC).

A brief explanation of each statistic is provided in **Table C4**, and further details can be found in Defra’s LAQM.TG16 document.

Table C4 – Model Performance Statistics

Statistical Parameter	Comments	Ideal value
RMSE	<p>RMSE is used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared.</p> <p>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.</p> <p>For example, if the model predictions are for the annual mean NO₂ objective of 40µg/m³, if an RMSE of 10µg/m³ or above is determined for a model it is advised to revisit the model parameters and model verification.</p>	0.00

	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.	
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.	0.00
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. This statistic can be particularly useful when comparing a large number of model and observed data points.	1.00

The calculations were carried out after model adjustment to provide information on the improvement of the model predictions as a result of the application of the verification adjustment factors.

ASSESSMENT VERIFICATION METHODOLOGY

The verification process involves a review of the modelled pollutant concentrations against corresponding monitoring data to determine how well the air quality model has performed. Depending on the outcome it may be considered that the model has performed adequately and that there is no need to adjust any of the modelled results LAQM.TG16¹³.

Alternatively, the model may perform outside of the ideal performance limits as stated by LAQM.TG16¹³ (i.e. model agrees within +/-25% of monitored equivalent, but ideally within +/-10%). There is then a need to check all the input data to ensure that it is reasonable and accurately represented in the air quality modelling process.

Where all input data, such as traffic data, emissions rates, and background concentrations have been checked and considered as reasonable, then the modelled results require adjustment to best align with the monitoring data. This may either be a single verification adjustment factor to be applied to the modelled concentrations across the study area, or a range of different adjustment factors to account for different zones in the study area e.g. major roads, local roads.

The air quality model has been run to predict the 2019 annual mean road-NO_x contribution at four KC roadside diffusion tubes adjacent to the modelled road network, based on traffic data provided for the 2019 baseline scenario. One diffusion tube, also adjacent to the model road roadwork (K35) was excluded from the verification as it had insufficient data capture for 2019 (50%).

The model outputs of road-NO_x have been compared with the 'measured' road-NO_x, which was determined from the NO₂ concentrations measured using diffusion tubes at the monitoring locations, utilising the NO_x from NO₂ calculator provided by Defra and the NO₂ background concentration (from the Defra background map). As discussed in the methodology section, the most recent suitable data available for model verification purposes is 2019 data.

The tables and figure below present the data used in the verification exercise.

Table C5 – Data Used in Model Verification – Before Adjustment

Monitoring Site	2019 Measured Data ($\mu\text{g}/\text{m}^3$)	Measured Road-NO _x ($\mu\text{g}/\text{m}^3$) (from NO _x :NO ₂ calculator)	Modelled Road-NO _x ($\mu\text{g}/\text{m}^3$) – Before Adjustment	Modelled Annual Mean NO ₂ Concentration ($\mu\text{g}/\text{m}^3$) – Before Adjustment	% Difference (Measured vs Monitored NO ₂)
K33	27.4	22.1	8.5	19.3	-29.6
K34	33.0	33.5	13.6	22.2	-32.7
K48	36.4	42.8	17.6	23.8	-34.8
K51	28.3	18.3	11.8	22.3	-21.3

Table C5 shows that the model is under predicting at all locations. Furthermore, the pre-adjustment RMSE was $9.7 \mu\text{g}/\text{m}^3$ which exceeds the ideal $4 \mu\text{g}/\text{m}^3$ (10% of the annual mean objective). Therefore, verification of the model was progressed to derive an appropriate road-NO_x adjustment factor.

The road-NO_x adjustment factor was determined as the slope of the best fit line between the ‘measured’ road contribution and the model derived road contribution, forced through zero (see **Figure C2**). This factor (**2.14**) was then applied to the modelled road-NO_x concentration for each monitoring site to provide adjusted modelled road-NO_x concentrations (as shown in **Table C6**). The total NO₂ concentrations were then determined by inputting the adjusted modelled road-NO_x concentrations and the background NO₂ concentration into the NO_x to NO₂ calculator.

Figure C2: Comparison of Measured Road-NO_x with Unadjusted Modelled Road-NO_x

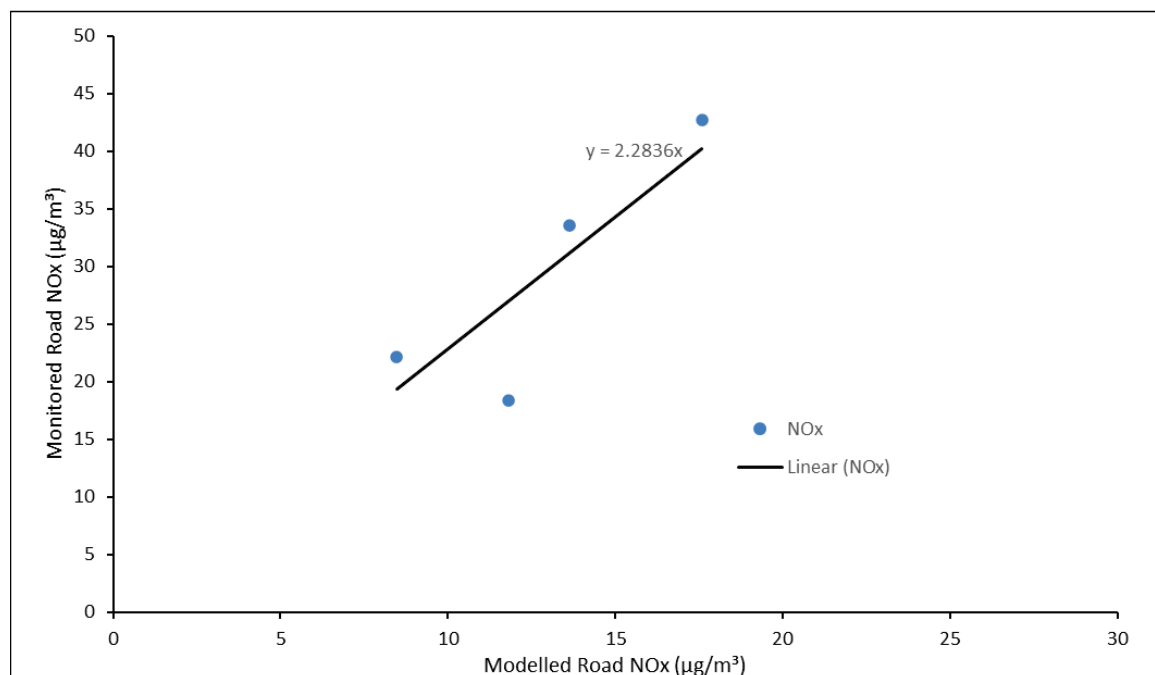
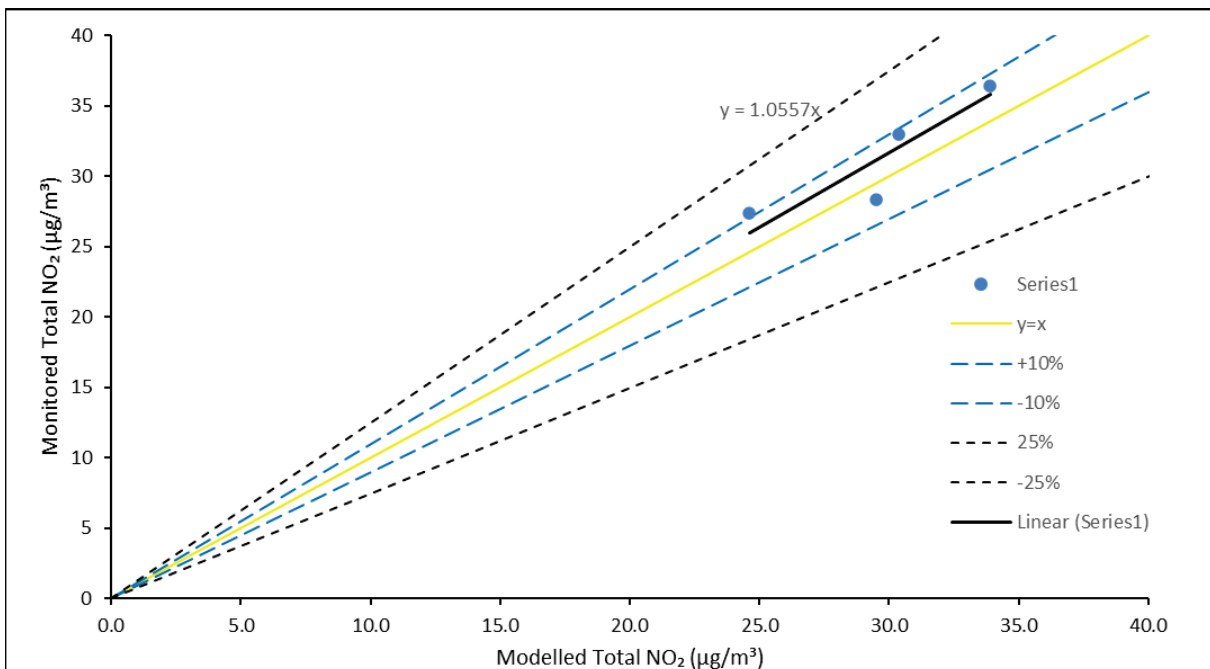


Table C6 – Data Used in Model Verification – After Adjustment

Monitoring Site	2019 Measured Data ($\mu\text{g}/\text{m}^3$)	Modelled Annual Mean NO_2 Concentration ($\mu\text{g}/\text{m}^3$) – After Adjustment	% Difference (Measured vs Monitored NO_2)
K33	27.4	24.6	-10.1
K34	33.0	30.4	-7.9
K48	36.4	33.9	-6.9
K51	28.3	29.5	+4.2

Figure C3 – Comparison of Monitored and Modelled Annual Mean NO_2 after Adjustment



With the adjustment of modelled road- NO_x applied, the resulting annual mean NO_2 concentrations at each monitoring site were within +/- 10.5% of the monitored equivalents apart from one point as shown in **Figure C4**.

Statistical analyses undertaken for the results is presented in **Table C7**.

Table C7 – Model Verification Statistics

Statistic	Pre-adjustment	Post-adjustment
RMSE ($\mu\text{g}/\text{m}^3$)	9.73	2.36
Fractional Bias	0.35	0.06
Correlation Coefficient	0.81	0.89



The information in Table C7 shows that the verification exercise has substantially reduced the error and bias in the model and improved its performance.

PM₁₀ AND PM_{2.5}

There are no local PM₁₀ 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-PM₁₀ and road-PM_{2.5} contributions, consistent with guidance set out in LAQM.TG16¹³.

Appendix D

DISPERSION MODEL RESULTS

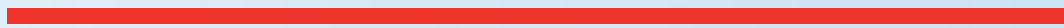


Table D1 – Impact of 2023 Annual Mean NO₂ Concentrations (µg/m³)

Receptor	2019 Base (µg/m ³)	2023 Without Proposed Development (µg/m ³)	2023 With Proposed Development (µg/m ³)	Change (µg/m ³)	% Change of AQO	Impact (EPUK/IAQM ¹⁴)
R1	13.1	9.2	9.5	0.3	0.8	Negligible
R2	13.7	9.6	9.9	0.3	0.7	Negligible
R3	15.8	11.2	11.1	0.0	0.1	Negligible
R4	14.3	10.0	10.2	0.1	0.3	Negligible
R5	14.8	10.4	10.9	0.5	1.3	Negligible
R6	18.6	13.0	13.7	0.7	1.6	Negligible
R7	22.8	16.1	16.0	-0.2	0.4	Negligible
R8	19.3	13.5	13.5	0.0	0.0	Negligible
R9	14.9	10.4	10.8	0.3	0.8	Negligible
R10	22.9	16.1	17.0	0.9	2.2	Negligible
R11	20.6	14.4	15.2	0.8	2.0	Negligible
R12	28.4	19.9	21.6	1.7	4.1	Negligible
R13	14.7	11.1	17.2	6.1	15.3	Moderate*
R14	13.6	9.5	10.2	0.8	1.9	Negligible
R15	19.1	13.5	15.1	1.7	4.2	Negligible
R16	9.8	6.9	7.2	0.3	0.8	Negligible
R17	12.6	8.9	9.6	0.8	1.9	Negligible
R18	23.1	16.4	20.0	3.6	9.0	Slight*
R19	17.2	12.1	12.9	0.8	2.1	Negligible
R20	10.6	7.3	7.7	0.4	0.9	Negligible
R21	20.7	14.2	14.7	0.5	1.1	Negligible

* Not representative of exposure over an annual averaged period

Table D2 – Impact of 2023 Annual Mean PM₁₀ Concentrations (µg/m³)

Receptor	2019 Base (µg/m³)	2023 Without Proposed Development (µg/m³)	2023 With Proposed Development (µg/m³)	Change (µg/m³)	% Change of AQO	Impact (EPUK/IAQM¹⁴)
R1	14.8	14.2	14.3	0.1	0.3	Negligible
R2	14.8	14.1	14.2	0.1	0.2	Negligible
R3	16.1	15.4	15.3	-0.1	0.2	Negligible
R4	14.7	14.1	14.1	0.0	0.0	Negligible
R5	14.6	14.0	14.1	0.1	0.2	Negligible
R6	15.3	14.6	14.8	0.2	0.5	Negligible
R7	15.9	15.2	15.1	-0.1	0.2	Negligible
R8	15.3	14.5	14.6	0.1	0.2	Negligible
R9	14.3	13.6	13.7	0.1	0.2	Negligible
R10	16.7	15.9	16.2	0.3	0.7	Negligible
R11	16.1	15.4	15.6	0.2	0.5	Negligible
R12	16.9	16.1	16.4	0.3	0.7	Negligible
R13	13.8	13.2	13.5	0.3	0.8	Negligible
R14	14.6	13.9	14.1	0.2	0.5	Negligible
R15	16.0	15.3	15.7	0.4	1.0	Negligible
R16	14.0	13.4	13.5	0.1	0.2	Negligible
R17	14.2	13.5	13.6	0.1	0.2	Negligible
R18	16.5	15.8	16.3	0.5	1.3	Negligible
R19	15.4	14.7	15.0	0.3	0.8	Negligible
R20	14.4	13.7	13.8	0.1	0.3	Negligible
R21	17.1	16.3	16.4	0.1	0.2	Negligible

Table D3 – Impact of 2023 Annual Mean PM_{2.5} Concentrations (µg/m³)

Receptor	2019 Base (µg/m ³)	2023 Without Proposed Development (µg/m ³)	2023 With Proposed Development (µg/m ³)	Change (µg/m ³)	% Change of AQO	Impact (EPUK/IAQM ¹⁴)
R1	9.8	9.3	9.3	0.0	0.0	Negligible
R2	9.8	9.3	9.3	0.0	0.0	Negligible
R3	10.3	9.8	9.8	0.0	0.0	Negligible
R4	9.4	8.9	8.9	0.0	0.0	Negligible
R5	9.4	8.9	8.9	0.0	0.0	Negligible
R6	9.8	9.2	9.3	0.1	0.5	Negligible
R7	10.1	9.5	9.5	0.0	0.0	Negligible
R8	9.7	9.2	9.2	0.0	0.0	Negligible
R9	9.4	8.9	8.9	0.0	0.0	Negligible
R10	10.5	10.0	10.1	0.1	0.5	Negligible
R11	10.2	9.7	9.8	0.1	0.5	Negligible
R12	10.7	10.1	10.2	0.1	0.5	Negligible
R13	9.4	8.9	9.1	0.2	1.0	Negligible
R14	9.5	9.1	9.1	0.0	0.0	Negligible
R15	10.2	9.6	9.8	0.2	1.0	Negligible
R16	9.5	9.0	9.0	0.0	0.0	Negligible
R17	9.6	9.1	9.2	0.1	0.5	Negligible
R18	10.3	9.8	10.0	0.2	1.0	Negligible
R19	10.0	9.5	9.6	0.1	0.5	Negligible
R20	9.4	9.0	9.0	0.0	0.0	Negligible
R21	10.4	9.8	9.8	0.0	0.0	Negligible



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