11 Air Quality

11.1 Introduction

11.1.1 This chapter of the ES was prepared by Buro Happold and presents an assessment of the likely significant effects of the Proposed Development on Air Quality at sensitive receptor locations. Mitigation measures are identified, where appropriate, to avoid, reduce or offset any significant adverse effects identified and/or enhance likely beneficial effects. The nature and significance of the likely residual effects are reported.

11.1.2 The chapter is supported by the following appendices:

- Appendix 11.1: Policy and guidance;
- Appendix 11.2: Diffusion tube survey;
- Appendix 11.3: Construction assessment methodology;
- Appendix 11.4: Supplied traffic data and scenarios;
- Appendix 11.5: IAQM criteria for undertaking detailed assessment;
- Appendix 11.6: Modelled receptors;
- Appendix 11.7: Assessment of air quality impacts on ecological sites methodology;
- Appendix 11.8: Model verification;
- Appendix 11.9: Human receptor modelled results;
- Appendix 11.10: Construction dust mitigation measures;
- Appendix 11.11: Ecological receptor modelled results; and
- Appendix 11.12: Damage cost calculations.

Competence

11.1.3 This work was overseen and approved by Peter Henshaw a chartered scientist (CSci), full member of the institute of air quality management (MIAQM) and full member of the Institute of Environmental Sciences (MIEnvSc) with over ten years experience in air quality consultancy, having produced numerous air quality assessments and air quality ES chapters.

11.1.4 This work was supported by Kit Benjamin. Kit has over two years professional experience including undertaking air quality assessments for a wide range of projects. He has a first class integrated master's degree in meteorology and climate (MMet) from the University of Reading. He is an associate member of the Institute of Air Quality Management and Institution of Environmental Science (AMIEnvSc).

11.2 Legislation, Planning Policy and Guidance

Legislation Context

11.2.1 The following legislation is relevant to the Proposed Development:

- Part IV of the Environment Act 1995[1];

- Environment Act 2021[2];
- The Air Quality Standards Regulations 2010[3]; and
- The Environmental Targets (Fine Particulate Matter) (England) Regulations 2023[4].

Policy Context

11.2.2 The following national, regional and local policy is relevant to the Proposed Development:

National

- National Planning Policy Framework (2021)[5];
- The Air Quality Strategy for England (2023)[6];
- 25 Year Environment Plan (2018)[7];
- The Clean Air Strategy (2019)[8]; and
- The Environmental Improvement Plan (2023)[9].

Regional

- Oxford-Cambridge Arc Spatial Framework (Consultation) (2021)[10];
- Oxfordshire County Council Local Transport and Connectivity Plan (2022)[11]; and
- Oxfordshire County Council Air Quality Strategy 2023-2030 (2023)[12].

Local

- Cherwell Local Plan 2011-2031 (2015)[13]; and
- Cherwell Air Quality Action Plan (2017)[14].

Guidance

11.2.3 The following guidance was followed in carrying out this assessment:

- Planning Practice Guidance (2019)[15]
- Institute for Air Quality Management (IAQM) guidance on the assessment of air quality impacts on designated nature conservation sites (2020)[16];
- Air Quality Advisory Group AQTAG06 technical guidance on detailed modelling approach for an appropriate assessment for emissions to air (2014)[17];
- Woodland Trust guidance on assessing air pollution impacts on ancient woodland – ammonia (2019)[18];
- IAQM guidance on land-use planning and development control (2017)[19];
- IAQM guidance on the assessment of dust from demolition and construction (2014)[20]; and
- Defra Local Air Quality Management Technical Guidance (TG22) (2022)[21].

11.2.4 The air quality legislation, policy and guidance relevant to the Proposed Development is outlined in further detail in Appendix 11.1.

11.3 Assessment Methodology

Consultation

EIA Scoping

11.3.1 No topic-specific consultation was carried out for air quality. A request for a Scoping Opinion was submitted by the Applicant to CDC on 9th December 2022. An EIA Scoping Report (the 'Scoping Report') accompanied the request (Appendix 3.2). A Scoping Opinion was issued by the CDC on 27th January 2023 (Appendix 3.3) which included comments from statutory consultees. Table 11.1 summarises key comments raised by consultees of relevance to this assessment by the EIA Scoping Opinion and how the assessment has responded to them.

Table 11.1: EIA Scoping Opinion Response

Consultee and Comment	Response
Canal and River Trust (28 December 2022)	
The applicant is asked to consider the need for the canal corridor, users of the canal towpath and occupants of moored boats to be included as a sensitive receptor for pollution including air quality/dust in particular during the construction phase.	Moored boats on surrounding canals were considered as high sensitivity receptors to dust soiling and health impacts from dust and PM_{10} emissions generated during construction. They have also been included as receptors in the dispersion model to assess the impact of traffic on surrounding air quality.
CDC (27 January 2023)	
It should be noted that measures should be included as a result of the introduction of climate policy, e.g. electric vehicle rollout and Future Homes Standard should be taken into account.	The site will accommodate electric vehicle (EV) infrastructure that will account for current and future charging requirements. Electric vehicle parking provision will be in compliance with OCC's New Street Design Guide and Parking Standards for New Developments. In addition, the smart energy system will allow for sufficient energy provision such that EVs can be accommodated on site during the early phases of the Proposed Development. Heating, cooling and hot water will be provided by air source heat pumps which will not give rise to any on-site emissions. The generation of on-site zero carbon energy will be optimised to reduce the requirement of imported energy from the grid.
CDC (27 January 2023)	
In respect of Para 9.10. the issue of remediation of the previously contaminated land and whether there would be any airborne contaminants released as part of	Ground conditions have been assessed in Chapter 15 of the ES, which includes a ground condition human health risk assessment (Appendix 15.1).

Consultee and Comment	Response
bringing this into meaningful use would need to be accounted for in the Environmental Statement.	Several contaminants were identified in the wider Site, including naturally occurring arsenic, beryllium and dibenz(a,h)anthracene. The risk level for human health exposure to these contaminants has been determined to be low. In the historical landfill area, the same elevated contaminants as the wider Site were reported, in addition to lead, benzo(b)fluoranthene, asbestos containing materials and low concentrations of asbestos fibres of chrysotile and amosite. The risk levels for lead and benzo(b)fluoranthene are low and from asbestos fibres is moderate. To mitigate this risk a remediation strategy has been prepared (Appendix 15.2). The remediation strategy and verification plan outlines a number of mitigation measures which are considered embedded mitigation. Following implementation of embedded mitigation, the effect on human health from exposure to contamination would be of negligible adverse significance.

Summary of Assessment Scope

11.3.2 As outlined within the EIA Scoping Report (Appendix 3.2), and as agreed with CDC via the EIA Scoping Opinion (Appendix 3.3), the scope of the Air Quality assessment within this chapter was limited to the following assessment of effects:

Construction

11.3.3 Effects from dust and PM_{10} emissions generated during the construction phase from demolition, earthworks, construction and trackout[1] was assessed. This focussed on risk of impacts to the health and amenity of surrounding human receptors, as well as the integrity of surrounding ecological sites.

11.3.4 The impact of pollutant emissions from construction vehicle traffic on air quality at surrounding sensitive human receptor locations was also assessed.

Completed Development

11.3.5 Environmental Protection UK (EPUK) and the IAQM have published guidance on the consideration of air quality within the planning and development control process. This guidance includes criteria which identify when relevant operational impacts can be screened

[1] 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.

out as 'not significant' or require further assessment. Criteria relevant to this assessment are detailed in Table 11.2.

Table 11.2: IAQM/EPUK screening criteria for detailed air quality assessment.

The development will:	*Indicative criteria to proceed to detailed assessment:*
Cause a significant change in Light Duty Vehicle (LDV) traffic flows on local roads with relevant receptors. (LDV = cars and small vans.	A change of LDV flows of: - more than 100 annual average daily traffic (AADT) within or adjacent to an AQMA - more than 500 AADT elsewhere.
Cause a significant change in Heavy Duty Vehicle (HDV) flows on local roads with relevant receptors. (HDV = goods vehicles + buses >3.5t gross vehicle weight).	A change of HDV flows of: - more than 25 AADT within or adjacent to an AQMA - more than 100 AADT elsewhere.
Have one or more substantial combustion processes, where there is a risk of impacts at relevant receptors. NB. this includes combustion plant associated with standby emergency generators (typically associated with centralised energy centres) and shipping.	Typically, any combustion plant where the single or combined NOx emission rate is less than 5 mg/sec is unlikely to give rise to impacts, provided that the emissions are released from a vent or stack in a location and at a height that provides adequate dispersion. In situations where the emissions are released close to buildings with relevant receptors, or where the dispersion of the plume may be adversely affected by the size and/or height of adjacent buildings (including situations where the stack height is lower than the receptor) then consideration will need to be given to potential impacts at much lower emission rates. Conversely, where existing nitrogen dioxide concentrations are low, and where the dispersion conditions are favourable, a much higher emission rate may be acceptable.

11.3.6 Heating, cooling and hot water will be provided via air source heat pumps which will not lead to any emissions of air pollutants on-site. Therefore, the heating, cooling and hot water strategy will not have an impact on surrounding air quality and combustion plant emissions are scoped out of the assessment.

11.3.7 Back-up energy requirements for emergencies has not been determined at this stage. This shall be determined at the detailed design stage. The air quality impact of any combustion plant required for emergency/back-up purposes should be assessed at the detailed design/reserved matters stage. However, it is anticipated with appropriate design such plant would not likely lead to any significant air quality effects.

11.3.8 The impact of emissions from traffic generated by the Proposed Development on air pollutant concentrations at human receptors and designated ecological sites was assessed quantitatively.

Non-Significant Effects

11.3.9 All other air quality and odour effects were scoped out of further assessment within this ES. Section 9 of the Scoping Report provides further details and justification.

Study Area

11.3.10 During the construction phase, sensitive receptors may be affected by construction activities up to 350m from the Site boundary and within 50m of roads used by construction traffic up to 500m from the Site access, in line with IAQM guidance.

11.3.11 In the operational phase, the spatial scope was determined by the scale of emissions arising from the operation of the Proposed Development. Air quality impacts were assessed in proximity to any road links on which there is an increase in traffic volume resulting from the Development that exceeds the criteria outlined in IAQM guidance.

Establishing Baseline Conditions

11.3.12 Baseline data was gathered from the following sources:

- CDC 2022 Air Quality Annual Status Report[22];
- Defra's air quality background maps[23]; and
- Diffusion tube monitoring carried out by Buro Happold.

11.3.13 2019 is considered to be the most representative 'typical baseline year from publicly available data as this is the most recent full year that was not impacted by the COVID-19 pandemic. The restrictions imposed in response to the COVID-19 pandemic, in addition to the changes in travel patterns and subsequent emissions, significantly impacted pollutant concentrations making monitoring results from 2020 and 2021 atypical from previous years. Therefore, the baseline assessment assumes 2019 to be the most representative year of baseline conditions.

11.3.14 To supplement available sources of baseline data, Buro Happold undertook a six-month air quality monitoring survey in the area surrounding the Site. Monitoring was carried out at eight locations. Monitoring commenced on 10th August 2022 and continued until 3rd February 2023. In line with Defra LAQM Technical Guidance (TG22), results were annualised and bias adjusted, to determine the equivalent annual mean value. Details of the monitoring study and associated data processing are presented in Appendix 11.2.

Assessing Likely Significant Effects

Construction

On-site Construction Activities

11.3.15 Potential construction effects were assessed in accordance with the IAQM construction dust guidance. This document provides a methodology for assessing air quality impacts from demolition, earthworks, construction and trackout activities which may be associated with a development. The construction assessment methodology involved the following steps:

1. A screening assessment to identify the need for detailed assessment. Detailed assessment was required as there was:
    a) A human receptor within:

- 350m of the Site boundary; or
- 50m of the route(s) used by construction vehicles on the public highway, up to 500m from the Site entrance(s).

b) An ecological receptor within:

- 50m of the Site boundary; or
- 50m of the route(s) used by construction vehicles on the public highway, up to 500m from the Site entrance(s).

2. Assessment of the risk of dust impacts by:

a) Defining the potential dust emission magnitude;
b) Defining the sensitivity of the area; and
c) Assessing the risk of impacts. Criteria for defining the dust impacts are shown in Appendix 11.3.

3. Determine site-specific mitigation for each of the four possible construction activities; and
4. Examine residual effects to determine whether they are significant.

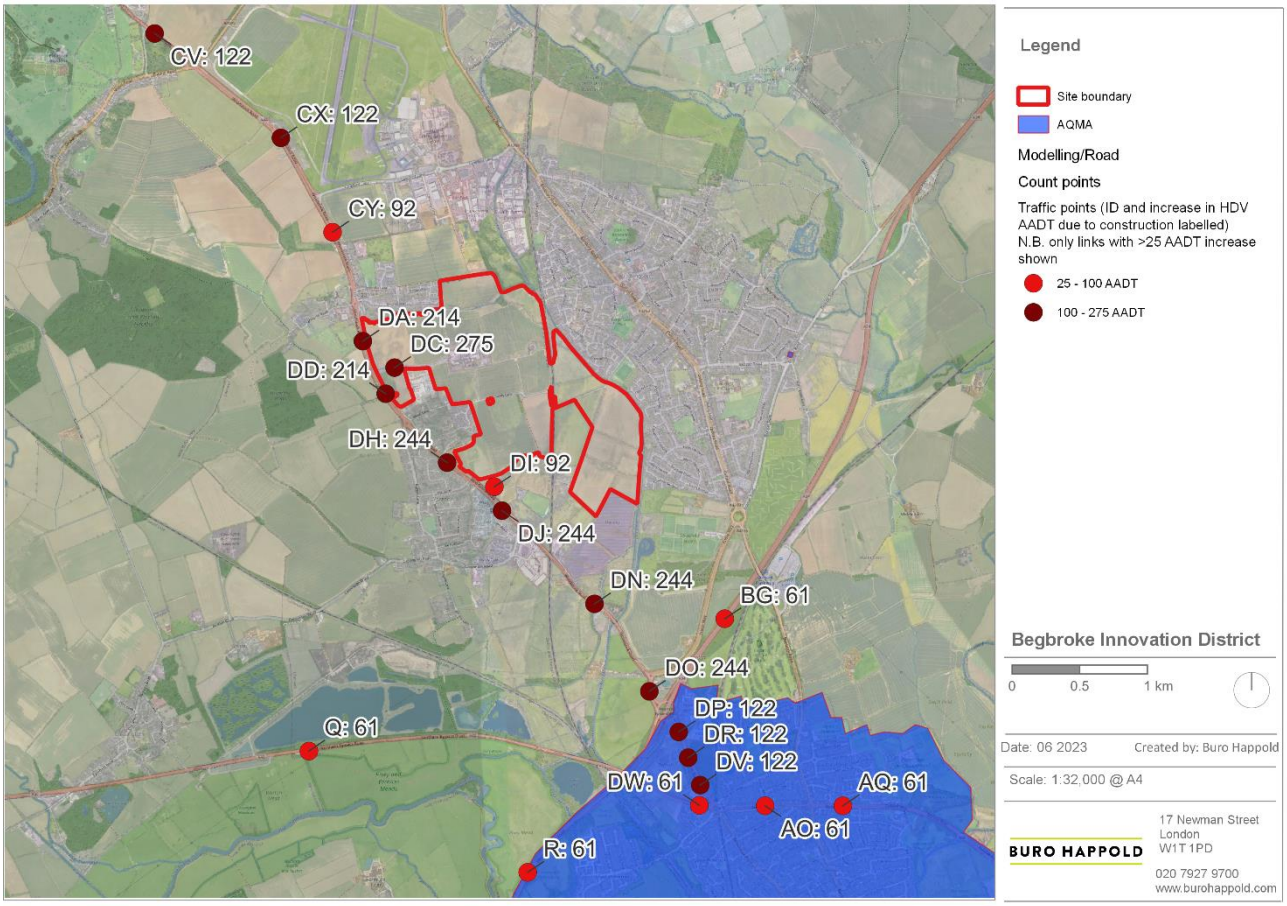
11.3.16 IAQM guidance suggests that the significance of any adverse effect is reported post-mitigation, assuming all actions to avoid or reduce environmental effects are an inherent part of the Proposed Development. A detailed explanation of the methodology is presented in Appendix 11.3.

Construction Traffic

11.3.17 Construction traffic data was provided by the project transport consultant. This is presented in full in Appendix 11.4. Links with increases in heavy duty vehicle (HDV) construction traffic greater than 25 annual average daily traffic (AADT) are presented in Figure 11.1.

11.3.18 Road links DC and DI are the only two access roads to the Site, with DC accessing the north and DI the south. There is predicted to be an increase in HDV traffic of 275 along DC and 91 AADT along DI. On the wider network, a maximum increase of 244 HDV AADT along the A44 Woodstock Road is predicted. Increases of over 100 HDV AADT within the City of Oxford Air Quality Management Area (AQMA) (see section 11.4.1) are also predicted. These increases are above the IAQM screening threshold for detailed assessment of 25 HDV AADT within an AQMA and 100 AADT outside of an AQMA (see Appendix 11.5). Therefore, a quantitative assessment was carried out following the methodology presented below.

Figure 11.1: Road links with an increase in HDV traffic >25 AADT due to the construction of the Proposed Development



Completed Development

Traffic Emissions

11.3.19 Traffic generated by the Proposed Development will give rise to emissions of nitrogen oxides (NO_x) and particulate matter (PM_{10} and $PM_{2.5}$), and to a lesser extent ammonia (NH_3), which can have a potential impact on air quality at both human and ecological receptors. Operational traffic data was provided by the project transport consultant (presented in full in Appendix 11.4).

11.3.20 Traffic data was supplied for the following six scenarios:

- **Scenario 1 -** Existing baseline (2019);
- **Scenario 2** - Future baseline (Do Nothing) with Sandy Lane closed (2033);
- **Scenario 3** - Future baseline with Proposed Development. Background mode shift included (2033);
- **Scenario 4** - Future baseline with Proposed Development and cumulative PR sites[2]. Background mode shift included (2033);
- **Scenario 5** - Future baseline without Proposed Development construction traffic (2028); and
- **Scenario 6** - Future baseline with Proposed Development construction traffic (2028).

11.3.21 The impact of the Proposed Development on traffic during the operational phase was determined by comparing scenario 2 and scenario 3. The cumulative impact of the Proposed Development and the PR sites on traffic during the operational phase was determined by comparing scenario 2 and scenario 4.

11.3.22 These scenarios include a background mode shift in traffic flows. The background mode shift is a result of increased connectivity via public and sustainable transport due to infrastructure improvements as part of the PR site transport strategy. As the infrastructure to instigate this mode shift relies on the Proposed Development, the mode shift is considered an inherent aspect of the Proposed Development.

11.3.23 The impact of the Proposed Development during the construction phase was assessed by comparing scenario 5 and scenario 6.

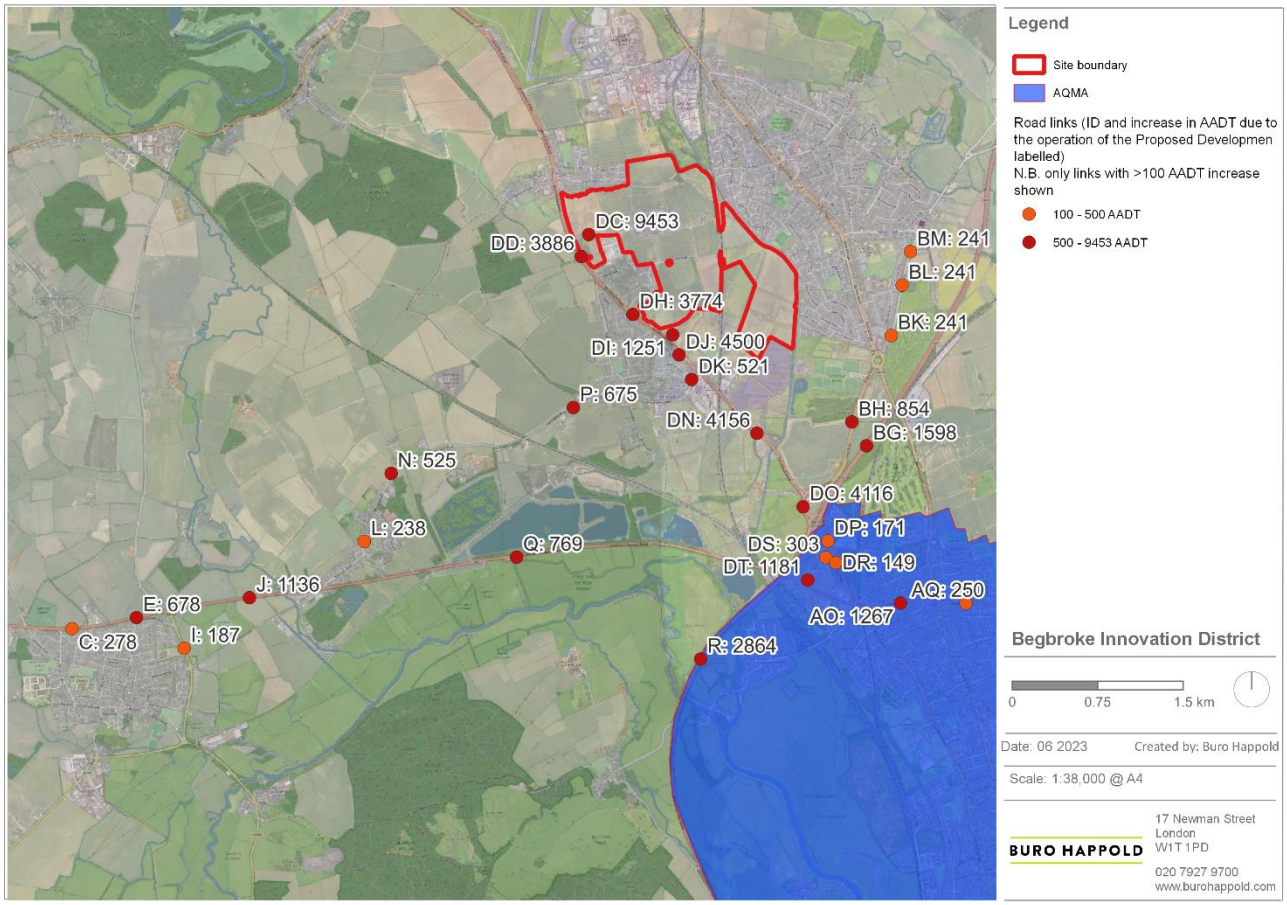
11.3.24 The changes in traffic flows on links will be a result of a combination of development traffic, re-routing of vehicles based on traffic conditions and a background mode shift towards sustainable modes. The traffic data scenarios are explained in more detail in Appendix 11.4 and Chapter 9 of the ES.

11.3.25 There will be an increase in light duty vehicle (LDV) traffic of 9,453 and 1,251 AADT on the Site access roads DC and DI, respectively (Figure 11.2). Therefore, the Proposed Development is predicted to generate 10,704 daily vehicle trips on average.

[2] The PR sites are land parcels allocated for development within the Cherwell Local Plan 2011-2031 (Part 1) Partial Review - Meeting Oxford's Unmet Housing Need, of which the Site is part of one, site PR8.

11.3.26 On the wider network, there will be a maximum increase of 4,500 AADT at link DJ along the A44 Woodstock Road. There will also be increases of over 100 AADT within the Bicester Road and City of Oxford AQMAs.

Figure 11.2: Road links with an increase in traffic >100 AADT due to the construction of the Proposed Development



11.3.27 As the increases in traffic are above the IAQM screening threshold for proceeding to a detailed assessment (>100 AADT within an AQMA, >500 AADT anywhere else, as shown in Table 11.2), a quantitative assessment was carried out.

11.3.28 Due to the proposed land uses, there will not be a material increase in HDV traffic directly associated with the Proposed Development. Whilst there will be an increase in HDV traffic on some road links due to re-routing of traffic, these increases are not considered significant in comparison to the change in LDV traffic.

11.3.29 The impact of the Proposed Development was predicted at reasonable worst case existing and proposed future receptor locations using the dispersion model ADMS-Roads (v5). This model is developed by Cambridge Environmental Research Consultants (CERC) and can be used to assess the impact of vehicle emissions on local air quality.

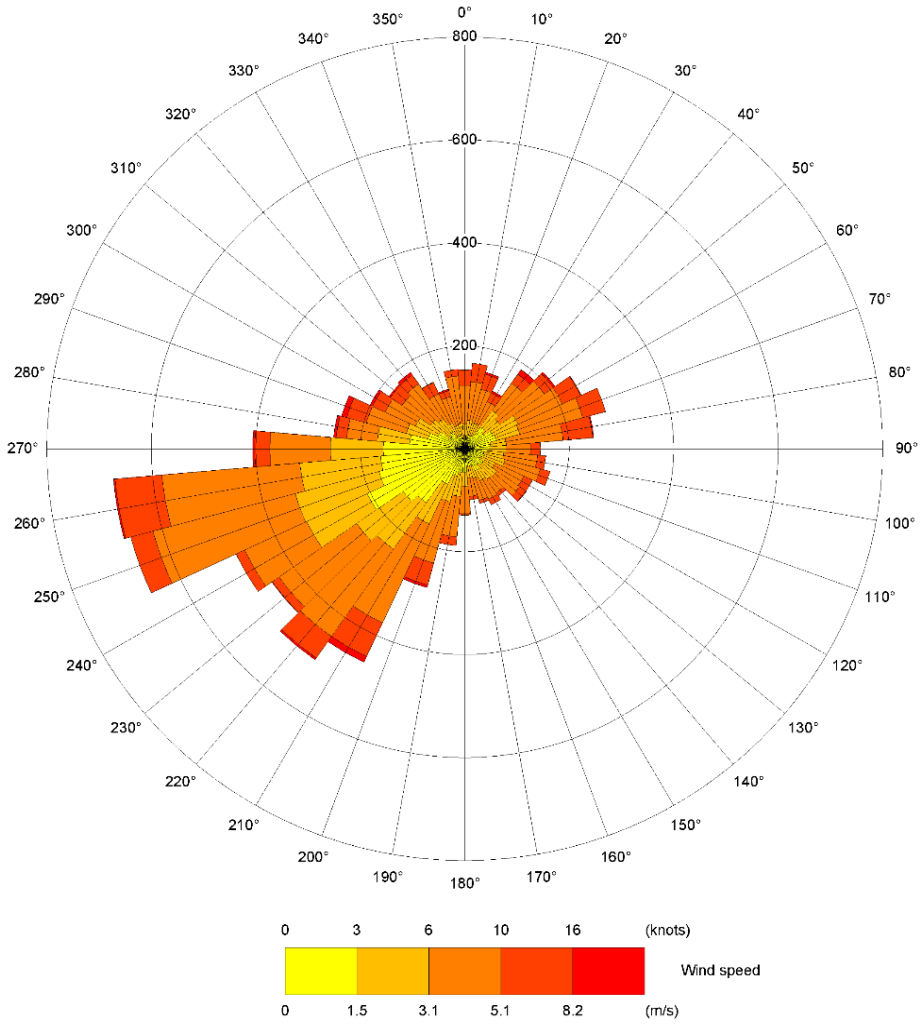
11.3.30 Unlike simpler spreadsheet screening tools, it can include parameters such as variable meteorological conditions, complex road networks (including the combined contribution of multiple road links on single sensitive receptors) and the capability of including the effects

of complex terrain, atmospheric chemistry and street-canyon effects. The model is widely used by local authorities in the UK as part of their review and assessment obligations.

Meteorological Data

11.3.31 Hourly sequential meteorological data from Brize Norton for 2019 was used in the traffic emissions modelling. This is the closest meteorological monitoring site to the Site and likely most closely represents meteorological conditions. Data was obtained from the Met Office MIDAS dataset[24]. There is a 99.7% data availability for all variables in 2019. A wind rose of the meteorological data used in this assessment is presented in Figure 11.3.

Figure 11.3: Wind rose for Brize Norton in 2019.



11.3.32 Surface roughness represents the extent of mechanical turbulence in the atmosphere caused by the roughness of the ground over which the air is passing. A surface roughness length was calculated using the morphometric calculator within the UMEP QGIS plugin[25]. A roughness length of 0.605m was used at the Site and 1.008m at the meteorological measurement site.

11.3.33 The Monin-Obukhov length represents the stability of the atmosphere. In urban areas, there is a significant amount of heat generated by buildings and traffic which warms the air above the city creating an effect called urban heat island. This additional heat prevents the

atmosphere from becoming very stable in urban areas, meaning the Obukhov length will never fall below a certain value in stable conditions. A minimum Obukhov length of 10m was used for the Site, which is typical for small towns and villages.

Background Concentrations

11.3.34 The background pollutant concentrations across the study area were determined using the national pollution maps published by Defra. These cover the whole of the UK on a 1x1 km grid and are published for each year from 2018 until 2030. The Site area covers multiple grid squares.

11.3.35 Defra modelled background concentrations for the grid square in which each existing receptor is within were used when assessing the impact of the Proposed Development. The background concentrations at each receptor are presented in Appendix 11.5.

Model Adjustment and Verification

11.3.36 The roads within the ADMS model have undergone a detailed adjustment and verification process which followed the methodology set out in Defra's local air quality management technical guidance (LAQM TG(22)) Box 7.18.

11.3.37 Each road was appraised and adjusted following a detailed review of the road layout using satellite imagery and geographical information system (GIS) software.

11.3.38 The drawn road layout considers:

- Road width;
- Existing junctions; and
- Road links where queuing is expected.

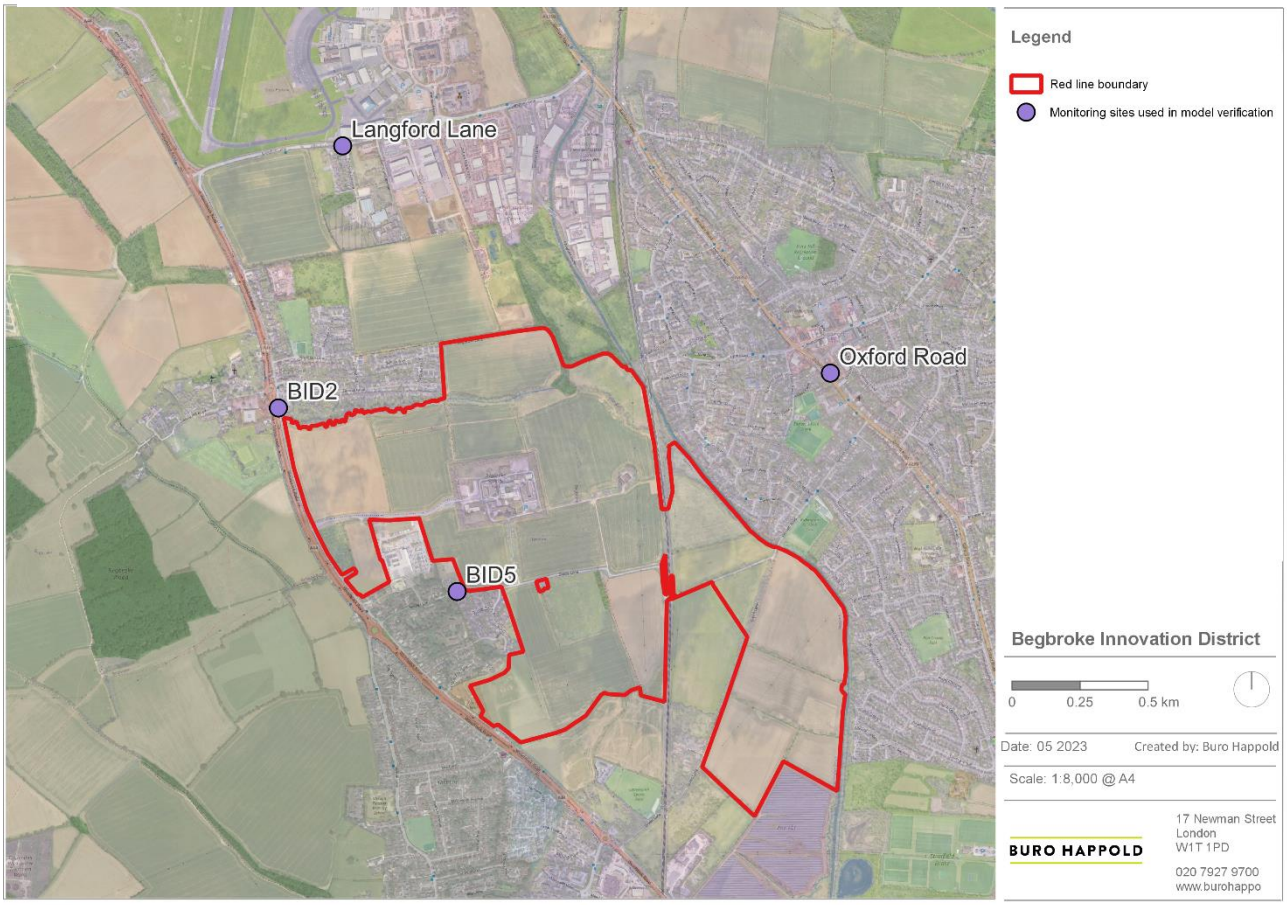
11.3.39 Speeds were determined based on the speed limit of each road, with a general reduction applied for all roads to account for any slowing of traffic. The speed was reduced on portions of roads close to junctions or where queuing is expected.

11.3.40 Verification is an iterative process that follows the following key steps:

- Identify all roadside monitoring sites within a relevant proximity to road links within the modelled domain;
- Appraise monitoring sites and ensure the location and height given in the Annual Air Quality Status Reports are as accurate as possible;
- Remove sites that are not suitable for model verification (e.g. located in close proximity to a bus stop, inappropriate diffusion tube siting, poor data capture);
- Compare modelled and monitored NOx concentrations, identify areas and sites where the differences are similar to identify verification zones; and
- Calculate adjustment factors for each of the identified zones and ensure difference between modelled and monitored NO_2 concentrations are within 25%.

11.3.41 CDC monitoring sites on Lanford Lane, Oxford Road and Buro Happold monitoring sites on Sandy Lane and Woodstock Road (locations shown in Figure 11.4) were used in the verification process.

Figure 11.4 Monitoring sites used in verification process



11.3.42 Results indicate that the model under-predicts road NOx contribution, which is a common occurrence, and it was necessary to apply an adjustment factor. An adjustment factor of 2.426 was calculated by comparing the modelled outputs to the monitored concentrations, this was applied to all modelled NOx concentrations and human and ecological receptor locations. Appendix 11.7 details the calculations and results from model verification.

11.3.43 The relevant adjustment factor was applied to modelled road NOx. The same adjustment factor was also applied to modelled PM_{10} and $PM_{2.5}$ results.

Model Post-processing

11.3.44 The model was used to predict road-NOx, PM_{10} and $PM_{2.5}$ concentrations (i.e. road contribution) at each receptor location. These concentrations were adjusted following the verification process set out above. To derive NO_2 concentrations from modelled NOx, results were processed through the NOx to NO_2 calculator (v8.1) available on the Defra LAQM Support website[26]. This calculator predicts the component of NO_2 based on the adjusted road-NOx and the background NOx and NO_2.

Human Receptors

11.3.45 Pollutant concentrations were predicted at human receptor locations adjacent to roads predicted to experience an increase in AADT flows above the IAQM criteria. Human receptors include moored canal boats on the River Thames, Oxford Canal and Dukes Cut. The human receptor locations for the operational assessment are presented in Figure 11.5. Human receptor locations for the construction traffic impacts are presented in Figure 11.6. Full details of human receptor locations are presented in Appendix 11.5.

Figure 11.5: Human receptor locations for operation impacts

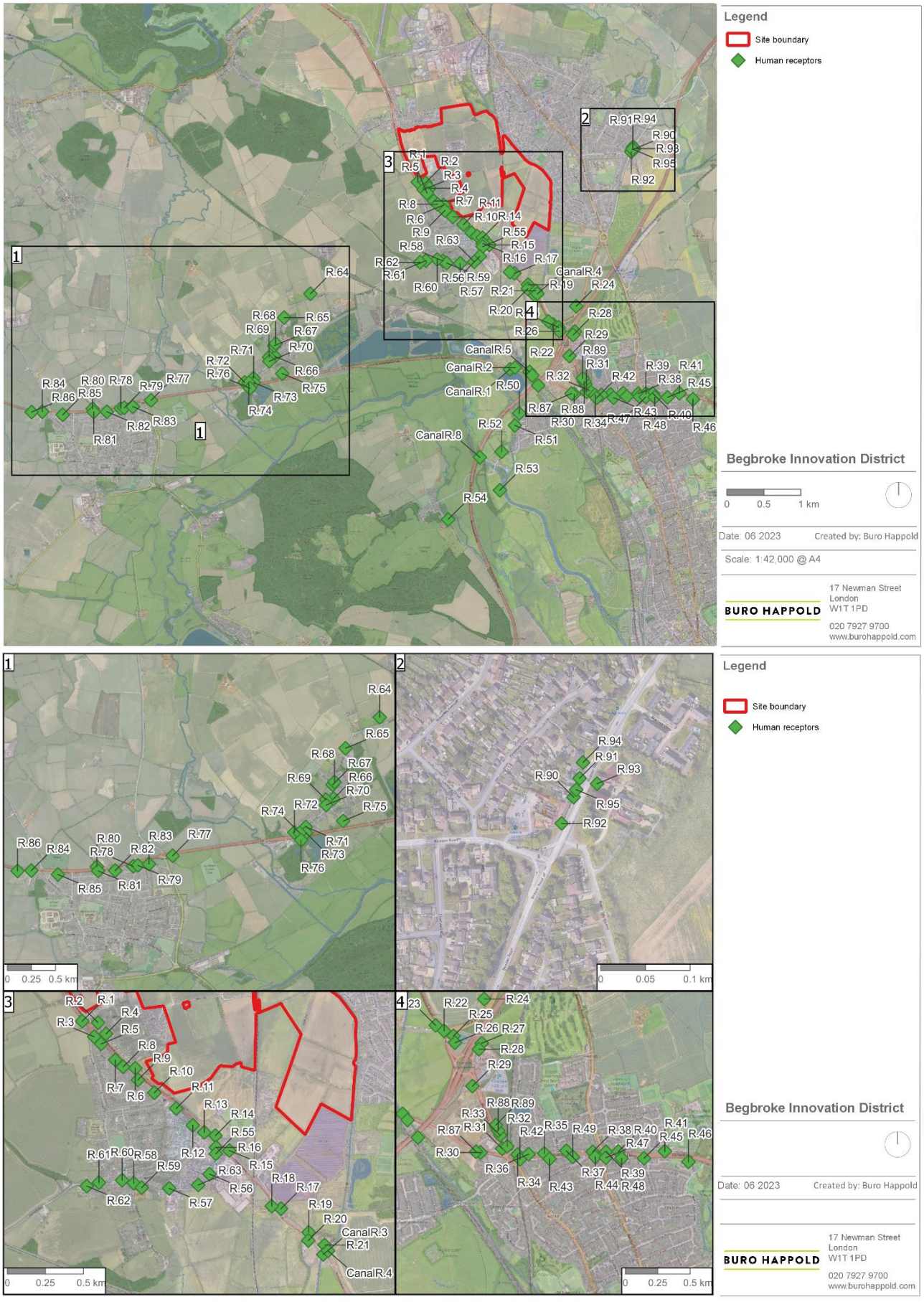
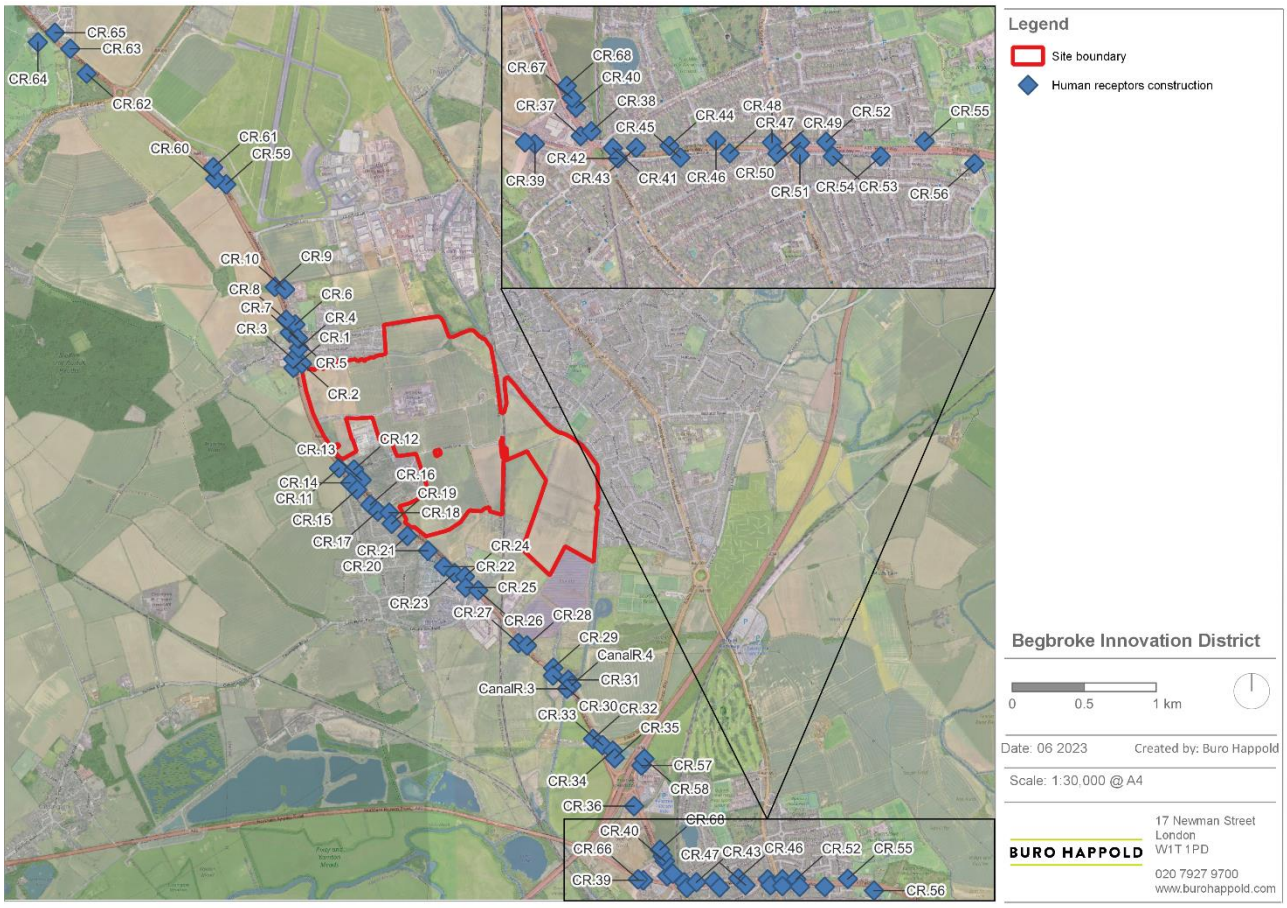


Figure 11.6: Human receptor locations for construction traffic impacts



On-site Exposure

11.3.46 The exposure of future site users was assessed by modelling pollutant concentrations at grid points across the Site. The gridded concentrations were used to create pollutant contours across the Site. In addition, the site-specific air quality monitoring data has supplemented the results and conclusions.

11.3.47 In addition to the AQOs, the World Health Organisation (WHO) air quality guidelines[27] considered when assessing exposure of future users of the Proposed Development to air pollutants. The WHO air quality guidelines were most recently updated in 2021. They present the most recent scientific understanding of air pollutant concentrations at which human health can impacts occur and are more stringent that the AQOs. The WHO also provide interim targets which can be set when achieving the guideline is not practicable. The WHO guidelines are not statutory objectives; and the UK AQOs are the only statutory objectives.

Assessment of Air Quality Impacts on Ecological Sites

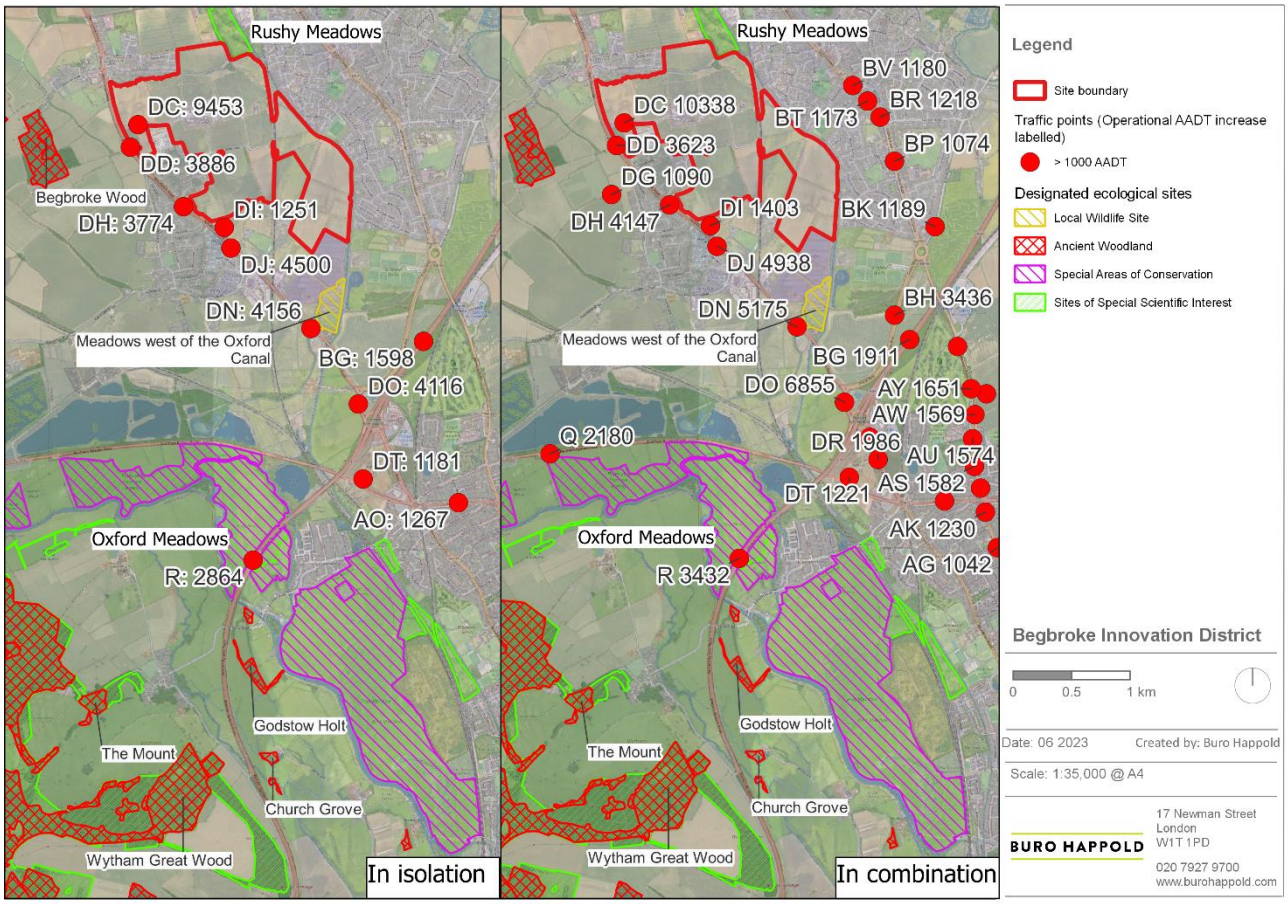
11.3.48 Ecological receptors were assessed in line with IAQM guidance on the assessment of air quality impacts on designated nature conservation sites. As per this guidance, a screening exercise was undertaken. The screening establishes sensitive ecological sites within 200m of roads predicted to experience an increase in AADT of >1,000 vehicles per day or >200 HDVs per day as a result of the operation of the Proposed Development.

11.3.49 Sensitive ecological sites were identified with the project ecologist and through the scoping process. These include internationally and nationally designated sites, as well as local designated sites with habitats sensitive to NO_x, ammonia (NH_3), nitrogen deposition and/or acidification.

11.3.50 It is predicted that there will be > 1000 AADT increase in traffic (Figure 11.7) within 200m of the following designated sites:

- Oxford Meadows, which is designated as a Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI);
- Meadows West of Oxford Canal, a Local Wildlife Site (LWS). This site has calcareous grassland habitat (as identified using Defra MAGIC maps tool[28]), which is sensitive to nitrogen;
- Wytham Wood SSSI; and
- Four Ancient Woodlands (AW): Godstow Holt, Church Grove and two other unnamed sites.

Figure 11.7: Operational traffic increases at road links at which there is an increase >1000 AADT for the Proposed Development in isolation (left) and in combination with the PR sites (right).



11.3.51 Whilst Rushy Meadows SSSI is the closest ecological site to the Proposed Development, it is not within 200m of any roads that are predicted to experience an increase in traffic of over 1000 AADT.

11.3.52 The in-combination effects of the Proposed Development and other PR sites were also considered.

11.3.53 Ambient NO_X and NH_3 concentrations were predicted along the boundaries of the designated sites. Nitrogen deposition and acidification due to increased nitrogen was calculated at each receptor location along the boundary.

11.3.54 Impacts on ecological sites were assessed against the critical level and critical load relevant to the designated site:

- The critical level is the concentration of an air pollutant above which adverse effects on ecosystems may occur based to present knowledge.
- The critical load is the deposition flux of an air pollutant below which significant harmful effects on sensitive ecosystems do not occur, according to present knowledge. This is usually measured in units of kilograms per hectare per year (kg/ha/yr).

11.3.55 The critical levels and loads for the SSSI and SAC sites were obtained from the Air Pollution Information Service[29] (APIS). APIS provides site specific critical levels and loads, as well as nitrogen deposition rates and background ammonia concentrations. The critical levels and loads for the ancient woodland were obtained from the Woodland Trust guidance assessing air pollution impacts on ancient woodland. The critical levels and loads used in this assessment are presented in Table 11.3.

11.3.56 The Oxford Meadows critical levels and loads were assumed for the Meadows West of Oxford Canal.

11.3.57 Wytham Wood contains both forest and grassland habitats, which have differing deposition rates and critical loads. Therefore, Wytham Wood has been assessed for both forest and grassland habitats. Results are presented for forest deposition, as this leads to worst case predictions.

11.3.58 Minimum and maximum critical loads were published to account for variation in ecosystem response. As a worst-case assumption, the minimum critical loads were considered in the screening exercise.

11.3.59 The next stage of the screening exercise is to compare the process contribution (PC) of the Proposed Development to the critical level and load. The PC is the incremental impact of the Proposed Development on the concentration or deposition flux. The PC of the Proposed Development and the cumulative PR sites was also considered in combination at designated sites.

11.3.60 The PC was calculated at locations along the boundaries of the ecological sites (Figure 11.8). Where the PC is 1% or greater than the critical level/load then the impact cannot be screened out as insignificant.

11.3.61 The boundary receptor PC percentage relative to the minimum critical level/loads for all ecological sites is presented in Table 11.4. The 1% screening threshold was exceeded at a number of receptor locations at designated sites.

11.3.62 Therefore, NOx concentration, NH_3 concentration, nitrogen deposition and acidification were modelled along transects across the sites. Receptor points for transects are perpendicular to the road up to 200m from the roadside, with receptors spaced at 10m

intervals. The transect locations are presented in Figure 11.8. All ecological receptors are modelled at a height of 0m.

11.3.63 The methodology for the assessment of air quality impacts on designated ecological sites are detailed further in Appendix 11.7.

Table 11.3: Site critical levels and loads

Site	Feature	Critical level NO_x ($\mu g/m^3$)	Critical level NH_3 ($\mu g/m^3$)	Critical load nitrogen (N) deposition min (kgN/ha/yr)	Critical load N deposition max (kgN/ha/yr)	Critical load acidification min (keq/ha/yr)	Critical load acidification max (keq/ha/yr)
Oxford Meadows SAC and Meadows West of Oxford Canal LWS	Lowland Hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	30	3	10	20	0.856	4.856
	Apium repens	30	3	10	20	0.856	4.856
Wytham Woods	Bromus Erectus - Brachypodium Pinnatum Lowland Calcareous Grassland	30	1 or 3	10	20	0.856	4.856
	Bromus Erectus Lowland Calcareous Grassland	30	1 or 3	10	20	0.856	4.856
	Fraxinus Excelsior - Acer Campestre - Mercurialis Perennis Woodland	30	1 or 3	15	20	0.142	10.88
	Quercus Robur - Pteridium Aquilinum - Rubus Fruticosus Woodland	30	1 or 3	15	20	0.142	10.88
	Vascular plant assemblage	30	3				
	Strymonidia pruni	30	0				
Ancient Woodland (Godstow Holt, Church Grove and 2 unnamed sites)	Ancient Woodland	30	1	10	10	0.142	10.88

Figure 11.8: Ecological receptor points and transect points at Oxford Meadows (top left) and Meadows West of Oxford Canal (bottom left), Godstow Holt and unnamed Ancient Woodland 1 (top right) and Wytham Wood, Church Grove and unnamed Ancient Woodland 2.

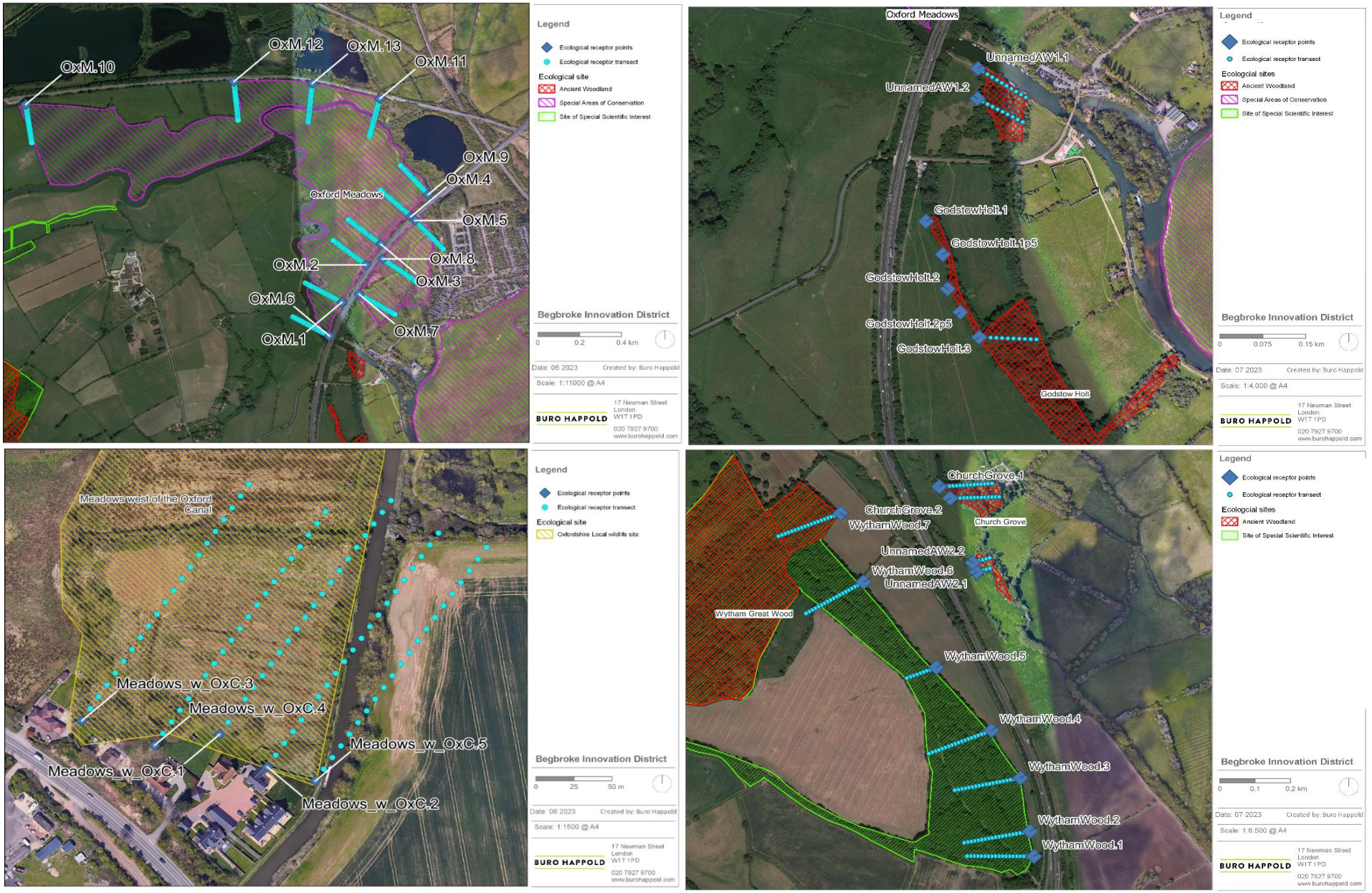


Table 11.4: Process contribution of Proposed Development in isolation as a percentage of the minimum critical level/load at modelled receptors on designated ecological site boundaries

Receptor ID	Site	PC as a % of critical level/load (Proposed Development in isolation)			
		N deposition	*Acidification*	*NO_x*	*NH_3*
OxM.1	Oxford Meadows SAC	1.65	1.38	0.95	0.93
OxM.2	Oxford Meadows SAC	2.02	1.68	1.16	1.14
OxM.3	Oxford Meadows SAC	1.80	1.50	1.04	1.02
OxM.4	Oxford Meadows SAC	4.55	3.78	2.64	2.56
OxM.5	Oxford Meadows SAC	6.30	5.24	3.64	3.58
OxM.6	Oxford Meadows SAC	2.92	2.43	1.69	1.64
OxM.7	Oxford Meadows SAC	3.57	2.97	2.05	2.02
OxM.8	Oxford Meadows SAC	3.90	3.24	2.24	2.20
OxM.9	Oxford Meadows SAC	1.59	1.32	0.91	0.89
OxM.10	Oxford Meadows SAC	0.50	0.42	0.26	0.28
OxM.11	Oxford Meadows SAC	1.68	1.40	0.87	0.95
OxM.12	Oxford Meadows SAC	0.88	0.73	0.46	0.50
OxM.13	Oxford Meadows SAC	0.86	0.72	0.45	0.49
Meadows_w_OxC.1	Meadows west of Oxford Canal LWS	1.49	1.24	0.79	0.84
Meadows_w_OxC.2	Meadows west of Oxford Canal LWS	1.42	1.18	0.76	0.81
Meadows_w_OxC.3	Meadows west of Oxford Canal LWS	3.01	2.50	1.59	1.70
Meadows_w_OxC.4	Meadows west of Oxford Canal LWS	2.26	1.88	1.19	1.27
Meadows_w_OxC.5	Meadows west of Oxford Canal LWS	1.26	1.05	0.67	0.71
GodstowHolt.1	Godstow Holt AW	2.36	11.82	0.86	2.54
GodstowHolt.2	Godstow Holt AW	1.39	6.95	0.50	1.48
ChurchGrove.1	Church Grove AW	1.46	7.33	0.49	1.58
ChurchGrove.2	Church Grove AW	1.30	6.49	0.43	1.40
UnamedAC1.1	Unnamed AW 1	1.72	8.62	0.62	1.84
UnamedAW1.2	Unnamed AW 1	1.45	7.28	0.53	1.57
UnamedAW2.1	Unnamed AW 2	1.64	8.24	0.53	1.78
UnamedAW2.2	Unnamed AW 2	1.58	7.90	0.52	1.73
WythamWood.1	Wytham Wood SSSI (Grassland)	0.78	0.64	0.39	1.30
WythamWood.2	Wytham Wood SSSI (Grassland)	0.72	0.60	0.36	1.21
WythamWood.3	Wytham Wood SSSI (Grassland)	0.86	0.71	0.44	1.46
WythamWood.4	Wytham Wood SSSI (Grassland)	0.60	0.50	0.31	1.02
WythamWood.5	Wytham Wood SSSI (Grassland)	0.32	0.26	0.17	0.56

Receptor ID	Site	PC as a % of critical level/load (Proposed Development in isolation)			
		N deposition	*Acidification*	*NO_x*	*NH_3*
WythamWood.6	Wytham Wood SSSI (Grassland)	0.22	0.18	0.11	0.36
WythamWood.7	Wytham Wood SSSI (Grassland)	0.24	0.20	0.13	0.41
WythamWood.1	Wytham Wood SSSI (Forest)	0.81	6.08	0.39	1.30
WythamWood.2	Wytham Wood SSSI (Forest)	0.75	5.61	0.36	1.21
WythamWood.3	Wytham Wood SSSI (Forest)	0.89	6.70	0.44	1.46
WythamWood.4	Wytham Wood SSSI (Forest)	0.63	4.70	0.31	1.02
WythamWood.5	Wytham Wood SSSI (Forest)	0.33	2.47	0.17	0.56
WythamWood.6	Wytham Wood SSSI (Forest)	0.22	1.69	0.11	0.36
WythamWood.7	Wytham Wood SSSI (Forest)	0.38	1.89	0.13	0.41

Cumulative Effects

11.3.64 Cumulative effects were considered within the construction dust assessment for any cumulative schemes for which there are construction activities with the potential to impact the same receptors. This includes developments with concurrent construction and within close enough proximity to the Site such that dust may impact the same receptors (i.e. within 350m of the receptors that may be impacted by the construction of the proposed development). The results of this assessment, however, are estimated as we cannot be sure about the start and duration of the construction phase of the cumulative schemes considered.

11.3.65 Traffic generated by several committed and cumulative developments were included in the future traffic flows supplied by the traffic consultant. The impact of these developments were considered inherently in the assessment.

11.3.66 However, several cumulative developments were not included in the traffic modelling due to lack of available information or scoping out due to distance from the Site. This has been agreed with OCC by the project transport. Further details of the cumulative developments included in the transport data is presented in Chapter 9 of the ES.

11.3.67 The impacts of cumulative developments that were not included inherently in the transport assessment have been assessed quantitatively when assessing significance. This was carried out by assessing the increase in air pollutant concentrations that would be required to lead to a significant impact.

11.3.68 The cumulative impact of the Proposed Development and the PR sites at human receptors was assessed quantitatively by comparing modelled concentrations for traffic scenario 2 and scenario 4.

11.3.69 Similarly, traffic generation from the PR sites was assessed for in combination effects at designated sites.

Determining Effect Significance

Sensitivity of Receptor

Construction Dust

11.3.70 Sensitivity of receptors with regards to construction dust are presented in Table 1 in Appendix 11.3.

11.3.71 For the sensitivity of people and their property to soiling, the IAQM recommends that the air quality practitioner uses professional judgement to identify where on the spectrum between high and low sensitivity a receptor lies, taking into account the general principles in the Table 1 in Appendix 11.3.

11.3.72 For the sensitivity of people to the health effects of PM_{10}, the IAQM recommends that the air quality practitioner assumes that there are three sensitivities based on whether or not the receptor is likely to be exposed to elevated concentrations over a 24-hour period, consistent with the Defra's advice for local air quality management.

11.3.73 With regards to ecological effects, it is advised to seek the advice of an ecologist to determine the need for an assessment of dust impacts on sensitive habitats and plants. Professional judgement is required to identify where on the spectrum between high and low sensitivity a receptor lies, taking into account the likely effect and the value of the ecological asset. A habitat may be highly valuable but not sensitive, alternatively it may be less valuable but more sensitive to dust deposition. Consequently, specialist ecological advice was sought from the project ecologist, BSG, to determine the sensitivity of the ecological receptors to dust impacts. In general, most receptors are either of high sensitivity or low sensitivity, i.e. either sensitive or not to dust deposition.

Traffic Emissions

Human Receptors

11.3.74 Operational impacts are considered at human receptor locations where there is relevant exposure to national air quality objectives (AQO), in line with Defra LAQM TG22. Examples of receptors, dependent on the averaging period for pollutant concentration, are shown in Table 11.5. AQO are based on standards which are set at a level below the lowest concentration at which more sensitive members of the public were observed to be affected by pollutant exposure.

11.3.75 As any member of the public could be present at receptor locations which have relevant exposure, it is considered that all receptors are of equal sensitivity. Therefore, all receptors considered, where there is relevant exposure, will be of high sensitivity.

Table 11.5: Receptor Sensitivity Principles: Operation

Averaging period	Sensitive receptors occur at	Sensitive receptors generally do not occur at
Annual mean	All locations where members of the public might be regularly exposed. Building façades of residential	Building façades of offices or other places of work where members of the public do not have regular access.

Averaging period	Sensitive receptors occur at	Sensitive receptors generally do not occur at
	properties, schools, hospitals, care homes etc.	Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
24 hour mean	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
Hourly mean	All locations where the annual mean and 24 -hour mean objective apply. Kerbside sites (for example, pavements of busy shopping streets) Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

Ecological Receptors

11.3.76 A screening exercise was undertaken, identifying designated sites within 200m of roads that are predicted to experience an increase of >1000 AADT either alone or in-combination. The results of this exercise are outlined in 11.3.48 – 11.3.63. Oxford Meadows SAC and SSSI, Meadows West of Oxford Canals LWS, Wytham Wood SSSI and four ancient woodlands exceeded this threshold. Therefore, all of these sites were considered in the ecological assessment.

Magnitude of Impact

Construction Dust

11.3.77 With regards to construction, the risk of impacts on human health, amenity and ecology is determined based on the sensitivity of the area and the dust emission magnitude. The risk of impacts are defined as ‘negligible’, ‘low’, ‘medium’ or ‘high’. The methodology is detailed in Appendix 11.3.

Traffic Emissions

Human Receptors

11.3.78 Magnitude of impact due to road traffic emissions arising from the construction and operation of the Proposed Development is determined with respect to the change in pollutant concentration at a receptor, in relation to the relevant AQO for a pollutant.

11.3.79 The impact is considered in relation to relevant AQOs. The effect significance will be determined in accordance with the IAQM's significance criteria. IAQM significance criteria is detailed in Table 11.6.

Table 11.6: IAQM Air Quality Impact Significance Descriptors

Long-term average concentration at receptor in assessment year	Change in concentration relative to AQO				
	0%	1%	2-5%	6-10%	>10%
75% or less of AQO	Negligible	Negligible	Negligible	Slight	Moderate
76-94% of AQO	Negligible	Negligible	Slight	Moderate	Moderate
95-102% of AQO	Negligible	Slight	Moderate	Moderate	Substantial
103-109% of AQO	Negligible	Moderate	Moderate	Substantial	Substantial
110% or more of AQO	Negligible	Moderate	Substantial	Substantial	Substantial

11.3.80 The magnitude of impact with regards to exposure of future site users to air pollution is determined by comparing the pollutant concentrations the site user will experience to the AQOs.

Ecological Receptors

11.3.81 The magnitude of impact on ecological sites is considered with regards to the process contribution of NO_x concentration, ammonia concentration, nutrient nitrogen deposition and acidification. This is considered in relation to the relevant critical load and critical level of the designated sites.

Assessing Significance

Construction Dust

11.3.82 IAQM guidance states that, with appropriate mitigation in place, the effects of construction dust will be not significant. The construction assessment defines a risk of impact of dust soiling, human health and ecology during earthworks, construction and trackout. Mitigation is recommended based on this level of risk.

Traffic Emissions

11.3.83 The overall significance of the air quality effect, whether beneficial or adverse, is considered holistically taking into account of a number of factors. Table 11.6 sets out impact descriptors

for individual receptors. Whilst a number of individual receptors may be 'slight' or 'moderate' the overall effect may not necessarily be considered significant.

11.3.84 Judgement on the overall significance of an effect must consider:

- Existing and future air quality in the absence of the Proposed Development;
- The extent of current and future population exposure to the impact; and
- The influence and validity of any assumptions adopted when undertaking the prediction of effects.

Ecological Receptors

11.3.85 For effects on ecological receptors, the IAQM ecological guidance recommends adopting the Environment Agency (EA)'s approach, which describes the process contribution as being insignificant when less than 1% of the long-term environmental standard.

11.3.86 Once the impact was quantified, the EA's 1% threshold is used as a precautionary screening criterion and where effects are found to be above this threshold, consideration will be given to the predicted environmental contribution (PEC)[3] and the project ecologist will be consulted to determine the significance of potential adverse effects on the site.

Assumptions and Limitations

11.3.87 Diffusion tubes, the technique used in the site-specific monitoring undertaken by Buro Happold, has an inherent uncertainty associated with them. Whilst this can be mitigated to an extent through bias adjustment, a lack of precision cannot be corrected for. Six months of data was collected and converted to an annual average concentration through annualisation. Whilst this is a recognised technique for correcting data to an annual average, it does introduce a level of uncertainty in comparison to collecting a full 12 months of data. In addition, the Defra roadside projection factors used to convert 2022 data to the baseline year of 2019 will introduce a level of uncertainty in the prediction of 2019 concentrations. This uncertainty should be considered when interpreting monitoring results.

11.3.88 There are a number of factors that will contribute to uncertainty in the modelling predictions, including the traffic and emissions data model inputs which will have inherent uncertainty associated with them. There is also additional uncertainty owing to the model simplifying real world conditions into a series of algorithms.

11.3.89 To reduce this uncertainty, model verification was carried out for the assessment of traffic emissions by comparing modelled and monitored concentrations, which will ensure a good degree of confidence in modelled results for the existing baseline year. For future years there will inevitably be a greater level of uncertainty owing to future trends in air quality conditions, as well as the uptake and performance of more stringent vehicle emission standards within the vehicle fleet. Therefore, to address the uncertainty in future air quality conditions, a conservative approach was taken that assumes there will be no improvement in background concentrations from 2019, for all future assessment years. With regards to future vehicle emissions, studies indicate that Defra's emission factor toolkit v.11 provides

[3] The total concentration or deposition (i.e. process contribution (PC) plus baseline)

an accurate prediction of the most likely future vehicle emissions reductions and may even under-predict the rate of vehicle emissions reduction[30].

11.3.90 There is uncertainty in the future mode of travel allowable along Sandy Lane, with the intention for it to be closed to private vehicles. A worst-case approach was taken, whereby the scenario with the highest traffic volumes on the wider road network was used in the assessment.

11.3.91 There is uncertainty in the critical loads of the designated ecological sites. As a precautionary approach, the minimum critical load provided by APIS was used in the screening exercise, as set out above.

11.3.92 Whilst 2033 is the expected full operational year of the Proposed Development, has been was assessed. Whilst the Defra emission factor toolkit is capable of projecting vehicle emissions up to 2050, as other Defra tools such as the NO_x to NO_2 calculator only support projections up to 2030, 2030 is the latest year that that is usable for an air quality assessment[31]. Emissions from the vehicle fleet are expected to improve year on year due to shifts towards newer vehicles with lower emissions. Therefore, the use of 2030 rather than 2033 as an assessment year for the operational phase represents a worst-case assessment.

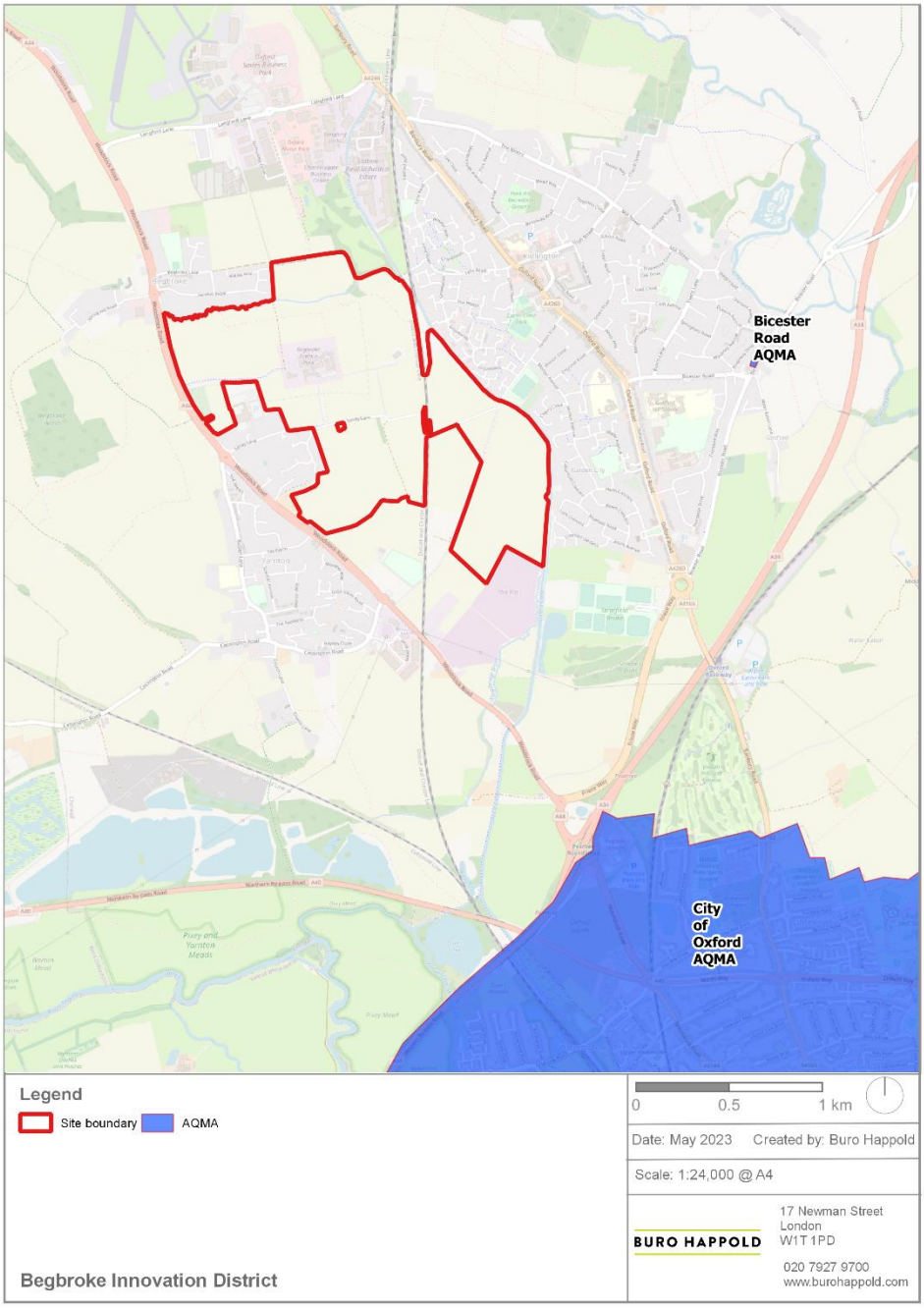
11.3.93 The cumulative assessment has included several cumulative and committed developments and the PR sites quantitatively. However, several cumulative developments were not included in the traffic modelling due to lack of available information or scoping out due to distance from the Site. The cumulative sites included have been agreed with OCC by the project transport consultant, with further details presented in Chapter 9 of the ES. In the absence of traffic data the cumulative developments scoped out of the transport assessment could not be assessed quantitatively and have hence been assessed qualitatively.

11.4 Baseline Conditions

Air Quality Management Areas

11.4.1 There are two AQMAs in the vicinity of the Site, the City of Oxford AQMA and the Bicester Road AQMA (Figure 11.9). The City of Oxford AQMA covers the entire authoritative jurisdiction of the City of Oxford, 1.5km to the south the Site at its closest point. This was declared in 2010 due to exceedances of the annual mean NO_2 objective with road transport cited as the primary source of emissions within the AQMA[32]. Although this AQMA is not in the immediate vicinity of the Site, the A44, which runs adjacent to the Site, runs into the AQMA. The Bicester Road AQMA is a small AQMA declared in Kidlington, which covers several properties on Bicester Road, which is approximately 1km to the east of the Site. This was declared in 2014, also due to exceedances of the annual average NO_2 objective[33].

Figure 11.9: Air Quality Management Areas (AQMAs) in the vicinity of the Proposed Development



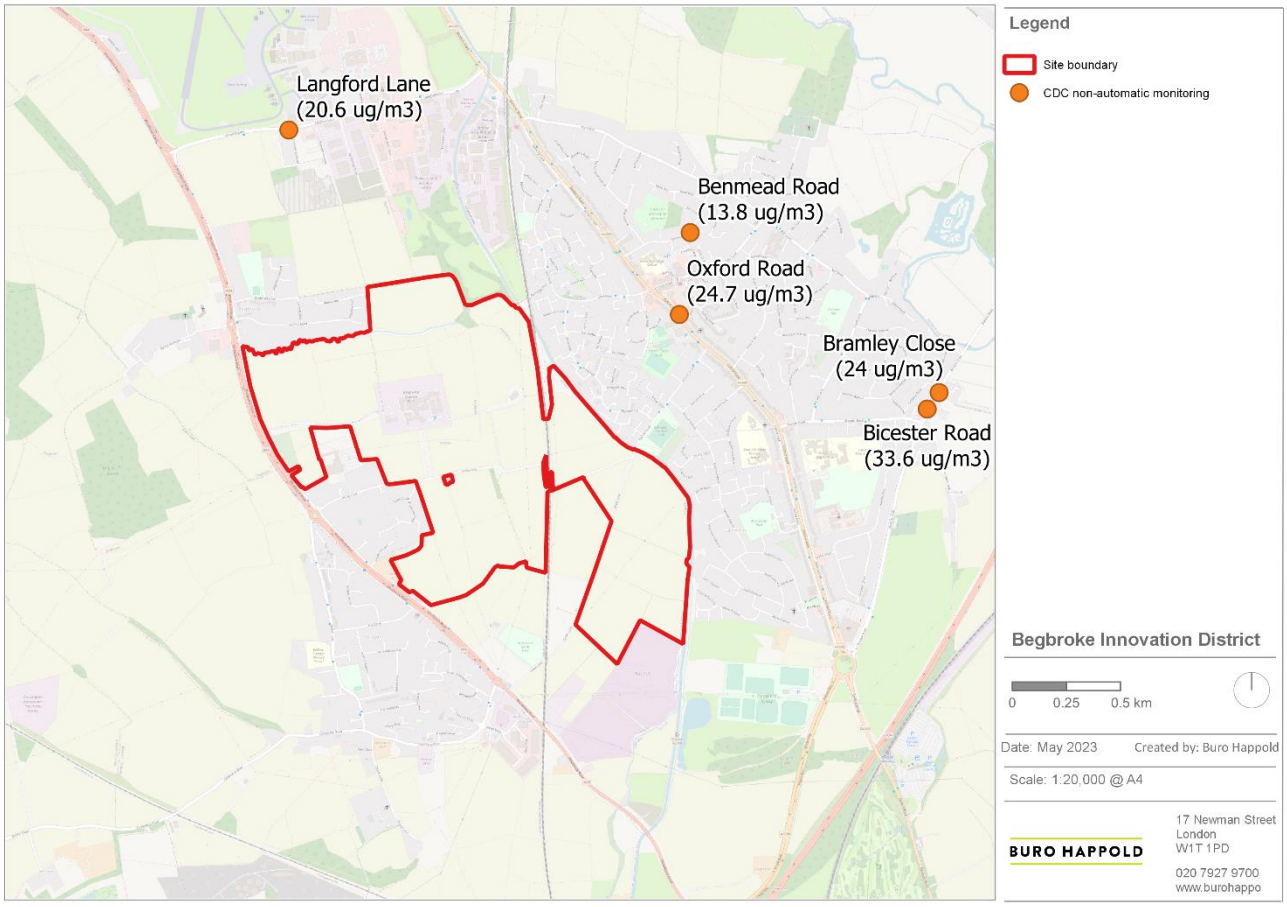
Local Authority Air Quality Monitoring

11.4.2 There are no automatic monitoring sites within CDC or within the neighbouring local authorities that are likely to represent baseline conditions at the Site. However, CDC does undertake air quality monitoring at 38 locations across the district. The closest monitoring sites to the Site are shown in Figure 11.10, which also shows the recorded annual average NO_2 concentration in 2019. Monitored concentrations over the last 5 years are presented in Table 11.7.

11.4.3 All local monitoring sites recorded concentrations in compliance with the annual average NO_2 AQO. The highest concentration was recorded at Bicester Road, within the Bicester Road AQMA. This site recorded an annual average concentration of 33.6 µg/m^3,

significantly lower than the 40 µg/m^3 AQO. The AQO has not been exceeded at this site since 2017, highlighting an improvement in air quality over recent years.

Figure 11.10: Local authority air quality monitoring sites in the vicinity of the Proposed Development



11.4.4 Monitoring sites on Lanford Lane, Oxford Road and Bramley Close all recorded concentrations 52 – 62 % of the AQO. The urban background monitoring site on Benmead Road recorded an annual average concentration of 13.8 µg/m^3 in 2019, significantly below the AQO and comparable to the Defra modelled background concentrations used in this assessment (12.7 µg/m^3).

11.4.5 There is a general trend of improving air quality in the local area of over the last five years and there has been year on year improvement at the majority of the sites, particularly at the roadside. Several sites recorded a significant drop off in concentrations in 2020. For example, annual average concentration at Langford Lane reduced by approximately 45%. This reduction is likely to have been influenced by the COVID-19 pandemic and the changes in travel patterns and therefore emissions that resulted from it.

Table 11.7: Local authority monitored concentrations in the vicinity of the Proposed Development over the last 5 years

Diffusion Tube ID	Site Name	Site Type	Distance from Site (m)	Mean NO_2 Monitoring Results (µg/m^3)				
				2017	2018	2019	2020	2021
38, 39	Bicester Road	Roadside	1,175	41.0	37.9	33.6	26.6	26.6
40	Oxford Road	Roadside	570	28.8	28.9	24.7	26.0	21.6
41	Bramley Close	Roadside	1,250	26.7	26.3	24.0	21.3	18.6
42	Benmead Road	Urban Background	875	12.6	13.4	13.8	18.4	11.8
43	Langford Lane	Roadside	800	21.7	21.5	20.6	11.6	16.0

Notes: numbers highlighted in **bold** indicate exceedance of the annual average NO_2 AQO (40 µg/m^3)

11.4.6 Neither CDC or any neighbouring authorities undertake the monitoring of PM_{10} or $PM_{2.5}$. Therefore, no representative baseline particulate matter data is available. Estimated background concentrations for PM across the study area are derived from the Defra background maps.

Buro Happold monitoring

11.4.7 Results from the Buro Happold monitoring survey are presented in Table 11.8 and Figure 11.11.

11.4.8 The highest concentration was recorded at BID2, roadside of the A44 to the north of the Site. The 2022 (20.8 µg/m^3) and the 2019 (24.5 µg/m^3) annual average NO_2 concentrations were significantly less than the AQO (40 µg/m^3).

11.4.9 BID4 was located adjacent to the Didcot and Chester railway line which runs through the Site. The monitored concentration (12.1 µg/m^3) was significantly lower than the AQO, indicating that the railway line is not a significant source of NO_2 emissions.

11.4.10 BID8 is located roadside of the A40, adjacent to Oxford Meadows SAC. The 2019 annual average concentration at this site was 17.1 µg/m^3.

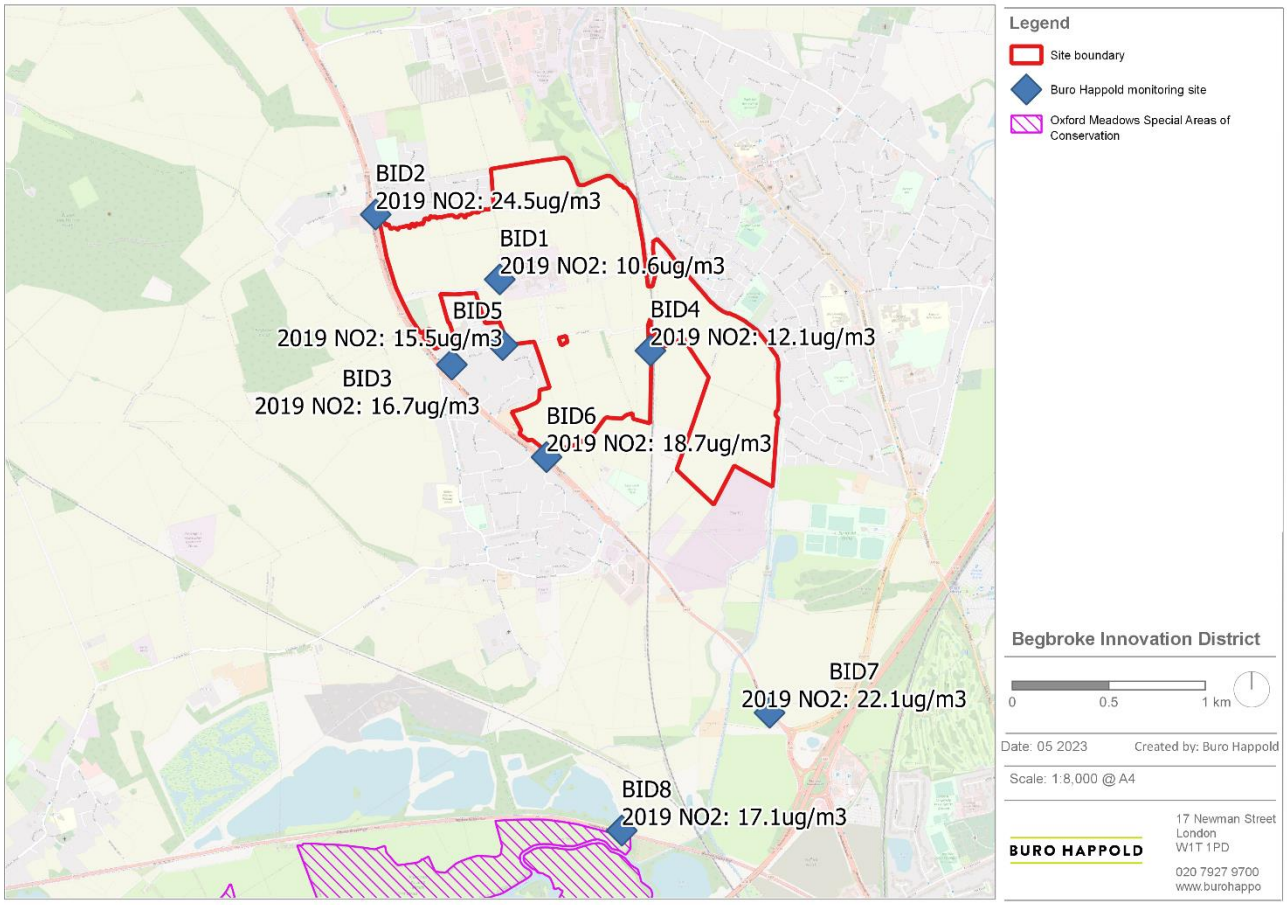
11.4.11 BID7 and BID6 may have been influenced by roadworks along the A44 over the monitoring survey.

11.4.12 Overall, results indicate that concentrations on-site are compliant with NO_2 AQOs.

Table 11.8: Bias adjusted and annualised monitored concentrations from Buro Happold survey

Site ID	Site name	Site type	2022 annual average NO_2 concentration ($\mu g/m^3$)	2019 annual average NO_2 concentration ($\mu g/m^3$)
BID1	Science Park entrance	Roadside	9.0	10.6
BID2	A44 N	Roadside	20.8	24.5
BID3	A44 Sandy Lane	Roadside	14.1	16.7
BID4	Sandy Lane railway	Roadside	10.2	12.1
BID5	Sandy Lane	Roadside	13.1	15.5
BID6	A44 Shell garage	Roadside	15.9	18.7
BID7	A44 S	Roadside	18.7	22.1
BID8	A40 Oxford Meadows	Roadside	14.5	17.1

Figure 11.11: Monitored 2019 NO_2 concentrations from the Buro Happold diffusion tube survey



Future Baseline

11.4.13 Future baseline traffic flows have been supplied by the project transport consultant (KMC Transport). These take into account additional traffic from local committed developments. The traffic flows consider a background mode shift due to improvements in connectivity via public and sustainable transport modes. This is detailed in further in Appendix 11.4.

11.4.14 Vehicle emissions are predicted to reduce in future years as the vehicle fleet shifts towards newer vehicles with lower emissions. This has been accounted for by using the future years emission scenarios in the Defra Emission Factor Toolkit.

11.4.15 Background concentrations are predicted to reduce in the future. For example, the maximum background concentrations at the site for 2019 and 2030 are presented in Table 11.9. As there is a large amount of uncertainty in the magnitude of reduction of background concentrations, the approach has been to use 2019 background concentrations in the future year scenarios.

Table 11.9: Current and future Defra modelled background concentrations at the Site

Year	Maximum grid square background concentration (µg/m^3)			
	NO_2	*NO_x*	*PM_{10}*	*$PM_{2.5}$*
2019	12.7	17.2	16.9	11.7
2030	9.7	12.8	15.5	10.7

Summary of Receptors and Sensitivity

11.4.16 Receptors to dust soiling and human health impacts during the construction phase are considered at sensitive locations in the vicinity of construction activities and trackout routes. The receptor locations are detailed in section 11.6.

11.4.17 Receptor locations considered with regards to traffic generation during the construction and operational phases of the Proposed Development are adjacent to roads at which there is predicted to be a significant increase in traffic. The locations are detailed in section 11.3.45 and in Appendix 11.5.

11.4.18 Ecological receptors are considered at designated ecological sites adjacent to roads that are predicted to experience a significant increase in traffic volumes. These are detailed in 11.3.48 - 11.3.63.

11.4.19 The receptors considered and their sensitivity are summarised in Table 11.10.

Table 11.10: Summary of Receptor Sensitivity

Receptor	Sensitivity (Value)
Existing	
Human receptors at locations at which air quality objectives apply. This includes residential properties, schools and nurseries in Begbroke, Kidlington and Yarnton that are adjacent to roads that are predicted to experience a significant increase in vehicle traffic. It also applies to moored canal boats in which people reside.	High
Oxford Meadows SAC, Meadows West of Oxford Canal LWS, Wytham Wood SSSI and four ancient woodlands have been identified as ecological receptors in the screening exercise.	High
Locations in the vicinity of construction activities and trackout route that may be impacted by construction dust and PM_{10} emissions.	High, medium and low (see section 11.6)

Receptor	Sensitivity (Value)
Rushy Meadows SSSI, which is within 350m of the Site boundary and therefore has the potential to be impacted by construction dust.	Low (see section 11.6)
Future	
Residential properties and schools introduced by the Proposed Development.	High
Human receptor locations at committed developments at which air quality objectives apply.	High

11.5 Embedded Mitigation (Scheme Design and Management)

Construction

11.5.1 Measures will be undertaken during the construction phase to minimise disruption and manage the impacts of the Proposed Development.

11.5.2 The assessment proposes best practice mitigation measures that are recommended to be implemented within an Air Quality and Dust Management Plan, in line with IAQM guidance. The measures are outlined in the Outline CEMP (see Appendix 6.1) and should be incorporated into the detailed CEMP(s), to be secured by condition. Successful implementation of these measures will ensure construction emissions are minimised and any residual impact on air quality will likely be not significant.

Completed Development

11.5.3 Air quality design input was provided throughout the development design process. This included providing recommendations to the design team to minimise emissions generated by the development as well as minimising onsite exposure to poor air quality. The following design measures represent primary mitigation relevant to the Air Quality assessment:

- Implementing set back distances from the roadside to reduce exposure to poor air quality at air quality sensitive locations. Air quality modelling has been used to confirm the suitability of the proposed school locations with regards to air quality;
- Encouraging a zero emission energy strategy: the Energy and Sustainability Strategy will lead to no on-site emissions of air pollutants; and
- Encouraging measures to reduce emissions from transport: the Proposed Development will discourage private vehicle use and promote sustainable transport modes. Details are set out in the Transport Assessment (Appendix 9.1) and Framework Travel Plan (Appendix 9.2) for more details.

11.6 Assessment of Effects - Construction Stage

Construction Dust and PM_{10} Emissions

11.6.1 The IAQM guidance criteria used to assess the potential impacts from construction activities is detailed in Appendix 11.3. The following steps explain the site-specific assessment in the context of the IAQM criteria.

Step 1: Screen the Need for a Detailed Assessment

11.6.2 In accordance with screening criteria in the IAQM Guidance, an assessment is required as sensitive receptors are located within 350m of the Site boundary. Receptors include residential housing in the villages of Begbroke, Yarnton and Kidlington and occupants of moored boats on the Oxford Canal. In addition, Rushy Meadows SSSI borders the Site to the north and is screened in as an ecological receptor. Screening indicates the need for a construction dust assessment.

Step 2A: Define the Potential Dust Emission Magnitude

11.6.3 Dust emission magnitudes for relevant construction activities are shown in Table 11.11.

Table 11.11: Dust Emission Magnitudes

Activity	Dust emission magnitude	Justification
Demolition	Medium	Total demolition volume is approximately 33,200m^3, which is within the medium IAQM threshold (20,000m^3 – 50,000m^3).
Earthworks	Large	Total site area is around 1,709,000m^2, greater than the large IAQM threshold (>10,000m^2).
Construction	Large	Total building GEA is approximately 412,000m^2, therefore building volume is greater than the large IAQM threshold (>100,000 m^3).
Trackout	Large	There will be an average of 153 outward HDV movements per day. This exceeds the IAQM large threshold of 50 outward movements.

Step 2B: Define the Sensitivity of the Area

11.6.4 The sensitivity of the surrounding area to potential construction impacts is detailed in Table 11.12.

Table 11.12: Area sensitivity to human health

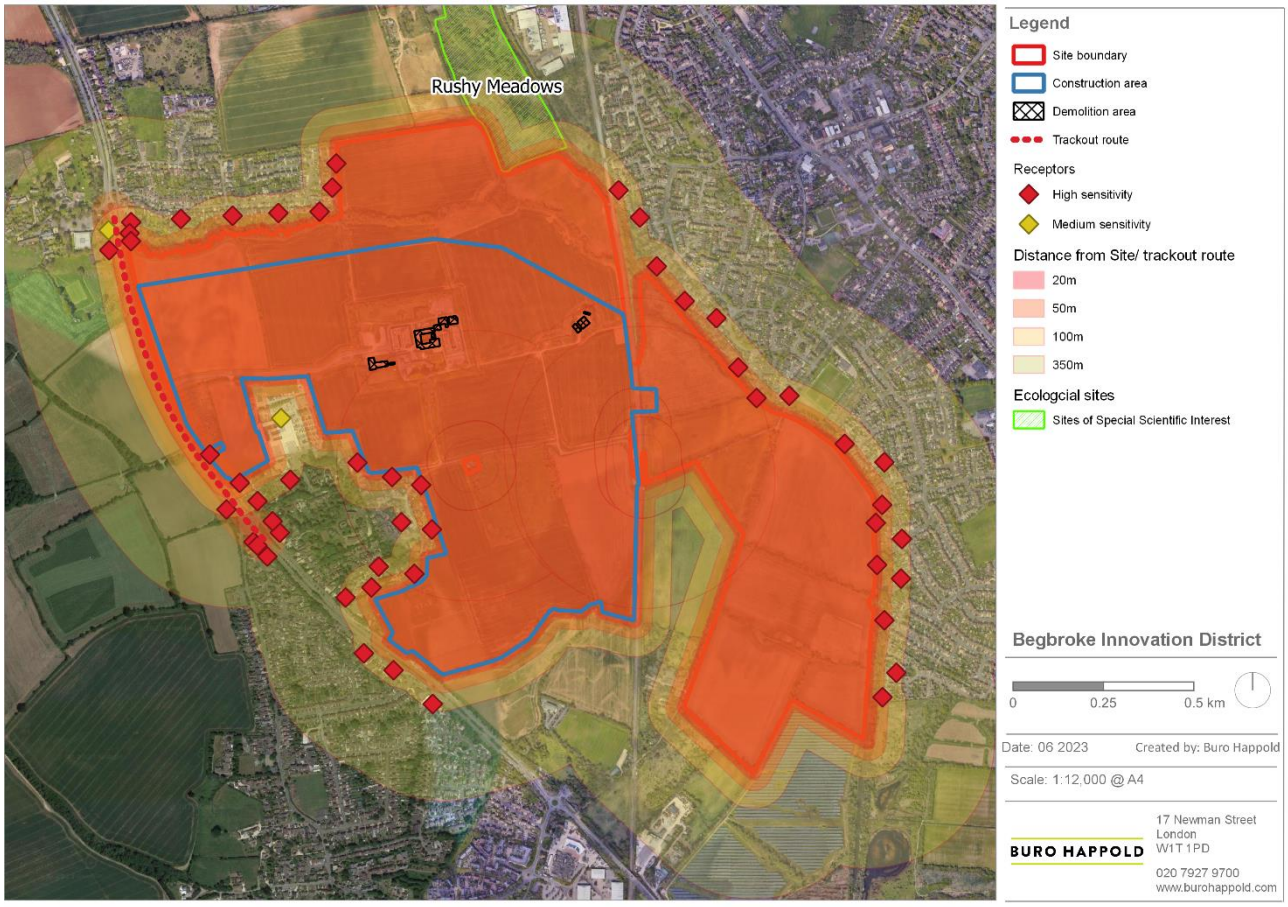
Potential impact	Sensitivity of the surrounding area			
	Demolition	Earthworks	Construction	Trackout
Dust soiling	Medium	High	High	Medium
Human Health	Low	Low	Low	Low
Ecological	Low	Low	Low	Low

11.6.5 The construction trackout route, buffers, demolition area and receptors within 100m area presented in Figure 11.12. In determining the sensitivity of the surrounding area, the following were taken into consideration:

- Demolition would be limited to up to four buildings on the existing Begbroke Science Park and three farm sheds to the east of the science park. The workplaces on the science park are medium sensitivity receptors within 20m of demolition activities. Therefore, the sensitivity of dust soiling due to demolition is medium.

- There are over 10 high sensitivity receptors within 20m of earthworks and construction activities. High sensitivity receptors include residential properties in Begbroke, Kidlington and Yarnton and moored boats on the Oxford Canal. Therefore, the area is highly sensitive to dust soiling due to earthworks and construction.
- There are estimated to be 1-10 high sensitivity receptors within 20m of the trackout route, therefore the sensitivity to trackout is medium.
- The Defra mapped background PM_{10} concentration is 16.9 µg/m^3. This is less than 24 µg/m^3 and therefore falls into the lowest band when determining sensitivity to human (see Table 3 in Appendix 11.3). As there are less than 100 high sensitivity receptors within 20m of site activities, sensitivity to human health impacts is low.
- The habitats at Rushy Meadows are considered medium sensitivity, in line with IAQM guidance. The project ecologist has been consulted on the area sensitivity. The parts of the Proposed Development in proximity to it will be greenspace and there is a double hedge row barrier between Rushy Meadows and the Site. All construction will be over 200 m from the site, therefore the ecological area sensitivity during construction is low. There is potential for earthworks to occur within 20 m of the site, therefore the ecological area sensitivity during earthworks is medium.

Figure 11.12: Construction dust buffers, trackout route and receptors



Step 2C: Define the Risks of Impacts

11.6.6 The risk of dust impacts for relevant construction activities are summarised in Table 11.13. These results take into account both the potential dust emission magnitude and the sensitivity of the area. It should be noted that activities on site will be temporary in nature, and mitigation appropriate to the level of risk and in line with good industry practices will be implemented across the site to ensure any adverse effects are minimised. The additional

mitigation, monitoring and residual effects section sets out appropriate mitigation measures to ensure the impact from construction activities will not be significant.

Table 11.13: Summary of risk from dust impacts

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

11.6.7 Without mitigation, the construction phase of the Proposed Development would result in a low risk of temporary, medium-term, direct adverse effects on human health. There would be low to medium risk for ecological receptors and medium to high risk of dust soiling. The IAQM guidance is clear, however, that with appropriate mitigation in place, the residual effect will not be significant.

Construction Traffic

11.6.8 Concentrations of key pollutants have been modelled at existing worst-case receptor locations for the peak construction year (2028). Receptor locations are presented in Figure 11.6:.

11.6.9 Predicted pollutant concentrations at existing receptors are presented in Appendix 11.8. 2019 background concentrations have been used throughout when processing the results to give the total predicted annual mean concentrations of the peak construction year.

11.6.10 The impact of construction traffic emissions associated with the Proposed Development is predicted to be negligible at all existing receptors. This includes receptors within the City of Oxford AQMA and moored canal boats on waterways adjacent to roads.

11.6.11 The highest increase in annual mean NO_2 concentrations is predicted at CR.26, which is at the Turnpike public house along the A44 Woodstock Road. The annual average NO_2 concentration is predicted to increase by 0.5 µg/m^3 as a result of construction traffic generated by the Proposed Development. This is 1.1% of the Air Quality Assessment Level (AQAL), which is the 40 µg/m^3 annual average NO_2 AQO. The annual average NO_2 concentration will be 56% of the AQAL and therefore the impact is negligible (as per IAQM criteria presented in Table 11.6). The modelled results for the five receptors at which the change in pollutant concentration due to the construction of the Proposed Development will be greatest are presented in Table 11.14.

11.6.12 The maximum increase in annual mean PM_{10} is 0.1 µg/m^3 (0.3% of AQAL) and maximum increase in $PM_{2.5}$ 0.07 µg/m^3 (0.4% of AQAL), both predicted at CR.26. This is a negligible increase in concentrations.

11.6.13 As the impact is negligible at all receptors, the effect on air quality will be not significant.

Table 11.14: Five receptors with the greatest impact on air quality due to the construction of the Proposed Development.

ID	NO_2			PM_{10}			$PM_{2.5}$		
	% of AQAL	% change relative to AQAL	Impact descriptor	% of AQAL	% change relative to AQAL	Impact descriptor	% of AQAL	% change relative to AQAL	Impact descriptor
CR.26	56	1.1	Negligible	45	0.3	Negligible	58	0.4	Negligible
CR.14	40	0.6	Negligible	42	0.2	Negligible	54	0.2	Negligible
CR.33	58	0.6	Negligible	49	0.2	Negligible	61	0.2	Negligible
CR.24	43	0.6	Negligible	42	0.2	Negligible	54	0.2	Negligible
CR.25	42	0.5	Negligible	41	0.1	Negligible	54	0.2	Negligible

Additional Mitigation, Monitoring and Residual Effects

Construction dust and PM_{10} emissions

11.6.14 Mitigation measures are recommended based on the risk of impact on amenity, human health and ecological sites due to demolition, earthworks, construction and trackout. The full suite of mitigation measures are based on measures outlined in IAQM guidance and are presented in Appendix 11.9.

11.6.15 Ground investigations found several ground contaminants, including asbestos at the historical landfill site in the centre of the Site. Therefore, additional mitigation should be applied during earthworks and remediation in this area to prevent adverse impacts during this process. The exact mitigation measures required are outlined in a Remediation Strategy, informed by a Desk Study Review and Ground Investigation Report (see Appendices 15.1 and 15.2).

11.6.16 As the construction dust and traffic impacts are determined to be negligible, no additional mitigation measures are required.

11.7 Assessment of Effects - Completed Development

Human Receptors

11.7.1 Existing receptor locations to operational traffic impacts are presented in Figure 11.5. NO_2, PM_{10} and $PM_{2.5}$ concentrations have been predicted at each location.

11.7.2 Full predicted pollutant concentrations at existing receptors are presented in Appendix 11.8.

The impact of operational traffic emissions associated with the Proposed Development is predicted to be negligible at all existing receptor locations. The modelled results for the five receptors at which the change in pollutant concentration due to the operation of the Proposed Development will be greatest are presented in

11.7.3 Table 11.15

11.7.4 The highest increase in annual mean NO_2 concentrations is predicted at R.15, which is at the Turnpike public house along the A44 Woodstock Road. The annual average NO_2 concentration is predicted to increase by 0.8 µg/m^3 as a result of traffic generated by the operation of the Proposed Development. This is 2.1% of the AQAL, which is the 40 µg/m^3 annual average NO_2 AQO. The annual average NO_2 concentration will be 54% of the AQAL and therefore the impact is deemed negligible.

11.7.5 The highest increase at a residential receptor was at R.22, which is along the A44 Woodstock Road, adjacent to the roundabout with Frieze Way. The increase in annual average NO_2 concentration at this receptor is predicted to be 0.6 µg/m^3 (1.4 % of AQAL). As the predicted concentration is 56% of the AQAL, this is a negligible increase.

11.7.6 The maximum increase in annual mean PM_{10} is 0.3 µg/m^3 (0.7% of AQAL) and maximum increase in $PM_{2.5}$ 0.2 µg/m^3 (0.8% of AQAL), both predicted at R.15. Considering that the predicted annual average concentrations are less than 60% of the relevant AQAL, this represents a negligible impact.

11.7.7 The impact at all receptors within the City of Oxford and Bicester Road AQMAs will be negligible.

11.7.8 As the impact is negligible at all receptors, the effect on air quality will be not significant.

Table 11.15: Five receptors with the greatest impact on air quality due to the operation of the Proposed Development.

ID	NO_2			PM_{10}			$PM_{2.5}$		
	% of AQAL	% change relative to AQAL	Impact descriptor	% of AQAL	% change relative to AQAL	Impact descriptor	% of AQAL	% change relative to AQAL	Impact descriptor
R.15	54	2.1	Negligible	45	0.7	Negligible	58	0.8	Negligible
R.22	56	1.4	Negligible	49	0.5	Negligible	61	0.6	Negligible
R.16	41	1.2	Negligible	42	0.4	Negligible	54	0.5	Negligible
R.14	42	1.1	Negligible	42	0.4	Negligible	55	0.5	Negligible
R.17	43	1.1	Negligible	41	0.5	Negligible	54	0.5	Negligible

On-site exposure

11.7.9 Contours of 2019 pollutant concentrations, overlayed on the land use parameter plan are presented in Figure 11.13 for NO_2 and Figure 11.14 for particulate matter. Modelled concentrations are for the 2019 baseline year. Concentrations are predicted to decrease for the opening year, as evidenced by all modelled existing receptors having higher concentrations in the baseline year compared to the future scenarios. Therefore, using 2019 to assess on-site exposure is a worst-case assumption.

11.7.10 There will be no exceedance of the AQOs on-site. Pollutant concentrations are influenced primarily by the A44 Woodstock Road, with the highest concentrations along the western boundary of the Site, adjacent to this road. Concentrations reduce with distance from the roadside towards the background concentration.

11.7.11 Modelling indicates that, in addition to being in compliance with the AQO (40 µg/m^3), the Site is in compliance with the WHO 3rd interim target for annual average NO_2 (20 µg/m^3). It is also in compliance with the 3rd interim target for $PM_{2.5}$ (15 µg/m^3) and the 4th interim target for PM_{10} (20 µg/m^3). As vehicle emissions and background concentrations reduce in the future, air pollutant concentrations on-site will reduce further in the future.

11.7.12 It should be noted that, whilst the WHO targets are a useful tool for the purpose of comparing to known guidelines, they are not statutorily enforceable. Only the AQOs are statutorily enforceable.

11.7.13 Several site specific monitoring locations (section 11.4.7 - 11.4.12) were located adjacent to the A44 Woodstock Road. Therefore these will be representative of worst-case on-site conditions. All of these monitoring sites recorded annual average NO_2 concentrations in compliance with the AQO. The maximum annual average concentration was recorded at BID 2, which recorded 24.5 µg/m^3, significantly below the AQO (40 µg/m^3). BID3 and BID6 both recorded concentrations less than 50% of the AQO. These monitoring sites are closer to the roadside than the Site, so concentrations will be lower on the Site. BID5, BID1 and BID4 were located within the Site boundary. These sites recorded NO_2 concentrations between 10.6 – 15.5 µg/m^3, significantly lower than the AQO.

11.7.14 Air quality is predicted to improve in the future for a number of reasons, for example reductions in traffic emissions as the vehicle fleet shifts towards newer vehicles with lower tailpipe emissions. Therefore, it is likely that future site users will be exposed to pollutant concentrations lower than these baseline monitored concentrations and therefore air quality will be in compliance with AQOs in the operational year.

11.7.15 As air pollutant concentrations will be in compliance with AQOs across the Site, the impact of air pollution on new receptors introduced by the Proposed Development will be not significant.

Figure 11.13: Modelled 2019 annual average NO_2 across the Site

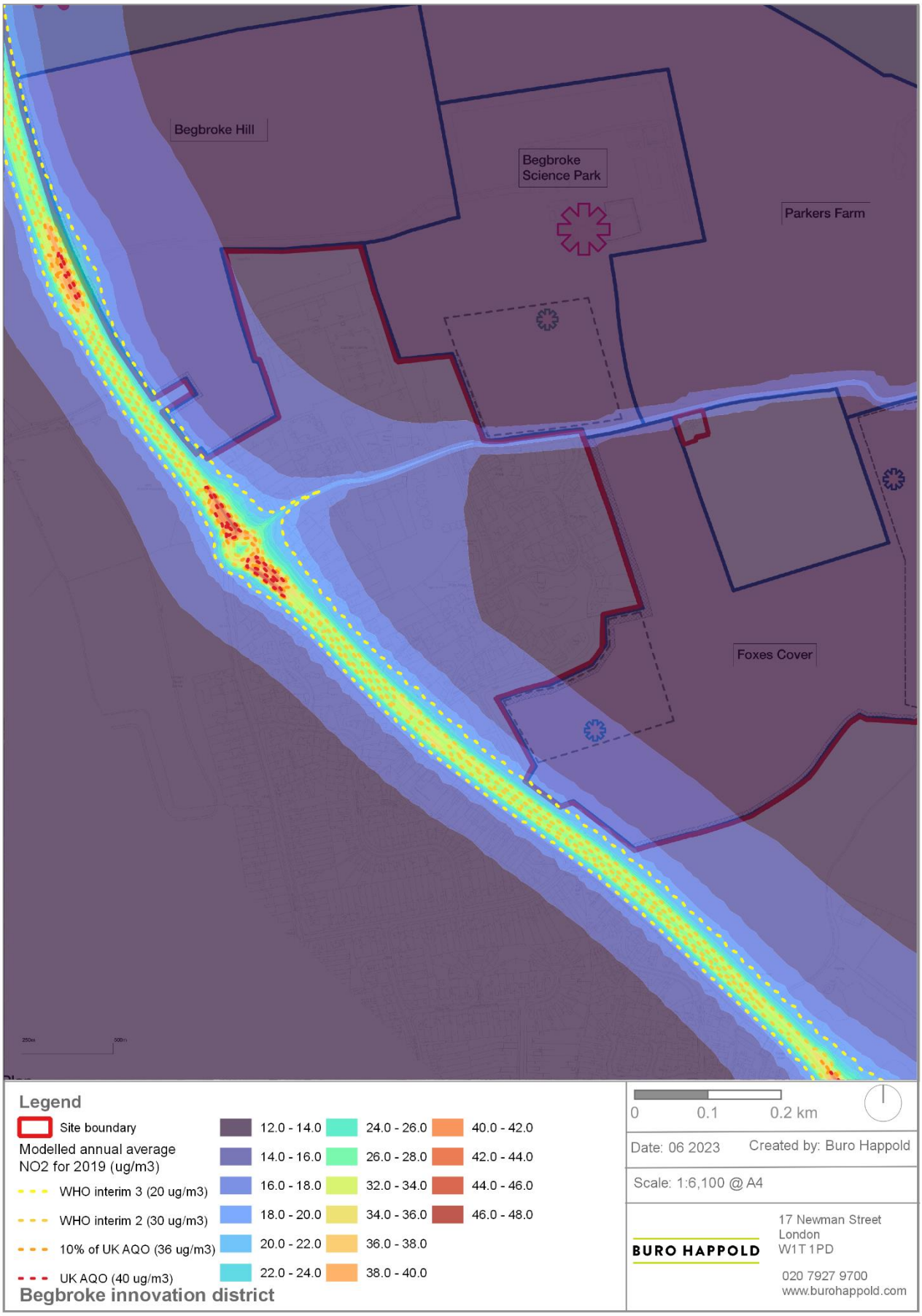
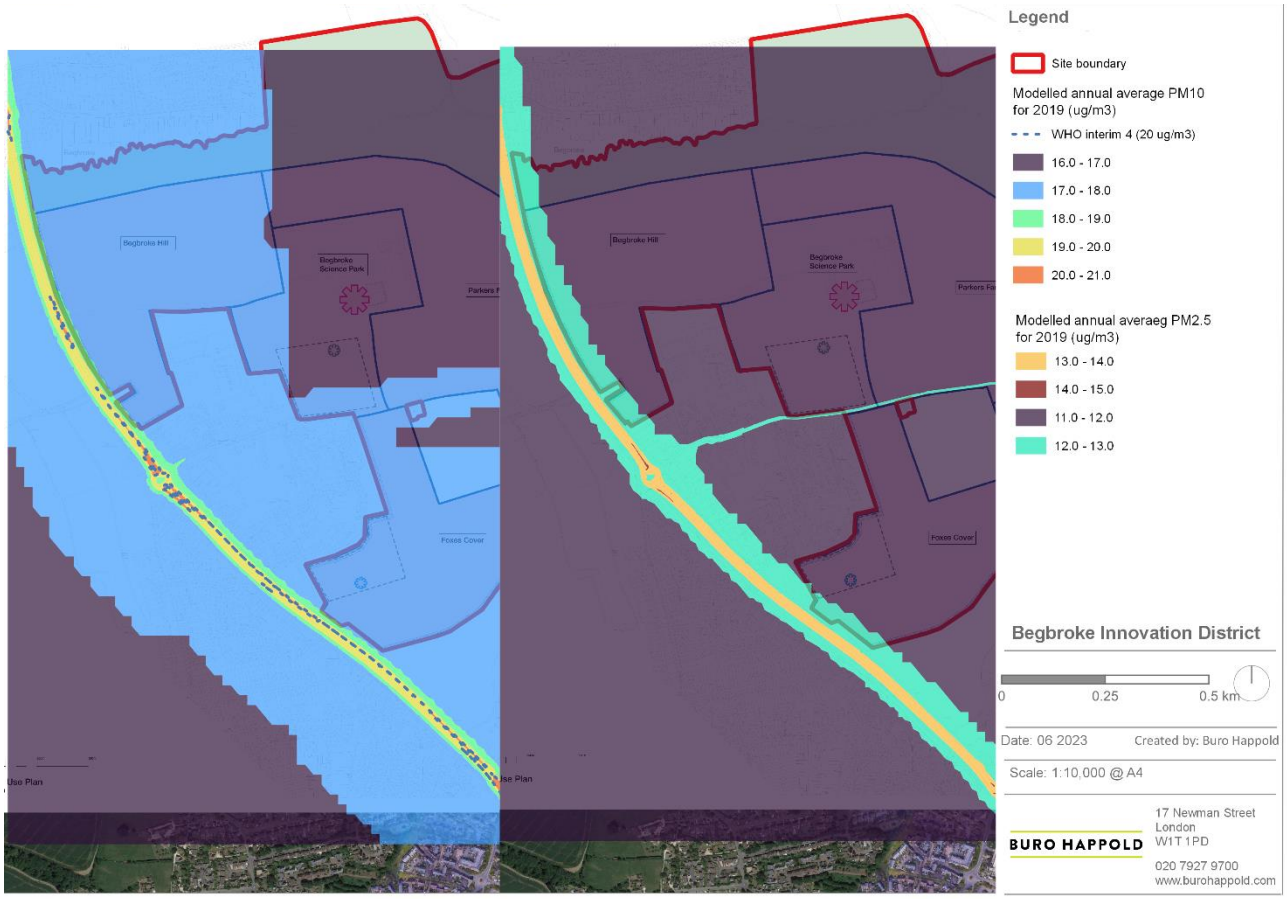


Figure 11.14: Modelled 2019 annual average PM_{10} (left) $PM_{2.5}$ (right) across the Site



Ecological Sites

11.7.16 NO_x concentration, NH_3 concentration, nitrogen deposition and acidification have been predicted along transects at Oxford Meadows SAC, Wytham Woods SSSI, nearby ancient woodland sites and Meadows West of Oxford Canal LWS (shown in Figure 11.8). The full results of the modelled transects are presented in Appendix 11.11.

11.7.17 The results have been analysed by the project ecologist to determine whether there will be any significant impacts. The significance of impacts is presented in Chapter 13: Ecology and Appendix 13.3 of the ES.

Mitigation, Monitoring and Residual Effects

11.7.18 As the impact of operational traffic on all human receptors will be negligible, no additional mitigation is recommended.

11.7.19 As per the Cherwell Air Quality Action Plan, air quality damage costs calculations have been carried out. The damage cost calculations are detailed in Appendix 11.11. Damage cost calculations show that the estimated damage cost of the Proposed Development is £356,140. These damage costs should be considered alongside the offsetting costs of mitigation measures embedded in the design of the Proposed Development. It is recommended that a detailed site wide low emission strategy be produced at the detailed design/reserved matters stage outlining the emission sources and proposed mitigation measures.

11.8 Cumulative Effects

Construction

Assessment

11.8.1 Surrounding cumulative developments have been considered in the construction assessment. Potential impacts of dust and PM_{10} emissions on surrounding receptors that will also be impacted by the construction of the Proposed Development have been considered. This includes cumulative developments that are within 350m of receptors that have the potential to be impacted by the construction of the Proposed Development.

Mitigation, Monitoring and Residual Effects

11.8.2 Cumulative developments have been assessed inherently within the construction dust assessment and therefore this is reflected in the mitigation measures above. Recommended mitigation also includes regular liaison meetings with other high risk construction sites within 500m of the Site boundary, to ensure potential cumulative effects are minimised and no significant cumulative effects are likely.

Completed Development

Assessment

11.8.3 Cumulative air quality impacts of the Proposed Development and other PR sites have been modelled. Other cumulative schemes are considered to be included inherently in the future baseline traffic flows used in the assessment, and have therefore contributed to the total modelled concentrations presented in this assessment. Total predicted pollutant concentrations at each receptor are presented in full in Appendix 11.8.

11.8.4 As with the construction and operational traffic impact assessments, the greatest impact will occur at R.15. The change in NO_2 concentration due to the Proposed Development and the PR sites will be 3% of the AQAL. The total annual average concentration will be 56% of the AQAL so therefore the impact will be negligible.

Similarly, the greatest change in PM_{10} and $PM_{2.5}$ (0.9% and 1.1%, respectively) will be at receptor R.15. Due to the total concentration being significantly below the AQAL, this equates to a negligible impact. The modelled results for five receptors at which there will be the greatest change in concentration are presented in

11.8.5 Table 11.16.

11.8.6 The impact of the Proposed Development and the PR sites on surrounding air quality is negligible at all receptors.

11.8.7 As mentioned in the Assumptions and Limitations section, there are several cumulative developments that were not included in the traffic modelling (details on this are presented in Chapter 9: Transport and Access of the ES).

11.8.8 As mentioned above, the largest change in NO_2 concentration will be at R.15 at which there will be a 3% increase relative to the AQAL. At this level of change the total concentration would need to be at least 76% of the AQAL for a slight impact to occur (as per IAQM criteria presented in Table 11.6). Of all the receptors, the highest total concentration is 67% of the AQAL. Therefore, a 9% change in concentration, relative to the AQAL would need to occur for this receptor to fall into the band at which slight impacts are possible. This is significantly less than the largest change in concentration relative to the AQAL due to the Proposed Development and the PR sites (3%).

11.8.9 It is anticipated that the combined air quality impact of the Proposed Development and the PR sites will be greater than the cumulative developments that have not been assessed quantitively. Therefore, it is not likely that these cumulative developments would lead to a greater than 9% increase in NO_2 concentration and therefore lead to a slight impact at any receptor.

11.8.10 Therefore, the cumulative impact on air quality is determined to be negligible and effects not significant.

Table 11.16: Five receptors with the greatest impact on air quality due to the cumulative impact of the operation of the Proposed Development and the PR sites.

ID	NO_2			PM_{10}			$PM_{2.5}$		
	% of AQAL	% change relative to AQAL	Impact descriptor	% of AQAL	% change relative to AQAL	Impact descriptor	% of AQAL	% change relative to AQAL	Impact descriptor
R.15	55	3.0	Negligible	46	0.9	Negligible	59	1.1	Negligible
R.22	56	2.3	Negligible	50	0.8	Negligible	61	0.9	Negligible
R.25	56	2.0	Negligible	50	0.7	Negligible	62	0.9	Negligible
R.3	39	1.6	Negligible	42	0.5	Negligible	55	0.6	Negligible
R.16	42	1.5	Negligible	42	0.5	Negligible	54	0.6	Negligible

11.8.11 The in-combination impact of cumulative PR sites has also been considered when assessing the potential impacts on Oxford Meadows SAC and is assessed in the standalone Information for Habitats Regulations Assessment Report.

Mitigation, Monitoring and Residual Effects

11.8.12 As no significant cumulative impacts are identified with regards to human health, no additional mitigation measures are recommended.

11.9 Summary

11.9.1 Table 11.17 summarises the impact of the Proposed Development on air quality and the significance of the residual effects.

Table 11.17: Summary of Effects

Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Magnitude of Impact	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
Construction						
Dust emissions due to construction activities adversely impacting amenity.	Surrounding existing residential properties, including moored canal boats (High)	Local, temporary	High risk	N/A	Employ site specific mitigation measures outlined in Appendix 11.10	Not significant
Dust emissions due to construction activities causing ecological damage	Rushy Meadows Site of Special Scientific Interest (Medium)	Local, temporary	Medium risk	N/A		Not significant
PM_{10} emissions due to on-site construction activities adversely impacting human health.	Surrounding existing residential properties, including moored canal boats (High)	Local, temporary	Low risk	N/A		Not significant
Effects of emissions arising from traffic generated by the construction of Proposed Development on human health	Surrounding sensitive uses, e.g. residential properties and schools (High)	Local, temporary	Negligible	Not significant	None	Not significant

Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Magnitude of Impact	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
Completed Development						
Effects of emissions arising from traffic generated by the operation of Proposed Development on human health	Surrounding sensitive uses, e.g. residential properties and schools (High)	Local, permanent	Negligible	Not significant	None	Not significant
Effect of air pollution on new exposure introduced by the Proposed Development	Future sensitive uses on-site, including residential properties and schools (High)	Local, permanent	Negligible	Not significant	None	Not significant
Effects of emissions arising from traffic generated by the operation of Proposed Development on designated ecological sites	Oxford Meadows SAC and SSSI (High) Meadows West of Oxford Canal LWS (High) Wytham Wood (High) Four Ancient Woodland: Church Grove, Godstow Holt and two unnamed sites.	Local, permanent	The significance of impacts is presented in Chapter 13: Ecology and Appendix 13.3 of the ES.			
Cumulative Effects						

Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Magnitude of Impact	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
Effects of emissions arising from traffic generated by the operation of Proposed Development and cumulative PR sites on human health	Surrounding sensitive uses, e.g. residential properties and schools (High)	Local, permanent	Negligible	Not significant	None	Not significant
In combination effects of emissions arising from traffic generated by the operation of Proposed Development and PR sites on designated ecological sites	Oxford Meadows SAC and SSSI (High)	Local, permanent	The significance of impacts is presented in Chapter 13: Ecology and Appendix 13.3 of the ES.			

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