LBR 2.63

ATKINS

Redbridge Billet Road High Level Transport Study

Air Quality Report

December 2015

Notice

This document and its contents have been prepared and are intended solely for London Borough of Redbridge's information and use in relation to the planning for the Billet Road High Level Transport Study.

Atkins Limited assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

This document has 39 pages including the cover.

Document history

Job number: 5141547			**Document ref: 5141547.670**			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	For Client Comment	RM	ML	VLS	SR	17/12/2015

Client signoff

Client	London Borough of Redbridge
Project	Billet Road High Level Transport Study
Document title	Air Quality Report
Job no.	5141547
Copy no.	
Document reference	5141547

Table of contents

Tables

Figures

1. Introduction

Atkins Limited has been commissioned to provide an air quality assessment for an alternative opportunity site should it not be possible to take forward preferred sites for development identified in the London Borough of Redbridge's Local Plan (from here on referred to as 'the Development Site').

An air quality assessment is required to address concerns regarding changes in air quality as a result of additional traffic movements generated by the Development Site. The site under consideration is on land to the south of Billet Road, adjacent to the A12 at Little Heath, which includes land to the east of Little Heath School.

Current masterplans show that the Development Site could yield between 1,100 and 1,600 new homes in total. The Development Site is expected to result in changes in traffic emissions and concentrations of air pollutants at air quality sensitive receptors around the Development Site. In addition, it is important to ensure that new air quality sensitive receptors such as the new homes, introduced within the Development Site, will not be exposed to air pollutant concentrations in excess of relevant Government criteria. The purpose of this report is to assess the potential impacts of the Development Site on local air quality, and to consider the suitability of the Development Site for the introduction of new air quality sensitive receptors.

The Development Site is located within the boundaries of the Redbridge borough-wide air quality management area (AQMA) designated for exceedances of the annual mean nitrogen dioxide (NO_2) and the 24-hour mean particulate matter (PM_{10}) Government criteria. On this basis the pollutants NO_2 and PM_{10} are the focus of this assessment.

To address potential air quality impacts for the Development Site, this air quality assessment includes:

- A review of relevant local air pollutants and air quality management in the regulatory and policy context;
- A summary of baseline conditions examining information on existing pollutant sources and measured ambient concentrations in the vicinity of the Development Site, comparing these with relevant air quality criteria; and identification of constraints – sensitive receptors (human health and designated ecological sites), AQMAs, and pollution sources, including roads and industry;
- Quantitative consideration of potential air quality impacts on local air quality during the operational phase;
- Consideration of options for mitigation to prevent or reasonably minimise any potentially significant effects, where required; and
- Conclusions and recommendations.

2. Legislation, Policy and Guidance

2.1. Key Air Pollutants

In most urban areas in the UK, including within the boundaries of the London Borough of Redbridge, the main local source of local air pollutants is road traffic. Emissions from vehicle exhausts contain a complex mixture of pollutants including oxides of nitrogen (a mixture of nitrogen dioxide and nitric oxide – dominated by the latter), particulate matter (PM), carbon monoxide, and hydrocarbons (including benzene and 1,3-butadiene). The quantities of each pollutant emitted depend upon the vehicle type, quantity and type of fuel used, engine size, speed of the vehicle and abatement equipment fitted. In recent years, the local air pollutants causing most concern have been nitrogen dioxide and particulate matter.

The pollutants most relevant to traffic emissions, nitrogen dioxide and particulate matter, are introduced briefly below.

2.1.1. Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a secondary pollutant produced by the oxidation of nitric oxide (NO). Nitric oxide and nitrogen dioxide are collectively termed oxides of nitrogen (NO_x). Just over a third of the UK NO_x emissions are from road transport. The majority of NO_x emitted from vehicles is in the form of NO, which oxidises rapidly in the presence of ozone (O_3) to form NO_2. In high concentrations, NO_2 can affect the respiratory system and can also enhance the response to allergens in sensitive individuals, whereas NO does not have any observable effect on human health at the range of concentrations found in ambient air.

2.1.2. Particulate Matter

Particulate matter in vehicle exhaust gases consists of carbon nuclei onto which a wide range of compounds are absorbed. These particles have an effective aerodynamic diameter of less than 10 micrometers (µm). Particles in this size range are referred to as PM_{10}. Diesel engines produce the majority of particulate emissions from the vehicle fleet. About a quarter of primary PM_{10} emissions in the UK are derived from road transport. Particulate matter appears to be associated with a range of symptoms of ill health including effects on the respiratory and cardiovascular systems, on asthma and on mortality. Reviews by the World Health Organisation (WHO) and the Committee on the Medical Effects of Air Pollutants (COMEAP) have suggested exposure to finer fraction of particles ($PM_{2.5}$, which typically makes up around two thirds of PM_{10} emissions[1] and concentrations) has a stronger association with observed ill health effects than PM_{10}.

2.2. Air Quality Legislation

There are two types of air quality regulations that apply in England:

- Regulations implementing mandatory European Union (EU) Directive limit values: The Air Quality Standards Regulations 2010 (Statutory Instrument (SI) 2010 No. 1001)[2]; and

- Regulations implementing national air quality objectives: Air Quality (England) Regulations 2000 (SI 2000 No. 928) and Air Quality (England) (Amendment Regulations 2002 (SI 2002 No. 3043)[3,4],

2.2.1. EU Limit Values

Mandatory legislative air quality criteria are set in EU Directives. In addition the Directives contain more stringent, but non-obligatory, guide values. In April 2008, the European Commission adopted a Directive on ambient air quality and cleaner air for Europe (2008/50/EC). This Directive was transposed into UK legislation through the Air Quality Standards Regulations 2010 (SI 2010 No. 1001). The relevant EU limit values in the context of this assessment for the protection of human health are presented in Table 2-1.

---

[2] The Air Quality Standards Regulations 2010: http://www.legislation.gov.uk/uksi/2010/1001/contents/made
[3] The Air Quality (England) Regulations 2000: http://www.legislation.gov.uk/uksi/2000/928/contents/made
[4] The Air Quality (England) (Amendment) Regulations 2002: http://www.legislation.gov.uk/uksi/2002/3043/contents/made

2.2.2. National Air Quality Strategy

The 2007 Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland[5] (UK AQS) sets out the national air quality standards and objectives for a number of local air pollutants. The standards are set by expert organisations with regard to scientific and medical evidence on the effects of the particular pollutant on health, and define the level of pollution below which health effects are expected to be minimal or low risk even for the most sensitive members of the population. The objectives are targets for air pollution levels to be achieved by a specified timescale, which take account of the costs and benefits of achieving the standard, either without exception or, for certain short term averaging period standards, with a permitted number of exceedances. Local authorities have a responsibility (under the Environment Act 1995) to review and assess local pollution levels against these objectives. These criteria are defined in Regulations SI 2000 No. 928 and SI 2002 No. 3043.

However, for some pollutants, such as particulate matter, it is recognised that there is no threshold concentration that can currently be determined, below which there are no effects on the whole population's health. An exposure reduction objective for the finer $PM_{2.5}$ fraction has therefore been introduced in the latest version of the strategy. This type of objective is designed to reduce average concentrations throughout an entire urban background area, thus ensuring that the majority of people will benefit, rather than just those who live in a particular hotspot area.

It should be noted that the UK air quality objectives only apply in locations likely to have 'relevant exposure' – i.e. where members of the public are exposed for periods equal to or exceeding the averaging periods set for the standards. For this assessment, locations of relevant exposure include building façades of residential premises, schools, public buildings and medical facilities; places of work (other than certain community facilities) are excluded.

The statutory air quality criteria for the protection of human health that are relevant to this assessment are outlined in Table 2-1.

Table 2-1 Statutory Air Quality Criteria

Pollutant	Objective
NO_2	Hourly average concentration should not exceed 200 µg/m^3 more than 18 times a year Annual mean concentration should not exceed 40 µg/m^3
PM_{10}	24-hour mean concentration should not exceed 50 µg/m^3 more than 35 times a year Annual mean concentration should not exceed 40 µg/m^3
$PM_{2.5}$	UK (except Scotland): annual mean concentration should not exceed 25 µg/m^3 by 2010† Exposure reduction^ (UK urban areas): target of 15% reduction in concentrations at urban background between 2010 and 2020*
† EU limit value is 25 µg/m^3 to be met by 2015, with a requirement in urban areas to bring exposure down to below 20 µg/m^3 by 2015. ^ New European obligations for a target of 20% reduction * 25 µg/m^3 is a cap to be seen in conjunction with 15% reduction	

2.2.3. Ecological Limit Values

The EU has set a limit value for the protection of vegetation for NO_x based on the work of the United Nations Economic Commission for Europe (UNECE) and WHO. The limit value for the protection of vegetation is a annual mean oxides of nitrogen concentration of 30 µg/m^3 and is included in SI 2010 No 1001. The limit value for the protection of vegetation applies in locations more than 20 kilometres from towns with more than 250,000 inhabitants or more than 5 kilometres from other built-up areas, industrial installations or motorways.

As the UNECE and the WHO have set a critical level for NOx for the protection of vegetation, the Statutory Nature Conservation Agencies' (in England, Natural England) policy is to apply the criteria, on a precautionary basis, as a benchmark, in internationally designated conservation sites (Ramsar, Special Area of Conservation (SAC), Special Area of Protection (SPA)) and Sites of Special Scientific Interest (SSSI). In addition, critical loads for nitrogen and acid deposition have been set that represent (according to current

[5] Department for Environment, Food and Rural Affairs (DEFRA), 2007. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. http://archive.defra.gov.uk/environment/quality/air/airquality/strategy/documents/air-qualitystrategy-vol1.pdf

knowledge) the exposure below which there should be no significant harmful effects on sensitive elements of the ecosystem.

2.2.4. Local Air Quality Management

Under Part IV of the Environment Act 1995 all local authorities are responsible for Local Air Quality Management (LAQM), the mechanism by which the Government's AQS objectives are to be achieved. As part of this LAQM role, local authorities are required to periodically review air quality in their area and to assess present and likely future air quality against the objectives defined in Regulations. Where a local authority anticipates an objective is expected to be breached within their area, they must designate an AQMA and develop an action plan to improve pollution levels. Under the current LAQM regime, a local authority is responsible for regular review and assessment of local air quality, reports on which are published following public consultation and review by the Department for Environment, Food and Rural Affairs (DEFRA).

Statutory responsibility for achieving EU limit values rests with the Secretary of State and local authorities have no responsibility for achieving the national air quality criteria, although they should contribute to this through local action plans designed to reduce pollution concentrations in AQMAs in pursuit of the AQS objectives. Guidance concerning local air quality is given in DEFRA's Technical Guidance LAQM.TG(09)[6]; the guidance provides relevant methods concerning treatment and interpretation of data.

All 33 of the London local authorities have declared AQMAs. The London Borough of Redbridge declared the whole borough as an AQMA in 2003, due to exceedances of the annual mean NO_2 and the 24 hour mean PM_{10} criteria. The London Borough of Redbridge adopted their Air Quality Action Plan (AQAP)[7] in 2007 with the aim of improving air quality and working towards achieving the AQS objectives. This AQAP sets out 57 key actions for reducing pollution concentrations within the London Borough of Redbridge administrative boundary. The AQAP identifies road traffic to be the primary source of air pollution and includes measures to both reduce the emissions from vehicles in the Borough and to reduce the amount of traffic on the roads.

2.3. Non-Statutory Guidance

2.3.1. Development Control

Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM) have published land use planning and development control guidance for air quality (referred to as the EPUK / IAQM Land-Use Planning and Development Control Guidance)[8]. The guidance sets out to ensure that air quality is adequately considered in the land-use planning and development control processes. It comprises an initial screening stage to determine the need for an air quality assessment. If an assessment is required, a number of more stringent criteria are provided to help establish the need for further work, which may be either qualitative or quantitative, simple or detailed. It also provides a framework for describing the impact of changes in local air pollutant concentrations at individual receptors and gives advice on how the significance may be assessed.

2.4. Air Quality Planning Policies

2.4.1. National Planning Policy

National Planning Policy Framework

The Government's planning guidance of general relevance for air quality is found within the National Planning Policy Framework (NPPF)[9]. It provides guidance to local authorities on incorporating air quality

[6] DEFRA Local Air Quality Management Technical Guidance (LAQM.TG(09): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69334/pb13081-tech-guidance-laqm-tg-09-090218.pdf

[7] The London Borough of Redbridge Air Quality Action Plan, 2007: http://aqma.defra.gov.uk/action-plans/LBoR%20AQAP.pdf

[8] EPUK / IAQM (2015). Land-Use Planning & Development Control: Planning For Air Quality, May 2015: http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

[9] Dept for Communities and Local Government (2012), National Planning Policy Framework, 27 March 2012. https://www.gov.uk/government/publications/national-planning-policy-framework--2

considerations into planning decisions and aims to protect the environment and to promote sustainable growth. It states that:

> *"Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas[10] and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan."*

Planning Practice Guidance

Planning Practice Guidance (PPG)[11] is intended to support the NPPF and provide further detail to its policies. PPG indicates at paragraph 006 that information relating to air quality could be important to decision makers, and when there are concerns about air quality, the local planning authority may want to know about:

- "The 'baseline' local air quality;
- Whether the proposed development could significantly change air quality during the construction and operational phases; and/or
- Whether there is likely to be a significant increase in the number of people exposed to a problem with air quality, such as when new residential properties are proposed in an area known to experience poor air quality."

PPG also advocates (at paragraph 006) early engagement with the local planning and environmental health departments to establish the scope of any assessment. Guidance is also given on the level of detail required in an air quality assessment, and measures which could be employed to mitigate adverse effects.

2.4.2. Regional Planning Policy

The London Plan

The London Plan (GLA, 2015)[12] is the overall strategic plan for London. This sets out a fully integrated economic, environmental, transport and social framework for the development of London over the next 20 to 25 years. Policy 7.14: Improving Air Quality states that:

> *"The Mayor recognises the importance of tackling air pollution and improving air quality to London's development and the health and well-being of its people. He will work with strategic partners to ensure that the spatial, climate change, transport and design policies of this plan support implementation of his Air Quality and Transport strategies to achieve reductions in pollutant emissions and minimise public exposure to pollution."*

The Mayor's priorities for development proposals include:

- Designing schemes so that they are at least 'air quality neutral' and designed to minimise the generation of air pollution;
- Minimising and mitigating against increased exposure to poor air quality;
- Selecting plant that meets the standards for emissions from combined heat and power and biomass plants; and
- Reducing emissions from the demolition and construction of buildings by following the guidance set out in The Control of Dust and Emissions during Construction and Demolition Supplementary Planning Guidance (SPG)[13].

Mayor of London's Air Quality Strategy

The Mayor of London's Air Quality Strategy (2010)[14] sets out specific policies and proposals to address the air quality issues, including reducing emissions from transport, reducing emissions from homes, business and industry and increasing awareness of air quality issues. The Mayor's Air Quality Strategy contains fourteen policies: Policy 1 to Policy 5 are aimed at reducing transport related air pollutants; Policy 6 to Policy

[10] Air quality management areas are discussed under Local Planning Policy
[11] http://planningguidance.planningportal.gov.uk/blog/guidance/air-quality/
[12] Greater London Authority (GLA), The London Plan Spatial Development Strategy for Greater London, March 2015 https://www.london.gov.uk/what-we-do/planning/london-plan/current-london-plan
[13] Greater London Authority, The Control of Dust and Emissions during Construction and Demolition Supplementary Planning Guidance, July 2014, available at: https://www.london.gov.uk/sites/default/files/Dust%20and%20Emissions%20SPG%208%20July%202014_0.pdf
[14] Greater London Authority, Cleaning the Air, The Mayor's Air Quality Strategy, December 2010, available at: https://www.london.gov.uk/sites/default/files/Air_Quality_Strategy_v3.pdf

12 relate to non-transport measures and include a policy on reducing emissions from construction sites; and Policy 13 and Policy 14 relate to implementation of the Air Quality Strategy including working with the Government, other authorities and London Boroughs.

2.4.3. Local Planning Policy

Redbridge Local Development Framework (LDF)

The Local Development Framework (LDF) is a portfolio of planning documents, individually known as Local Development Documents. The LDF for the London Borough of Redbridge delivers the spatial development strategy for the Borough and builds on the London Plan.

Documents within the London Borough of Redbridge LDF addressing air quality consist of the:

- Core Strategy Development Plan Document;
- Borough Wide Primary Policies Development Plan Document;
- Sustainable Design and Construction Supplementary Planning Document; and
- Redbridge Draft Local Plan 2015 - 2030

Core Strategy Development Plan Document

The London Borough of Redbridge Core Strategy Development Plan Document, adopted in 2008[15], sets out an overall spatial strategy for the Borough and provides general guidelines on the types and location of future development.

The Core Strategy contains Strategic Objectives to guide the future planning of the Borough and help achieve its spatial vision. Twelve Strategic Policies are provided to help achieve the Strategic Objectives. They include the following objectives relevant to air quality:

- SP6: Movement and Transport which states that "*A transport network that supports a prosperous economy and socially cohesive community, reduces car dependence, encourages sustainable transport, improves air quality and reduces greenhouse gas contributions to climate change will be achieved by: (i) locating new development within close proximity to public transport nodes..[inter alia].".*

Borough Wide Primary Policies Development Plan Document

This Borough Wide Primary Policies Development Plan Document[16] translates the twelve strategic policies of the Core Strategy Development Plan Document into thirty-four policies to be applied in the detailed assessment of planning applications. Air Quality is directly addressed in E8 – Air Quality:

- *"To complement the Air Quality Area Action Plan, the Council will:*
  1. *Require air quality assessments for major development proposals considered likely to have a significant and harmful impact on air quality*
  2. *Refuse development proposals which could cause significant deterioration in air quality or expose members of the public to poor air quality, unless appropriate mitigating measures are put into place*
  3. *Require developers to use the most up to date Best Practice Guidance for all stages of development, with particular reference to dust, vapours, plant and vehicle emissions."*

Sustainable Design and Construction Supplementary Planning Document

The London Borough of Redbridge Sustainable Design and Construction Supplementary Planning Document (SPD), adopted in 2012[17], provides guidance on how development in Redbridge should be designed, built

---

[15] London Borough of Redbridge, Local Development Framework, Core Strategy, Development Plan Document, March 2008, available at: http://www2.redbridge.gov.uk/cms/planning_land_and_buildings/planning_policy__regeneration/local_development_framework.aspx#dpds

[16] London Borough of Redbridge, Local Development Framework, Borough Wide Primary Policies, Development Plan Document, May 2008, available at: http://www2.redbridge.gov.uk/cms/planning_land_and_buildings/planning_policy__regeneration/local_development_framework.aspx

[17] London Borough of Redbridge, Planning and Regeneration Service, Sustainable Design and Construction, Supplementary Planning Document, January 2012, available at:

and occupied in order to achieve best practice standards (or better) or sustainable design and construction. Guidance is provided for seven main areas including: "*Minimising air, land, water and noise pollution*". The following requirement is included for air quality:

> "*All new development should be 'air quality neutral' or better through the management and mitigation of emissions. An air quality assessment is required for all development:*
>
> > *(i)Likely to have a significant and harmful impact on air quality (i.e. it will increase pollutant concentrations) either through the operation of the proposed development or trip generation arising from the development.*
> > *(ii) Located in an area of poor air quality (i.e. it will expose future occupiers to unacceptable pollutant concentrations / new exposure).*
> > *(iii) If the demolition / construction phase will have a significant impact on the local environment (i.e. through fugitive dust and exhaust emissions). If this is the case, the Mayor of London's 'control of dust and emissions from construction and demolition' must be followed.*
> > *(iv) If the development prevents implementation of measures in the Air Quality Action Plan."*

Redbridge Local Plan 2015 - 2030

The London Borough of Redbridge Local Plan 2015-2030 is currently being produced. It will set out where, when and how growth may take place across the borough.

A Preferred Options Report was published in January 2013[18]. This identifies locations where housing and infrastructure development could be accommodated to support the Local Plan development. This air quality assessment is in support of the High Level Transport Study for determining alternatives should it not be possible to take forward sites identified in the Preferred Options Report.

http://www2.redbridge.gov.uk/cms/planning_and_the_environment/planning_policy__regeneration/local_development_framework/supplementary_planning_doc.aspx

[18] London Borough of Redbridge, Preferred Options Report, January 2013, available at: http://www2.redbridge.gov.uk/cms/planning_and_the_environment/planning_policy__regeneration/local_development_framework/redbridge_local_plan/preferred_options_report.aspx

3. Baseline Conditions

The review of the existing air quality in the vicinity of the Development Site and notable air pollution sources have been determined by reference to the following sources of information:

- London Borough of Redbridge LAQM review and assessment reports[19] [20];
- Monitoring data from the local authority and the London Air Quality Network (LAQN) website[21];
- Background data from DEFRA's UK Air Information Resource (UK-AIR) website[22];
- London Atmospheric Emissions Inventory (LAEI)[23]; and
- Environment Agency's Pollution Inventory website[24].

3.1. Study Area

The Development Site lies within the London Borough of Redbridge area.

The Development Site lies within land to the east of Hainault Road and Little Heath School, extending east towards the residential area bordering Padnall Road. The surrounding area largely residential. There is a housing area to the east of the Development Site, schools and housing to the west and south and an area of open space to the north. The A12 passes immediately to the south of the Site and Billet Road along its northern boundary.

The nearest sensitive receptors to the Development Site with relevant public exposure include residential properties within 10 metres of its east and northwest boundaries, and Little Heath School approximately 60 metres to the west. There are no statutory designated ecological sites located within one kilometre of the Development Site boundary and therefore these types of receptor are not considered further in the assessment.

The Development Site is within the boundary of the London Borough of Redbridge AQMA declared for exceedances of the annual mean NO_2 and 24-hour mean PM_{10} AQS objectives. The Development Site is shown in Figure 3-1.

[19] 2014 Air Quality Progress Report for London Borough of Redbridge, February 2015
[20] 2012 Air Quality Updating and Screening Assessment for London Borough of Redbridge, November 2012
[21] London Air, Environmental Research Group, King's College London: www.londonair.org.uk
[22] UK-Air: Air Information Resource, DEFRA, 2015. http://uk-air.defra.gov.uk/
[23] GLA, London Atmospheric Emissions Inventory (LAEI): http://www.cleanerairforlondon.org.uk/londons-air/air-quality-data/london-emissions-laei/gla-emissions-summary
[24] http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e

Figure 3-1 Local Air Quality Constraints Map

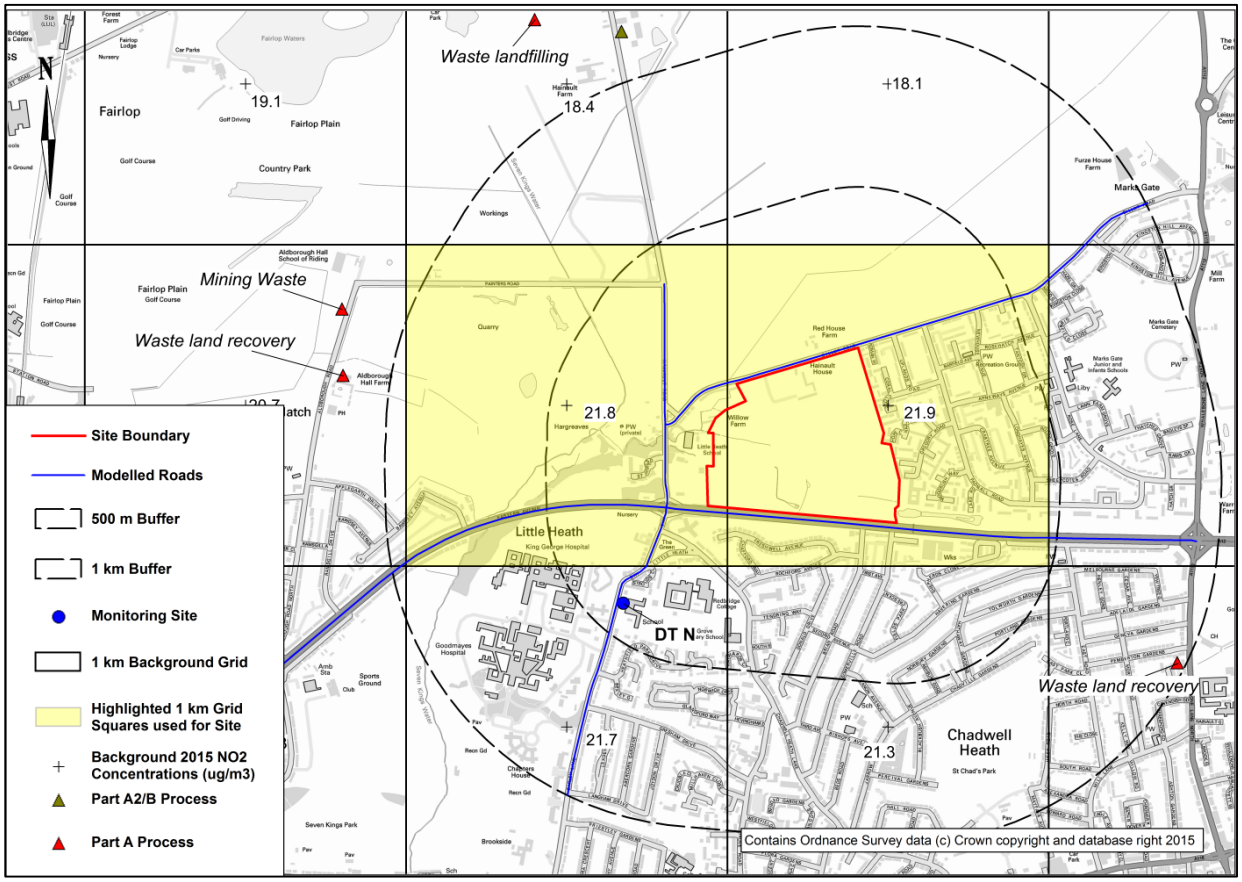
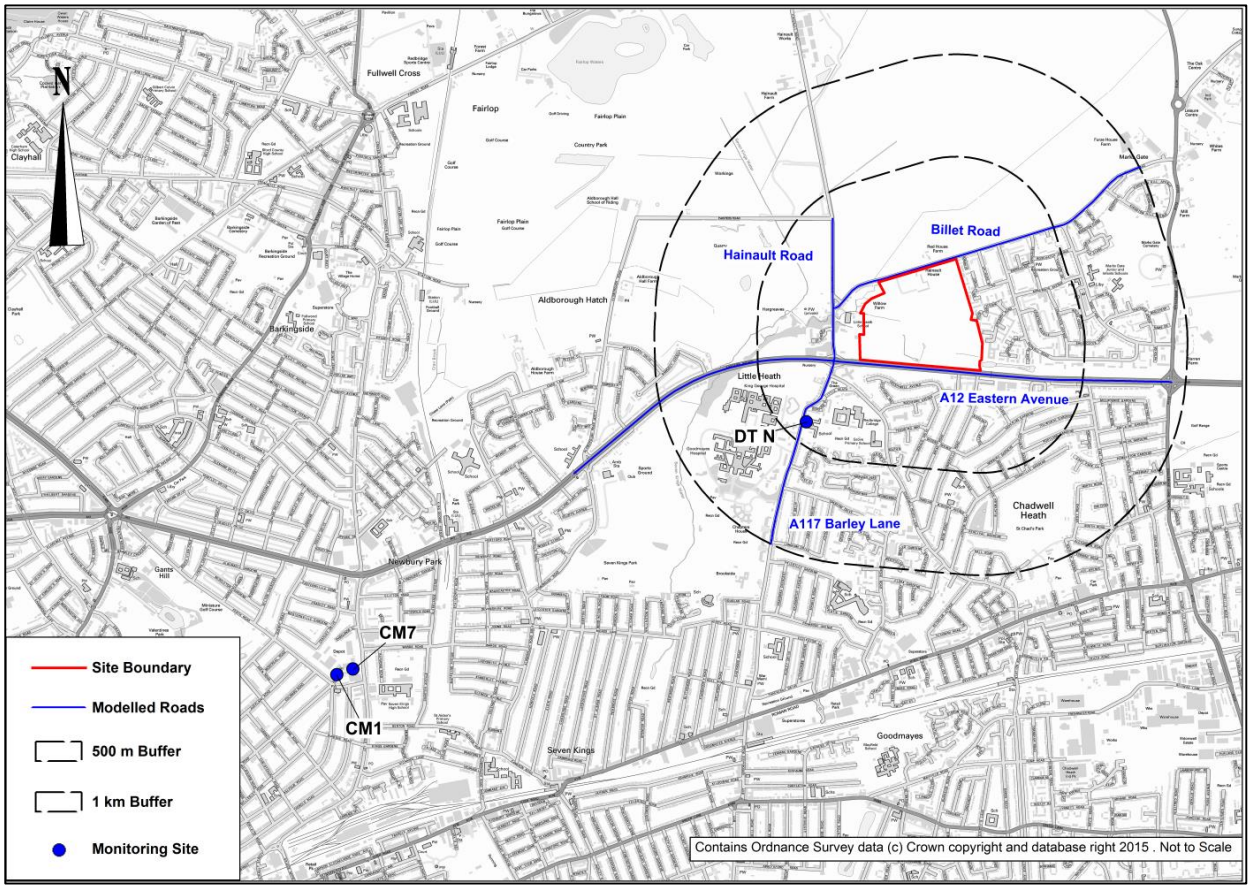


Figure 3-2 Local Air Quality Monitoring Sites



3.2. Local Air Quality Monitoring

There are currently two continuous monitoring stations (CMS) in operation within the London Borough of Redbridge boundary. These sites are:

- CM1 – Redbridge 1: An urban background site located around Perth Terrace. This site was on Perth Terrace, but relocated nearby to Ley Street in May 2014 and renamed CM7. This site is 3 kilometres southwest of the Development Site; and
- CM4 – Redbridge 4: A roadside site close to the A12 located 6.2 kilometres west of the Development Site.

The Council previously operated three other CMS in the Borough, all of which closed during or prior to 2012 and are not considered relevant to this assessment:

Given the distance of the CM4 monitoring site this is not considered further in this assessment. CM1 and CM7 are considered relevant to the assessment. There are no continuous monitoring sites within 1 kilometre of the Development Site. CM1 and CM7 are within 3 kilometres of the Development Site and are shown in Figure 3-2. Recent CMS data is shown in Table 3-1 and Table 3-2.

The London Borough of Redbridge also operates a network of passive NO_2 diffusion tubes at 22 locations across the Borough. One relevant NO_2 diffusion tube monitoring location is shown in Figure 3-1. This diffusion tube monitoring site is located 400 metres away from the Development Site (DT N) at a 'near road' location. Bias adjusted data for this site is shown in Table 3-1

Monitoring data shows that annual mean and hourly mean NO_2 concentrations below their respective AQS objectives. Annual mean and 24 hour mean PM_{10} concentrations are also below their respective AQS objectives.

Trend analysis of the monitored concentrations has been undertaken. This analysis indicates that there are no statistically significant trends in concentrations at any of the monitoring sites. Further details of this analysis are presented in Appendix A.

Table 3-1 Nitrogen Dioxide Annual Mean Concentrations (µg/m^3) (Hourly Exceedances in Brackets)

Name of Monitoring Site and Type-	Distance from Site	Grid Reference	2010	2011	2012	2013	2014
CM1 – UB Perth Terrace	3 kilometres Southwest	544381,187649	33.0 (0)	33.3 (0)	36.8 (0)	35.4 (1)	32.8* (0)
CM7 – UB Ley Street	3 kilometres Southwest	544455,187682	closed	closed	closed	closed	34.6* (0)
DT N – NR Ethel Davis School	0.4 kilometres Southwest	546676,188885	31.4	28.5	31.9	32.9	25.8

Diffusion Tube data adjustment factors: 2010 – 0.79; 2011 – 0.87; 2012 – 0.86; 2013 – 0.80; 2014 – 0.76
* data was annualised by London Borough of Redbridge as data capture was less than 75%
Definition of monitoring types:
- DT - diffusion tube
- CM = continuous monitoring site
- NR = Near Road sites – Sample inlets beyond roadside location, typically within 40 metres of the kerbside.
- UB = Urban Background sites - Urban locations distanced from sources and broadly representative of city-wide background concentrations e.g. elevated locations, parks and urban residential areas.

Table 3-2 PM_{10} Annual Mean Concentrations (µg/m^3) (No. of Exceedances of the 24 Hour Mean are in Brackets)

Name of Monitoring Site and Type-	Distance from Site	Grid Reference	2010	2011	2012	2013	2014
CM1 – UB	3 kilometres Southwest	544381,187649	14.7 (0)	16.3 (5)	14.9 (2)	17.7 (2)	16.9* (5)
CM7 – UB	3 kilometres Southwest	544455,187682	closed	closed	closed	closed	22.9* (7)
* data was annualised by London Borough of Redbridge as data capture was less than 75% Definition of monitoring types: - CM = continuous monitoring site - UB = Urban Background sites - Urban locations distanced from sources and broadly representative of city-wide background concentrations e.g. elevated locations, parks and urban residential areas.							

3.3. Background Pollution Mapping

Estimates of background pollutant concentrations in the UK are available on the DEFRA UK-AIR website. The background estimates, which are a combination of measured and modelled data, are available for each one kilometre grid square throughout the UK for a base year of 2011, which is the basis for the future year estimates up to 2030.

The estimated annual mean background concentrations of relevant pollutants averaged for the grid squares in which the Development Site is located (546500, 189500; 547500, 189500; as shown in Figure 3-1) are provided in Table 3-3, for the years 2014 (the base year in the air quality assessment) and 2015 (the current year). The estimated average background annual mean concentrations are below relevant air quality criteria.

Table 3-3 Background Annual Mean Concentrations at the Development Site for 2014 and 2015 (µg/m^3)

Pollutant	2014	2015
NO_2	22.4	21.8
PM_{10}	20.4	20.1

3.4. Local Emissions Sources

The London Atmospheric Emissions Inventory (LAEI) contains emissions estimates on a 1 kilometre grid square for the Greater London Authority (GLA) Area. The emissions are provided for source sectors split into broad types (e.g. road transport, domestic gas combustion, industry, aviation) as well as into a more detailed breakdown of the road transport sector by vehicle type (e.g. petrol car, bus, motorcycle).

Table 3-4 presents the NO_x and PM_{10} emission estimates for the average of the two 1 kilometre grid squares encompassing the Development Site (highlighted in Figure 3-1). The data are presented for 2015, which was deemed the most suitable year relevant to this assessment.

The greatest contributor to both NO_x and PM_{10} emissions within the grid squares of interest at the Development Site is road transport, contributing to an average of 87% of all NO_x emissions and 66% of all PM_{10} emissions in 2015. The main road sources within the vicinity of the Development Site are shown in Figure 3-2 and include the A12 Eastern Avenue Fields, Billet Road, Hainault Road and Barley Lane.

The next three largest contributors to emissions are ‘Domestic Gas’, ‘Industry Non Road Mobile Machinery’ and resuspension, the latter only associated with PM_{10}. All of these sectors are accounted for in the background pollutant concentrations used in the air quality assessment and are further discussed below.

Table 3-4 2015 Emissions of Pollutants (tonnes) at the Development Site by Source Type

Sector	NO_x	PM_{10}
Road Transport	**9.41**	**1.32**
Gas - Domestic	0.53	0.01
Gas - Non-Domestic	0.37	0.01
Industry Non Road Mobile Machinery	0.40	0.03
Agriculture: Stat and Mach	0.12	0.03
Household and Garden	0.01	<0.01
Domestic Oil	0.01	<0.01
Fires	<0.01	0.02
Waste	<0.01	0.03
Non-Domestic Coal	<0.01	<0.01
Aviation	0	0
Domestic Coal	<0.01	<0.01
Part B Industrial	0	0.02
Non-Domestic Oil	0	0
Resuspension	0	0.55
Highest emission source for each pollutant is in **bold** type		

Industrial processes can be classified as Part A1, A2 and B processes, according to the regulatory body under which they are permitted. Part A processes are permitted by the Environment Agency and Part A2 and B processes by the local authority. Data available from the Environment Agency[25] and the Redbridge Public Register[26] have been used to identify potential air quality constraints to the development.

The London Borough of Redbridge's latest LAQM report indicates that there are no Part A processes in the Borough. The London Borough of Redbridge permits more than 70 smaller Part B industrial and other minor installations, the majority of which are dry cleaning processes. A review of the Environment Agency's website confirms that there are no Part A1 processes within 500 metres of the Development Site, however one waste land recovery processes was found within one kilometre of the Development Site. This processes is a waste land recovery site and is shown in Figure 3-1. This regulated process is unlikely to be a constraint on the Development Site.

3.5. Baseline Conditions Summary

The Development Site lies within the Redbridge AQMA, a borough wide AQMA declared for exceedances of the annual mean NO_2 and 24 hour PM_{10} Government criteria.

Background pollution mapping data from DEFRA and the air quality monitoring data for the urban background monitoring sites, both indicate that background concentrations are currently below relevant air quality criteria Air quality monitoring data for near road monitoring sites also indicate that concentrations near to roads are currently below relevant air quality criteria. On this basis the Development Site is not expected to be in an area of exceedance of the annual mean NO_2 government air quality criterion.

The PM_{10} air quality criteria are have not been exceeded at any location within the London Borough of Redbridge.

Road transport emissions are the primary source of air pollutant emissions in the vicinity of the Development Site. The nearest major road to the Development Site is the A12 Eastern Avenue, which lies immediately to the south of the Development Site. There are a number of regulated industrial processes within one kilometre of the boundary of the Development Site, but these processes are unlikely to be a constraint.

[25] https://www.gov.uk/check-local-environmental-data
[26] http://emissions.redbridge.gov.uk/asp/processes.asp?level=All&DryClean=N&processName=First&view=

4. Potential Effects

4.1. Operational Effects

Once complete, there may be changes in traffic flows or composition on roads near to the Development Site which could affect concentrations of air pollutants at nearby receptors. In order to assess the potential impact, an assessment of local air quality has been undertaken for the proposed development.

4.1.1. Methodology

The need for assessment of operational impacts of the Development Site has been determined based on the criteria given in the 2015 EPUK / IAQM Land-Use Planning and Development Control Guidance. An air quality assessment is required if the development comprises:

- 10 or more residential units or a site area of more than 0.5 ha; or
- More than 1,000 m^2 of floor space for all other uses or a site area greater than 1 ha; and either:
- More than 10 parking spaces; or
- A centralised energy facility or other centralised combustion process.

Given that there are expected to be more than 10 residential units, further screening was undertaken using the traffic change criteria in the 2015 EPUK / IAQM Land-Use Planning and Development Control Guidance. The relevant traffic change criteria are:

- Change of light duty vehicles (LDV) of 100 AADT or more within or adjacent to an AQMA; and
- Change of heavy duty vehicles (HDV) of 25 AADT or more within or adjacent to an AQMA;

Traffic data were provided by the project transport consultant (Atkins Transportation) for three roads around the Development Site: Billet Road; B177 Barley Lane; and Hainault Road.

The traffic data was estimated from automatic traffic count (ATC) data collected for a full typical week commencing on the 5th of November 2015 and factored to provide future flows with and without the Development Site completed and operational in the future year of 2030[27]. The traffic data for the year 2030 assumed traffic growth based on the relevant TEMPRO[28] growth factors for London Borough of Redbridge and additional trips generated by relevant committed developments.

Changes in traffic flows met the criteria for assessment given in the 2015 EPUK / IAQM Land-Use Planning and Development Control Guidance on all of the three roads where data was available.

Given the proximity of the A12 Eastern Avenue to the Development Site, traffic data for the A12 was also included in the air quality model. The DfT provides street-level data for every junction-to-junction link on the 'A' road and motorway network in the UK. Twenty four hour Annual Average Daily Traffic (AADT) flows and percentages of heavy duty vehicles (HDVs) for the A12 were obtained from the Department for Transport (DfT) website[29] and factored by Atkins Transportation to 2030 using a TEMPRO traffic growth factor

Traffic data used in the assessment are presented in Appendix B.

Given the location of the Development Site within an AQMA, assessment of the operational traffic emissions was undertaken using the dispersion modelling software, ADMS-Roads (version 3.4). The model uses information on traffic flows, speeds and composition, vehicle emission rates, road alignment and width, and local meteorological data to estimate local air pollutant concentrations at identified receptor locations.

4.1.1.1. Assessment Scenarios

Pollutant concentrations were determined for the following three scenarios:

- Base year (2014) to permit model verification using local monitoring data;

---

[27] Future year flows were estimated for the Development Site under Low Yield and a Medium Yield. For the purpose of the air quality assessment only the worst case scenarios was assessed, this was Medium Yield (High Yield was not an option for this site). Further information is provided in the Transport Assessment.

[28] Trip End Model Presentation Program (TEMPRO) software is used for transport planning purposes to calculate simple traffic growth factors. Accessible from: https://www.gov.uk/government/collections/tempro#documents

[29] Department for Transport Traffic Counts: http://www.dft.gov.uk/traffic-counts/

- Future year (2030) without the Development Site; and
- Future year (2030) with the Development Site.

The future year of 2030 was assessed at this stage as it is the year used in the Billet Road High Level Transport Study and reflects the end year of the Redbridge Local Plan which covers the period 2015 to 2030.

4.1.1.2. Emission Factors

Vehicle exhaust emissions of NO_x and PM_{10} for each road link in each scenario were calculated using DEFRA's latest Emissions Factors Toolkit (EFT, version 6.0.2, November 2014), using traffic data provided for the Development Site by Atkins Transportation. The emission calculations assumed a "London - Outer" road type for all modelled roads. Emission factors for 2014 were used for the base year and emission factors for 2030 were used for the future year with and without the Development Site.

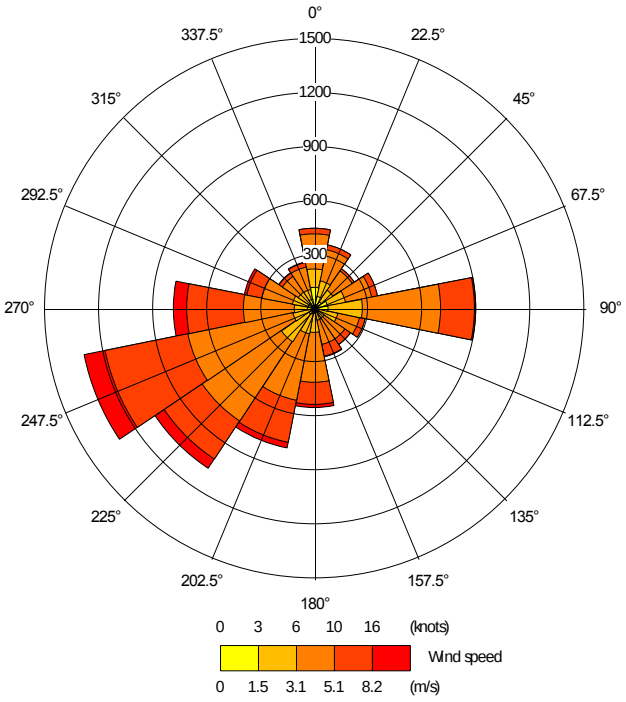
4.1.1.3. Meteorological Data

Hourly sequential meteorological data were taken for the nearest suitable weather station, in this case London City Airport, for the year 2014 (the base year in the assessment). The London City Airport weather station is located approximately 9 kilometres to the south of the Development Site. The basic data include: date, hour, direction from which the wind is blowing, wind speed, how many eighths ('oktas') of the sky are covered by cloud, and surface air temperature.

A windrose for the London City Airport weather station is presented in Figure 4-1; this shows winds predominantly blowing from the south west, typical of the situation in the UK.

When running the dispersion model, the meteorological data are processed an hour at a time to generate values for other parameters that describe atmospheric turbulence. These data are then used to calculate dispersion and thus estimate pollutant concentrations in ambient air.

Figure 4-1 London City Airport 2014 Windrose



4.1.1.4. Receptors

A total of 39 discrete receptors were included in the model. These comprise 8 human health receptors (residential properties, care home, hospital and schools), one air quality monitoring location (for use in model verification) and 30 points along two transects within the Development Site at increased distance away from road sources. The assessed receptors are listed in Table 4-1 and are shown in Figure 4-2. Model verification is discussed in detail in Appendix C.

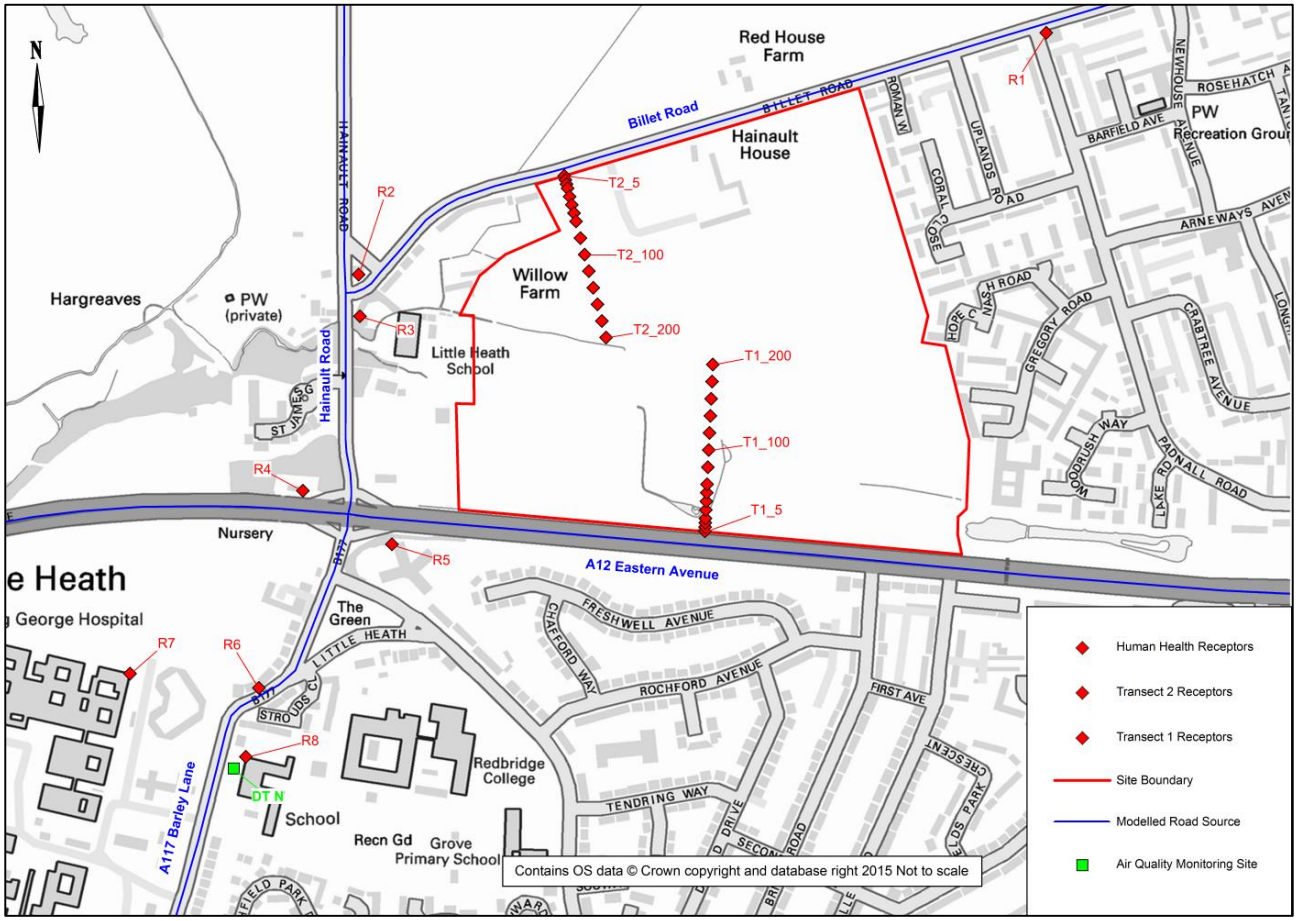
The height of all human health receptors and transects was set at 1.5 metres above ground level to represent breathing height, whilst the height of the monitoring site was set as 2.8 metres, as noted in the London Borough of Redbridge's most recent LAQM Report[19].

Table 4-1 Receptors Included in the Air Quality Model

Receptor Ref	Description	Easting, X	Northing, Y
Existing Sensitive Receptors			
R1	Residential property at 1 Billet Road	547625	189744
R2	Residential property at Billet Road and Hainault Road intersection	546822	189462
R3	Little Heath School, Adjacent to Hainault Road	546823	189413
R4	Residential property adjacent to A12 Eastern Avenue	546756	189209
R5	Chadwell House Care Home	546861	189147
R6	Residential property adjacent to B117 Barley Lane	546705	188979
R7	King George Hospital, adjacent to B117 Barley Lane	546554	188996
R8	Newbridge School, Adjacent to B117 Barley Lane	546690	188899
Monitoring Site for Verification Purposes			
DT N*	Ethel Davis School, Near Roadside Diffusion Tube	546677	188884
Development Site Transects			
T1_5	Transect 1, 5m from A12 Eastern Avenue	547226	189162
T1_10	Transect 1, 10m from A12 Eastern Avenue	547227	189167
T1_15	Transect 1, 15m from A12 Eastern Avenue	547227	189172
T1_20	Transect 1, 20m from A12 Eastern Avenue	547227	189177
T1_30	Transect 1, 30m from A12 Eastern Avenue	547227	189187
T1_40	Transect 1, 40m from A12 Eastern Avenue	547228	189197
T1_50	Transect 1, 50m from A12 Eastern Avenue	547228	189207
T1_60	Transect 1, 60m from A12 Eastern Avenue	547229	189217
T1_80	Transect 1, 80m from A12 Eastern Avenue	547230	189237
T1_100	Transect 1, 100m from A12 Eastern Avenue	547231	189257
T1_120	Transect 1, 120m from A12 Eastern Avenue	547232	189277
T1_140	Transect 1, 140m from A12 Eastern Avenue	547233	189297
T1_160	Transect 1, 160m from A12 Eastern Avenue	547234	189317
T1_180	Transect 1, 180m from A12 Eastern Avenue	547235	189337
T1_200	Transect 1, 200m from A12 Eastern Avenue	547236	189357
T2_5	Transect 2, 5m from Billet Road	547062	189577
T2_10	Transect 2, 10m from Billet Road	547063	189572
T2_15	Transect 2, 15m from Billet Road	547065	189568
T2_20	Transect 2, 20m from Billet Road	547066	189563
T2_30	Transect 2, 30m from Billet Road	547068	189553
T2_40	Transect 2, 40m from Billet Road	547071	189543
T2_50	Transect 2, 50m from Billet Road	547073	189534
T2_60	Transect 2, 60m from Billet Road	547076	189524
T2_80	Transect 2, 80m from Billet Road	547081	189505
T2_100	Transect 2, 100m from Billet Road	547086	189485
T2_120	Transect 2, 120m from Billet Road	547091	189466
T2_140	Transect 2, 140m from Billet Road	547096	189447

Receptor Ref	Description	Easting, X	Northing, Y
T2_160	Transect 2, 160m from Billet Road	547101	189427
T2_180	Transect 2, 180m from Billet Road	547106	189408
T2_200	Transect 2, 200m from Billet Road	547111	189388
*Included for model verification only			

Figure 4-2 Modelled Roads and Receptors Included in the Air Quality Model



4.1.1.5. Background Concentrations

The dispersion modelling provides an estimate of the contribution of a road to total pollutant concentrations; it does not take into account existing background concentrations. A background contribution must therefore be added to the modelled road contribution in order to derive the total pollutant concentration.

Estimates of current and future year background pollutant concentrations in the UK are available on the DEFRA UK-AIR website. Background estimates are available for one kilometre grid squares throughout the UK for years between 2011 and 2030.

Estimated annual mean background concentrations for the years 2014 (the assessment base year) for NO_2 and PM_{10} were obtained from the background mapping provided on the DEFRA UK-AIR website (Table 3-3) and compared with 2014 monitoring data from the urban background sites (CM1 site in Table 3-1 and Table 3-2). Table 4-2 presents the comparison of NO_2 and Table 4-3 the comparison for PM_{10}. The DEFRA background mapping underestimated the measured NO_2 concentrations by between 3% and 24% and overestimated the measured PM_{10} concentrations by 20%. DEFRA background mapping has been verified as being within 30% of Automatic Urban and Rural Network (AURN) CMS sites operated by DEFRA[30]. The

[30] DEFRA, 2011, UK modelling under the Air Quality Directive (2008/50/EC) for 2010 covering the following air quality pollutants: SO_2, NO_x, NO_2, PM_{10}, $PM_{2.5}$, lead, benzene, CO, and ozone

underestimation of concentrations of the background mapping is less than 30% and therefore is considered suitable to use in the assessment.

No statistically significant trend in monitored background concentrations was observed in background monitoring data therefore the background NO_2 and PM_{10} concentrations are assumed to remain constant for the 2030 future year (i.e. the 2014 background concentration was used for 2030).

Table 4-4 presents the background concentrations used in the air quality model for each of the receptors described above in Table 4-1.

Further detail on background concentrations is provided in the Baseline Conditions Section and Appendix A.

Table 4-2 Comparison of Annual Mean NO_2 Pollutant Concentrations (µg/m^3) for DEFRA Background Mapping and CM1 Urban Background Monitoring Site

Site ID	x	y	Grid Square x,y	DEFRA Background	Monitored Background	DEFRA Mapping - Monitored	DEFRA Mapping / Monitored	% Difference
CM1	544381	187659	544500, 187500	25.0	32.8	-7.8	0.76	-24%

Table 4-3 Comparison of Annual Mean PM_{10} Pollutant Concentrations (µg/m^3) for DEFRA Background Mapping and CM1 Urban Background Monitoring Site

Site ID	x	y	grid square x,y	DEFRA Background	Monitored Background	DEFRA Mapping - Monitored	DEFRA Mapping / Monitored	% Difference
CM1	544381	187659	544500, 187500	20.3	16.9	3.4	1.20	20%

Table 4-4 Background Annual Mean Pollutant Concentrations (µg/m^3) for Receptors Included in the Air Quality Model

Receptor Ref	2014		2030	
	NO_2	PM_{10}	NO_2	PM_{10}
R1	22.4	20.1	22.4	20.1
R2	22.3	20.7	22.3	20.7
R3	22.3	20.7	22.3	20.7
R4	22.3	20.7	22.3	20.7
R5	22.3	20.7	22.3	20.7
R6	22.3	20.5	22.3	20.5
R7	22.3	20.5	22.3	20.5
R8	22.3	20.5	22.3	20.5
T1 (distances 5 – 200 m)	22.4	20.1	22.4	20.1
T2 (distances 5 – 200 m)	22.4	20.1	22.4	20.1

4.1.1.6. Model Inputs and Assumptions

The air quality model scenarios were based on the following key inputs and assumptions:

- Traffic conditions vary throughout the day; hence diurnal profiles have been applied in the model to improve the approximation of vehicle emissions in each hour of the year based on traffic data

provided by Atkins Transportation. Average diurnal profiles were calculated for an average weekday (Monday to Friday), Saturday and Sunday for all roads based on traffic count data.
- Ordnance Survey mapping was used to define the modelled road geometry and receptor locations;
- Road widths were taken to be 3.65 metres per lane in the absence of specific data. The number of lanes was determined from aerial photography and central reservation width added where applicable;
- Hourly sequential meteorological data for 2014 (the assessment base year) was taken from the London City Airport meteorological station;
- Surface roughness has been defined as 0.5 metres for the study area and 0.5 metres for the weather station[31]. The surface roughness used is considered appropriate given the study area and weather station are surrounded by open parkland areas and low density residential areas of predominantly low structures (buildings of 2 to 3 storeys).
- Values for surface albedo and Priestly-Taylor parameter were assumed to be as per the model default. The Monin-Obukhov length for the dispersion site was assumed to be 30 metres (representative of cities and large towns), with the meteorological site assuming a Monin-Obukhov length of 100 (representative of large conurbations >1 million)[32].

4.1.1.7. Model Uncertainty

Any air quality dispersion model has inherent areas of uncertainty, including:

- Traffic data;
- Appropriateness of emissions data;
- Simplifications in model algorithms and empirical relationships that are used to simulate complex physical and chemical processes in the atmosphere;
- Appropriateness of background concentrations; and
- Appropriateness of meteorological data.

Uncertainly associated with traffic data has been minimised by using traffic data provided by the project transport consultant (Atkins Transportation) which has been derived from traffic count surveys undertaken for roads around the Development Site in 2015.

Uncertainty associated with emissions data has been minimised by using the most recent version of the ADMS-Roads modelling software (version 3.4) and DEFRA emission factors (EFT v6.0.2).

Uncertainty associated with model algorithms and empirical relationships have been minimised by using algorithms and relationships within a dispersion model (ADMS-Roads) that has been independently validated and judged as fit for purpose.

Uncertainty associated with background data has been minimised by verifying DEFRA background concentrations against local monitoring data and determining the trend in background concentrations from a time series of historical local monitoring data.

Another uncertainty is with using historical meteorological data to estimate future concentrations. The key limiting assumption is that conditions in the future will be the same as in the past; however, in reality no two years are the same. DEFRA's Technical Guidance LAQM.TG(09) reviewed a number of studies examining inter-annual variability of meteorological data and the effect on dispersion model output and concluded that variability in source contribution should be no more than 30% between any two years.

Given the above, the approach taken to this assessment is considered to be sufficiently robust.

4.1.1.8. Model Verification

Model verification is the process of determining the local area performance of the base year model in comparison with measured data. The verification step involves comparison of modelled pollutant concentrations at suitable monitoring sites with monitored values that are representative of the base model period (in this case 2014). Where there is a disparity between the predicted and the measured concentrations, and where further improvements to input data are not possible, then if required an appropriate adjustment factor is determined to correct systematic bias. This adjustment is applied to the

[31] Surface roughness length is a measure of the vertical height of obstacles to wind flow at the earth's surface.
[32] Model default surface albedo = 0.23 (not snow covered); model default Priestly-Taylor parameter = 1 (moist grassland); model default minimum Monin-Obukhov length = calculated by model based on surface roughness; the Monin-Obukhov length is a parameter that limits occasions of very stable conditions with minimal thermal turbulence.

base year and future year model output. For this assessment there was no need to adjust the air quality model. Model verification and adjustment is discussed in detail in Appendix C.

4.1.1.9. Comparison with Air Quality Criteria (NO_2)

To derive total NO_2 concentrations from modelled road NO_x concentrations, and hence to allow a comparison with the air quality criteria, the method described in DEFRA's Technical Guidance LAQM.TG(09) was used. Total annual mean NO_2 concentrations were calculated from modelled road NO_x and background NO_2 concentrations, using the latest version of the 'NO_x to NO_2 conversion spreadsheet' (version 4.1) available from the DEFRA UK-AIR website.

In addition to the modelled road NO_x and background NO_2 data, DEFRA's NO_x to NO_2 conversion spreadsheet requires a local authority area to be specified to determine regional oxidant concentrations, and a traffic mix to determine the proportion of primary NO_2. The local authority specified in the conversion tool was "Redbridge"; the traffic mix selected was "All London traffic" for all modelled roads.

For NO_2, as only annual mean NO_2 estimates have been generated using the air quality dispersion model, commentary on potential impacts on hourly mean NO_2 concentrations, which has its own criterion, is possible with reference to DEFRA's Technical Guidance LAQM.TG(09). The guidance suggests that if annual mean concentrations of NO_2 do not exceed 60 µg/m³ then it is unlikely that hourly mean concentrations would exceed the relevant criterion.

4.1.1.10. Comparison with Air Quality Criteria (Particulate Matter)

To determine total annual mean concentrations of PM_{10} at human health receptors, the modelled road contribution is added to the background concentration to give the total concentration for comparison with the annual mean assessment criterion.

Annual mean PM_{10} concentrations can also be used to derive the number of exceedances of the 24-hour mean PM_{10} criterion, of which 35 are allowed. The method described in DEFRA's Technical Guidance LAQM.TG(09) was applied. This method is based on the relationship between the number of 24-hour exceedances of 50 µg/m³ and the annual mean concentration derived from UK Automatic Network Sites. This is described in Equation 1 below:

Equation 1: Number of exceedances of 24-hour mean of 50 µg/m³ = $-18.5 + 0.00145 * a^3 + (206/a)$

where 'a' = total annual mean PM_{10} concentration.

4.1.1.11. Impact and Significance

Descriptors for the magnitude of impact of changes in ambient concentrations of pollutants in relation to AQS objectives at individual receptors, and guidance for the interpretation of the significance of these effects, are provided in the 2015 EPUK / IAQM Land-Use Planning and Development Control Guidance. Changes in concentration are grouped according to the percentage change relative to an Air Quality Assessment Level (AQAL), and the description of that change, in terms of whether it is slight, moderate, substantial, or negligible, depends upon the absolute concentration in the future year. The term AQAL is used to include relevant air quality criteria, which in this case is the annual mean AQS objective. Percentage values are rounded to zero decimal places before application of the impact descriptors. The descriptors are provided in Table 6.3 in the guidance (repeated in Table 4-5 below for application to annual mean NO_2 and particulate matter).

Table 4-5 Descriptors for Changes in Annual Mean NO_2 and Particulate Matter Concentrations

Long Term Average Concentration at Receptor	Percentage Change in Concentration Relative to AQA			
	1	2 – 5	6 – 10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76 – 94% of AQAL	Negligible	Slight	Moderate	Moderate
95 – 102% of AQAL	Slight	Moderate	Moderate	Substantial
103 – 109% of AQAL	Moderate	Moderate	Substantial	Substantial

Long Term Average Concentration at Receptor	Percentage Change in Concentration Relative to AQA			
	1	2 – 5	6 – 10	>10
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

For the purposes of this assessment, changes of negligible or slight impact are deemed – individually – to be not significant. However, as explained in the 2015 EPUK / IAQM Land-Use Planning and Development Control Guidance, any judgement on the overall significance of effect of a development must take into account such factors as:

- The existing and future air quality in the absence of the Development Site;
- 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.

4.1.2. Air Quality Model Results

The findings from the local air quality assessment for the 2014 base year and 2030 future year are provided in this section. Modelled concentrations at all receptors have been combined with background concentrations and compared with AQS objectives to determine whether there are likely to be any exceedances. In addition, the changes in concentrations have been analysed in relation to the AQS objectives to determine the effects at selected receptors and the significance of these changes has been interpreted in line with the current 2015 EPUK / IAQM Land-Use Planning and Development Control Guidance.

4.1.2.1. Potential Local Air Quality Impacts

Total concentrations and changes in concentrations of annual mean NO_2 and PM_{10} for receptors included in the air quality model are presented in Table 4-6 and Table 4-7 respectively and for the PM_{10} 24-hour mean in Table 4-8.

Concentrations at all receptors are expected to be below relevant annual mean AQS objectives and EU limit values both without and with the Development Site in 2030. The impact at all assessed receptors is expected to be 'negligible' for both annual mean NO_2 and PM_{10} concentrations.

For the 1-hour mean AQS objective for NO_2, DEFRA advises that if the annual mean NO_2 concentration is less than 60 µg/m^3 the hourly mean objective is unlikely to be exceeded. The maximum annual mean NO_2 concentration modelled at any receptor in any scenario is 31.8 µg/m^3, and as such the 1-hour mean AQS objective is unlikely to be exceeded.

No receptors are expected to exceed the PM_{10} 24-hour mean AQS objective in the baseline 2014 and 2030 either with or without the Development Site. There is a maximum of 7 exceedances of the 24 hour mean concentration of 50 µg/m^3 predicted at any given receptor, which is below the 35 permitted exceedances each calendar year.

Table 4-6 Local Air Quality Modelling Results and Impact: Annual Mean NO_2 Concentrations ($\mu g/m^3$)

Receptor ID	2014 Base	2030 Without Development Site	2030 With Development Site	2030 Change	Impact
R1	25.4	23.2	23.3	0.1	Negligible
R2	29.7	24.2	24.5	0.3	Negligible
R3	28.5	23.9	24.1	0.2	Negligible
R4	30.6	25.2	25.3	0.1	Negligible
R5	28.0	24.3	24.3	0.0	Negligible
R6	29.2	24.4	24.5	0.1	Negligible
R7	23.5	22.7	22.7	0.0	Negligible
R8	25.3	23.2	23.2	0.0	Negligible
T1 (5 – 200 m)	23.5 – 31.8	22.8 – 25.9	22.8 – 25.9	0.0	Negligible
T2 (5 – 200 m)	23.6 – 26.2	22.8 – 23.4	22.8 – 23.6	0.0 – 0.2	Negligible

Table 4-7 Local Air Quality Modelling Results and Impact: Annual Mean PM_{10} Concentrations ($\mu g/m^3$)

Receptor ID	2014 Base	2030 Without Development Site	2030 With Development Site	2030 Change	Impact
R1	20.5	20.5	20.6	0.1	Negligible
R2	21.7	21.7	21.9	0.2	Negligible
R3	21.6	21.6	21.7	0.1	Negligible
R4	22.3	22.3	22.3	0.0	Negligible
R5	21.7	21.8	21.8	0.0	Negligible
R6	21.5	21.6	21.6	0.0	Negligible
R7	20.7	20.7	20.7	0.0	Negligible
R8	21.0	21.0	21.0	0.0	Negligible
T1 (5 – 200 m)	20.3 – 22.0	20.3 – 20.1	20.3 – 20.1	0.0	Negligible
T2 (5 – 200 m)	20.3 – 20.7	20.3 – 20.7	20.3 – 20.8	0.0 – 0.1	Negligible

Table 4-8 Local Air Quality Modelling Results and Impact: Number of Exceedances of PM_{10} 24 Hour Mean (days)

Receptor ID	2014 Base	2030 Without Development Site	2030 With Development Site	2030 Change
R1	4	4	4	0
R2	6	6	6	0
R3	6	6	6	0
R4	7	7	7	0
R5	6	6	6	0
R6	6	6	6	0
R7	4	4	4	0
R8	5	5	5	0

Receptor ID	2014 Base	2030 Without Development Site	2030 With Development Site	2030 Change
T1 (5 – 200 m)	4 – 6	4 – 6	4 – 6	0
T2 (5 – 200 m)	4	4	4	0

4.1.2.2. Assessment Conclusions

The results of the local air quality assessment indicate that concentrations of key air pollutants are expected to be below relevant AQS objectives and EU limit values in both the 2014 baseline and 2030 future year scenarios at all assessed receptor locations, both with and without the Developments Site being in place.

Changes in pollutant concentrations as a result of the operation of the Development Site in 2030 are expected to result in a 'negligible' impact at all assessed receptor locations. For the assessment of the future year, NO_2 background concentrations were unchanged to those in the 2014 base year.

It is therefore concluded that, overall, the Development Site, even at its highest yield scenario, is unlikely to have a significant effect on local air quality at existing receptors and that the introduction of new sensitive receptors associated with the Development Site in 2030 is unlikely to result in exposure to pollutant concentrations in excess of relevant AQS objective and EU limit values.

5. Mitigation

5.1. Mitigation during Operation

The results of the local air quality assessment indicate that the operational development is not likely to have a significant adverse effect on local air quality and that the introduction of new sensitive receptors associated with the Developments Site in 2030 is unlikely to result in exposure to pollutant concentrations in excess of relevant AQS objectives and EU limit values. On this basis it is considered that specific mitigation measures to control emissions associated with the Development Site are not required.

Nonetheless, the overall masterplan for the Development Site should include cycle parking provisions to encourage the uptake of sustainable modes of transport, and a Framework Travel Plan to reduce vehicle trips made by residents, staff, students and visitors. The Framework Travel Plan for the Proposed Development should aim to keep the numbers of additional vehicle movements generated by the development to a minimum, for example by encouraging the use of sustainable means of transport.

6. Summary and Recommendations

An air quality assessment for the Development Site currently under consideration in the London Borough of Redbridge High Level Transport Study at Billet Road in Redbridge has been undertaken. Road transport emissions are the primary source of air pollutant emissions in the vicinity of the Development Site.

The Development Site lies within the Redbridge borough-wide AQMA which has been declared for annual mean NO_2 and PM_{10} 24 hour exceedences. However, background pollution mapping data from DEFRA and monitoring sites relevant to the Development Site indicate that concentrations of NO_2 are currently below relevant air quality criteria. Background pollution mapping data from DEFRA and monitored PM_{10} concentrations are also below the relevant air quality criteria.

Local air quality in the area surrounding the Development Site could be affected. Air quality sensitive receptors in the surrounding area include residential properties, schools, a care home and a hospital. There are no relevant ecological receptors which could be affected.

The air quality assessment considered the future year of 2030. This reflects the end year of the Redbridge Local Plan which covers the period 2015 to 2030. The results of the assessment of the operational phase of the Development Site indicate that there is not likely to be a significant adverse effect on local air quality at existing air quality sensitive receptors and that the introduction of new air quality sensitive receptors associated with the Development Site in 2030 is unlikely to result in exposure to pollutant concentrations in excess of relevant AQS objectives and EU limit values. Specific mitigation measures to control emissions associated with the operational development are therefore not required.

Should the Development Site be taken forward, further air quality assessment should be undertaken as part of the planning application process to reflect the detailed layouts for the Development Site and the actual opening years.

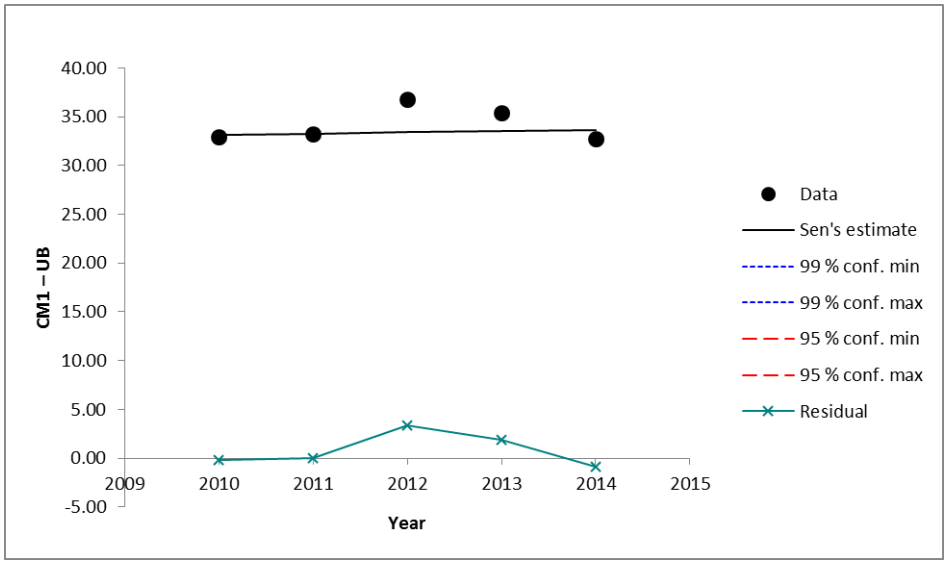
Appendix A. Trends in Monitored Air Pollutant Concentrations

Trend analysis of NO_2 and PM_{10} concentrations was undertaken for monitoring sites relevant to the Development Site. The analysis has been undertaken using the Finnish Meteorological Institute MAKESENS (v1) spreadsheet for annual mean time series data.

In order to conduct the statistical analysis 5 or more series of data must be present for each site. On this basis the analysis has been undertaken for sites CM1 for NO_2 and PM_{10} and DT N for NO_2.

A.1. Nitrogen Dioxide

Figure A-1 Site CM1 - Mann-Kendall and Sen Estimate of Annual Mean NO_2 Trend

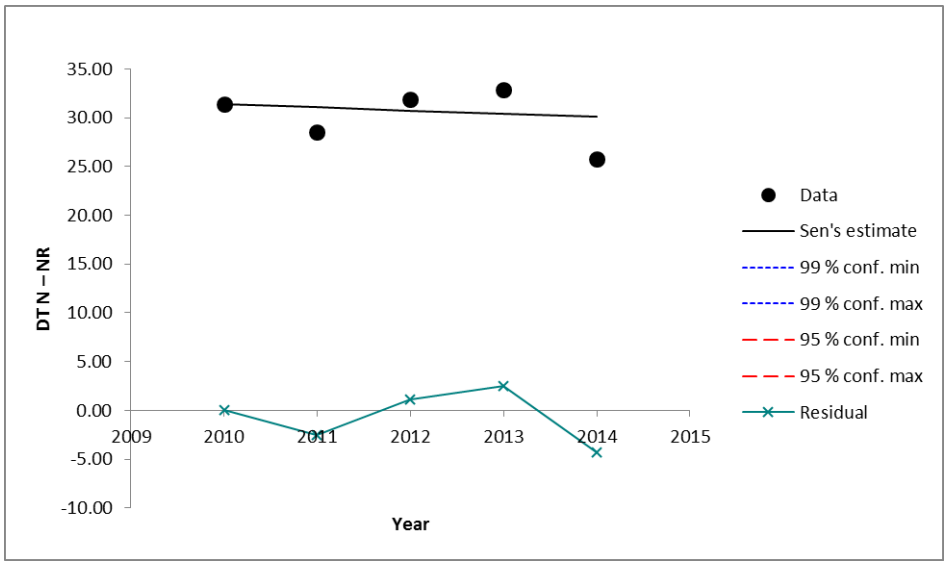


The trend analysis of site CM1 consisted of five data points. The Sen's slope[33] estimate of the linear trend line (shown above as a solid black line) is 0.125. This means that over five years there appears to be a general increase in NO_2 concentration by 0.125 µg per year. The plot of the residual concentrations[34] (shown as a solid light blue line) shows some variation year on year.

The Mann-Kendall test statistic (S) is expressed as a whole number; for site CM1 this is 0. For the null hypothesis of a random distribution of the data to be rejected, where the number of data is only five, the value of S [35] would have to be equal to or greater than an absolute value of 8 (equivalent to a probability of less than 0.1 or 10%). For five data points, only S values of 8 or more give a reasonably robust indication of a significant monotonic trend. Evidence of a monotonic trend is therefore weak for site CM1.

[33] The "Sen Slope" refers to the equation of the linear trend line and give the rate of change per year.
[34] The difference in the actual monitored concentration compared to the concentration indicated by the trend line.
[35] Nielsen, D. M. (Ed.). (2005). Practical handbook of environmental site characterization and ground-water monitoring. CRC press.

Figure A-2 Site DT N - Mann-Kendall and Sen Estimate of Annual Mean NO_2 Trend

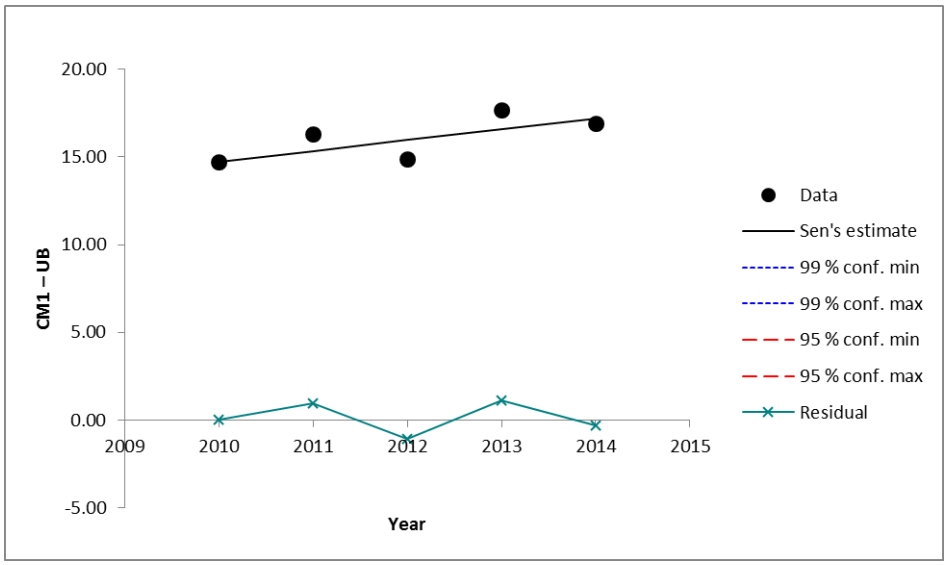


The trend analysis of site DT N consisted of five data points. The Sen's slope estimate of the linear trend line (shown above as a solid black line) is -0.325. This means that over five years there appears to be a general decrease in NO_2 concentration by 0.325 µg per year. The plot of the residual concentrations (shown as a solid light blue line) shows some variation year on year.

The Mann-Kendall test statistic (S) is expressed as a whole number; for site DT N this is 0. For the null hypothesis of a random distribution of the data to be rejected, where the number of data is only five, the value of S would have to be equal to or greater than an absolute value of 8 (equivalent to a probability of less than 0.1 or 10%). For five data points, only S values of 8 or more give a reasonably robust indication of a significant monotonic trend. Evidence of a monotonic trend is therefore weak for site DT N.

A.2. PM_{10}

Figure A-3 Site CM1 - Mann-Kendall and Sen Estimate of Annual Mean PM_{10} Trend



The trend analysis of site CM1 consisted of five data points. The Sen's slope estimate of the linear trend line (shown above as a solid black line) is 0.625. This means that over five years there appears to be a general increase in NO_2 concentration by 0.625 µg per year. The plot of the residual concentrations (shown as a solid light blue line) shows some variation year on year.

The Mann-Kendall test statistic (S) is expressed as a whole number; for site CM1 this is 6. For the null hypothesis of a random distribution of the data to be rejected, where the number of data is only five, the value of S would have to be equal to or greater than an absolute value of 8 (equivalent to a probability of less than

0.1 or 10%). For five data points, only S values of 8 or more give a reasonably robust indication of a significant monotonic trend. Evidence of a monotonic trend is therefore weak for site CM1.

Appendix B. Traffic Data Used in Air Quality Assessment

Table B-1 Traffic Data Used in the Air Quality Assessment

Link ID	Name	LDV (AADT)			HDV (AADT)			Speed (km/ hour)
		Base 2014	Without (2030)	With (2030)	Base (2014)	Without (2030)	With (2030)	All
1	Billet Road	5904	7371	10538	1307	1631	1631	53
2	Hainault Road	13338	16650	19373	2606	3254	3254	45
3	Barley Lane	13670	17065	18362	1557	1943	1943	44
4	A12 Eastern Avenue	51549	64230	64230	2387	2974	2974	64

Appendix C. Air Quality Model Verification and Adjustment

It is good practice to compare modelled estimates of pollutant concentrations with real-world monitoring to assess the model's performance for a base year and to inform the interpretation of model results for future years. Verification of the 2014 base model has been undertaken with comparison of modelled concentrations against those derived from monitoring at a single diffusion tube monitoring site located near to the Development Site, as shown in Figure 3-1.

An air quality model can be considered to perform reasonably well where modelled concentrations are within 25% of monitored concentrations at 95% of sites, in accordance with DEFRA's Technical Guidance LAQM.TG(09). The root mean square error (RMSE) is acceptable if it is well below 25% of the AQS objective at 10 µg/m^3 (a requirement), and is ideal if below 10% of the AQS objective i.e. an RMSE of 4 µg/m^3.

Step 1

Firstly, unadjusted modelled estimates of total annual mean NO_2 concentrations have been compared against monitored annual mean concentrations as shown in Table C-1. The model estimate matches the monitored concentration at site DT N, the site closest to the Development Site. Model statistics of RMSE or Fractional Bias (FB) value are not applicable when assessing a single monitoring site.

Table C-1 Comparison of Modelled and Measured NO_2 Concentrations (µg/m^3), Unadjusted

Site Name	Background Annual Mean NO_2 (µg/m^3)	Monitored Annual Mean Total NO_2 (µg/m^3)^	Modelled Annual Mean Total NO_2 (µg/m^3)	Modelled NO_2 Minus Monitored NO_2 (µg/m^3)	% Difference (unadjusted modelled NO_2 - monitored NO_2) / monitored NO_2 * 100
DT N	22.3	25.8	25.8	-0.02	0%
^See Table 3-1.					

Based on the results shown above in Table C-1, no model adjustment has been applied as the air quality model shows acceptable agreement with the monitoring results.