Bartram's Convent

Rowland Hill Street, NW3 2AD London
October 2014

PegasusLife

A Detailed Planning Application, Submitted on behalf of PegasusLife to Provide Specialist Living Accommodation for Older People

Supporting Document 11
Air Quality Assessment

Bartrams - Air Quality Assessment

Prepared by: Zadie Stock
Graduate Environmental Scientist

Checked by: Patrick Froggatt
Principal Consultant

Approved by: Michele Hackman
Technical Director

Bartrams Air Quality Assessment

Rev No	Comments	Checked by	Approved by	Date
0	Draft for review	PF	MH	18/09/2014
1	Updated following comments	PF	MH	26/09/2014

9th & 10th Floors, Sunley House, 4 Bedford Park, CR0 2AP
Telephone: 020 8639 3500 Website: http://www.aecom.com

Job number: 60331083 Reference: PF Date Created Sept 2014

Table of Contents

1 Introduction 1

2 Legislative Framework and Planning Policy 2
2.1 National and European Air Quality Legislation and Policy 2
2.2 Planning Policy 2

3 Baseline Conditions 8
3.1 Pollutant of Concern 8
3.2 Summary of Local Air Quality Management 9
3.3 Local Authority Air Quality Monitoring 10
3.4 Defra Mapped Background Pollutant Concentrations 11

4 Assessment Methodology 13
4.1 Scope of the Assessment 13
4.2 Local Air Quality Assessment Methodology 14
4.3 Construction Dust Assessment Methodology 18
4.4 Air Quality Neutral Assessment Methodology 19

5 Air Quality Neutral Assessment 20
5.1 Building Emissions 20
5.2 Transport Emissions 20
5.3 Summary 21

6 Operation Assessment 22
6.1 Modelled Effects at Sensitive Human Receptors 22
6.2 Modelled Effects at Ecological Receptors 24

7 Construction Dust 25
7.1 Assessment Methodology 25
7.2 Assessment 25

8 Camden Air Quality Checklist 28
8.1 Travel and Transport 28
8.2 Energy 28
8.3 Exposure 28
8.4 Construction Dust 28

9 Summary 29
9.1 Air Quality Neutral Assessment 29
9.2 Local Air Quality Assessment 29
9.3 Construction Dust Assessment 29

10 Figures 31

11 Appendix 38
11.1 Air Quality Neutral Assessment Guidance 38
11.2 Buildings Emissions 38
11.3 Dust Mitigation measures 44

No table of figures entries found.

Table 1: Camden Council's Automatic Monitoring Results 10
Table 2: NO_2 Monitoring with Diffusion Tubes in LB of Camden 11
Table 3: Comparison of Monitored and Mapped Background Concentrations, 2013 12
Table 4: Background Pollutant Concentrations (µg/m³) Used in the Assessment 12
Table 5: Modelled Discrete Receptors 15
Table 6: Building Heights (m) 16

Table 7: Summary of Energy Centre Model Input Parameters 17
Table 8: Information Used in Air Quality Neutral Assessment 19
Table 9: Transport Benchmark Calculations 21
Table 10: Modelled Hourly 99.79th Percentile NO_2 Concentrations 22
Table 11: Modelled Annual Mean NO_2 Concentrations 23
Table 12: Predicted Process Contributions at Belsize Wood Local Nature Reserve 24
Table 13 Numbers and Dust-Sensitivities of Dust-Sensitive Receptors....................25
Table 14 Summary of Area Sensitivity With Respect to Dust Effects 26
Table 15: Summary of Dust Emission Magnitude 27
Table 16: Summary Dust Risk Table to Define Site-Specific Mitigation....................27
Table 17: Emissions Benchmarks for Buildings 39
Table 18: Band Categories 40
Table 19: Emission Standards for 50 kWth -20 MWth for Band A 41
Table 20: Emission Standards for 50 kWth – 20 MWth for Band B....................42
Table 21: Calculation of Benchmarked NO_x and PM_{10} Emissions using Building Emission Benchmarks....................43
Table 22: Mitigation Measures for Construction Phase Activities 44

Figure 1: Air Quality Monitoring Locations 31
Figure 2: Receptor Locations....................32
Figure 3: Windroses....................33
Figure 4: Modelled Building Layout....................34
Figure 5: Contour Plot of Annual Mean NO_2 Concentrations (µg/m³) 35
Figure 6: Contour Plot of Maximum Daily 99.79th Percentile NO_2 Concentrations (µg/m³) 36
Figure 7: Potential Construction Dust Impacts, Without Mitigation 37

1 Introduction

AECOM has been commissioned by Pegasus Life to provide an air quality assessment in support of the redevelopment of Bartrams Convent and Hostel in Hampstead, London. The existing building contains 69 bedrooms plus communal facilities with a gross internal area (GIA) of 2,671 m^2.

The application site is located off Rowland Hill Street in the London Borough of Camden. The development proposals include the demolition of the existing building and construction of a new building comprising extra care accommodation for older people, incorporating 60 apartments, a health and well being facility; communal facilities including a restaurant/ cafe, activity room and a library, gardens and terraces; staff and concierge facilities; storage facilities and basement car parking.

The proposed development has the potential to affect local air quality during its construction phase due to construction dust and emissions from construction plant. A qualitative assessment of the potential impacts has been carried out in accordance with the Institute of Air Quality Management's (IAQM) construction dust guidance. Mitigation measures have been identified to minimise any potential impacts.

The application site has good public transport links in the local area and the development will include a maximum of twelve on-site parking spaces, while local parking restrictions will act as a significant discouragement to staff and visitors driving to the site. Heating and power for the development will be provided by a gas CHP and gas-fired boilers.

2 Legislative Framework and Planning Policy

2.1 National and European Air Quality Legislation and Policy

2.1.1 Local Air Quality Management

The provisions of Part IV of the Environment Act 1995 establish a national framework for air quality management, which requires all local authorities in England, Scotland and Wales to conduct local air quality reviews. Section 82(1) of the Act requires these reviews to include an assessment of the current air quality in the area and the predicted air quality in future years. Should the reviews indicate that the objectives prescribed in the UK Air Quality Strategy (Defra, 2007) and the Air Quality (England) Regulations (Defra, 2000 and 2002) will not be met, the local authority is required to designate an Air Quality Management Area (AQMA). Action must then be taken at a local level to ensure that air quality in the area improves. This process is known as 'Local Air Quality Management' or LAQM.

2.1.2 UK Air Quality Strategy

The UK Air Quality Strategy (AQS) identifies nine ambient air pollutants that have the potential to cause harm to human health and two for the protection of vegetation and ecosystems. These objectives aim to reduce the impacts of the pollutants to negligible levels. The objectives are not mandatory but targets that local authorities should try to achieve.

2.1.3 European Air Quality Directives

The Air Quality Framework Directive (96/62/EC) on ambient air quality assessment and management defines the policy framework for 12 air pollutants known to have a harmful effect on human health and the environment. The limit values for the specific pollutants are set through a series of Daughter Directives. The limit values have been transposed into The Air Quality Standards Regulations 2010 (SI 2010 No. 1001).

2.1.4 Air Quality Criteria

The pollutants of concern for this assessment are nitrogen dioxide (NO_2) and particles (PM_{10}).

The Government's Air Quality Strategy objectives and EU limit values for nitrogen dioxide (NO_2) are:

- An annual mean concentration of 40 $\mu g/m^3$; and
- A one-hour mean concentration of 200 $\mu g/m^3$, not to be exceeded more than eighteen times per year.

The Government's Air Quality Strategy objectives and the EU limit value for PM_{10} are:

- An annual mean concentration of 40 $\mu g/m^3$ (gravimetric); and
- A 24-hour mean concentration of 50 $\mu g/m^3$ (gravimetric) to be exceeded no more than 35 times per year.

2.2 Planning Policy

2.2.1 National Planning Policy Framework

The NPPF was published on 27 March 2012 and sets out the Government's planning policies for England and how these are expected to be applied. The National Planning Policy Framework advises 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 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 has been produced for air quality which provides guiding principles on how planning can take account of the impact of new development on air quality.

2.2.2 London Planning Policy

2.2.2.1 The London Plan[1]

The London Plan is the overall strategic plan for London, and it sets out a fully integrated economic, environmental, transport and social framework for the development of the capital to 2031. It forms part of the development plan for Greater London. London boroughs' local plans need to be in general conformity with the London Plan, and its policies guide decisions on planning applications by councils and the Mayor.

Improvement of air quality is one of the key policy objectives of the London Plan:

"7.14 Improving air quality

Development proposals should:

a minimise increased exposure to existing poor air quality and make provision to address local problems of air quality (particularly within Air Quality Management Areas (AQMAs) and where development is likely to be used by large numbers of those particularly vulnerable to poor air quality, such as children or older people) such as by design solutions, buffer zones or steps to promote greater use of sustainable transport modes through travel plans (see Policy 6.3)

b promote sustainable design and construction to reduce emissions from the demolition and construction of buildings following the best practice guidance in the GLA and London Councils' 'The control of dust and emissions from construction and demolition'

c be at least 'air quality neutral' and not lead to further deterioration of existing poor air quality (such as areas designated as Air Quality Management Areas (AQMAs)).

d ensure that where provision needs to be made to reduce emissions from a development, this is usually made on-site. Where it can be demonstrated that on-site provision is impractical or inappropriate, and that it is possible to put in place measures having clearly demonstrated equivalent air quality benefits, planning obligations or planning conditions should be used as appropriate to ensure this, whether on a scheme by scheme basis or through joint area-based approaches

e where the development requires a detailed air quality assessment and biomass boilers are included, the assessment should forecast pollutant concentrations. Permission should only be granted if no adverse air quality impacts from the biomass boiler are identified."

2.2.2.2 Mayor of London's Air Quality Strategy

The Mayor of London's Air Quality Strategy[2] (Policy 7) states that *"the Mayor will ensure that new developments in London shall as a minimum be 'air quality neutral' through the adoption of best practice in the management and mitigation of emissions."* It should be demonstrated therefore that any development has no significant impact on local air quality in order to obtain approval.

In addition, Policy 6 of the Mayor's Air Quality Strategy '*Reducing emissions from construction and demolition sites*' states the following:

The Mayor will work with London boroughs, the GLA group and the construction industry to encourage implementation of the Best Practice Guidance for construction and demolition sites across London so as not to pose health risk to people working or living nearby.

[1] The London Plan, The Mayor of London, available at https://www.london.gov.uk/priorities/planning/london-plan
[2] Clearing the Air, The Mayor of London's Air Quality Strategy, December 2010.

2.2.2.3 Mayor of London’s Sustainable Design and Construction

The Mayor of London’s Supplementary Planning Guidance (SPG) on sustainable design and construction[3] provides guidance on air quality assessment requirements, design and occupation and construction and demolition. The key priorities are:

a. Developers are to design their schemes to that they are at least ‘air quality neutral’.

b. Developments should be designed to minimise the generation of air pollution.

c. Developments should be designed to minimise and mitigate against increased exposure to poor air quality.

d. Developers should select plant that meets the standards for emissions from combined heat and power and biomass plants as set out in Appendix 7 of the SPG.

e. Developers and contractors should follow the guidance set out in the emerging “Minimising dust and emissions from construction and demolition” SPG when constructing their development.

2.2.2.4 Mayor of London’s Control of Dust and Emissions SPG[4]

The Mayor of London’s SPG on the control of dust and emissions during construction and demolition sets out the requirements of an Air Quality Statement, a dust risk assessment, emission control measures, air quality monitoring and cleaner construction machinery for London. The key requirements affecting this proposed development are summarised below:

a. *Air Quality Statement is required to be submitted to the Local Planning Authority during the application stage prior to works commencing on site. This Statement shall include:*

- *Summary of work to be carried out;*
- *Description of site layout and access;*
- *Inventory and timetable of all dust and NO_x generating activities;*
- *Air quality (Dust) risk assessment (in accordance to the IAQM);*
- *List of all dust and emission control methods to be employed;*
- *Details of any fuel stored on-site;*
- *Identification of an authorised responsible person on-site for air quality. This person needs to have knowledge of pollution monitoring and control methods and vehicle emissions;*
- *Summary of monitoring protocols and agreed procedure of notification to the local authority nominated person(s); and*
- *A site log book to record details and action taken in response to exceptional incidents or dust-causing episodes and the mitigation measures.*

b. *Non-road mobile machineries (NRMM) to be used on any construction sites would need to comply with the European emission standards. This is as set out below:*

- *From 1st September 2015 onwards, all NRMM of net power between 37 kW and 560 kW within Greater London will be required to meet the Stage IIIA of the EU Directive 97/68/EC and its subsequent amendments as a minimum. Compliance of Stage IIIB of the Directive will be required as a minimum of Central Activity Zone or Canary Wharf.*

- *From 1st September 2020 onwards, all NRMM of net power between 37 kW and 560 kW within Greater London will be required to meet the Stage IIIB of the EU Directive 97/68/EC and its subsequent amendments*

[3] Sustainable Design and Construction, SPG, The Mayor of London, April 2014.
[4] The Control of Dust and Emissions during Construction and Demolition, Draft SPG, The Mayor of London, September 2013.

as a minimum. Compliance of Stage IV of the Directive will be required as a minimum of Central Activity Zone or Canary Wharf.

- *This policy is enforced through the planning process and compliance with the NRMM standards should be secured by the local authorities as a planning condition or s106 agreement.*
- *If emissions of NRMM are unknown, developers will be required to provide a written statement of their commitment and ability to meet these standards as part of the Air Quality Statement.*
- *An inventory of all NRMM should be kept on-site stating the emission limits for all equipment and made available to local authority officers if required.*

2.2.3 Local Planning Policy

Camden adopted its Core Strategy in 2010, which sets out the key elements of the Council's planning vision and strategy for the borough from 2010 to 2025. Parts of this strategy highlight the need to improve air quality in the borough, including CS16, in which the Council states its aim to "*recognise the impact of poor air quality on health and implement Camden's Air Quality Action Plan which aims to reduce air pollution levels*."

Camden's Local Development Framework (LDF) also contains policies that focus on the Council's expectation for developments to reduce their impact on air quality. In Development Policy 32, the Council states "*Mitigation measures will be expected in developments that are located in areas of poor air quality*".

Other relevant Local Development Framework policies include:

- CS13 - Tackling climate change through promoting higher environmental standards. The Council expects "*all new developments to be designed to minimise carbon dioxide emissions by being as energy efficient as is feasible and viable*"
- DP22 - Promoting sustainability. The Council will require developments to "*incorporate sustainable design and construction measures*".
- DP17 - Promoting sustainable and efficient transport; "*Development should make suitable provision for pedestrians, cyclists and public transport*."

2.2.4 Camden's Planning and Air Quality Policy

Camden has produced several pieces of air quality guidance which must be followed when submitting a planning application. Camden's air quality guidance states that, "*A basic air quality assessment should accompany applications for developments where local residents will be exposed to poor air quality (due its location next to a busy road/diesel railway lines or in a generally congested area)".* Where as a*, "A detailed air quality assessment should accompany applications for:*

- *commercial developments with a floor space of more than 2500m^2;*
- *developments that have the potential to significantly change road traffic on a busy road (that is, a road that handles more than 10,000 vehicles per day). Significant changes include, any increase in traffic volumes (either annual average daily traffic or peak), any increase to the average vehicle speed, any increase in traffic congestion and/or any increase in the percentage of heavy goods vehicles*
- *developments that will introduce or increase car parking facilities by 300 spaces or more*
- *developments that bring sensitive receptors into an area of poor air quality*
- *developments that include biomass boilers and/or combined heat and power"*

Camden requires that basic air quality assessments should include:

- *"a review of air quality around the development site using existing air quality monitoring and/or modelling data;*
- *an assessment of the impact on air quality during the construction phase and detailed mitigation methods for controlling dust and pollution emissions associated with plant and vehicles;*
- *an indication of the number of receptors which will be exposed to poor air quality as a result of the development, and show their location on a map. The significance of air pollution exposure should be quantified in accordance with the "Air Quality Impact Significance Criteria – New Exposure" outlined in the NSCA Guidance Note;*
- *an outline and justification of mitigation measures associated with the design, location and operation of the development in order to reduce air pollution and exposure to poor air quality. Where a proposed development is in an area of poor air quality it is essential to demonstrate that from the earliest stages, the building has been designed to reduce occupant exposure. This includes consideration of orientation, elevation of residences, and the use of green infrastructure such as green walls, screens and trees. "*

While a detailed air quality assessments should include:

- *air quality dispersion modelling data carried out in accordance with the London Councils Air Quality and Planning Guidance;*
- *an indication of the number of receptors which will be exposed to poor air quality as a result of the development, and show their location on a map •the significance of air pollution exposure should be quantified in accordance with the "Air Quality Impact Significance Criteria – New Exposure" outlined in the NSCA Guidance Note;*
- *an outline and justification of mitigation measures associated with the design, location and operation of the development in order to reduce air pollution and exposure to poor air quality. Where a proposed development is in an area of poor air quality it is essential to demonstrate that from the earliest stages, the building has been designed to reduce occupant exposure. This includes consideration of orientation, elevation of residences, and the use of green infrastructure such as green walls, screens and trees."*

As this development includes a Combined Heat and Power unit, a detailed assessment is required.

Camden has produced an air quality checklist which should be completed for all development which requires an air quality assessment. This has been completed and is presented in Section 8 of this assessment. Camden has also provided additional guidance in the form of a series of guides to reduce air pollution from your buildings including "Manual B – Minimising Air Pollution from new Developments" which details the approach to energy efficient design, calculating the developments heat requirement, selecting appropriate technology, fuel and heating controls.

Camden Planning Guidance (CPG) 3 on Sustainability states that, "*All biomass boilers and CHP will require an air quality assessment, including location and height of flues, details of emissions and how the emissions can be mitigated*" and that, "*Biomass boilers and CHP are required to be designed, operated and maintained in accordance with best practise measures to minimise emissions to air.*"

Camden Planning Guidance (CPG) 6 on Amenity includes a section specifically related to air quality. The guidance sets out the following policies which are relevant to the proposed development:

- *We will encourage best practice measures to be adopted during construction and demolition work to reduce and mitigate air pollution emissions. You will be encouraged to adopt the procedures outlined in the London*

Council's best practice guidance The control of dust and emissions from construction and demolition. These focus around three principles to control emissions – prevention, suppression and containment.

- *Gas boilers are a large source of NO_x emissions in Camden. In order to minimise NO_x emissions arising from heating and hot water systems the Council requires boilers fitted in new development to achieve a NO_x emissions of <40 mg/m^3 and an energy efficiency rating >90%.*
- *We will require evidence that the exhaust stack height of gas CHP/CCHP has been appropriately calculated to guarantee that NO_x emissions are effectively dispersed, and do not risk increasing ground level NO_2 concentrations. An air quality assessment will be required for developments including CHP/CCHP. Where the assessment reveals a negative impact on air quality, mitigation measures will be required entailing the best available techniques to reduce emissions. This includes the installation of NO_x abatement technology such as:*
    - *use of low NO_x burners; or*
    - *increasing stack height.*

  A programme of on-going maintenance and servicing will be necessary to minimise gas emissions released from CHP/CCHP.
- *Reducing car usage caused by new developments is the principle way to minimise vehicle emissions and protect local air quality. Please refer to transport policy CS11 - Promoting sustainable and efficient travel in the Camden Core Strategy for more on our approach to improving air quality through transport measures. This requires:*
    - *the adoption of car free and car capped developments;*
    - *provision cycling facilities to encourage sustainable transport;*
    - *green travel plans;*
    - *provision of car club bays; and*
    - *infrastructure for low emissions vehicles such as electric vehicle recharging points.*

Camden's Core Strategy policy CS13 promotes the use of renewable energy technologies to reduce carbon emissions and tackle climate change. The measures that CS13 sets out include, "*solar thermal collectors and ground source heat pumps in addition to gas and hydrogen fuel cell combined heat and power (CHP) or combined cooling heat and power (CCHP)"*.

3 Baseline Conditions

3.1 Pollutant of Concern

3.1.1 Nitrogen Dioxide (NO_2)

Nitrogen dioxide (NO_2) and nitric oxide (NO) are both oxides of nitrogen, and are collectively referred to as nitrogen oxide (NO_x). All combustion processes produce NO_X emissions, largely in the form of NO, which is then converted to NO_2, mainly as a result of its reaction with ozone in the atmosphere. Therefore the ratio of NO_2 to NO is primarily dependent on the concentration of ozone and the distance from the emission source.

The Government and the Devolved Administrations adopted two Air Quality Strategy (AQS) objectives for NO_2 which were to be achieved by the end of 2005. In 2010, mandatory EU air quality limit values on pollutant concentrations were to apply in the UK; however the UK Government applied for derogation. For some parts of the UK the application was refused. The EU limit values for NO_2 are the same as the national objectives:

- An annual mean concentration of 40 µg/m³; and
- An hourly mean concentration of 200 µg/m³, to be exceeded no more than 18 times per year; equivalent to 99.8th percentile of annual hourly mean values.

NO_2 can irritate the lungs and lower resistance to respiratory infections such as influenza. Continued or frequent exposure to concentrations, that are typically much higher than those normally found in the ambient air, may cause increased incidence of acute respiratory illness in children.

Updated total NO_x emissions estimates for 2012[5] showed that electricity and heat production, passenger car and heavy duty vehicles accounted for the largest proportion of total UK NO_x emissions, 27%, 15% and 11% respectively. Total UK NO_X emissions have fallen by 60% between 1980 and 2012 to around 1,100 kilotonnes. Passenger car emissions have declined significantly since peaking in 1990 as a consequence of various policy measures, with total emissions reducing by 70% between 1980 and 2012, while heavy duty vehicles emissions have reduced by 54% between 1980 and 2012. Further reductions are expected in future years.

Emissions from industrial sources have declined significantly, due to the fitting of low NO_x burners, and the increased use of natural gas plant. Industrial sources generally make a small contribution to ground level NO_2 levels, although breaches of the hourly NO_2 objective may occur under rare meteorological conditions due to emissions from these sources.

The annual mean objective of 40 µg/m³ is currently widely exceeded at roadside sites throughout the UK, with exceedences also reported at urban background locations in major conurbations. The number of exceedences of the hourly objective show considerable year-to-year variation, largely driven by meteorological conditions, which give rise to winter episodes of poor dispersion and summer oxidant episodes.

3.1.2 Particulate Matter (PM_{10})

The Government and the Devolved Administrations adopted two AQS objectives for PM_{10}, to be achieved by the end of 2004:

- An annual mean concentration of 40 µg/m³ (gravimetric); and
- A 24-hour mean concentration of 50 µg/m³ (gravimetric) to be exceeded no more than 35 times per year.

The EU First Daughter Directive sets limit values for PM_{10} to be achieved by 1st January 2005, which have been transposed into UK legislation. The Directive includes a 24-hour limit value of 50 µg/m³, not to be exceeded more than thirty five times per year and an annual mean limit value of 40 µg/m³.

[5] National Atmospheric Emissions Inventory, http://naei.defra.gov.uk/ Accessed 27/08/2014.

Particulate matter is composed of a wide range of materials arising from a variety of sources, and is typically assessed as total suspended particulates, or as a mass size fraction. The European air quality standards have adopted the PM_{10} standard for the assessment of fine particulate matter. This expresses particulate levels as the total mass size fraction at or below an aerodynamic diameter of 10 µm. Particles of this size are able to penetrate beyond the nose and throat, deep into the respiratory system reaching the bronchi and lungs.

Extensive scientific research has provided evidence of associations between exposure to fine PM and increased morbidity and mortality. Numerous studies have associated particulate pollution with acute changes in lung function and respiratory illness, resulting in increased hospital admissions for respiratory disease and heart disease and the aggravation of chronic conditions such as bronchitis and asthma.

Adverse effects on the cardiovascular and respiratory systems have been causally linked with both short-term and long-term exposures to PM. Two collaborative projects undertaken in 90 cities in the United States and 29 European cities reported links between daily mortality and PM concentration on the same day or several preceding days. Increases in total mortality of 0.27% per 10 µg/m³ increase in PM_{10} and 0.6% per 10 µg/m³ increase in PM_{10} were determined for the US and European city studies, respectively[6,7]. Long-term exposure to PM has been implicated in observed increases in all-cause, cardiopulmonary and lung cancer mortality[8,9].

There is some concern that fine particles from diesel exhaust may have a carcinogenic effect. This may be due to air-stream entrained particles carrying adsorbed carcinogens into the respiratory system. The effects of particulate matter exposure on human health are complex and masked by other factors such as weather and lifestyle. Importantly, however, there is broad agreement in the scientific community that there is no threshold exposure level below which the adverse effects of PM exposure are no longer discernible[10].

In the UK, commercial, residential, agriculture and fishing, stationary and mobile combustion were the major sources of particulate emissions in 2011 (24%). Total UK PM_{10} emissions have fallen by more than 60% between 1980 and 2011 to around 113 kilotonnes. Revised figures indicate that after commercial, residential, agriculture and fishing, stationary and mobile combustion sources, road transport (21%) and industrial processes emissions (14%) remain the principal sources of PM_{10} in 2011.

Emissions of PM_{10} have decreased considerably in the past thirty years. PM_{10} emissions from road transport peaked during the early 1990s and have since fallen by around 46% (1993 to 2011). The energy and industry sectors have seen a decrease of 86%, for the same period. The reduction is mainly due to the decline in coal use and also the result of legislative and technical control of emissions from both road traffic and industrial sources. Energy Industries accounted for 7% of total PM_{10} emissions in 2011, compared with 27% in 1990.

3.2 Summary of Local Air Quality Management

In the 5th stage of the Review and Assessment in 2012, Camden Council found the UK objectives for NO_2 were being exceeded. As a result, the Council retained the Air Quality Management Area (AQMA) over the whole Borough, which had been designated AQMA since 2001. The concentrations of NO_2 continue to exceed short term and long term air quality objectives at all of the Council's automatic monitoring sites and the vast majority of nitrogen

---

[6] Dominici F, Burnett R (2003). Risk models for particulate air pollution. J Toxicol Env Health Part A. 66: 1883–1889.

[7] Katsouyanni K., Touloumi G., Samoli E., et al (2001). Confounding and effect modification in the short-term effects of ambient particles on total mortality: results from 29 European cities within the APHEA-II project. Epidemiology 12: 521–531.

[8] Krewski D, Burnett RT, Goldberg MS, Hoover K, Siemiatiycki J, Jerrett M, Abrahamowicz M, White WH (2000). Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality. Cambridge, MA: Health Effects Institute.

[9] Hoek G, Brunekreef B, Goldbohm S, Fischer P, van den Brandt PA. (2002). Association between mortality and indicators of traffic-related air pollution in the Netherlands: a cohort study. Lancet 360:1203–1209.

[10] WHO (2003). Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide.

dioxide diffusion tube sites. The air quality objective continues to be met for all of the other pollutants monitored including PM_{10}.

3.3 Local Authority Air Quality Monitoring

The Council monitors NO_2 at four automatic monitoring sites, illustrated in Figure 1; three of which are also used to monitor PM_{10}. Two of the monitoring sites are classified as roadside sites, one as a kerbside site and one as an urban background site. Recent measurements recorded at these locations are summarised in Table 1. The Swiss Cottage station (CD1) is located close to a busy road, approximately 1.7 km south-west of the application site. Concentrations in the years 2011-2013 exceeded both the annual mean NO_2 objective and the hourly NO_2 objective, but satisfied the UK PM_{10} objectives. The other monitoring sites are all located over 5 km away from the application site. The annual mean NO_2 objective was exceeded at all sites but all PM_{10} objectives were achieved.

Table 1: Camden Council's Automatic Monitoring Results

Site ID	Site Name	Grid Reference	Distance from the site (km)	Site Type	Annual Mean NO_2 Concentration / µg/m^3 Number of Hourly Exceedences in Parenthesis		
					2011	2012	2013
LB	London Bloomsbury	530123, 182014	4.4	Urban Background	**50** (0)	**55** (1)	**44** (0)
CD1	Swiss Cottage	526633, 184392	1.1	Kerbside	**71 (79)**	**70 (43)**	**63 (28)**
CD3	Shaftesbury Avenue	530060, 181290	4.9	Roadside	**76** (15)	**71** (12)	**74** (6)
CD9	Euston Road	529878, 182648	3.8	Roadside	**122 (726)**	**106 (295)**	**106 (296)**
Site ID	**Site Name**	**Grid Reference**	**Distance from the site (km)**	**Site Type**	**Annual Mean PM_{10} Concentration / µg/m^3 Number of Daily Exceedences in Parenthesis**		
					2011	**2012**	**2013**
LB	London Bloomsbury	530123, 182014	4.4	Urban Background	22 (17)	19 (10)	18 (4)
CD1	Swiss Cottage	526633, 184392	1.1	Kerbside	27 (31)	23 (21)	21 (8)
CD3	Shaftesbury Avenue	530060, 181290	4.9	Roadside	32 (27)	29 (18)	29 ()

Notes: Figures in bold indicate exceedences of the UK objective and EU Limit Value for annual mean NO_2 set at 40 µg/m^3 or of the UK objective and EU Limit Value for 1-hour mean NO_2 set at 200 µg/m^3 not to be exceeded 18 times in a year. For PM_{10}, figures in bold indicate exceedences of the UK objective and EU Limit Value for annual mean PM_{10} set at 40 µg/m^{3}or of the number of exceedences of the 24 hour mean over 50 µg/m^3 not to be exceeded 35 times in a year. All results were obtained from the Council's 2014 Air Quality Progress Report.

Camden Council also operates a network of NO_2 diffusion tubes at fourteen locations, illustrated in Figure 1, within the Borough (reduced from sixteen locations in 2011). The results from 2011 to 2013 are reported in Table 2 for the six sites located closest to the proposed development (sites within 3 km). The closest monitoring site, 47 Fitzjohn's Road, is located approximately 1.1 km south-west of the application site. Monitored concentrations from this roadside site were above the UK annual mean NO_2 objective in the years 2011-2013.

Table 2: NO_2 Monitoring with Diffusion Tubes in LB of Camden

Site Name and Site ID	OS Grid Reference	Site Type	Distance from the site (km)	Bias Adjusted Annual Mean NO_2 Concentration ($\mu g/m^3$)		
				2011	2012	2013
Frognal Way (CA7)	526213, 185519	Urban background	1.6	31.5	28.9	32.0
Swiss Cottage (CA15)	526633, 184392	Kerbside	1.7	**73.2**	**72.7**	**83.1**
Kentish Town Road (CA15)	529013, 185102	Roadside	2.8	**57.2**	**59.0**	**65.3**
47 Fitzjohn's Road (CA15)	526547, 185125	Roadside	1.1	**58.4**	**61.2**	**65.2**
Chetwynd Road (CA21)	528722, 185950	Roadside	2.6	**44.1**	**43.7**	**76.1**
Mill Lane/West End Lane (CA24)	525366, 185253	Roadside	2.9	**57.1**	**52.1**	**47.8**

Notes: 1) Figures in bold indicate exceedences of the UK objective and EU Limit Value for annual mean NO_2 set at 40 $\mu g/m^3$; 2) Figures underlined indicate possible exceedences of the UK objective and EU Limit Value for 1-hour mean NO_2 set at 200 $\mu g/m^3$ not to be exceeded 18 times in a year. 3) All results were obtained from the Council's 2014 Air Quality Progress Report. 4) Bias adjustment factors were for 2011=0.95, 2012=0.95, 2013=1.00.

3.4 Defra Mapped Background Pollutant Concentrations

A large number of small sources of air pollutants exist, which individually may not be significant, but collectively, over a large area, need to be considered in the modelling process. Pollutant emissions from these sources contribute to background air quality, which when added to modelled emissions allow estimates of total ambient pollutant concentrations to be made.

Defra has produced maps of background pollutant concentrations covering the whole of the UK for use by local authorities and consultants in the completion of LAQM reports and Air Quality Assessments where local background monitoring is unavailable or inappropriate for use. The maps provide background pollutant concentrations for each 1-km grid square within the UK for all years between 2011 and 2030. A comparison of mapped and monitored background annual mean NO_2 concentrations is shown in Table 3.

Table 3: Comparison of Monitored and Mapped Background Concentrations, 2013

Monitor Site Name and ID	Site/Grid Square	Pollutant	Annual Mean Concentration (µg/m^3)	
			Monitored	Mapped
London Bloomsbury (LB)	530500, 182500	NO_2	44	46.6
Frognal Way (CA7)	526500, 185500	NO_2	32	31.8
London Bloomsbury (LB)	530500, 182500	PM_{10}	18	25.7

From Table 3 it is seen that mapped background NO_2 concentrations are very close to the monitored concentrations at both the London Bloomsbury automatic monitoring station and Frognal Way diffusion tube site. The background maps over estimate background concentrations of PM_{10} at the London Bloomsbury automatic monitoring station.

Mapped background pollutant concentrations have been used in the local air quality assessment for NO_2 while for the construction assessment PM_{10} concentrations have been derived from the London Bloomsbury automatic monitoring station. Details of the background concentrations used in the study are given in

Table 4: Background Pollutant Concentrations (µg/m^3) Used in the Assessment

Pollutant	2014 Annual Mean Concentrations (µg/m^3)
NO_x	49.5
NO_2	30.7
PM_{10}	21.7

Note: Background concentrations are based on grid square 527500,185500, which is considered most representative of the development site.

4 Assessment Methodology

4.1 Scope of the Assessment

The proposed development has the potential to impact upon local air quality during construction and when operational.

Effects during the construction phase will be mainly associated with on-site vehicle emissions and dust generation. Impacts during the construction phase of the scheme have been assessed qualitatively in accordance with the Mayor of London's SPG on the control of dust and emissions during construction and demolition. Mitigation measures are subsequently proposed to control the identified impacts in accordance with best practice guidance.

Operational phase impacts on air quality are generally restricted to effects from additional vehicle movements and emissions from on site heat and power generation. The proposed development will include a maximum of 28 car parking spaces. There are estimated to be a maximum of 48 two-way vehicle movements associated with the development.

The Highways Agency's Design Manual for Roads and Bridges (DMRB) guidance sets out criteria against which road traffic changes can be screened. The DMRB[11] guidance states that roads are likely to be affected by a proposal where they, *"meet any of the following criteria:*

- road alignment will change by 5 m or more; or
- daily traffic flows will change by 1,000 AADT or more; or
- Heavy Duty Vehicle (HDV) flows will change by 200 AADT or more; or
- daily average speed will change by 10 km/hr or more; or
- peak hour speed will change by 20 km/hr or more."

The Environmental Protection UK (EPUK) Development Control guidance[12] states that:

"Proposals that will give rise to a significant change in either traffic volumes, typically a change in annual average daily traffic (AADT) or peak traffic flows of greater than ±5% or ±10%, depending on local circumstances a change of ±5% will be appropriate for traffic flows within an AQMA"

It is anticipated that the additional movements associated with the proposed development will not lead to a change in local traffic movements of more than 1,000 AADT, 200 HDV or 5% of the existing flows and will not alter the speeds or alignment of existing roads, as such, the development is not expected to have a significant impact on local air quality due to vehicle emissions during its operational phase. However, the effects of transport emissions have been considered as part of the Air Quality Neutral Assessment.

The proposed development includes an on site energy centre consisting of one CHP and three boilers. The potential air quality effects associated with the CHP and boilers have, therefore, been assessed using detailed dispersion modelling. Of the three boilers only one will operate all year (up to a maximum of 8 hours per day) while the second is only required for a maximum of 8 hours during December to February to meet winter periods peak heat demands. The third boiler is provided as a backup in the event that either the CHP or one of the other boilers is inoperable due to maintenance or failure. The CHP has been sized to meet the base load requirements of the development and will operate between 6 am and midnight on a daily basis.

The London Plan and Mayor of London's SPG on Sustainable Design and Construction require that emissions from all new developments in Greater London are assessed against emission benchmarks for buildings and transport to determine whether the proposed development is 'air quality neutral'. An Air Quality Neutral Assessment has been

[11] DMRB Air Quality Volume 11 Section 3 Chapter 3 Part 1 HA207-07
[12] Environmental Protection UK (EPUK) Development Control: Planning For Air Quality (2010 Update)

carried out in accordance with the methodology set out in the Air Quality Neutral Planning Support document published by the Greater London Authority.

4.2 Local Air Quality Assessment Methodology

To predict the impacts of NO_x emissions from the proposed energy centre on local air quality detailed dispersion modelling was carried out using the US Environmental Protection Agency's (EPA) AERMOD dispersion modelling software version 14134. PM_{10} concentrations were not considered for the energy centre assessment since gas-fuelled boilers and CHP systems emit negligible amounts of PM_{10} into the atmosphere. The model was used to predict annual mean NO_2 concentrations at the identified sensitive receptor locations. Short-term (hourly mean and 99.79^{th} percentile) NO_2 concentrations were also predicted at each receptor location to assess the short-term air quality impacts. As a conservative assumption, the CHP has been assumed to run at 100% load during its operation for the purposes of the dispersion modelling.

4.2.1 Sensitive Receptors

Sensitive receptors were chosen to represent facades of surrounding buildings at the worst-case locations at the in terms of exposure to pollution and where impacts might be expected to be greatest. Pollutant concentrations were predicted at 17 sensitive receptor locations at 1.5 metres above the ground to represent typical breathing height of receptors. In addition elevated receptors were modelled at each of these locations to represent receptors on each floor of the adjacent hospital, school and residential buildings. Details of all modelled sensitive receptors are presented in Table 5 and Illustrated in Figure 2.

Table 5: Modelled Discrete Receptors

Receptor Number	Receptor Name	Grid Reference (X, Y)		Receptor Heights* (metres)
1	Rosary RC Primary School	527211	185284	1.5 to 18.2
2	Royal Free Hospital	527259	185310	1.5 to 4.7
3	Royal Free Hospital	527265	185363	1.5 to 45.5
4	Royal Free Hospital	527217	185360	1.5 to 24.5
5	Royal Free Hospital	527266	185333	1.5 to 4.7
6	240 Haverstock Hill	527193	185290	1.5 to 8.5
7	Rosary RC Primary School	527204	185306	1.5
8	250 Haverstock Hill	527169	185315	1.5 to 8.5
9	Ornan Court	527160	185269	1.5
10	239 Haverstock Hill	527146	185281	1.5
11	243 Haverstock Hill	527131	185296	1.5
12	St Stephens	527105	185394	1.5
13	Hampstead Hill School	527131	185420	1.5
14	Rosary RC Primary School	527247	185286	1.5
15	Aspen Grove	527284	185265	1.5
16	Aspen Grove	527345	185274	1.5
17	63 Belsize Avenue	527246	185238	1.5
18	Belsize Wood Local Nature Reserve	527485	185293	N/A

In addition to the receptors representing human exposure, one receptor was chosen to allow the impacts of the proposed scheme on the adjacent ecological site, Belsize Wood Local Nature Reserve (LNR), located approximately 250 metres to the east/south east of the CHP and boiler stacks, see Figure 2. In addition to modelling individual receptor locations a grid of receptors with a 20 metre grid spacing, covering a 2 km by 2 km area centred on the CHP and boiler stacks. From this grid of receptors the maximum ground-level NO_2 concentration has also been calculated.

4.2.2 Meteorological Data

Meteorological data from Heathrow Airport, located approximately 19 km to the south west of the proposed development site, were used in the dispersion modelling. Five consecutive years of meteorological data, 2009 to 2013, from Heathrow Airport were modelled and the worst-case results reported. The data consisted of the frequencies of occurrence of wind speed, wind direction and Pasquill stability classes. Pasquill stability classes categorise the stability of the atmosphere from A (very unstable) through D (neutral) to G (very stable). The meteorological data were used to produce a wind/stability roses. The rose consisted of 36 wind direction sectors of 10° and 6 wind speed bands. The wind roses for Heathrow Airport for each year are shown in Figure 3. Each windrose bar is designed to illustrate three wind properties: the direction the wind is coming from; the relative number of hours the wind is from this direction; and the magnitude of the wind speeds.

4.2.3 Modelled Building Downwash

The movement of air over and around buildings generates areas of flow circulation, which can lead to increased ground level concentrations in the building wakes. Where building heights are greater than about 30 - 40% of the stack height, downwash effects can be significant. The buildings on the proposed development site have been included in the dispersion modelling and their heights are detailed in Table 6 and their locations illustrated in Figure 4.

Table 6: Building Heights (m)

Building*	Description	Height from Ground Level (m)
1	Proposed Building A	13.75
2	Proposed Building B	33.65
3	Proposed Building C	20.30
4	Proposed Building D	10.55
5	Hospital Building	6.30
6	Hospital Building	6.30
7	Hospital Building	16.50
8	Hospital Building	47.70
9	Hospital Building	18.80
10	Hospital Building	26.80
11	Hospital Building	26.80
12	Rosary RC Primary School Building	20.00
13	Rosary RC Primary School Building	5.17
14	Rosary RC Primary School Building	4.00
15	Rosary RC Primary School Building	10.27
16	240 to 240 Haverstock Hill	7.50 to 10.50

*See building layout diagram Figure 4.

4.2.4 Terrain Data

The terrain heights for the buildings and stacks on the application site have been based on the terrain data provided by the development architects, while terrain heights for receptors of the application site have been derived from Open Ordinance Survey panorama terrain data.

4.2.5 Energy Centre Model Inputs

The main energy centre model inputs are summarised in Table 7. The proposed plant comprises one gas-fired CHP, supplemented by three conventional gas-fuelled boilers, one of which will operate only during peak demand period in the winter and another acting as a backup should the CHP or one of the other boilers be unavailable. All model inputs are based on information provided by Max Fordham LLP and manufacturer's technical datasheets for the proposed CHP and gas boiler plant. Where it has been necessary to make assumptions the best available information, combined with professional judgement and previous experience, has been applied to determine appropriate input data.

It is anticipated that the CHP would operate for 17 hours per day, 365 days per year, from 0700 to 2400. The proposed gas-fired boilers are of a condensing boiler design, producing NO_X emissions of 35 mg NO_x/kWh. Only 2 of the proposed 3 boilers would run at any one time, the third boiler serving as a backup in the event of breakdown of one of the CHP or one of the other boilers. It is anticipated that the gas boilers will only operate at times of peak demand, for approximately 8 hours per day with one boiler operating in this way all year while the second will only be required in the winter months (December to February). Due to the limited operation of the boilers each day the annual emission rate has been adjusted to take account of the limited operations per day while the hourly maximum NO_2 dispersion modelling has been based on maximum emission rates to ensure that the worst-case impacts are assessed.

Table 7: Summary of Energy Centre Model Input Parameters

Parameter	CHP	Gas Boilers
Stack Locations (X, Y)	527224.70, 185333.69	527224.97, 185333.85
Stack Height (m)	34.65	34.65
Exhaust Gas Volumetric Flow Rate (m^3/hr)	176	318
Exhaust Gas Volumetric Flow Rate (m^3/s)	0.05	0.09
Exhaust Gas Temperature (°C)	120	78
Stack Diameter (m)	0.05	0.15
Exhaust Gas Exit Velocity (m/s)	25	5
Heat Capacity – gross (kW)	45	194.8
NO_X Emission Rate	250 mg/Nm^3	35 mg/kWh
NO_X Emissions (g/s)	0.0085[a]	0.0019[b]/0.0006[c]

[a] the percentage oxygen and water in the flue gas is not set out in the manufacturers literature, as such as a worst-case assumption a value of 0% has been used for both with emission rates calculated from the volumetric flow adjusted for temperature only. This is very much a worst-case assumption.

[b] Based on peak operations

[c] Annualised mass emission to take account of the boilers operating for a maximum of 8 hours per day.

4.2.6 Conversion of NO_x to NO_2

The proportion of NO_2 in NO_x varies greatly with location and time according to a number of factors including the amount of ozone available and the distance from the emission source.

In this assessment NO_x concentrations predicted by the model were converted to NO_2 concentrations in accordance with the approach outlined by the Environment Agency[13]. This approach provides a worse-case assessment of ground level NO_2 concentrations.

For comparison against the long-term NO_2 objective i.e. annual mean, a conversion rate of 70% NO_x to NO_2 was assumed. Annual mean NO_2 process contributions were then added directly to road traffic NO_2 concentrations (after the conversion of road NO_x to NO_2) to derive total predicted annual mean NO_2 concentrations.

For the assessment of the potential short-term impacts of the proposed energy centre, a conversion rate of 35% NO_x to NO_2 was applied:

4.2.7 Significance Criteria

Air quality impacts of a proposed scheme may be considered to be significant if air quality objectives are predicted to be exceeded or if the development leads to significant impacts on air quality at sensitive receptors.

The EA Horizontal Guidance document H1, Annex F, advises that local air quality impacts should be screened in order to determine whether the emission source is significant. The EA H1 screening tool and guidance state that emissions may be considered insignificant and screened out where:

- the long term process contribution is <1% of the long term environmental standard; and
- the short term process contribution is <10% of the short term environmental standard

4.3 Construction Dust Assessment Methodology

A qualitative assessment has been undertaken to assess the potential impacts of airborne dust and emissions generated during the construction phase of the proposed development. The assessment has been conducted in accordance with the IAQM Guidance published in February 2014. This guidance, which is replicated within the Mayor of London's Control of Dust and Emissions SPG, classifies the risk posed by demolition and construction activities on a development site on the basis of the scale and nature of the activities, and the sensitivity and proximity of dust-sensitive receptors. According to the IAQM the main impacts that may arise due to construction activities are:

- Dust deposition resulting in the soiling of surfaces;
- Visible dust plumes, which are evidence of dust emissions;
- Elevated PM_{10} concentrations as a result of dust-generating activities on site; and
- An increase in the concentrations of airborne particles and NO_2 resulting from exhaust emissions of diesel-powered vehicles and equipment used on site.

Activities on construction sites with the potential to generate dust and emissions can be categorised into four types of activities, which are:

- Demolition – any activities associated with the removal of existing structures on site;
- Earthworks – includes the processes of soil-stripping, ground-levelling, excavation and landscaping;
- Construction – any activities relating to the provision of new structures on site; and
- Trackout – the transport of dust and dirt from the construction site onto the public road network where it may be deposited and resuspended by traffic using the network.

[13] Environment Agency Air Quality Modelling and Assessment Unit. Conversion Ratios for NO_x and NO_2

The potential for dust emissions has been assessed for each activity that is likely to take place, following the process described by IAQM in order to determine the risk of impacts, appropriate mitigation measures to be adopted and the significance of residual impacts.

4.4 Air Quality Neutral Assessment Methodology

The Mayor of London's Air Quality Strategy and SPG on Sustainable Design and Construction, and the London Plan place an emphasis on all new development in Greater London being at least 'air quality neutral', that is to ensure no further deterioration in air quality.

The Air Quality Neutral Planning Support guidance note has been used to assess the proposed development against benchmarked emissions for buildings and transport associated with the proposed development which are set out in the Appendix. The information collated for use in the Air Quality Neutral Assessment is summarised in Table 8.

Table 8: Information Used in Air Quality Neutral Assessment

Data / Information Used	Source of Data / Information
Number of Residential Dwellings= 60	Development plans
Land use: the proposed development is classed as sui generis however for purposes of the air quality neutral calculations it is assumed to be Class C2. GIA 8,676 m^2	Development plans
NO_X emission rates: CHP = 0.0085g/s Gas boilers = 0.0019g/s Operating Hours: CHP = 6,570 hours per annum (18 hr/day, 365 days per year) Gas boilers (three in total) = - One boiler will operate for 2,920 hours per annum (8 hr/day, 365 days per year); - The second boiler will operate for 720 hrs per year (8 hr/day, 90 days per year i.e. December to February) - The third boiler acts only as a backup for the other two units and is not intended to be used)	Max Fordham LLP building services engineers.
Development traffic flows: 48 vehicle trips per day	Traffic data provided by AECOM transport team based on TRAVL and TRICS trip generation data.

5 Air Quality Neutral Assessment

5.1 Building Emissions

The proposed energy centre associated with the development would be gas-fuelled; consequently, only NO_x emissions need to be considered in the assessment of building emissions.

Annual NO_x emissions for the proposed CHP unit, assuming 18 hours per day operation, are calculated as follows:

NO_x emissions (kg/annum) = NO_X emission rate (g/s) x Operating hours (hr/year) x 3,600 s/hr ÷ 1,000 g/kg

NO_x emissions (kg/annum) = 0.0085 g/s x 6,205 hrs/year x 3,600 s/hr ÷ 1000 g/kg

NO_x emissions (kg/annum) = 190 kg/annum

Annual NO_x emissions for the proposed gas boilers, assuming 8 hours per day operation, are calculated as follows:

NO_x emissions (kg/annum) Boiler 1 = 0.0019 g/s x 2,920 hr/year x 3,600 s/hr ÷ 1,000 g/kg

NO_x emissions (kg/annum) = 19.91 kg/annum

NO_x emissions (kg/annum) Boiler 2 = 0.0019 g/s x 720 hr/year x 3,600 s/hr ÷ 1,000 g/kg

NO_x emissions (kg/annum) = 4.91 kg/annum

Therefore, Total Building NO_x Emissions are calculated to be 214.47 kg/annum.

The NO_x Building Emissions Benchmark (BEB)[14] for C2 is 68.5 g.NO_X/m^2/annum. The GFA of the proposed development is 8,676 m^2. The Benchmarked Building NO_X Emissions are, therefore:

NO_x emissions (kg/annum) = 68.5 g.NO_x/m^2/annum x 8,676 m^2 ÷ 1,000 g/kg

NO_x emissions (kg/annum) = 594.31 kg/annum

The Total Building Emissions of NO_x are calculated to be 379.84 kg/annum lower than the Benchmarked Building Emissions. Therefore, the proposed development is considered to be air quality neutral in terms of it energy centre.

5.2 Transport Emissions

The Transport Emission Benchmarks for Sui generis or C2 use is 496 g/dwelling/annum for NO_x and 89.6 g/dwelling/annum for PM_{10}.

TRAVL (Trip Rate Assessment Valid for London) is a multi-modal trip generation database to estimate the effect of proposed changes in land use on transport patterns and, in particular, on the amount of road traffic in an area. For the proposed development, the total number of car trips generated is estimated to be 48 trips per day or 17,520 trips per annum. As a worst case, it has been assumed that all of these trips are associated with the dwellings. For 60 dwellings, this number of trips corresponds to 292 trips/dwelling/annum. For a Class C2 development located in Inner London, the average number of trips generated is 407 trips/dwelling/annum.

As the number of trips generated by the proposed development is lower than the trip rates obtained from TRAVL the proposed development can be assumed to be ‘air quality neutral’ with respect to transport emissions. The NO_x and PM_{10} emissions per dwelling per year have been calculated and are set out in Table 9 for information. No further mitigation will be necessary.

[14] Building Emissions Benchmarks are provided in Table 6 of the GLA’s Air Quality Neutral Planning Support guidance note.

Table 9: Transport Benchmark Calculations

Average distance travelled by car per trip for Inner London (km)	3.7
Car trips per day	48
Total distance driven (km/year)	64,824
Number of dwellings	60
Trip rate (km/dwelling/year)	1080
NO_x emissions (g/vehicle-km)	0.37
PM_{10} emissions (g/vehicle-km)	0.0665
NO_x emissions (g/dwelling/annum)	399.7
PM_{10} emissions (g/dwelling/annum)	71.85

5.3 Summary

The proposed development is air quality neutral for buildings and transport.

6 Operation Assessment

6.1 Modelled Effects at Sensitive Human Receptors

For the detailed modelling, the maximum process contribution predicted at each sensitive receptor has been presented in Table 10 and Table 11 along with the maximum ground-level concentration predicted across the 2 km by 2 km grid of receptors. The modelling has been undertaken using five years of meteorological data with the highest process contribution (PC) predicted across the five year presented in the table. The background annual mean NO_2 concentration was taken to be 30.7 µg/m^3 and the 99.79th percentile of hourly NO_2 concentrations to be twice the annual mean background concentration in accordance with Defra's Technical Guidance TG(09). The process contribution has been added to the background concentration to give the predicted environmental concentration which can then be compared with the Air Quality Strategy objective or EU limit value. Contour plots of the gridded NO_2 results are presented in Figure 5 and Figure 6.

Table 10: Modelled Hourly 99.79th Percentile NO_2 Concentrations

Receptor*	Process Contribution (µg/m^3)	PC as % of AQS[a]	Predicted Environmental Concentration (µg/m^3)	PEC as % of AQS[b]
1	0.52 to 0.63	0.26% to 0.32%	61.92 to 62.03	30.96% to 31.02%
2	0.70 to 0.72	0.35% to 0.36%	62.10 to 62.12	31.05% to 31.06%
3	0.35 to 0.70	0.18% to 0.35%	61.75 to 62.10	30.88% to 31.05%
4	0.50 to 0.71	0.25% to 0.35%	61.90 to 62.11	30.95% to 31.05%
5	0.75 to 0.79	0.38% to 0.40%	62.15 to 62.19	31.08% to 31.10%
6	0.57 to 0.59	0.29%	61.97 to 61.99	30.99%
7	0.68	0.34%	62.08	31.04%
8	0.52 to 0.55	0.26% to 0.27%	61.92 to 61.95	30.96% to 30.97%
9	0.38	0.19%	61.78	30.89%
10	0.35	0.17%	61.75	30.87%
11	0.33	0.16%	61.73	30.86%
12	0.28	0.14%	61.68	30.84%
13	0.45	0.22%	61.85	30.92%
14	0.61	0.31%	62.01	31.01%
15	0.60	0.30%	62.00	31.00%
16	0.62	0.31%	62.02	31.01%
17	0.35	0.18%	61.75	30.88%
Gridded Maximum	0.75	0.37%	62.15	31.07%

Note: * – For receptors modelled on multiple floors the range of concentrations has been presented.
** Following the EA H1 methodology double the annual mean background concentration of 30.7 µg/m^3 has been used as the short-term background.
a – Where PCs are less than 10% of the short term AQS of 200 µg/m^3, the impact can be considered negligible.
b – Where PECs are less than 100% of the annual mean AQS of 200 µg/m^3, the impact can be considered negligible.

Table 11: Modelled Annual Mean NO_2 Concentrations

Receptor*	Process Contribution (µg/m^3)	PC as % of AQS[a]	Predicted Environmental Concentration (µg/m^3)	PEC as % of AQS[b]
1	0.04 to 0.05	0.10% to 0.12%	30.74 to 30.75	76.85% to 76.87%
2	0.09 to 0.09	0.22% to 0.23%	30.79 to 30.79	76.97% to 76.98%
3	0.06 to 0.13	0.14% to 0.32%	30.76 to 30.83	76.89% to 77.07%
4	0.06 to 0.09	0.16% to 0.24%	30.76 to 30.79	76.91% to 76.99%
5	0.11 to 0.12	0.28% to 0.29%	30.81 to 30.82	77.03% to 77.04%
6	0.04 to 0.04	0.11% to 0.11%	30.74 to 30.74	76.86% to 76.86%
7	0.06	0.15%	30.76	76.90%
8	0.04 to 0.04	0.10% to 0.10%	30.74 to 30.74	76.85% to 76.85%
9	0.02	0.06%	30.72	76.81%
10	0.02	0.05%	30.72	76.80%
11	0.02	0.05%	30.72	76.80%
12	0.02	0.05%	30.72	76.80%
13	0.03	0.07%	30.73	76.82%
14	0.07	0.16%	30.77	76.91%
15	0.06	0.14%	30.76	76.89%
16	0.05	0.12%	30.75	76.87%
17	0.03	0.07%	30.73	76.82%
Gridded Maximum	0.12	0.29%	30.82	77.04%

Note: * – For receptors modelled on multiple floors the range of concentrations has been presented.
** Background concentration of 30.7 µg/m^3 has been used to determine the PEC.
a – Where PECs are less than 1% of the short term AQS of 40 µg/m^3, the impact can be considered negligible..
b – Where PECs are less than 70% of the annual mean AQS of 40 µg/m^3, the impact can be considered negligible.

Table 10 shows that predicted short-term NO_2 concentrations from the proposed energy centre are predicted to result in short-term NO_2 process contributions of 0.75 µg/m³, well below 10% of the hourly NO_2 standard of 200 µg/m³. According to the Environment Agency, where short-term process contributions are below 10% of the relevant environmental standard air quality impacts could be can, therefore, be considered insignificant. When combined with double the annual average NO_2 background of 30.7 µg/m^3 the maximum concentration at any of the models receptors is 62.15 µg/m^3 or 31.1% of the AQS and as such can be considered negligible.

Table 11 Annual mean NO_2 concentrations at sensitive receptor locations are predicted to be well below 1% of the annual mean NO_2 objective of 40 µg/m³ at all modelled receptor locations. The highest predicted annual mean NO_2 concentrations of 0.13 µg/m³ is predicted on the development site itself, based on the gridded maximum, and represents 0.32% of the annual AQS. As such, in accordance with Environment Agency H1 guidance contributions from the CHP and boilers to local air quality can be considered insignificant.

Background NO_2 concentrations in the vicinity of the application site have been taken from the Defra mapped background concentrations. The mapped background concentrations in the vicinity of the application site are estimated to be 30.7 µg/m³. If the maximum gridded PC is added to this background concentration the predicted environmental concentration (PEC) is 30.83 µg/m³ which represents 77.1% of the AQS. As such, it is unlikely that the proposed energy centre will lead to an exceedence of the annual AQS objective in the vicinity of the application site.

6.2 Modelled Effects at Ecological Receptors

Table 12 presents the maximum predicted daily and annual processes contributions of NO_x to Belsize Wood LNR.

Table 12: Predicted Process Contributions at Belsize Wood Local Nature Reserve

Ecological Receptor	Critical Level/Load	Process Contribution	PC as a % of Critical Level/Load	Background	Predicted Environmental Concentration	PEC as a % of Critical Level/Load
Daily NO_x (µg/m³)	75	0.26	0.35%	n/a	n/a	n/a
Annual NO_x (µg/m³)	30	0.019	0.06%	28.92	28.94	96.5%
Nitrogen Deposition (Kg N/ha/year)	10 - 20	0.005	0.03% to 0.05%	34.02	34.03	170% to 340%
Acid Deposition (keq/ha/yr)	Max N: 2.73	0.0004	0.01%	N: 2.43	N: 2.43	89%

Table 12 shows that, based on 5 years of meteorological data, the maximum daily PC is 0.26 µg/m³ (0.35% of the daily Critical Level) while the annual average PC is 0.019 µg/m³ (0.06% of the annual mean NO_x Critical Level). As contributions from the proposed development are less than 1% of both the daily and annual Critical Levels the impact of the proposed development upon NO_x concentrations can be considered negligible.

Existing background nitrogen deposition rates exceed the Critical Load for broadleaved woodland for which Belsize Wood LNR is designated. The suggested Critical Load for nitrogen deposition for use in environmental assessments is 10 to 20 kg.N/ha/year – background nitrogen deposition rates are estimated to be 34.02 kg.N/ha/year. The proposed development is predicted to contribute up to 0.005 µg/m³ NO_2 at locations within the LNR or between 0.03% and 0.05% of the minimum and maximum Critical Loads. For Designated Sites, the Environment Agency advises that process contributions can be considered insignificant if the long term process contribution is less than 1 % of the environmental standard. The results indicate, therefore, that the impact of the proposed development on nitrogen deposition at Belsize Wood LNR can be considered negligible.

At the modelled receptor location representing the LNR the highest predicted annual acid deposition 0.0004 keq/ha/yr or 0.01% of the daily Critical Load. As contributions from the proposed development are less than 1% of the Critical Load the impact of the proposed development upon acid deposition can be considered negligible.

7 Construction Dust

7.1 Assessment Methodology

A qualitative assessment has been undertaken to assess the potential impacts of airborne dust and emissions generated during the demolition and construction phases of the scheme. The assessment has been conducted in accordance with the IAQM Guidance[15] .

Activities on construction sites with the potential to generate dust and emissions can be categorised into four types of activities, which are:

- Demolition – any activities associated with the removal of existing structures on site;
- Earthworks – includes the processes of soil-stripping, ground-levelling, excavation and landscaping;
- Construction – any activities relating to the provision of new structures on site; and
- Trackout – the transport of dust and dirt from the construction site onto the public road network where it may be deposited and resuspended by traffic using the network.

The potential for dust emissions has been assessed for each activity that is likely to take place, in order to determine the risk of impacts, appropriate mitigation measures to be adopted and the significance of residual impacts.

7.2 Assessment

7.2.1 Assessment of Risk of Dust Effects

Dust sensitive receptors have been identified in the vicinity of the application site in accordance with the methodology outlined in the IAQM guidance. A summary of the approximate numbers of receptors in distance bands from the development site boundary and sensitivity of those receptors is shown in Table 13. The area within 350 m of the site that could potentially be affected by dust is shown in Figure 1.

Table 13 Numbers and Dust-Sensitivities of Dust-Sensitive Receptors

Activity	Number of Receptors and Sensitivity			
	<20 m	<50 m	<100 m	<350m
Demolition	10-100 High	>100 High	>100 High	>100 High
Earthworks	10-100 High	>100 High	>100 High	>100 High
Construction	10-100 High	>100 High	>100 High	>100 High
Trackout	10-100 High	>100 High	>100 High	>100 High

There are likely to be between 10 and 100 receptors with high sensitivity to dust soiling effects and to the health effects of PM_{10} located within 20 metres of the proposed demolition, earthworks, construction areas trackout routes, and >100 high sensitivity receptors located within 50 metres of these areas. This is due to the close proximity (<20m) of a primary school and the nearby Royal Free Hospital, both of which are considered to be highly sensitive to dust soiling and health effects. It should be noted that the hospital has been considered to represent more than 1 receptor.

Background PM_{10} concentrations in the study area have been considered to determine the sensitivity of the area to human health impacts. The Defra mapped background PM_{10} concentration for 2014 for the development site is 21.7 µg/m³; this concentrations is well within the annual mean PM_{10} objective. It should be noted that this background concentration is based on the Defra mapped concentrations. While the mapped background data does take account of road sources of PM_{10}, those receptors adjacent to the A502 PM_{10} concentration may be slightly higher than this background value, however, monitored kerbside PM_{10} concentrations at the Swiss Cottage automatic monitoring location, approximately 1.1 km to the south west of the application site on the A41, do not show any exceedences of 30 µg/m³. As such the findings of the construction dust assessment are considered appropriate at receptors both at roadside locations and located away from local road sources.

[15] Guidance on the assessment of dust from demolition and construction, IAQM, February 2014.

The Belsize Wood Local Nature Reserve is located approximately 350m to the south-east of the development site. There are no other ecological receptors within 500 metres of the application site. The LNR is located over 50 metres from the constriction activities on the site and, as such, the sensitivity of the site is considered to be negligible, likewise traffic associated with the construction phase of the development is not anticipated to pass within 50 metres of the LNR and as such trackout is also considered to be negligible.

A summary of the sensitivity of the area for each construction activity is presented in Table 14.

Table 14 Summary of Area Sensitivity With Respect to Dust Effects

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

7.2.2 Demolition

Demolition activities on the site will involve the demolition of the existing buildings. The total building volume involved in demolition is likely to be <10,000m^3. This activity will involve potentially dusty construction material and activities around 10-20 m above ground level, therefore the potential dust emission magnitude for demolition activities is expected to be medium. Given that the sensitivity of the area to dust soiling is high and to human health is low, the risk of dust impact for demolition activities is classified as medium risk for dust soiling and low risk for human health. The risk of dust impacts upon ecological receptors is classified as Negligible.

7.2.3 Earthworks

The application site area is between 2500m^2 and 10,000m^2. The potential dust emissions magnitude associated with earthworks is therefore considered to be of medium magnitude. Given that the sensitivity of the area to dust soiling is high and to human health is low, the risk of dust impact for earthworks activities is classified as medium risk for dust soiling and low risk for human health. The risk of dust impacts upon ecological receptors is classified as Negligible.

7.2.4 Construction

Construction activities will likely involve a total building volume of 25,000-100,000m^3 and the use of potentially dusty material. The potential dust emission class for construction activities is therefore likely to be medium on the basis of building volume. The proposed development is defined as medium risk for dust soiling and low risk for PM_{10} effects with respect to construction activities. However due to the presence of dust-sensitive receptors within 20 m of the site boundary mitigations measures should be implemented. The risk of dust impacts upon ecological receptors is classified as Negligible.

7.2.5 Trackout

The number of construction-related heavy duty vehicle (HDV) movements generated by the proposed development is not currently known. However, for a development site of the proposed scale and nature it would be expected that the number of HDV movements generated would be small. The potential dust emissions class for trackout is assumed to be medium due to dust-sensitive receptors within 20 m of potential routes used by construction vehicles. The site is defined as medium risk for dust soiling and low risk for PM_{10} effects with respect to trackout activities. The risk of dust impacts upon ecological receptors is classified as Negligible.

7.2.6 Summary of Risk of Dust Effects

The results of the assessment of risk of dust effects associated with construction phase activities are summarised in Table 3. It should be noted that the risk classifications presented in Table 4 have assumed no mitigation is in place. Furthermore, as proximity to sensitive receptors has been determined by distance from the site boundary, the risk categorisations can be considered conservative.

Table 15: Summary of Dust Emission Magnitude

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

Table 16: Summary Dust Risk Table to Define Site-Specific Mitigation

Source	Dust Soiling	Human Health	Ecology
Demolition	Medium Risk	Low Risk	Negligible
Earthworks	Medium Risk	Low Risk	Negligible
Construction	Medium Risk	Low Risk	Negligible
Trackout	Medium Risk	Low Risk	Negligible

7.2.7 Construction Vehicle and Plant Exhaust Emissions

Exhaust emissions from construction vehicles and machinery will also impact on air quality during the construction phase. The number of construction vehicles using the local road network is likely to be small in comparison to normal traffic flows. The impact is thus considered to be of negligible significance.

Construction plant used at the proposed development will have to comply with GLA's 2015 emission standards for NRMM. This requires emissions from plant (between 37 kW and 560 kW) to meet Stage IIIA of the EU Directive 97/68/EC. This and good maintenance practice should ensure the residual impact of construction vehicle and plant exhaust emissions is negligible

7.2.8 Mitigation Measures and Residual Effects

Dust will be mitigated in accordance with the Mayor of London's SPG on the control of dust and emissions from construction and demolition for a medium risk site for demolition and low risk site for construction and track-out. The mitigation measures required are set out in Appendix 8 of the SPG. The implementation of appropriate mitigation measures should effectively reduce the effects to negligible significance for all construction activities.

There are a number of mitigation measures that can be employed to lessen the nuisance and human-health impacts of the dust and PM_{10} generated during construction activities. Construction dust usually responds well to these measures as long as a co-ordinated Construction Environmental Management Plan (CEMP) is implemented.

All potential dust-generating activities and locations should be identified prior to commencement of work.

Dust should be controlled at source by the use of appropriate plant handling techniques, good maintenance and housekeeping. A list of appropriate mitigation measures is presented in the Appendix.

Should effective mitigation measures be enforced and implemented within a Dust Management Plan and/or CEMP then the residual impact of the construction phase will be 'not significant' for all the activities, with respect to dust soiling and PM_{10} effects.

8 Camden Air Quality Checklist

8.1 Travel and Transport

Question 1) If there will be parking in the development, will electric vehicle charging points be included?

Answer: Yes the development will include electric vehicle charging points in accordance with the London Plan. .

Question 2) Will secure cycle storage be provided for users of the building?

Answer: Yes the development will include secure storage for bicycles.

8.2 Energy

Question 3) If a CHP is to be included, did you ensure that this technology is suitable for the energy requirements of the building? Please see Camden's Boiler Guidance Manual B for more information.

Answer: Yes the development will include a gas CHP to meet the base load of the building with additional gas boilers to provide top-up, peak demand and backup capacity to the development. A CHP unit has been selected to provide the base load heating requirement for the development as it has a high steady heat and electricity demand and few site or planning restrictions with high efficiency boilers employed to mead the more variable top-up and peak load demand. All plant has been selected to conform to the Mayor of London's Air Quality Strategy (Policy 7) and has been determined to be 'air quality neutral'.

Question 4) If CHP is to be included, was this included within the air quality modelling in the AQA?

Answer: Yes the air quality assessment has undertaken detailed dispersion modelling of both the CHP and boiler operations.

Question 5) If CHP will be included and the final technology agreed, have you ensured that it is the best in class in terms of NO_x *emissions?*

Answer: Yes and the dispersion modelling undertaken for the development has demonstrated that the development will have a Negligible impact at all identified receptors,

8.3 Exposure

Question 6) If located in an area of poor air quality and/or next to a busy road or diesel railway line, does the AQA include details of the way in which the building has been designed to reduce the exposure of occupants (e.g. through orientation, greening, placement of residential properties, or, only for developments in areas of very poor air quality, mechanical ventilation?)

Answer: The application site is not located directly adjacent to any busy roads and replaces the existing building containing 69 bedrooms and communal facilities with 60 extra care apartments, a health and well being facility; communal facilities including a restaurant/ cafe, activity room and a library, gardens and terraces; staff and concierge facilities; storage facilities and basement car parking.

8.4 Construction Dust

Question 7) Does the project have a Construction Management Plan written in accordance with the recommendations in the Control of Dust and Emissions during Construction and Demolition Supplementary Planning Guidance, including an assessment of the risk? And, if the risk is High, a real time monitoring proposal?

Answer: The risk of dust impacts form the construction phase of the proposed development have been assessed in accordance with the recommendations in the Control of Dust and Emissions during Construction and Demolition Supplementary Planning Guidance and mitigation measures proposed which should be incorporated into the Construction Management Plan. The risk has been assessed to be Medium.

9 Summary

An Air Quality Assessment has been carried out for the redevelopment of the application site including the demolition of the existing Bartram's Convent building and construction of 60 extra care apartments, a health and well being facility; communal facilities including a restaurant/ cafe, activity room and a library, gardens and terraces; staff and concierge facilities; storage facilities and basement car parking. The proposed site is located off Rowland Hill Street in the London Borough of Camden. The development proposals include the provision of up to 28 parking spaces to serve the development.

9.1 Air Quality Neutral Assessment

The proposed development is predicted to have a total Building NO_x Emissions Benchmark for NO_x by 214.47 kg.NO_x/annum which is 379.84 kg.NO_x/annum lower than the benchmark for a C2 use building of a comparable size. As such, the proposed development is considered 'air quality neutral' with respect to building emissions.

The proposed development is predicted to have Transport Emissions Benchmarks for NO_x of 399.7 g/dwelling/annum and for PM_{10} of 71.8 g/dwelling/annum which are well within the Benchmarks. The development can be considered 'air quality neutral' with respect to transport emissions and no further mitigation will be required.

9.2 Local Air Quality Assessment

- Annual mean NO_2 concentrations from the proposed energy centre are predicted to be well below the annual mean NO_2 AQS objective of 40 µg/m³ in all modelled receptor locations.
- The maximum impact on annual mean NO_2 concentrations modelled across a grid of receptors covering a 2 km by 2 km area centred on the application site is 0.13 µg/m³, which represents 0.32% of the annual mean AQS objective of 40 µg/m which can be considered insignificant in accordance with the Environment Agency H1 guidance on modelling stack emissions.
- The impact of NO_2 emissions from the proposed energy centre on short-term NO_2 concentrations is predicted to be negligible. A maximum short-term NO_2 process contribution of 0.79 µg/m³ is predicted across the grid of receptors representing 0.40% of the AQS objective of 200 µg/m³ and as such can be considered insignificant in accordance with the Environment Agency H1 guidance.
- Annual mean NO_x process contributions within the Belsize Wood LNR are predicted to be less then 1% of the Critical Level for the protection of vegetation and ecosystems of 30 µg/m³ with the predicted environmental concentration, once background NO_x is accounted for, is also predicted to achieve the standard.
- Background nitrogen deposition rates affecting the Belsize Wood LNR currently exceed the relevant Critical Load, however, the additional nitrogen deposition predicted to be contributed by the proposed development is 0.005 kg.N/ha/year, which represents 0.05% of the Critical Load of 10 kg.N/ha/year and, as such, the predicted effect of the proposed development on nitrogen deposition is considered to be negligible.
- The proposed development's energy centre is predicted to contribute a maximum of 0.0004 keq/ha/yr to annual acid deposition at the Belsize Wood LNR which represents 0.01% of the daily Critical Load of 2.73 keq/ha/yr. As contributions from the proposed development are less than 1% of the Critical Load the impact of the proposed development upon acid deposition can be considered negligible. Once background acid deposition is taken into account the total acid deposition at Belsize Wood LNR is predicted to be 2.43 keq/ha/yr or 89% of the Critical Load for broadleaved woodlands for which the site has been designated.

9.3 Construction Dust Assessment

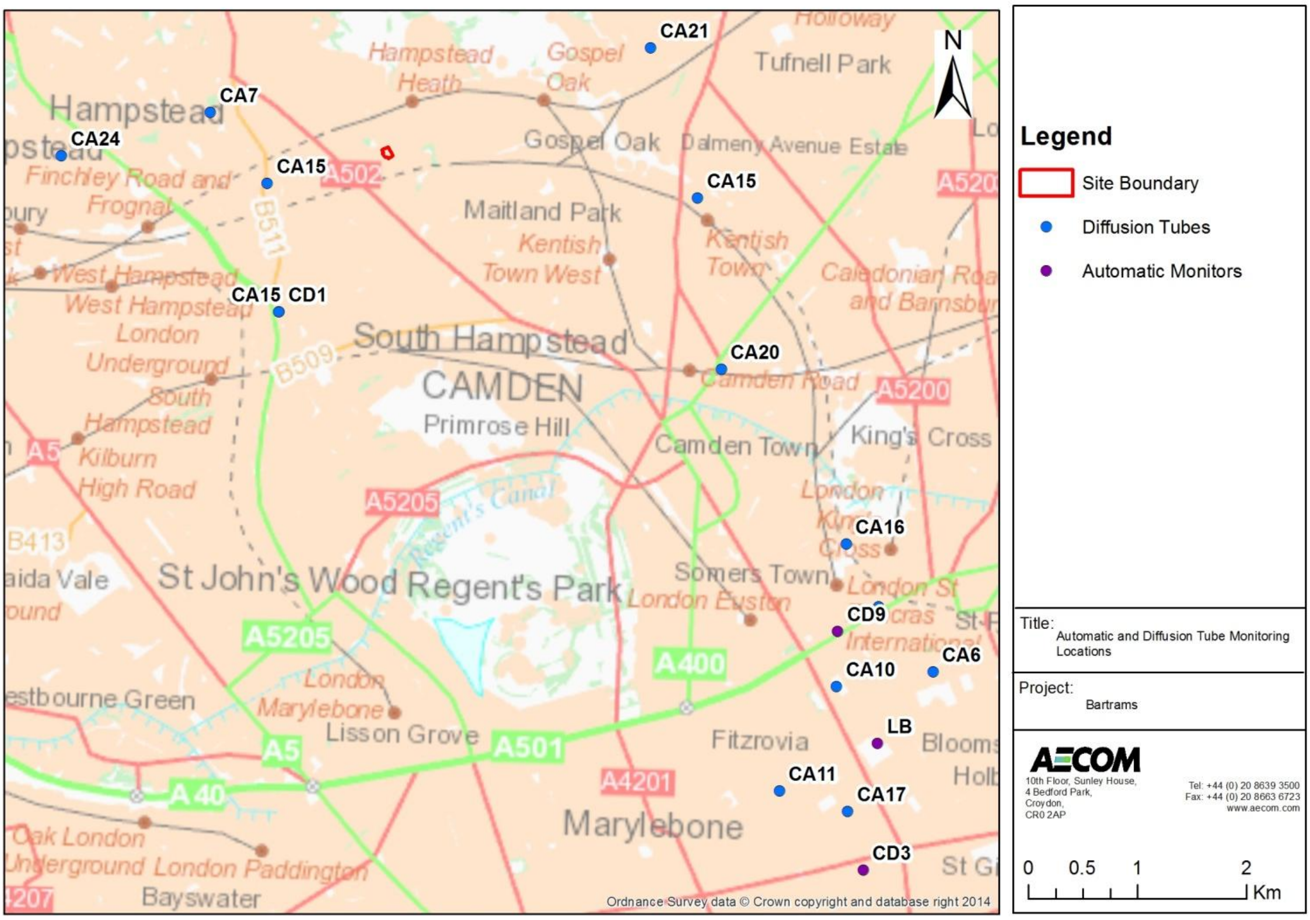
The proposed development has the potential to generate dust and emissions during the construction phase due to on-site activities including demolition works, construction activities and exhaust emissions from construction vehicles and plant. Due to the proximity of high-sensitivity receptors to the proposed development site boundary the site is classified as medium risk with respect to dust soiling. The site is defined as low risk with respect to human health effects and negligible risk for ecological effects.

Through the implementation of a coordinated Construction Environmental Management Plan and / or Air Quality Dust Management Plan all impacts associated with construction phase activities are likely to be negligible. It is important that all potential dust-generating activities and locations are identified prior to commencement of work. Dust should be controlled at source by the use of appropriate plant handling techniques, good maintenance and housekeeping. A list of recommended mitigation measures can be found in Table 22 of the appendix.

All construction plant used at the proposed development will have to comply with the latest emission standards for non-road mobile machinery as detailed in guidance issued by the Mayor of London. This will ensure that air quality impacts associated with exhaust emissions from these vehicles will be negligible.

10 Figures

Figure 1: Air Quality Monitoring Locations



Capabilities on project:
Environment

Figure 2: Receptor Locations

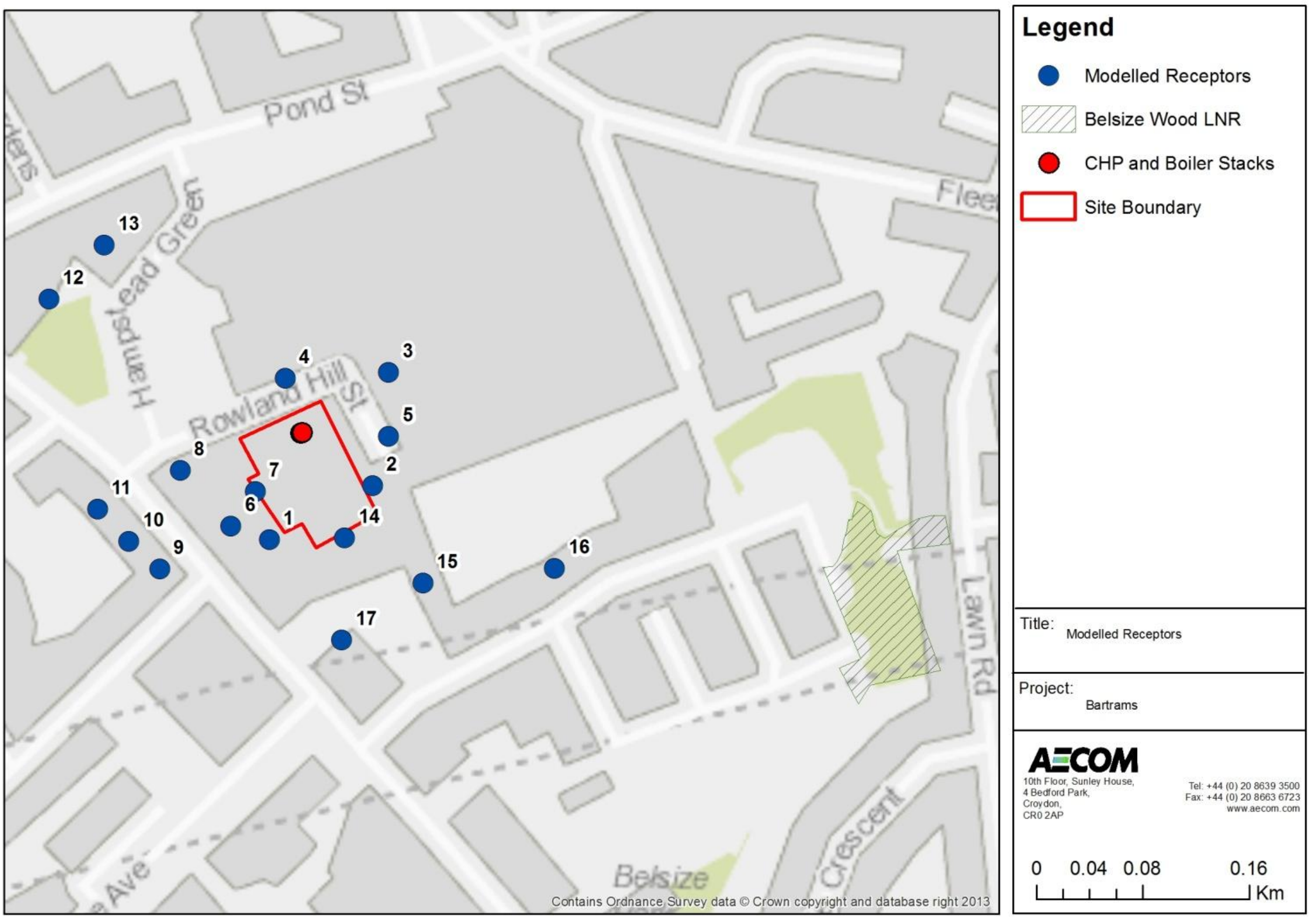
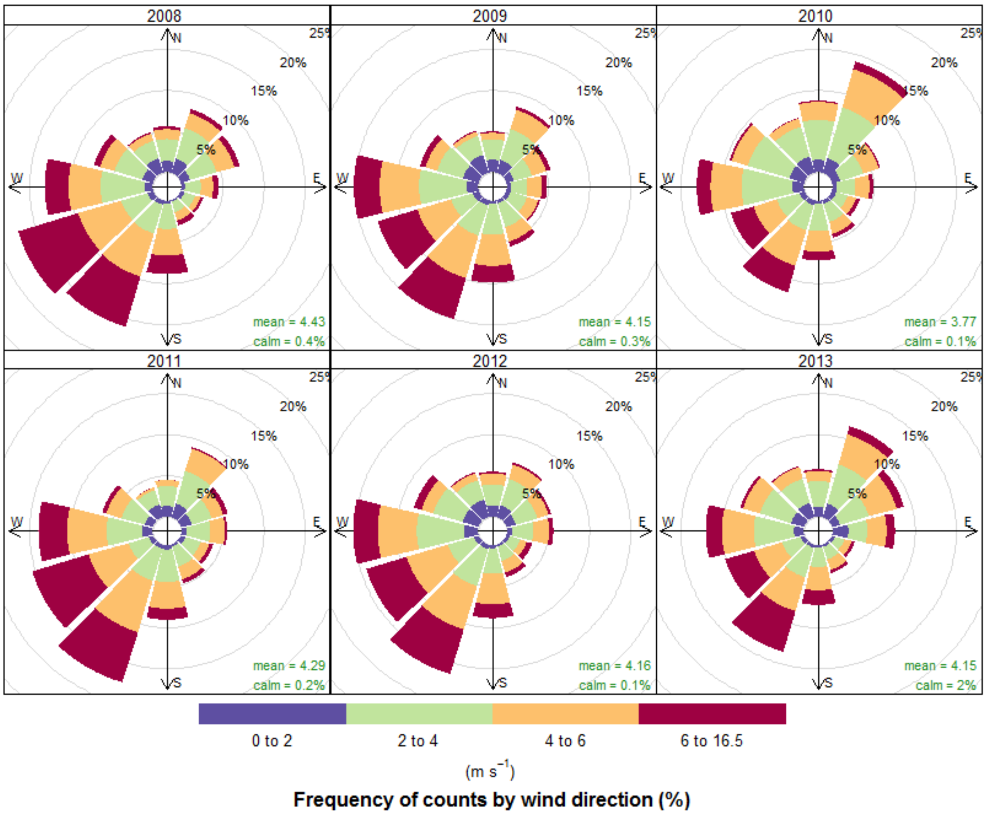


Figure 3: Windroses



Capabilities on project:
Environment

Figure 4: Modelled Building Layout

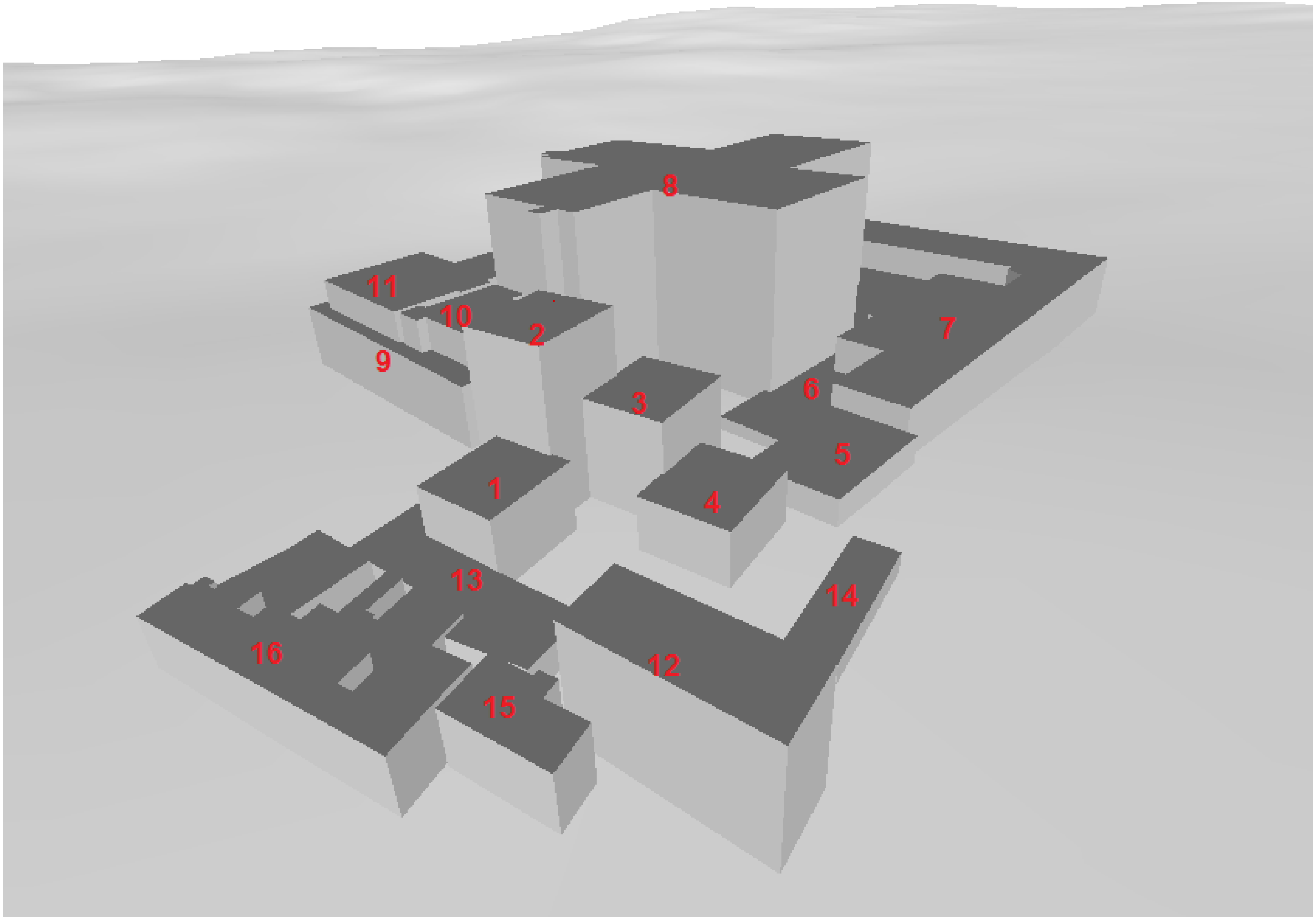
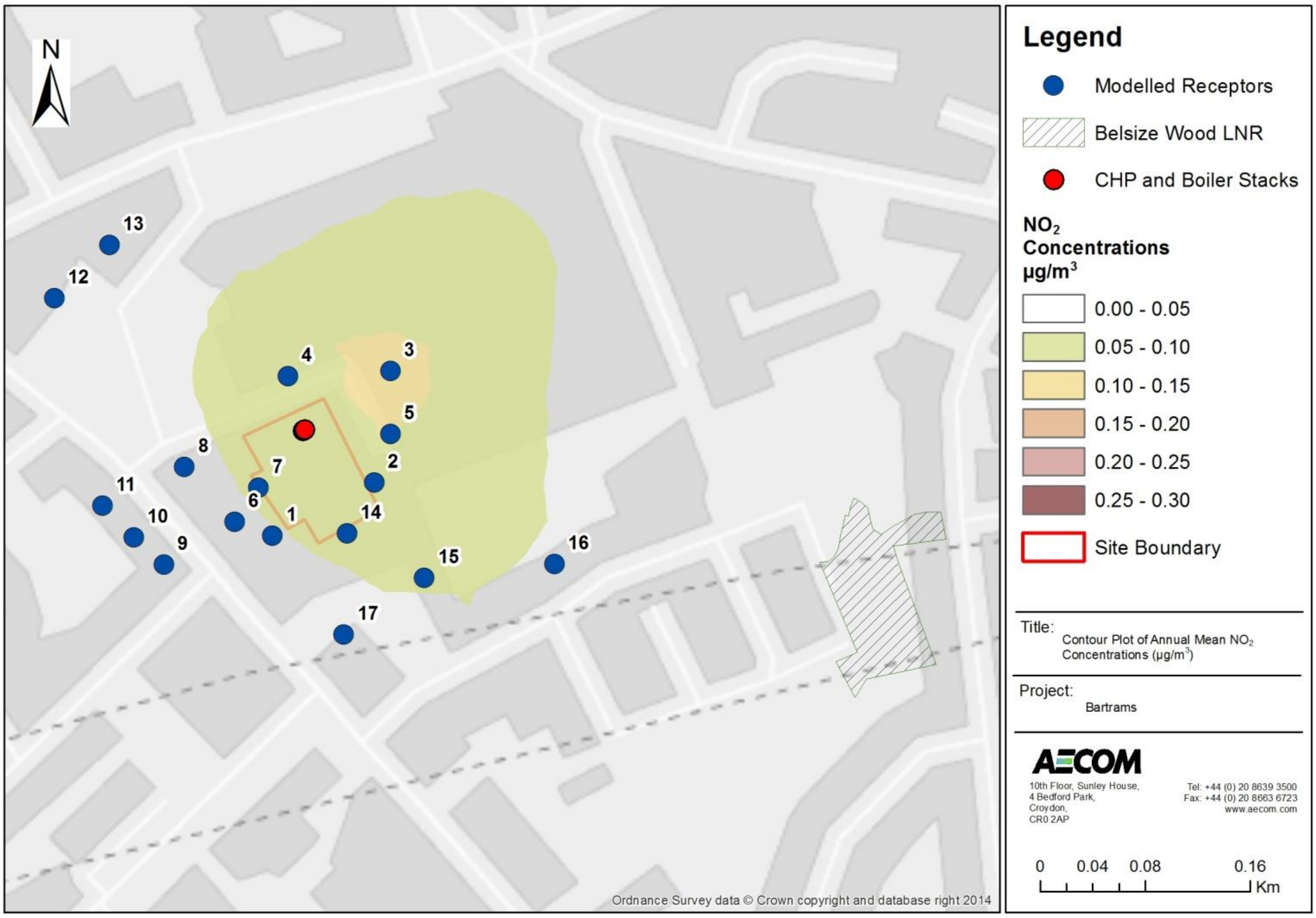
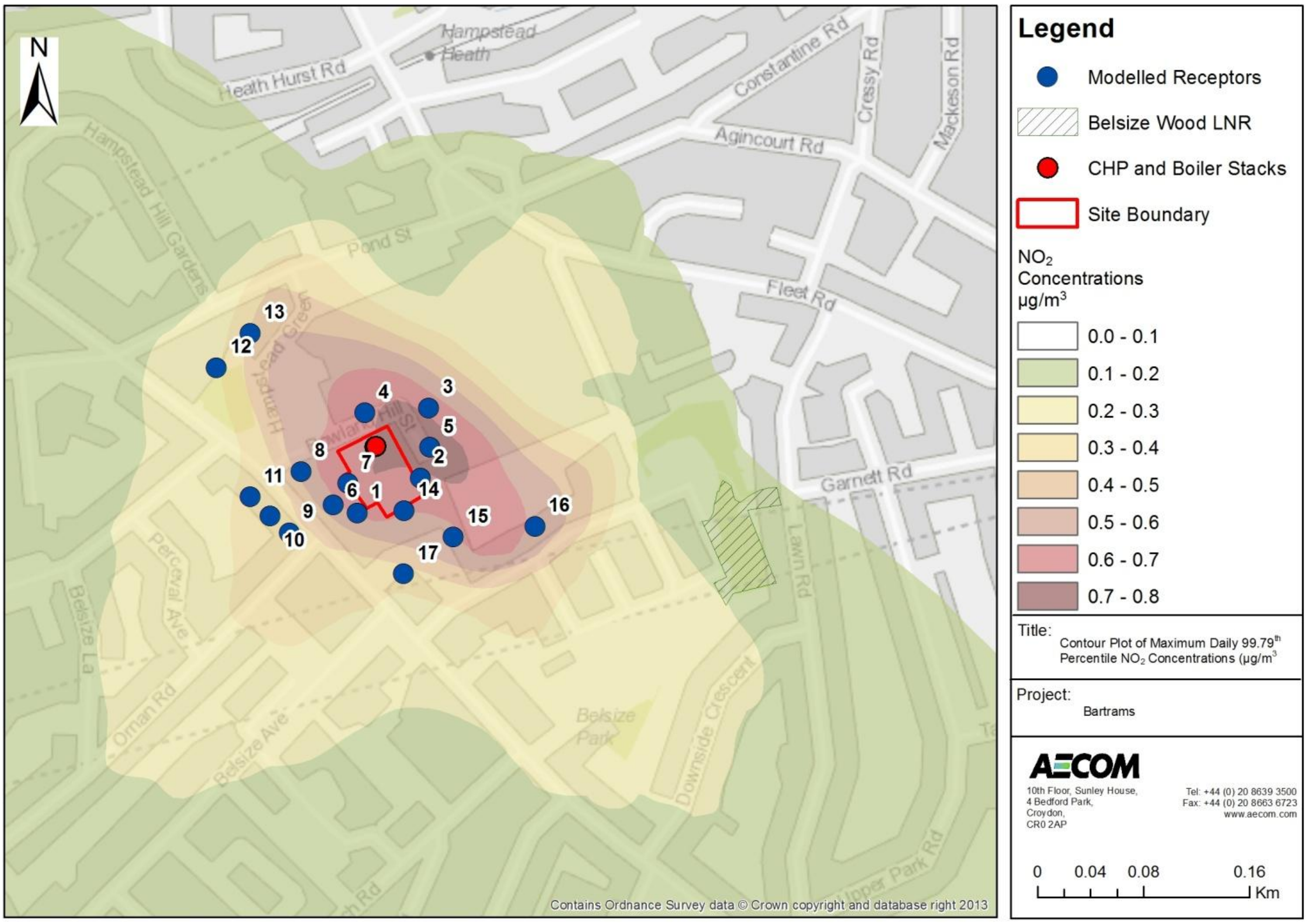


Figure 5: Contour Plot of Annual Mean NO_2 Concentrations (µg/m³)



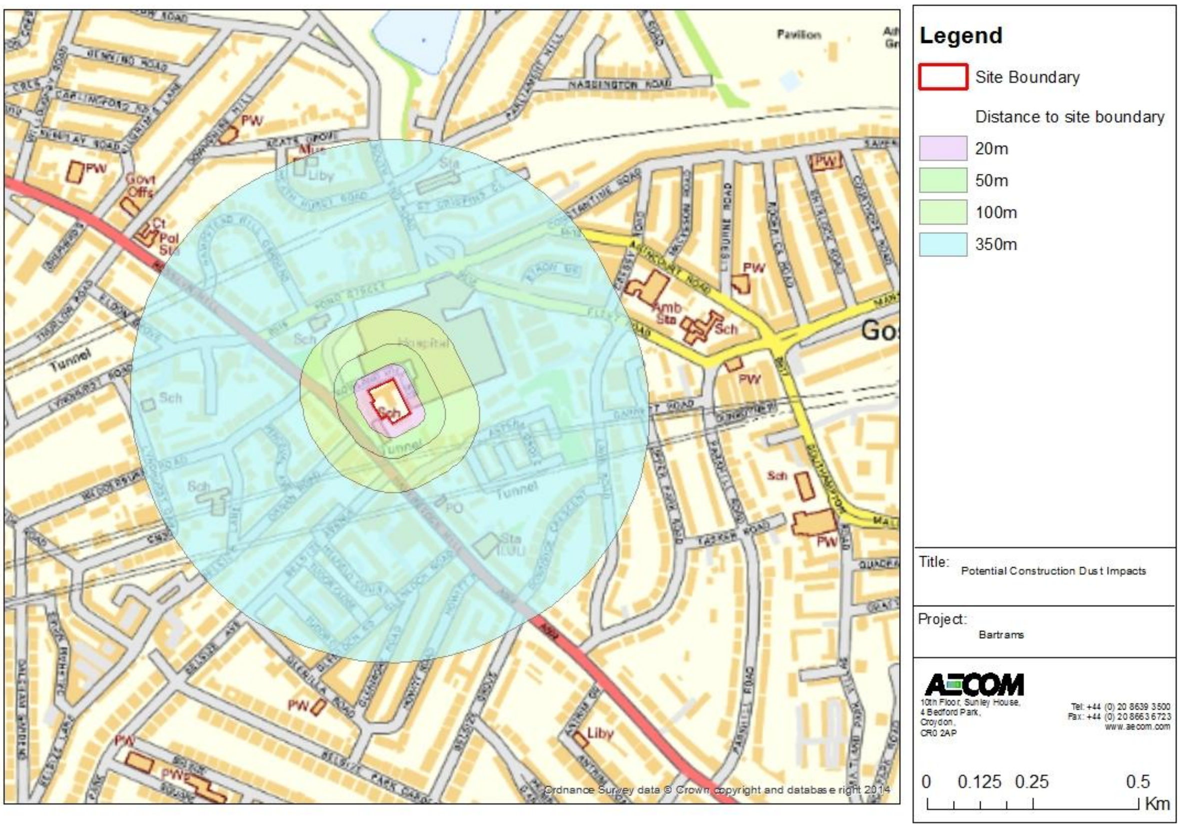
Capabilities on project:
Environment

Figure 6: Contour Plot of Maximum Daily 99.79th Percentile NO_2 Concentrations (µg/m³)



Capabilities on project:
Environment

Figure 7: Potential Construction Dust Impacts, Without Mitigation



11 Appendix

11.1 Air Quality Neutral Assessment Guidance

The London Plan and Mayor of London's Sustainable Design and Construction SPG require that emissions from proposed developments in London are assessed against emissions benchmarks for buildings and transport in accordance with the methodology set out in the Air Quality Neutral Planning Support document published by the Greater London Authority.

The Mayor's guidance sets benchmarks for emissions from buildings and transport. Regarding transport based emissions there is no change in the estimate number and length of trips due to the reconfiguration of the building. As no further information on the transportation is available, the emissions from transportation cannot be calculated.

In terms of building emissions, the proposed development's energy strategy is not sufficiently progressed to determine the onsite energy consumption (kWh/annum) for each proposed use. The final energy strategy is likely to involve a combined heat and power (CHP) unit and/or gas-fired boilers. Any boilers or CHP unit would however be designed to achieve the emissions standards specified within the Mayor of London Sustainable Design and Construction SPG. Such an approach is in accordance with the London Mayors SPG which states that "*it is acknowledged that developers may not procure plant until planning permission has been obtained. Developers will therefore be required to provide a written statement of their commitment and ability to meet the emission standards within their Air Quality Assessments.*" Section 4.1 details the benchmarked emissions for the proposed developments that the air quality strategy shall aim to achieve.

11.2 Buildings Emissions

Two Building Emission Benchmarks (BEBs) have been defined; one for NO_x and one for PM_{10}, for a series of land-use classes based on oil and gas combustion. These are shown in Table 17. The benchmark emissions are expressed in terms of g/m^2/annum and are multiplied by the gross floor area (GFA) to calculate the Benchmark emission for each land use class. The development is for an extra care facility and is considered to be a sui generis or Class C2 use.

Table 17: Emissions Benchmarks for Buildings

Land Use Class	**NO_x (g/m^2)**	**PM_{10} (g/m^2)**
Class A1	22.6	1.29
Class A3 - A5	75.2	4.32
Class A2 and Class B1	30.8	1.77
Class B2 - B7	36.6	2.95
Class B8	23.6	1.90
Class C1	70.9	4.07
Class C2 *	68.5	5.97
Class C3 *	26.2	2.28
D1 (a)	43.0	2.47
D1 (b)	75.0	4.30
Class D1 (c -h)	31.0	1.78
Class D2 (a-d)	90.3	5.18
Class D2 (e)	284	16.3

*These benchmarks have been calibrated for London

11.2.1 Emission Standards for Solid Biomass and CHP Plant

Developments are to meet these emission standards along with the ‘air quality neutral’ benchmark values. Where meeting these emission standards still does not allow the air quality neutral benchmarks to be met, further reduction or offsetting measures would be required.

The emission standards are ‘undertaken on the actual installed plant or, where this does not exist at planning application stage end-of-pipe’ concentrations expressed at specific reference conditions for temperature, pressure, oxygen and moisture content. Compliance with these standards should be demonstrated based on monitoring, based on manufacturer guaranteed performance levels supported by type approval monitoring undertaken by the equipment supplier. At the very least, a statement of intent to only include combustion plant within the development that meets these standards must be made at application stage. Providing further details on actual installed combustion plant and emissions performance prior to full operation of the development should be made compulsory by way of planning condition. It is not permissible for emission factors (e.g. g/kWh, g/GJ etc) to be converted into an equivalent concentration for compliance purposes.

To deliver both reductions in carbon dioxide emissions and improve air quality a tiered approach has been developed for applicable emission standards in the Thermal Input range 50kWth – 20 MWth. This approach is based upon differentiation according to the baseline air quality in the area of development and will be dependent upon whether or not the development falls into the two tiers defined below. These bands are shown in Table 18.

Table 18: Band Categories

Band	Applicable Range	
	Baseline Annual Mean NO_2 and PM_{10}	**Baseline 24-Hour Mean PM_{10}**
Band A	> 5% below national objective	> 1-day less than national objective
Band B	Between 5% below or above national objective	1 day below or above national objective

The emission standards below are target minimum standards, due to the baseline concentrations at the site it falls within Band A. If an assessment indicates that significant air quality effects may occur even when meeting the emission standards, additional measures (such as stack height increase, enforcement of more stringent standards etc.) should be considered in order to produce an acceptable level of impact. The emissions standards are shown in Table 19 and Table 20.

Table 19: Emission Standards for 50 kWth -20 MWth for Band A

Combustion Appliance[A]	**Pollutant/ Parameter**	**Emission Standard at Reference O_2 ($mg.Nm^{-3}$)**	**Equivalent Concentration at 0% O_2 ($mg.Nm^{-3}$)**	**Likely Technique Required to Meet Emission Standard**
Spark ignition engine (natural gas/biogas)[B]	NO_x	250	329	Advanced lean burn operation (lean burn engines) NSCR (rich burn engines)
Compression ignition engine (diesel/bio-diesel)[B]	NO_x	400	526	SCR
Gas turbine[C]	NO_x	50	177	None above standard technology for modern turbines
Solid biomass boiler (including those involved in CHP applications)[D]	NO_x	275	386	Modern boiler with staged combustion and automatic control
	PM	25	35	Modern boiler with staged combustion and automatic control including cyclone/ multicyclone
All (stack heat release less than 1 MW)[E]	Stack discharge velocity	10 ms^{-1}	N/A	Appropriate design of stack discharge diameter to achieve required velocity
All (stack heat release greater than or equal to 1 MW)[E]	Stack discharge velocity	15 ms^{-1}	N/A	Appropriate design of stack discharge diameter to achieve required velocity

Notes:

[A] Combustion appliances operating less than 500 hours per annum are exempt from these standards

[B] Emission standard quoted at reference conditions 273 K, 101.3 kPa, 5% O_2, dry gas

[C] Emission standard quoted at reference conditions 273 K, 101.3 kPa, 15% O_2, dry gas

[D] Emission standard quoted at reference conditions 273 K, 101.3 kPa, 6% O_2, dry gas

[E] The stack heat release can be calculated as per equation (3) in the D1 guidance note:

N.B. Stacks should discharge vertically upwards and be unimpeded by any fixture on top of the stack (e.g., rain cowls, ‘China man Hats’)

Table 20: Emission Standards for 50 kWth – 20 MWth for Band B

Combustion Appliance[A]	Pollutant/ Parameter	Emission Standard at Reference O_2 ($mg.Nm^{-3}$)	Equivalent Concentration at 0% O_2 ($mg.Nm^{-3}$)	Likely Technique Required to Meet Emission Standard
Spark ignition engine (natural gas/biogas)[B]	NO_x	95	125	SCR (lean burn engines) NSCR (rich burn engines)
Compression ignition engine (diesel/bio-diesel)[B]	NO_x	400	526	SCR
Gas turbine[C]	NO_x	20	71	Latest generation DLN burners and / or SCR
Solid biomass boiler < 1 MWth input (including those involved in CHP applications)[D]	NO_x	180	252	Modern boiler with staged combustion, automatic control and/ or SNCR
	PM	5	7	Fabric/ceramic filter
Solid biomass boiler ≥ 1 MWth input (including those involved in CHP applications)[D]	NO_x	125	175	Modern boiler with staged combustion, automatic control and/ or SNCR
	PM	5	7	Fabric/ceramic filter
All (stack heat release less than 1 MW)[E]	Stack discharge velocity	10 ms^{-1}	N/A	Appropriate design of stack discharge diameter to achieve required velocity
All (stack heat release greater than or equal to 1 MW)[E]	Stack discharge velocity	15 ms^{-1}	N/A	Appropriate design of stack discharge diameter to achieve required velocity

Notes:
[A] Combustion appliances operating less than 500 hours per annum are exempt from these standards
[B] Emission standard quoted at reference conditions 273 K, 101.3 kPa, 5% O_2, dry gas
[C] Emission standard quoted at reference conditions 273 K, 101.3 kPa, 15% O_2, dry gas
[D] Emission standard quoted at reference conditions 273 K, 101.3 kPa, 6% O_2, dry gas
[E] The stack heat release can be calculated as per equation (3) in the D1 guidance note:
N.B. Stacks should discharge vertically upwards and be unimpeded by any fixture on top of the stack (e.g., rain cowls, 'China-man Hats')

11.2.2 Building Emission Benchmarking

This process is used in order to compare with the predicted building emissions. Separate benchmarks emissions are calculated for NO_x and $PM_{10,}$ defined in terms of g/m^2/annum. The following information is required to define the benchmarks for building emissions;

- fossil fuel energy density (kWh/m^2) for different land-use classes;
- percentage energy use for gas and oil, for domestic, commercial and industrial activities;
- local gas consumption data; and
- NO_x and PM_{10} emission factors for gas and oil, for domestic and commercial/industrial use.

The benchmarked emissions have been calculated for different land use on the basis of gas and oil consumption. Emission factors are grouped for different land use under domestic and industrial/commercial sources.

Table 21 shows the building emission benchmarks for NO_x and PM_{10}. These are calculated using the Emission Benchmarks as detailed in Table 17 multiplied by the GIA.

Table 21: Calculation of Benchmarked NO_x and PM_{10} Emissions using Building Emission Benchmarks

Land Use	**Total Floor Area (m^2)**	**Building Emission Benchmark**		**Benchmarked Emissions**	
		NO_x (g/m^2)	**PM_{10} (g/m^2)**	**NO_x (kgNO_x/annum)**	**PM_{10} (gPM_{10}/annum)**
Sui generis*	8,676	68.5	5.97	594.3	51.8

* proposed development is classed as sui generis however for purposes of the air quality neutral calculations is assumed to be Class C2

11.2.3 Applying the Building Emissions Benchmark (BEB)

In order to calculate the predicted building emissions each land-use category the following information is required;

- Gross Floor Area (m^2) of development
- On-site emissions of NO_x associated with building use (kg/annum) calculated from energy use (kWh/annum) and default or site specific emission factors (kg/kWh)
- On-site emissions of PM_{10} associated with oil or solid fuel use (kg/annum) calculated from energy use (kWh/annum) and default or site specific emission factors (kg/kWh)

PM_{10} emissions are only considered for oil and solid fuel use, if gas is the sole fuel source within the building then PM_{10} emissions are not required to be calculated. For developments with mixed land use associated with a single release point, emissions are assigned to each land use class based on the proportion of the gross internal area. The proposed development is classed as sui generis however for purposes of the air quality neutral calculations is assumed to be Class C2.

11.2.4 Mechanisms for offsetting where emissions exceed the benchmark

In circumstances where the benchmark is exceeded, measures to reduce emissions may be applied on-site or off-site. This can be done using published marginal abatement costs (MAC) or damage costs.

11.3 Dust Mitigation measures

Table 22: Mitigation Measures for Construction Phase Activities

Activity	**Mitigation Measures for Medium Risk Site**	**Desirable or Highly Recommended**
Site Management	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	Highly Recommended
	Develop a Dust Management Plan.	Highly Recommended
	Display the name and contact details of person(s) accountable for air quality pollutant emissions and dust issues on the site boundary.	Highly Recommended
	Display the head or regional office contact information.	Highly Recommended
	Record and respond to all dust and air quality pollutant emissions complaints.	Highly Recommended
	Make a complaints log available to the local authority when asked.	Highly Recommended
	Carry out regular site inspections to monitor compliance with air quality and dust control procedures, record inspection results, and make an inspection log available to the local authority when asked.	Highly Recommended
	Increase the frequency of site inspections by those accountable for dust and air quality pollutant emissions issues when activities with a high potential to produce dust and emissions and dust are being carried out, and during prolonged dry or windy conditions.	Highly Recommended
	Record any exceptional incidents that cause dust and air quality pollutant emissions, either on or off the site, and the action taken to resolve the situation is recorded in the log book.	Highly Recommended
	Hold regular liaison meetings with other high risk construction sites within 500m of the site boundary, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised.	Highly Recommended
Preparing and maintaining the	Plan site layout: machinery and dust causing activities should be located away from receptors.	Highly Recommended

Activity	Mitigation Measures for Medium Risk Site	Desirable or Highly Recommended
site	Erect solid screens or barriers around dust activities or the site boundary that are, at least, as high as any stockpiles on site.	Highly Recommended
	Fully enclosure site or specific operations where there is a high potential for dust production and the site is active for an extensive period.	Highly Recommended
	Install green walls, screens or other green infrastructure to minimise the impact of dust and pollution.	Desirable
	Avoid site runoff of water or mud.	Highly Recommended
	Keep site fencing, barriers and scaffolding clean using wet methods.	Highly Recommended
	Remove materials from site as soon as possible.	Highly Recommended
	Cover, seed or fence stockpiles to prevent wind whipping.	Highly Recommended
	Carry out regular dust soiling checks of buildings within 100m of site boundary and cleaning to be provided if necessary.	Desirable
	Agree monitoring locations with the Local Authority.	Highly Recommended
	Where possible, commence baseline monitoring at least three months before phase begins.	Highly Recommended
	Put in place real-time dust and air quality pollutant monitors across the site and ensure they are checked regularly.	Highly Recommended
Operating vehicle/machinery and sustainable travel	Ensure all on-road vehicles comply with the requirements of the London Low Emission Zone.	Highly Recommended
	Ensure all non-road mobile machinery (NRMM) comply with the standards set within this guidance.	Highly Recommended
	Ensure all vehicles switch off engines when stationary – no idling vehicles.	Highly Recommended

Activity	Mitigation Measures for Medium Risk Site	Desirable or Highly Recommended
	Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where possible.	Highly Recommended
	Impose a signpost a maximum-speed-limit of 10mph on surfaced haul routes and work area (if long haul routes are required these speed may be increased with suitable additional control measure provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate).	Desirable
	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	Highly Recommended
	Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing)	Desirable
Operations	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.	Highly Recommended
	Ensure an adequate water supply on the site for effective dust/particulate matter mitigation (using recycled water where possible).	Highly Recommended
	Use enclosed chutes, conveyors and covered skips.	Highly Recommended
	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.	Highly Recommended
Waste Management	Reuse and recycle waste to reduce dust from waste materials.	Highly Recommended
	Avoid bonfires and burning of waste materials.	Highly Recommended
Demolition	Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	Desirable
	Ensure water suppression is used during demolition operations.	Highly Recommended

Activity	Mitigation Measures for Medium Risk Site	Desirable or Highly Recommended
	Avoid explosive blasting, using appropriate manual or mechanical alternatives.	Highly Recommended
	Bag and remove any biological debris or damp down such material before demolition.	Highly Recommended
Earthworks	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces.	Desirable
	Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil.	Desirable
	Only remove secure covers in small areas during work and not all at once.	Desirable
Construction	Avoid scabbling (roughening of concrete surfaces) if possible	Desirable
	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place	Highly Recommended
	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	Desirable
	For smaller supplies of fine powder materials ensure bags are sealed after use and stored appropriately to prevent dust.	Desirable
Trackout	Regularly use a water-assisted dust sweeper on the access and local roads, as necessary, to remove any material tracked out of the site.	Highly Recommended
	Avoid dry sweeping of large areas.	Highly Recommended

Activity	**Mitigation Measures for Medium Risk Site**	**Desirable or Highly Recommended**
	Ensure vehicles entering and leaving sites are securely covered to prevent escape of materials during transport.	Highly Recommended
	Record all inspections of haul routes and any subsequent action in a site log book.	Highly Recommended
	Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems and regularly cleaned.	Highly Recommended
	Inspect haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	Highly Recommended
	Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	Highly Recommended
	Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.	Highly Recommended
	Access gates to be located at least 10m from receptors where possible.	Highly Recommended
	Apply dust suppressants to locations where a large volume of vehicles enter and exit the construction site	Highly Recommended