50-57 High Holborn – Air Quality Assessment

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1 Introduction

AECOM Ltd was commissioned by *Sheppard Robson* to carry out an air quality assessment in support of a planning application for the proposed 50-57 High Holborn redevelopment, consisting of a restaurant and pub, 28 residential units, 22 student units, offices and retail space. The development site is located between Brunlow Street and Red Lion Street within the London Borough of Camden.

The proposed development is considered to have the potential to impact on air quality during its construction and operational phases. Air quality impacts during the construction phase would be mainly associated with construction dust and emissions to air from construction plant. Operational phase impacts could occur as a result of NO_x emissions from gas fired boilers and a Combined Heat and Power (CHP) plant and the introduction of new exposure to pollution within the residential aspects of the development.

Impacts during the construction phase of the scheme have been assessed qualitatively and mitigation measures subsequently proposed to control these impacts in accordance with best practice guidance. Concentrations of nitrogen dioxide (NO_2) associated with emissions from the proposed CHP and boilers have been predicted using a dispersion model.

The proposed development does not incorporate any car parking and as such no significant change in road traffic is anticipated. Therefore the impact of changes in road traffic emissions on air quality has not been assessed. Instead, existing road traffic sources have been modelled in order to determine total pollutant concentrations likely to affect the proposed and nearby existing sensitive receptors.

Combined Heat and Power Systems

CHP can help reduce carbon dioxide emissions and cut fuel costs, as it is usually a more efficient way of providing heat and power than using boilers and electricity from the national grid. As such it is being encouraged by the Government in order to help the UK meet stretching targets under the Climate Change Act.

Unabated climate change presents a major environmental and health hazard to the whole world, and de-carbonising our energy supply is therefore a priority. At the same time the UK is currently failing to meet legally binding EU air quality standards in many parts of the country, and public health is suffering as a result. Management of CHP emissions should therefore seek to encourage CHP use, whilst limiting any negative effect on air quality.

Installing a CHP system replaces emissions from two locations (boilers and power stations) with a single source. In some situations installing a CHP system may cause overall emissions of air pollutants to fall but local emissions may actually rise.

2 Policy and Guidance

2.1 Overview of Recent Air Quality Policy

The provisions of Part IV of the Environment Act 1995[1] 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[2] and the Air Quality (England) Regulations[3,4] 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'.

2.1.1 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. These pollutants are associated with local air quality problems, with the exception of ozone, which is instead considered to be a regional problem. These objectives aim to reduce the health impacts of the pollutants to negligible levels. The objectives are presented in **Appendix A**. Unlike the EU limit values, the objectives outlined in the UK AQS are not mandatory.

2.1.2 European Air Quality Directives

The Air Quality Framework Directive (96/62/EC) on ambient air quality assessment and management defines the European Union policy framework for 12 air pollutants known to have a harmful effect on human health and the environment. The mandatory limit values for the pollutants were set through a series of Daughter Directives. The limit values for nitrogen dioxide and particulate matter have recently been amalgamated with those for other pollutants into a new air quality directive (Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe). This Directive came into force in June 2008, and has subsequently been transposed into national legislation[5]. The UK has applied for a time extension to meet the PM_{10} limit values in Greater London which has been granted so the attainment date has been extended until 11.06.11.

2.2 National Planning Policy Framework

The National Planning Policy Framework[6] was published on 27 March 2012 and replaced the Planning Policy Statements (PPS) including Planning Policy Statement 23: Planning and Pollution Control.

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."*

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1 UK Government, Environment Act 1995, http://www.legislation.gov.uk/ukpga/1995/25/contents, Accessed April 2011.
2 Defra, The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007) Vol 1, http://archive.defra.gov.uk/environment/quality/air/airquality/strategy/documents/air-qualitystrategy-vol1.pdf, Accessed April 2011
3 Defra (2000). The Air Quality (England) Regulations, 2000 (SI 2000/928).
4 Defra (2002). The Air Quality (England) (Amendment) Regulations, 2002 (SI 2002/3043).
5 Defra (2010). The Air Quality Standards (England) Regulations, 2010 (SI 2010 No. 1001).
6 Department for Communities and Local Government (2012). National Planning Policy Framework

2.3 Regional Planning Policy

2.3.1 The London Plan[7]

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.

Policy 5.5 of the London Plan, 'Decentralised Energy Networks', states that:

"*The Mayor expects 25 per cent of the heat and power used in London to be generated through the use of localised decentralised energy systems by 2025.*"

This is one of the primary reasons why a CHP plant is proposed as part of the proposed development.

However, improvement of air quality is also 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."

2.3.2 Mayor of London's Air Quality Strategy[8]

The Mayor of London released an amended Air Quality Strategy in December 2010. The Air Quality Strategy 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.

[7] Mayor of London (2011). The London Plan, Spatial Development Strategy for Greater London, Greater London Authority.
[8] Mayor of London (2010). Clearing the Air: The Mayor's Air Quality Strategy December 2010.

In addition, Policy 8 of the Mayor's Air Quality Strategy '*Maximising the air quality benefits of low to zero carbon energy supply*' states the following with regard to CHP plant:

"*The Mayor will use his planning powers to:*

Apply emissions limits for both PM and NO_x *for new biomass boilers (including use of biofuels) and NOx emission limits for Combined Heating and Power Plant (CHP) across London. These emission limits will be regularly reviewed as new evidence becomes available and abatement technology improves. This will be applicable at a strategic and local level.*

Require an emissions assessment to be included as part of the standard air quality assessment that is submitted at the planning application stage for new developments that include biomass boilers or CHP.

Require biomass and CHP operators to monitor and provide evidence on a yearly basis in the form of an annual maintenance report to show continued compliance with emission limits."

2.4 Local Planning Policy

The LBC Local Development Framework (LDF) replaced its Unitary Development Plan (UDP) in November 2010 and includes the planning documents that (in conjunction with national planning policy and the Mayor's London Plan) set out the councils strategy for managing growth and development in the borough, including where new homes, jobs and infrastructure will be located. Planning policies associated with air quality, which are relevant to this application, are summarised below:

- Camden Core Strategy 2010-2025 Local Development Framework:

  "Mixed use developments

  The provision of an appropriate mix of uses, both within areas and in individual buildings, can also contribute to successfully managing future growth in Camden and making efficient use of its limited land. A mix of uses can also:

  - *reduce commuting and the need for some other journeys, helping to cut congestion in the borough and improve air quality;*
  - *increase the provision of much-needed housing;*
  - *promote successful places that have a range of activities and are used throughout the day, increasing safety and security.*

  The Council will encourage the provision of a mix of uses in suitable locations and expect development proposals of an appropriate size in Central London and the town centres of Camden Town, Swiss Cottage and Kilburn High Road to contribute towards the supply of housing. This reflects the designation of housing as the priority land use of the Core Strategy (see policy CS6). Camden Development Policies policy DP1 contains further detail on the Council's approach to mixed use development. The Council's Site Allocations document will identify future development sites and provide guidance for their future development, including where mixed use development is appropriate."

- CS16 – Improving Camden's health and well-being: 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 suffers from poor air quality which impacts on human health, particularly the very young, older people and those with existing heart and lung conditions. The avoidance of localised air pollution is therefore very important in avoiding a potential negative impact on health and on the environment. The Council has

declared the whole borough an Air Quality Management Area (AQMA) for failing to meet the government's health based air quality objectives for nitrogen dioxide and particulate matter. An Air Quality Action Plan has been produced setting out measures to reduce air pollution emissions from a variety of sources including new developments. Policy DP32 in our Camden Development Policies Local Development Framework document sets out how we will expect developments to reduce their impact on air quality."

- DP32 – Air quality and Camden's Clear Zone in Camden Development Policies.

  "The Council will take into account impact on air quality when assessing development proposals. Regard will be paid to Camden's Air Quality Action Plan and to Cleaning London's Air: The Mayor's Air Quality Strategy. Where development could potentially cause significant harm to air quality, we require an air quality assessment. Where the assessment shows that a development would cause significant harm to air quality, planning permission will be refused unless mitigation measures are adopted to reduce the impact to acceptable levels. Further guidance on air quality and when assessments will be required is provided in the Council's Camden Planning Guidance supplementary planning document.

  Our growth areas of Euston, Kings Cross, Holborn, Tottenham Court Road and West Hampstead (see Core Strategy policy CS2) are located along busy roads and currently experience poor levels of air quality and disturbance from noise. Developments in these areas will need to be well protected against air and noise pollution to ensure they are suitable for occupation. Where mechanical ventilation is required due to poor environmental conditions we will expect developments to incorporate high standards of energy efficient design, for example 'Passivhaus' principles. Policy DP22 – Promoting sustainable design and construction gives more guidance on energy efficient design and Passivhaus. Our Camden Planning Guidance supplementary document gives more information on mitigating against poor air quality and Passivhaus principles. The Council will require air quality assessments where development could potentially cause significant harm to air quality. Mitigation measures will be expected in developments that are located in areas of poor air quality. The Council will also only grant planning permission for development in the Clear Zone region that significantly increases travel demand where it considers that appropriate measures to minimise the transport impact of development are incorporated. We will use planning conditions and legal agreements to secure Clear Zone measures to avoid, remedy or mitigate the impacts of development schemes in the Central London Area."

2.4.1 Camden Planning Guidance CPG 6 Amenity

Camden Planning Guidance CPG 6 Amenity states the following with regard to air quality:

"*The Council's overarching aim is for new development is to be 'air quality neutral' and not lead to further deterioration of existing poor air quality.*

You will be required to include mitigation and offsetting measures to deal with any negative air quality impacts associated with your development proposals. At the same time your development should be designed to minimise exposure of occupants to existing poor air quality.

To manage and prevent further deterioration of air quality in Camden, we will require an air quality assessment with planning applications for development that could have a significant negative impact in air quality. This impact can arise during both the construction and operational stages of a development as a result of increased NOx and PM10 emissions.

and

"*Gas boilers*

Gas boilers are a large source of NOx emissions in Camden. In order to minimise NOx emissions arising from heating and hot water systems the Council requires boilers fitted in new development to achieve a NOx emissions of <40 mg/m^3 *and an energy efficiency rating >90%.*

Renewable Energy and Combined Heat and Power

Core Strategy policy CS13 promotes the use of renewable energy technologies to reduce carbon emissions and tackle climate change. The adoption of renewable energy and energy efficiency technologies in major developments can minimise air pollution emissions through reductions in gas consumption required for heating and hot water. These 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).

We will require evidence that the exhaust stack height of gas CHP/CCHP has been appropriately calculated to guarantee that NOx emissions are effectively dispersed, and do not risk increasing ground level NO2 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 NOx abatement technology such as:

- *use of low NOx burners; or*
- *increasing stack height."*

2.5 Assessment of Results

Reference will be made to the following planning guidance and strategic documents in order to determine the significance of the results of this assessment:

- the policy and technical guidance notes, LAQM.PG(09)[9] and LAQM.TG(09)[10], issued by the Government to assist local authorities in their Local Air Quality Management responsibilities;
- Environmental Protection UK, 'Development Control: Planning for Air Quality (2010 Update)'[11];
- The London Councils Air Quality and Planning Guidance[12];
- Environmental Protection UK, 'Combined Heat and Power: Air Quality Guidance for Local Authorities'[13],
- Institute of Air Quality Management (IAQM) 'Guidance on the Assessment of the Impacts of Construction on Air Quality and the Determination of their Significance';
- The GLA / London Councils Best Practice Guidance on Construction dust [14]; and
- Minerals Policy Statement 2, Controlling and Mitigating the Environmental Effects of Mineral Extraction in England: Annex 1 Dust[15].

2.5.1 Local Air Quality Impacts

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

[9] Defra, (2009) Local Air Quality Management, Policy Guidance. LAQM.PG(09).
[10] Defra, (2009) Local Air Quality Management, Technical Guidance. LAQM.TG(09).
[11] Environmental Protection UK, Development Control: Planning for Air Quality (2010 Update), April 2010.
[12] The London Air Pollution Planning and the Local Environment (APPLE) working group (2007), Air Quality and Planning Guidance, London Councils.

[13.] Environmental Protection UK, (2012) Combined Heat and Power: Air Quality Guidance for Local Authorities
[14] Greater London Authority and London Councils, The Control of Dust and Emissions from Construction and Demolition: Best Practice Guidance, November 2006.
[15] Office of the Deputy Prime Minister, Minerals Policy Statement 2, Controlling and Mitigating the Environmental Effects of Mineral Extraction in England: Annex 1 Dust, 2005.

Environmental Protection UK (EPUK) there are two main aspects which need to be taken into account when describing predicted impacts. These are:

- the magnitude of the change; and
- the absolute concentration in relation to air quality objectives.

The first of these aspects is addressed in **Table 1**, in which impacts are assigned a magnitude according to the absolute change in pollutant concentrations, derived based upon the predicted change in pollutant concentrations relative to the specific air quality objective or limit value in question.

Table 1: Assessment of the Magnitude of Change

Magnitude of Change	Annual Mean NO_2/PM_{10}
Large	Increase / decrease >4 μg/m^3
Medium	Increase /decrease 2-4 μg/m^3
Small	Increase / decrease 0.4-2 μg/m^3
Imperceptible	Increase / decrease <0.4 μg/m^3

The magnitude of change can then be compared to the absolute concentration in relation to the relevant air quality standard in order to describe predicted air quality impacts as detailed in **Table 2**.

Table 2: Air Quality Impact Descriptors

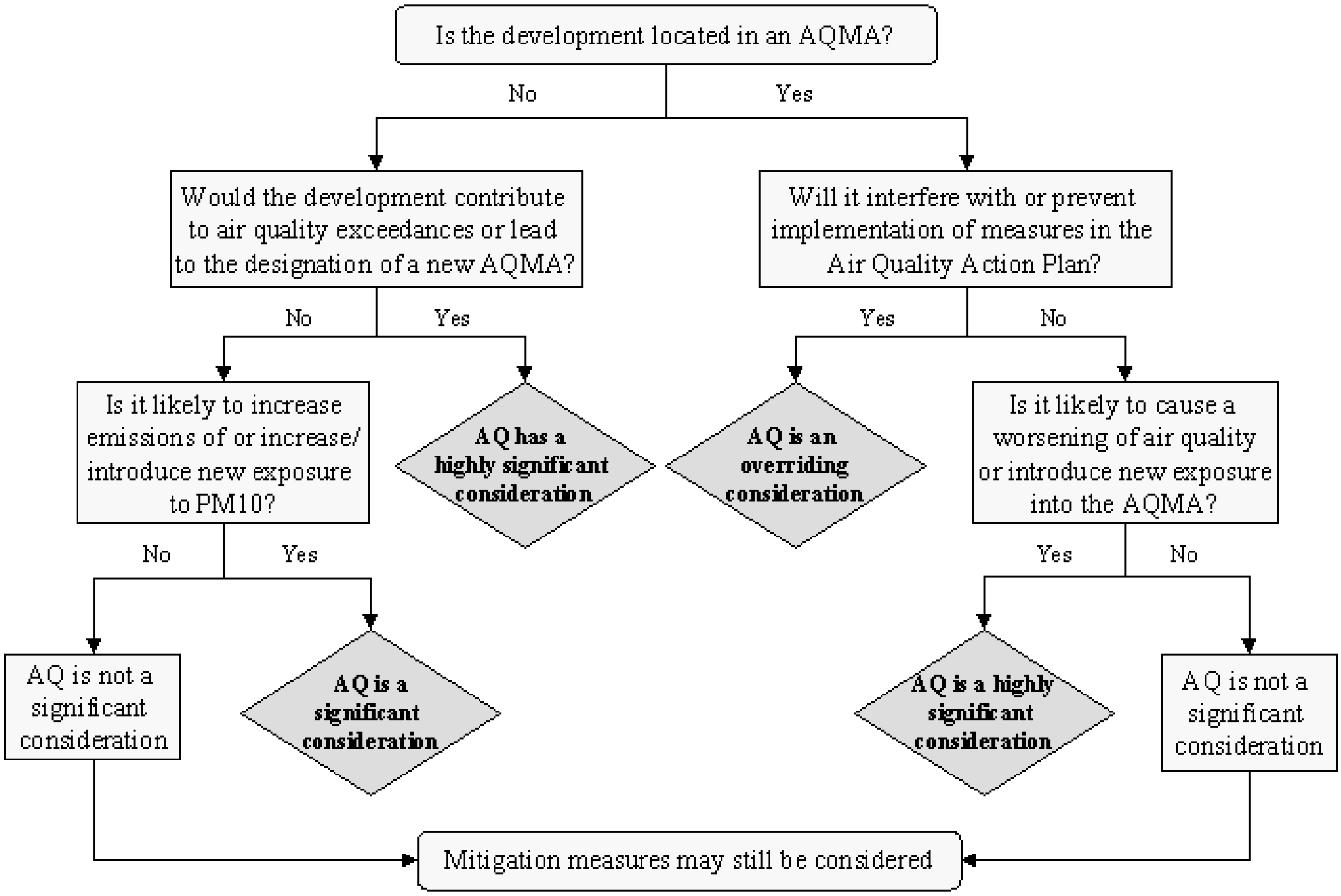
Absolute Concentration in Relation to Standard	Magnitude of Impact		
	Small	Medium	Large
Above Objective/Limit Value With Scheme (>40 μg/m^3)	Slight Adverse / Beneficial	Moderate Adverse / Beneficial	Substantial Adverse / Beneficial
Just Below Objective/Limit Value With Scheme (36-40 μg/m^3)	Slight Adverse / Beneficial	Moderate Adverse / Beneficial	Moderate Adverse / Beneficial
Below Objective/Limit Value With Scheme (30-36 μg/m^3)	Negligible	Slight Adverse / Beneficial	Slight Adverse / Beneficial
Well Below Objective/Limit Value With Scheme (<30 μg/m^3)	Negligible	Negligible	Slight Adverse / Beneficial

EPUK also suggests that the following factors should be taken into account when determining the overall significance of predicted air quality impacts:

- The magnitudes of the changes and the descriptions of the impacts at the receptors;
- The number of people affected by increases and/or decreases in concentrations and a judgement on the overall balance;
- Where new exposure is being introduced into an existing area of poor air quality, then the number of people exposed to levels above the objective or limit value will be relevant;
- Whether or not an exceedence of an objective or limit value is predicted to arise in the study area where none existed before or an exceedence area is substantially increased;
- Whether or not the study area exceeds an objective or limit value and this exceedence is removed or the exceedence area is reduced;

- Uncertainty, including the extent to which worst-case assumptions have been made; and
- The extent to which an objective or limit value is exceeded, e.g. an annual mean NO_2 of 41 µg/m^3 should attract less significance than an annual mean of 51 µg/m^3.

The London Councils Air Quality and Planning Guidance suggests that the following diagram should assist in determining whether an application is significant in terms of air quality.



As the proposed development is located in an AQMA and has the potential to cause a worsening of air quality (AQ), air quality could be "*a highly significant consideration*" in the decision making process. It should be noted that this conclusion would be reached for the majority of proposed developments in London, as all London Boroughs have declared AQMAs, albeit that some do not cover the entire borough.

3 Baseline Conditions

3.1 Pollutants of Concern

3.1.1 Nitrogen Dioxide (NO_2)

The Government and Devolved Administrations adopted two Air Quality Objectives for nitrogen dioxide (NO_2) to be achieved by the end of 2005. These are:

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

In practice, meeting the annual mean objective was anticipated to be considerably more challenging than attaining the one-hour objective. The EU First Daughter Directive also sets limit values for NO_2 to be achieved by 1st January 2010, which have been incorporated into UK legislation. The Directive includes a one-hour limit value of 200 µg/m^3, not to be exceeded more than eighteen times per year and an annual mean limit value of 40 µg/m^3.

NO_2 and nitric oxide (NO) are collectively known as oxides of nitrogen, or NO_X. All combustion processes produce NO_X emissions, predominantly in the form of NO, which then undergoes conversion in the atmosphere to NO_2, mainly as a result of its reaction with ozone (O_3). It is NO_2 that has been most strongly associated with adverse effects upon human health.

Nitrogen dioxide 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 2008[16] showed that road transport accounted for the largest proportion (32%) of total UK NO_X emissions. Energy industries remained the second largest contributor. Road transport emissions have declined significantly since peaking in 1990 as a consequence of various policy measures, with total emissions reducing by 58% between 1990 and 2008. Further reductions are expected in future years.

Emissions from industrial sources have also 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/m^3 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 1-hour objective show considerable year-to-year variation, driven by meteorological conditions, which give rise to winter episodes of poor dispersion and summer oxidant episodes.

Projections for 2010 indicate that the mandatory EU limit value may be exceeded at urban background sites in London, and at roadside locations in other cities.

3.1.2 Particulate Matter (PM_{10})

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

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

The EU First Daughter Directive also sets limit values for PM_{10} to be achieved by 1st January 2005, which have been incorporated into UK legislation. The Directive includes a 24hr limit value of 50 µg/m^3, not to be exceeded more than thirty five times per year and an annual mean limit value of 40 µg/m^3.

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[16] http://www.naei.org.uk/emissions/emissions.php

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 particulate matter (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 $\mu g/m^3$ increase in PM_{10} and 0.6% per 10 $\mu g/m^3$ increase in PM_{10} were determined for the US and European city studies, respectively[17,18]. Long-term exposure to PM has been implicated in observed increases in all-cause, cardiopulmonary and lung cancer mortality[19,20].

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[21].

In the UK, coal burning, diesel combustion, construction, mining and quarrying are the major sources of particulate emissions. Total UK PM_{10} emissions have fallen by almost 60% between 1980 and 2008 to around 133 kilotonnes. Revised figures indicate that after industrial sources road transport (18.1%) and domestic / commercial / public sector emissions (16.8%) were the principal sources of PM_{10} in 2008[22].

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 45% (1993 to 2008). The domestic / commercial / public and energy industries sectors have seen decreases of 56% and 83%, respectively 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 7.5% of total PM_{10} emissions in 2008, compared with 26% in 1990.

3.1.3 Construction Dust

Dust is defined as all particulate matter up to 75 µm in diameter and comprising both suspended and deposited dust, whereas PM_{10} is a mass fraction of airborne particles of diameter of 10 microns or less. The health impacts associated with dust include eye, nose and throat irritation in addition to the nuisance caused by deposition on cars, windows and property. Dust and PM_{10} emissions arise from a number of sources, so both construction activities and emissions from vehicles associated with the construction site need to be considered.

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

18 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.

19 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.

20 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.

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

22 http://www.naei.org.uk/emissions/emissions.php

Literature suggests that the most sensitive vegetation species appear to be affected by dust deposition at levels above 1000 mg/m^2/day which is five times greater than the level at which most dust deposition may start to cause a perceptible nuisance to humans. Most species appear to be unaffected until dust deposition rates are at levels considerably higher than this. Without mitigation, some construction activities can generate considerable levels of fugitive dust, although this is highly dependent on the nature of the ground and geology, time of year construction occurs in, length of time specific construction activity (e.g. boring) occurs for and prevailing meteorology during this activity.

3.2 Summary of Local Air Quality Management in the London Borough of Camden

The London Borough of Camden's' first round of local air quality Review and Assessment indicated exceedences of the annual air quality strategy (AQS) objectives for NO_2 and PM_{10} and daily AQS objective for PM_{10}. The air quality objectives for all other pollutants however were likely to be achieved. The whole of the London Borough of Camden was subsequently declared an AQMA with the subsequent second and third rounds of the Review and Assessment process, referred to as Updating and Screening Assessments, confirming this. The fourth round Updating and Screening Assessment, completed in 2009 reported that PM_{10} no longer exceeded the short or long term objective at the three automatic monitoring sites within the Borough. NO_2 concentrations were shown to still exceed the long-term AQS objective at all monitoring locations, with some diffusion tube locations and one automatic monitor showing exceedences of the short-term objective. Despite the reduction in monitored PM_{10} concentrations the council do not intend to amend the existing Air Quality Management Order to reflect this as modelling has demonstrated likely exceedences of the objective on those roads within the borough which experience high volumes of traffic and a large proportion of Heavy Duty Vehicles (HDV). The London Borough of Camden revised its Air Quality Action Plan in 2009 to address the findings of the most recent round of the Updating and Screening Assessment.

The proposed development site and surrounding area are therefore located within the AQMA. Further information on local air quality management and Review and Assessment undertaken by the London Borough of Camden can be found on the Council's website[23].

3.3 Air Quality Monitoring in the London Borough of Camden

There are a number of automatic air quality monitoring stations in the London Borough of Camden, measuring NO_2 and/or PM_{10}, which are part of the London Air Quality Network (LAQN). The locations of these sites are shown in relation to the proposed development (shown in red) in **Figure 1** of **Appendix B**. The London Bloomsbury urban background automatic monitoring site is approximately 0.83 km to the North West of the application site.

NO_2 monitoring results from these sites in recent years are summarised in **Table 3**.

[23] http://www.camden.gov.uk/ccm/content/environment/air-quality-and-pollution/air-quality/twocolumn/policies-reports-and-research.en?page=2

Table 3: NO_2 Continuous Monitoring Results

Site	OS Grid Reference	Type	Annual Mean NO_2 Concentration (µg/m^3) with No. of Exceedences of Hourly Mean NO_2 Objective in Parenthesis				
			2007	2008	2009	2010	2011
London Bloomsbury	530120, 182034	Urban background	**61** (6)	**55** (0)	**54** (2)	**55** (1)	**50** (0)
Shaftesbury Avenue	530060, 181290	Roadside	**75** (**24**)	**78** (9)	**87** (11)	**89** (**21**)	**76** (*)
Swiss Cottage	526633, 184392	Kerbside	**77** (**113**)	**75** (**70**)	**84** (**151**)	**82** (**128**)	**71** (**79**)

NOTE: Exceedences of national air quality objectives are shown in bold.
* Data not available

Table 3 indicates that the annual average NO_2 objective was exceeded at all continuous monitoring sites in Camden in all years. The hourly NO_2 objective was also exceeded at the Shaftesbury Avenue and Swiss Cottage roadside/kerbside sites.

PM_{10} is also monitored at three same three sites within the London Borough of Camden, as shown in **Table 4**. The results shown have been corrected using the Volatile Correction Method (VCM) unless otherwise stated.

Table 4: PM_{10} Continuous Monitoring Results

Site	OS Grid Reference	Type	Annual Mean PM_{10} Concentration (µg/m^3) with No. of Days PM_{10} > 50 µg/m^3 in Parenthesis				
			2007	2008	2009	2010	2011
London Bloomsbury	530120, 182034	Urban background	30 (22)	26 (10)	25 (9)	26 (2)	22 (17)
Shaftesbury Avenue	530060, 181290	Roadside	33 (32)	29 (20)	32 (19)	29 (5)	31 (24)
Swiss Cottage	526633, 184392	Kerbside	26 (**37**)	23 (12)	19 (8)	18 (11)	*

NOTE: Exceedences of national air quality objectives are shown in bold.
* Data not available

Table 4 indicates that annual mean PM_{10} concentrations have been within the annual mean objective at all three automatic monitoring locations since 2007, however, exceedences of the daily mean objective were observed at Swiss Cottage in 2007.

In addition to continuous monitoring, the Council also undertakes NO_2 diffusion tube monitoring at 24 sites across the borough, with the Russell Square Gardens urban background site being the nearest to the proposed development, approximately 0.83 km to the North West, co-located with the London Bloomsbury automatic monitor. Results from the council's diffusion tubes are shown in **Table 5**.

Table 5: NO_2 Diffusion Tube Monitoring Results

Site	Type	OS Grid Reference (X, Y)	Annual Mean NO_2 Concentration ($\mu g/m^3$)			
			2007	2008	2009	2010
Argyle School	Roadside	530210, 182762	**50.2**	**51.9**	**49.9**	**50**
Robert St	Roadside	529133, 182695	**48.2**	**48.2**	**49.4**	**45**
Mansfield Rd	Roadside	528215, 185637	**40.4**	**42.9**	**45.6**	**42**
Euston Rd	Roadside	530110, 182795	**91.2**	**93.3**	**87.1**	**82**
Drummond St/Cobourg St	Roadside	529395, 182567	**48.1**	**46.2**	**50.9**	**48**
Wakefied Gds	Urban background	530430, 182430	**49.6**	37.8	39.4	34
Frognal Way	Urban background	526213, 185519	28.7	30.5	33.9	29
Croftdown Rd	Urban background	528588, 186249	31.4	36.4	35.5	35
63 Gower St	Roadside	529671, 181970	**94.9**	**73**	**82.6**	**74**
Tavistock Gardens	Urban background	529880, 182334	**46.3**	**46.8**	**50.1**	**52**
Tottenham Court Road	Kerbside	529568, 181728	**101.1**	**84.2**	**107.7**	**92**
British Library	Urban background	529977, 182809	**54.5**	**48.7**	**54.1**	**47**
Russell Square Gardens	Urban background	530120, 182034	**44.3**	**43.6**	**44.5**	**44**
Finchley Rd	Kerbside	526633, 184392	**81.5**	**68.1**	**87.5**	**71**
Kentish Town Road	Roadside	529013, 185102	**66.6**	**61.8**	**68.3**	**74**
47 Fitzjohn's Ave	Roadside	526547, 185125	**63.6**	**55.6**	**62.9**	**73**
Corner Gloucester Ave/Parkway	Kerbside	528672, 183642	**53.6**	**56.7**	**61.7**	**63**
Inverness St	Roadside	528815, 183909	**52.6**	**41.5**	**45.7**	**55**
Brill Place	Roadside	529914, 183147	**51.5**	**49**	**51.9**	**54**
Bloomsbury St	Roadside	529962, 181620	-	**76.5**	**81.3**	**41**
Goodge St	Roadside	529488, 181719	-	**56.8**	**60.6**	**50**
Camden Road	Roadside	529173, 184129	-	**66.5**	**73**	**84**
Chetwynd Road	Roadside		-	**-**	**50**	**68**

NOTE: Exceedences of national air quality objectives are shown in bold.

3.3.1 Summary

The proposed development is located in an area of poor air quality, with the entire borough having been declared an AQMA for NO_2 and PM_{10}. Concentrations of NO_2 in excess of the annual mean air quality objective have been consistently monitored at both roadside and urban background locations. The hourly NO_2 objective has also been exceeded at the majority of roadside locations.

Monitored PM_{10} concentrations indicate that the annual mean PM_{10} objective is unlikely to be exceeded within the London Borough of Camden; however exceedences of the daily mean air quality objective are possible at roadside locations.

4 Methodology

4.1 Scope of the Assessment

The proposed 50-57 High Holborn development is expected to be fully open in 2013. Concentrations of NO_2 and PM_{10} were therefore predicted at existing and proposed sensitive receptors for the following scenarios:

- The 2013 Do-Minimum Scenario (2013 DM), which considers pollutant concentrations without the proposed development in 2013; and
- The 2013 Do-Something Scenario (2013 DS), which considers pollutant concentrations with the proposed development in 2013.

4.2 Modelling Methodology

There are four main categories of air pollutant sources: road traffic sources; industrial sources (Part A and B processes); diffuse sources (e.g. domestic heating); and mobile sources (e.g. airports, rail and shipping). For this assessment road traffic were modelled as line sources using AAQuIRE and the gas boilers and CHP plant associated with the proposed development as point sources using AERMOD View. Contributions to pollutant concentrations from other sources were included as background concentrations.

4.2.1 Gas Boiler and CHP Emissions

Lakes AERMOD View (Version 7.1) was used to model emissions of NO_x from the proposed gas boilers and CHP plant. PM_{10} emissions from these sources were not modelled as they will be insignificant.

The main inputs to the AERMOD model for the gas boilers and CHP plant are shown in **Table 6** below, with the location of the stacks illustrated graphically in **Figure 2** and **Figure 3** of **Appendix B**.

Table 6: AERMOD Model Input Data

Parameter	Unit	Boiler	CHP Plant*
Plant Size	kW_{th}	1,375.5	140
Exhaust Location	OS Ref.	530864.7, 181657.7	530865.5, 181657.9
Stack Height	m	37.5 (above ground level)	
		3 (above roof level, not elevator overrun)	
Stack Diameter	m	0.32	0.15
Efflux Velocity	m/s	10	10
Exhaust Gas Temperature	K	373	393
Actual Volumetric Flow	Am^3/s	0.825**	0.172
Normalised Volumetric Flow	Nm^3/s	0.394	0.114
NO_x Emission Concentration	mg/kWh	40	-
	mg/Nm^3	-	250***
NO_x Emission Rate	g/s	0.0153	0.0284

* Emissions data based on the Hoval KWK EG-140 CHP unit

** Calculated using the EPUK Unit Con and Screening Tool based on the thermal output of the boilers and assumed oxygen and moisture contents of 10% and 5% respectively

*** Normalised based on 273K, 5% O_2 and 0% H_2O

It has been assumed that the CHP and boilers will all operate continuously at maximum load throughout the year to allow the maximum effect to be assessed. This is a worst-case assumption, particularly during the summer months.

In reality, the boilers are anticipated to only operate at times of peak demand, generally the winter, or in the event of the CHP not being operational due to maintenance or failure.

4.2.1.1 Buildings

The presence of buildings close to the emission stacks could affect the dispersion of pollutants by causing the plume to come down to the ground much sooner than usual, giving rise to higher ground level concentrations closer to the stack. All buildings which form part of the proposed development together with existing buildings within 5 times the height of the tallest surrounding buildings (approximately 250 m) were therefore included within the AERMOD model as shown in **Figure 2** of **Appendix B**.

4.2.2 Road Traffic Emissions

Concentrations of NO_x and PM_{10} associated with emissions from road traffic were predicted using the AAQuIRE regional dispersion model, which was developed by AECOM (formerly Faber Maunsell) and has been used widely for the past 15 years.

AAQuIRE uses the CALINE4 model for the dispersion of road-traffic emissions, which has been fully validated and is used extensively worldwide. CALINE4 is a relatively complex model designed for detailed assessment of local areas, which is used within AAQuIRE for both local and larger scale studies. Further details are provided in **Appendix C**.

In recent years it has been noted that NO_2 concentrations have typically not been falling, particularly at roadside monitoring sites, despite emissions of NO_x falling. At the end of September 2010, Defra released a brief FAQ note on the issue[24] acknowledging that NO_2 concentrations have not fallen as projected over the past 6-8 years. At the present time it is thought likely that vehicle emissions factors for diesel vehicles underestimate NO_x and NO_2 emissions under ‘real-world’ conditions. In particular, it has been proposed that diesel vehicle compliant with the Euro 2, 3, 4 and 5 emission standards emit similar quantities of NO_x as Euro 1 compliant vehicles. Therefore, for the purposes of this modelling study, the vehicle emissions database that is interrogated by AAQuIRE has been altered so that NO_x emission rates for diesel Euro 2-5 vehicles are the same as NO_x emission rates for diesel Euro 1 vehicles. At the time of writing this was considered to be the most accurate and representative method of predicting current and future NO_x and NO_2 concentrations. A recent document commissioned by Defra[25] on “*Trends in NO_x and NO_2 emissions and measurements in the UK*” provides support and evidence for the alterations that were made to the vehicle emissions database.

4.3 Receptors

The modelling procedure adopted calculated NO_2 and PM_{10} concentrations at discrete receptor locations representing positions on the facades of the proposed and existing sensitive receptors. Details of the receptor locations are shown in **Figure 3** of **Appendix B** and detailed in **Table 7.** Pollutant concentrations were predicted at a height of 1.5 metres to represent ground level exposure and at the maximum height of the relevant building in order to consider both maximum pollutant concentrations and the likely greatest impacts of the gas boilers and CHP plant on surrounding sensitive receptors.

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24 Local Air Quality Management Helpdesk (2010); ‘*Measured nitrogen oxides (NO_x) and/or nitrogen dioxide (NO_2) concentrations in my local authority area do not appear to be declining in line with national forecasts. Should I take this into account in my Review and Assessment work?*’, Defra.

25 Carslaw et al (2011), ‘Trends in NO_x and NO_2 emissions and ambient measurements in the UK’, Defra.

Table 7: Receptor Locations

Ref.	Receptor	Type	Grid Reference		Height (m)	
			X	Y	Ground Level	Maximum
1	42 High Holborn	Existing Commercial	530944	181601	1.5	27.0
2	46 High Holborn	Existing Commercial	530902	181594	1.5	27.0
3	50 High Holborn	Existing Commercial	530870	181589	1.5	27.0
4	54 High Holborn	Existing Commercial	530845	181585	1.5	27.0
5	MidCity Place	Existing Commercial	530826	181647	1.5	41.7
6	Brownlow Street	Existing Commercial	530890	181663	1.5	23.3
7	52 Bedford Row	Existing Commercial	530878	181689	1.5	21.4
8	29 Bedford Row	Existing Commercial	530872	181712	1.5	21.7
9	38 Sandland Street	Existing Commercial	530819	181701	1.5	21.7
10	57 High Holborn	Existing Commercial	530818	181580	1.5	27.0
11	43 High Holborn	Existing Commercial	530926	181620	1.5	32.1
12	71 High Holborn	Existing Commercial	530833	181602	1.5	13.0
13	47 Bedford Road	Proposed Commercial	530850	181681	1.5	34.5
14	45 Bedford Road	Proposed Residential	530830	181684	1.5	12.1
15	45 Bedford Road	Proposed Residential	530839	181677	1.5	20.2
16	Montagu House	Proposed Residential	530846	181666	1.5	20.2
17	Brownlow House	Proposed Residential	530894	181614	1.5	20.2
18	Caroline House	Proposed Commercial	530865	181609	1.5	19.2
19	Main Office	Proposed Commercial	530854	181661	1.5	23.3
20	Highest Point of Building	Proposed Commercial	530867	181649	1.5	36.4

Of the existing buildings on the application site only Montague House (Receptor 16) is currently residential (Floors 3 to 5 only) with all other properties on the application site being used as office space. In comparison, the proposed development maintains the residential use in Montague House, as student accommodation, and introduces residential use in 45 – 51 Bedford Row and in Brownlow House.

4.4 Background 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. The emissions from these background sources were applied to the model as background concentrations.

Background NO_2 concentrations were obtained from the monitored concentrations recorded at the London Bloomsbury automatic monitoring station, which is the closest monitoring location to the development site. Future background NO_2 concentrations were estimated using the revised adjustment factors provided in the Defra Local Air Quality Management Note on Projecting NO_2 Concentrations, 2012.

Urban background PM_{10} concentrations monitored at the London Bloomsbury automatic monitoring site were also used to represent background PM_{10} concentrations in the study area. Background PM_{10} concentrations in future years were estimated by reducing this monitored concentration at the same rate as mapped background PM_{10} concentrations.

The background concentration data used in this assessment are summarised in **Table 8**.

Table 8: Background Pollutant Concentrations (µg/m^3)

Pollutant	Source	2011	2013
NO_2	Monitored (London Bloomsbury)	50	47.8
PM_{10}	Monitored (London Bloomsbury)	26	25

4.5 Meteorological Data

A meteorological dataset was compiled using data from London City Airport, which is considered to be representative of the study area. The dispersion modelling was performed using data from 2011.

The windrose for this location are shown in **Appendix E** along with further details about the methodology used to compile the meteorological data ready for the model.

4.6 Traffic Data

The proposed development does not incorporate any car parking provision with the site well served by public transport. As such, no change in vehicle movements are associated with the operational phase of the scheme. The assessment of road traffic emissions has therefore been limited to assessing the contribution of NO_2 and PM_{10} from local roads to pollutant concentrations likely to affect the proposed residential properties that form part of the proposed redevelopment.

Traffic data for the major roads within the study area were obtained from the London Atmospheric Emissions Inventory (LAEI)[26]. Annual Average Daily Traffic (AADT), heavy-duty vehicle (HDV) percentage and vehicle speeds were all obtained from the LAEI for 2011 and are presented in **Table 9**.

Table 9: Traffic Data used in the AAQuIRE Roads Modelling

Road Link	AADT	HDV	Speed (kmph)
High Holborn A40	18952	9.2%	18
Chancery Lane B400	2472	2.3%	17

4.7 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, the proportion of NO_x as NO_2 was calculated differently for the modelled NO_x contribution from the proposed gas boilers and CHP plant than for the modelled contribution from road traffic.

[26] London Atmospheric Emissions Inventory 2008.

4.7.1 Gas Boilers and CHP Contribution

4.7.1.1 Annual Mean NO_2

Annual mean NO_x concentrations from the proposed gas boilers and CHP plant, predicted using AERMOD, were converted to annual mean NO_2 concentrations based upon the following equation, which assumes 70% of the NO_x would be converted to NO_2:

Annual Mean NO_2 Contribution = (Modelled Annual Mean NO_x Contribution x 0.7)

This methodology has been suggested by the Environment Agency for calculating ground level annual mean NO_2 concentrations in England and Wales. Using this calculation is likely to overestimate NO_2 concentrations in close proximity to the release point because instantaneous mixing of the plume with ambient air is unlikely.

4.7.1.2 Hourly Mean NO_2

Hourly mean NO_x concentrations from the proposed gas boilers and CHP plant, predicted using AERMOD, were converted to hourly mean NO_2 concentrations based upon the following equation, which assumes 35% of the NO_x would be converted to NO_2:

99.8% Hourly Mean NO_2 Contribution = (Modelled 99.8% Hourly Mean NO_x Contribution x 0.35)

This methodology has been suggested by the Environment Agency for calculating ground level 99.8% hourly mean NO_2 contributions from point sources in England and Wales. To calculate the total hourly contribution the predicted NO_2 contribution is then added to twice the annual mean NO_2 concentrations at each receptor (including both road and background NO_2 contributions).

4.7.2 Road Traffic Contribution

AQEG[27] reported that urban NO_x concentrations had declined since the early 1990s as a result of decreasing road traffic emissions. Decreases in NO_2 were not as distinct, resulting in an increase in the NO_2/NO_x ratio. The magnitude of the increase was inconsistent with the increase expected solely as a consequence of reduced NO_x concentrations. The findings were supported by monitoring data from a number of locations in London and AURN data from across the UK.

The observations prompted research into the NO_2/NO_x relationship and an updated version of the relationship was published[28]. More recently a spreadsheet[29] has been produced, which provides a revised methodology for converting NO_x to NO_2 for any given year. This methodology has been used for the purpose of this assessment for all scenarios as the best representation of the NO_2/NO_x relationship for the London Borough or Camden. The 'All London traffic' mix was used.

4.8 Construction Dust Assessment Methodology

Fugitive dust emissions can pose a number of problems including detrimental effects on health, nuisance problems and effects on vegetation. The potential for a demolition or construction site to impact at sensitive receptors is dependent on many factors including the following:

- Location of the building site;
- Proximity of sensitive receptors;
- Whether demolition will take place;
- Extent of any intended excavation;
- Nature, location and size of stockpiles and length of time they are on-site;

[27] Air Quality Expert Group; Nitrogen Dioxide in the United Kingdom; 2004
[28] Deriving NO_2 from NO_x for Air Quality Assessments of Roads –Updated to 2006, Air Quality Consultants.
[29] NO_X from NO_2 Calculator, 2010. Available from http://laqm.defra.gov.uk/tools-monitoring-data/no-calculator.html

- Occurrence and scale of dust generating activities;
- Necessity for onsite concrete crusher or cement batcher;
- Number and type of vehicles and plant required on-site;
- Potential for dirt or mud to be made airborne through vehicle movements; and
- Weather conditions.

Examples of dust-sensitive receptors considered in this part of the assessment are listed in **Table 10** below (taken from Minerals Policy Statement 2)[30]. The development site is surrounded by a number of medium sensitivity receptors, namely office buildings which are around 10 metres from the site boundary.

Table 10: Dust Sensitive Receptors

High Sensitivity	Medium Sensitivity	Low Sensitivity
Hospitals and clinics Retirement homes Hi-tech industries Painting and furnishing Food processing	Schools Residential areas Food retailers Greenhouses and nurseries Horticultural land Offices	Farms Light and heavy industry Outdoor storage

The London Councils Best Practice Guidance outlines criteria to determine the level and detail of mitigation deemed appropriate for a proposed construction. The assessment criteria take into account the following:

- the area taken up by the development;
- the number of properties being developed; and
- the potential impact of the development on dust sensitive receptors close to the development.

Recent guidance published by IAQM[31] classifies the risk posed by demolition and construction activities on a development site on the basis of the scale and nature of the activities. The proximity of the activities to dust sensitive receptors is then used to assign a significance descriptor to potential construction dust effects at those receptors. Full details of the IAQM methodology for assessment of construction dust are contained in **Appendix D**.

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[30] Office of the Deputy Prime Minister, Minerals Policy Statement 2, Controlling and Mitigating the Environmental Effects of Mineral Extraction in England: Annex 1 Dust.

[31] Institute of Air Quality Management's (IAQM) 'Guidance on the Assessment of the Impacts of Construction on Air Quality and the Determination of their Significance'

5 Assessment Results

5.1 Local Air Quality Assessment Results

Concentrations of NO_2 and PM_{10} were predicted at a number of discrete receptors representing positions on the facades of the existing and proposed buildings in the study area at a height of 1.5 metres and at the maximum height of the relevant building. These predictions were made in order to assess pollutant concentrations likely to affect sensitive receptors at ground level, where absolute concentrations are likely to be highest, and at height, where the impacts of the proposed gas boilers and CHP plant are likely to be greatest.

A review of properties within the study area has shown that the ground-floor levels of the neighbouring buildings are all of a commercial nature, as opposed to residential. As such, only the 1-hour objective for NO_2 is applicable at ground level, as for national air quality objectives to apply people need to be present over durations relevant to the objective. The use of the upper floors of surrounding buildings is however uncertain. While the majority appear to be commercial in nature, the absence of residential properties on these upper floors cannot be confirmed. As such, the effects of the proposed CHP and boilers have been assessed against both long-term and short-term air quality objectives at the elevated receptor locations.

Predicted concentrations of NO_2 and PM_{10} at the receptors considered in this assessment are shown in **Table 11** to **Table 14**. The modelling has assumed that both the CHP and gas boilers will operate continuously throughout the year. As stated previously, this is considered to be a conservative assumption as the boilers will only operate during certain periods, generally in the winter, or in the event that the CHP is not in operation.

The 99.8th percentile hourly mean NO_2 concentrations, predicted using Equation B2 in Section 4.7.1.2 of LAQM.TG(09) at the receptors considered in this assessment are shown in **Table 11**.

Table 11: Predicted Short-term NO_2 Concentrations at Modelled Receptors

Receptor			99.8th Percentile Hourly Mean NO_2 Concentration (µg/m^3)			
			2013 DM		2013 DS	
Ref	Description	Type	1.5 m AGL	Max Building Height AGL	1.5 m AGL	Max Building Height AGL
1	42 High Holborn	Existing Commercial	117.8	96.0	118.7	97.1
2	46 High Holborn	Existing Commercial	116.7	96.0	118.8	97.1
3	50 High Holborn	Existing Commercial	118.4	95.9	120.5	97.0
4	54 High Holborn	Existing Commercial	119.7	96.0	121.5	97.1
5	MidCity Place	Existing Commercial	102.8	95.7	104.4	96.4
6	Brownlow Street	Existing Commercial	102.3	96.3	102.9	96.6
7	52 Bedford Row	Existing Commercial	100.0	96.5	101.3	97.3
8	29 Bedford Row	Existing Commercial	98.9	96.4	100.7	97.5
9	38 Sandland Street	Existing Commercial	98.4	96.3	100.1	97.3
10	57 High Holborn	Existing Commercial	119.6	96.0	121.2	96.8
11	43 High Holborn	Existing Commercial	125.1	95.8	126.2	97.5
12	71 High Holborn	Existing Commercial	127.8	98.5	129.9	100.0

NOTE: AGL = Above Ground Level. Values in bold indicate exceedences of the relevant national air quality objective.

The results in **Table 11** suggest that the hourly mean NO_2 objectives will be met at all of the receptors considered in this assessment, even with the proposed development.

The predicted impact of NO_2 emissions from the gas boilers and the CHP plant associated with the proposed development on annual and hourly mean NO_2 concentrations are summarised in **Table 12** and **Table 13**.

Table 12: Predicted Impact on 99.8th%ile Hourly Mean NO_2 Concentrations at Modelled Receptors

Receptor			Predicted Impact on 99.8th%ile Hourly Mean NO_2 Concentrations					
			Change in µg/m^3		Change as a % of AQO		Magnitude (worst-case)*	Description (worst-case)*
Ref.	Description	Type	1.5 m AGL	Max Height AGL	1.5 m AGL	Max Height AGL		
1	42 High Holborn	Existing	0.9	1.1	0.5%	0.5%	Imperceptible	Negligible
2	46 High Holborn	Existing	2.1	1.1	1.1%	0.6%	Small	Negligible
3	50 High Holborn	Existing	2.1	1.1	1.0%	0.6%	Small	Negligible
4	54 High Holborn	Existing	1.8	1.1	0.9%	0.6%	Imperceptible	Negligible
5	MidCity Place	Existing	1.6	0.8	0.8%	0.4%	Imperceptible	Negligible
6	Brownlow Street	Existing	0.6	0.3	0.3%	0.2%	Imperceptible	Negligible
7	52 Bedford Row	Existing	1.4	0.8	0.7%	0.4%	Imperceptible	Negligible
8	29 Bedford Row	Existing	1.8	1.0	0.9%	0.5%	Imperceptible	Negligible
9	38 Sandland Street	Existing	1.7	1.0	0.8%	0.5%	Imperceptible	Negligible
10	57 High Holborn	Existing	1.6	0.8	0.8%	0.4%	Imperceptible	Negligible
11	43 High Holborn	Existing	1.1	1.8	0.5%	0.9%	Imperceptible	Negligible
12	71 High Holborn	Existing	2.1	1.5	1.0%	0.8%	Small	Negligible

* The EPUK significance criteria are based absolute change relative to the annual mean concentration, and as such are not applicable to short-term effects. However, to allow the significance of the proposed development to be assessed it has been assumed that the % change relative to the short-term AQS objective would represent the same magnitude of change to that set out in the EPUK guidance, e.g. a <2 µg/m^3 change (representing <1% of the AQS objective of 200 µg/m^3) is considered imperceptible, and 2 µg/m^3 to 10 µg/m^3 change (1% to 5% of the AQS objective of 200 µg/m^3) is small.

Table 12 shows that the maximum change in Hourly NO_2 concentration occurs at Receptor 2, where the change in comparison to the AQS objective is 1.1%. It should be noted that this assessment has been based on the conservative assumption that both the CHP and boilers will operate continuously throughout the year. In reality the boilers will only operate during periods of peak demand, generally the winter months.

Table 13: Predicted Impact on Annual Mean NO_2 Concentrations at Existing Receptors

Receptor			Predicted Impact on Annual Mean NO_2 Concentrations at Existing Elevated Receptors					
			µg/m³			Change As % of AQO	Magnitude (worst-case)	Description (worst-case)
Ref.	Description	Type	DM	DS	Change			
1	42 High Holborn	Existing	48.0	48.1	0.1	0.3%	Imperceptible	Negligible
2	46 High Holborn	Existing	48.0	48.1	0.2	0.4%	Imperceptible	Negligible
3	50 High Holborn	Existing	48.0	48.1	0.2	0.4%	Imperceptible	Negligible
4	54 High Holborn	Existing	48.0	48.2	0.2	0.5%	Imperceptible	Negligible
5	MidCity Place	Existing	47.8	48.2	0.4	0.9%	Imperceptible	Negligible
6	Brownlow Street	Existing	48.2	48.2	0.1	0.2%	Imperceptible	Negligible
7	52 Bedford Row	Existing	48.3	48.5	0.2	0.6%	Imperceptible	Negligible
8	29 Bedford Row	Existing	48.2	48.5	0.3	0.8%	Imperceptible	Negligible
9	38 Sandland Street	Existing	48.2	48.4	0.3	0.7%	Imperceptible	Negligible
10	57 High Holborn	Existing	48.0	48.1	0.1	0.3%	Imperceptible	Negligible
11	43 High Holborn	Existing	47.9	48.0	0.1	0.4%	Imperceptible	Negligible
12	71 High Holborn	Existing	49.3	49.6	0.3	0.8%	Imperceptible	Negligible

Table 13 indicates that the proposed development is predicted to have an imperceptible impact on annual mean NO_2 concentrations at existing elevated receptors.

Table 14: Predicted Hourly and Annual Mean NO_2 Concentrations at Proposed Receptor Locations

Receptor			99.8th Percentile Hourly Mean NO_2 Concentration (µg/m³)		Annual Mean NO_2 Concentration (µg/m³)	
Ref.	Description	Type	1.5 m AGL	Max Building Height AGL	1.5 m AGL	Max Building Height AGL
13	47 Bedford Road	Proposed	**101.7**	**99.3**	-	-
14	45 Bedford Road	Proposed	**101.5**	**97.6**	**50.3**	**48.6**
15	45 Bedford Road	Proposed	**102.0**	**97.6**	**50.7**	**48.6**
16	Montagu House	Proposed	102.7	**97.5**	**51.1**	**48.6**
17	Brownlow House	Proposed	128.4	**98.1**	**63.4**	**48.6**
18	Caroline House	Proposed	128.1	97.6	-	-
19	Main Office	Proposed	103.2	101.5	-	-
20	Highest Point of Building	Proposed	105.0	100.7	-	-

Table 14 indicates that the hourly mean NO_2 objective will be achieved at all of the modelled receptors. The annual mean air quality objective / EU limit value (40 µg/m^3) is however predicted to be exceeded at all modelled receptors in all scenarios both at ground level and at height. It should be noted however that the annual mean NO_2 objective only applies at locations where members of the public are likely to be regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the objective. EU limit values apply at all locations except for workplaces where the general public do not have regular access. The annual mean NO_2 objective is therefore only presented for those receptors in the table above which represent the new residential elements introduced as part of the development, as the other receptors considered are either commercial premises such as offices, meaning that exposure is either non-public, or retail, meaning that exposure only occurs on a relatively short-term basis.

The annual mean PM_{10} concentration and number of days where PM_{10} concentrations are expected to exceed 50 µg/m^3 (predicted using the equation in LAQM.TG(09)) are shown in **Error! Reference source not found.**. The proposed development is not anticipated to cause a change in PM_{10} concentrations during its operational phase as it does not include any car park provision and the boilers and CHP will operate using natural gas. As such, only those receptors introduced as part of the redevelopment have been considered. There is the potential for PM_{10} emissions to occur during the construction phase and this is considered qualitatively in Section 5.2 in accordance with the London Best Practice Guidance for Construction and Demolition, as well as the IAQM Dust Assessment Methodology.

Table 15: Predicted Annual Mean PM_{10} Concentrations and Number of Exceedences of Daily 50 µg/m^3 Limit

Receptor			Annual Mean PM_{10} Concentration (µg/m^3)		Number of Days PM_{10} > 50 µg/m^3	
Ref.	**Description**	**Type**	**1.5 m AGL**	**Max Building Height AGL**	**1.5 m AGL**	**Max Building Height AGL**
13	47 Bedford Road	Proposed	25.2	25.1	4.6	4.4
14	45 Bedford Road	Proposed	25.1	25.0	4.5	4.2
15	45 Bedford Road	Proposed	25.2	25.0	4.6	4.2
16	Montagu House	Proposed	25.2	25.0	4.7	4.2
17	Brownlow House	Proposed	26.2	25.0	7.6	4.3
18	Caroline House	Proposed	26.2	25.0	7.5	4.2
19	Main Office	Proposed	25.2	25.0	4.7	4.2
20	Highest Point of Building	Proposed	25.3	25.0	5.0	4.2

Table 15 indicates that the annual mean (40 µg/m^3) and daily mean (35 days) air quality objectives for PM_{10} will be achieved at all modelled receptors.

5.1.1 Discussion of Results

Emissions from the proposed gas boiler and CHP plant at the proposed development are predicted to have at worst, a **negligible** effect on air quality.

LBC has designated the whole borough an AQMA due to widespread exceedences of the annual-mean AQS objectives for NO_2 and PM_{10} associated with road traffic emissions. The Environmental Protection UK (EPUK) Development Control: Planning for Air Quality document advises that:

"It is important to balance all aspects of development within an AQMA. For example a new residential development in the central area of a town or city may increase the number of people exposed to poor air quality. On the other hand, there may be social and economic benefits arising from the regeneration of the area. Moreover, if the development is close to a main shopping or employment area, there may be a reduction in the need to travel by car, with a corresponding potential to reduce emissions if people who previously travelled into the area by car no longer do so, leading to an improvement in air quality"

It is considered good practice that where possible, an assessment should communicate effects both numerically and descriptively. The EPUK's Development Control: Planning for Air Quality document sets out an approach for describing effects according to numerical predictions. The EPUK guidance advocates that the *"conclusion as to the overall significance of the air quality impacts should be based on the professional judgement of the person preparing the report."*

As shown in **Table 14**, the extent to which the annual mean NO_2 air quality objective is predicted to be exceeded at proposed sensitive receptors is potentially large. Whilst concentrations are expected to decrease with height, NO_2 concentrations are expected to exceed the annual mean air quality objective even at roof level due to high background concentrations. It should be noted that background concentrations monitored at ground level have been used in this study. In reality however, background concentrations at height may be lower than this value.

As there are currently 6 residential units within the existing buildings on the development site and with the proposed scheme increasing this to 50 units (18 Private Residential, 10 Affordable Residential and 22 Student Properties), the development results in a net increase of 44 units.

On the basis of the above discussion and in our professional judgment, we consider the significance of the introduction of new exposure to pollution as a result of the proposed development of **moderate adverse** significance. In order to minimise the concentration of pollutants to which residents of the proposed development are exposed, it is therefore recommended that these units are mechanically ventilated, with intake air drawn from as high a point as possible and away from sources of pollution such as busy roads. Such mitigation measures would reduce the significance of the introduction of new exposure to pollution to be of minor adverse significance.

5.2 Construction Dust Assessment

The construction phase of the proposed development has the potential to generate emissions of dust and PM_{10} within the boundaries of the construction areas. Whilst the majority of this dust would be contained within the boundaries, some will be transported in the air to sites outside the construction areas, possibly giving rise to adverse impacts.

The construction phase of the proposed development will include:

- Demolitions of the existing office building from the site whilst retaining a portion of High Holborn House, Brownlow House, 45 Bedford Row, 46-48 Bedford Row, 49-51 Bedford Row and the facade of 23 Hand Court; and
- Construction of a new office building within the void left between the retained buildings.

5.2.1 Assessment of Risk of Dust Events

Demolition activities associated with the proposed development will be significant due to the removal of the existing office building; however the retention of some of the buildings fronting Bedford Row, Brownlow Street and High Holborn will offer a level of dust screening. In accordance with IAQM guidance, the potential dust emissions class for demolition activities is **large**. There are dust-sensitive receptors within 100 metres of the site boundary (office buildings and adjacent presidential properties). In consideration of IAQM guidance the site is defined as **high risk** for dust soiling and PM_{10} effects with respect to demolition activities.

Earthworks are not anticipated to be required on any significant scale as part of the proposed expansion and so the risk associated from earthwork activities are considered **negligible** and have been excluded from further assessment.

The construction phase includes the renovation of the retained buildings and construction of the new 'Main Office Building' within the centre of the site between the retained buildings. The new extension will reuse materials removed during the demolition phase where possible. It is anticipated that potentially dusty activities such as on-site concrete batching and piling will be necessary. On this basis and in accordance with IAQM guidance the potential dust emissions class for construction activities is **medium** and the corresponding risk category for the site is **medium risk**.

Trackout associated with the proposed development is not anticipated to present a significant dust issue. There will be no requirement for earthworks or establishment of haul routes on site and the movement of construction related traffic on site will be negligible. In accordance with IAQM guidance the potential dust emissions classification for trackout is **medium** and the site risk is **medium risk**.

The results of the assessment of risk of dust events associated with construction phase activities are summarised in **Table 16**. It should be noted that these risk classifications presented assume 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 16: Summary of Risk of Dust Effects for Construction Phase Activities

Activity	Dust Soiling	PM_{10} Effects	Ecological
Demolition	High Risk	High Risk	None
Earthworks	Negligible	Negligible	None
Construction	Medium Risk	Medium Risk	None
Track-out	Medium Risk	Medium Risk	None

5.2.2 Assessment of Area Sensitivity to Dust and Determination of Significance

The development site lies within an Air Quality Management Area, declared on the basis of exceedences of the annual mean NO_2 objective and the daily mean PM_{10} objective, however automatic PM_{10} monitoring within the borough has shown no exceedence of the daily or annual objective since 2007. There are between 10 and 100 dust-sensitive receptors within 20 metres including a number of offices and warehouses. There are no sensitive ecological receptors within 20 metres of the site boundary. On the basis of these factors and in accordance with IAQM guidance the sensitivity of the area to dust is **High**.

Combining the risk of dust effects with area sensitivity, the significance of construction phase effects, assuming no mitigation, is determined. The unmitigated significance descriptors are presented in **Table 17**.

Table 17: Summary of Construction Phase Impacts

Activity	Significance of Effect of Site Activities (No Mitigation)		
	Dust Soiling	**PM_{10} Effects**	**Ecological**
Demolition	Moderate Adverse	Moderate Adverse	None
Earthworks	Negligible	Negligible	None
Construction	Moderate Adverse	Moderate Adverse	None
Track-out	Moderate Adverse	Moderate Adverse	None

5.2.3 Mitigation Measures and Residual Effects

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.

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 at most of **slight** significance according to IAQM guidance. A summary of the construction phase impacts following appropriate mitigation are shown in **Table 18**.

Table 18: Summary of Mitigated Construction Phase Impacts

Activity	Significance of Effect of Site Activities (With Mitigation)		
	Dust Soiling	**PM_{10} Effects**	**Ecological**
Demolition	Minor Adverse	Minor Adverse	Negligible
Earthworks	Negligible	Negligible	Negligible
Construction	Minor Adverse	Minor Adverse	Negligible
Track-out	Minor Adverse	Minor Adverse	Negligible

The London Councils Best Practice Guidance outlines mitigation measures to be followed to lessen the nuisance and human-health impacts of the dust and PM_{10} generated during construction activities. 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, and the measures listed in **Table 19**. A comprehensive list of appropriate mitigation measures can be found in **Table 32**.

Table 19: Construction Dust Mitigation Measures for Medium Risk Site

Activity	Mitigation Measures
Site Planning and Preparation	Erect solid barriers to site boundary. No bonfires. Plan site layout – machinery and dust causing activities should be located away from the site boundaries and sensitive receptors where possible. Identify responsible person in charge. Hard surface site haul routes.
Construction traffic, Site Entrances and Exits	All vehicles to switch off engines – no idling vehicles. Effective vehicle cleaning and specific wheel-washing on leaving site. All loads entering and leaving site to be covered. No site runoff of water or mud. All non road mobile machinery (NRMM) to use ultra low sulphur tax-exempt diesel (ULSD) where available. On-road vehicles to comply with the requirements of the London Low Emission Zone (LEZ). Hard surfacing and effective cleaning of haul routes and appropriate speed limit around site. Ideally there should be a paved area between the wheel wash and before the public road.
Demolition Works	Use water as dust suppressant. Cutting equipment to use water as suppressant or suitable local exhaust ventilation systems. Securely cover skips and minimise drop heights. Wrap buildings to be demolished.
Site Activities	Minimise dust generating activities. Use water as dust suppressant where applicable. Enclose stockpiles or keep them securely sheeted. If applicable, ensure concrete crusher or concrete batcher has a permit to operate.

5.2.4 Exhaust Emissions from Construction Vehicles and Plant
Exhaust emissions from construction vehicles and plant have the potential to impact on air quality during the construction phase. However, the total number of construction vehicles using the local road network will be small compared with the normal traffic flows. Exhaust emissions from plant can be mitigated by enforcing the following best practice means.

From 3rd January 2012 lorries and other heavy goods vehicles of gross vehicle weight greater than 3.5 tonnes are required to meet the Euro IV emissions standard for PM_{10} under the conditions of the London Low Emission Zone. Additionally, light goods vehicles of between 1.205 and 3.5 tonnes gross vehicle weight are required to meet at least Euro III standards for PM_{10}. These emissions controls should serve to reduce the emissions relating to on-road construction vehicle movements.

All Non-Road Mobile Machinery (NRMM) should use fuel equivalent to ultra-low sulphur diesel (ULSD), especially where a bunkered supply is available – this measure can reduce particulate emissions by 30%. Fitting of suitable exhaust after-treatment devices to construction vehicles and plant can reduce the remaining particles by at least 85%.

In addition to the emission standards specified above, further measures should be put in place to reduce exhaust emissions and these are listed below. As well as local air pollutants, carbon dioxide is also emitted from vehicle exhausts. As it is a key gas linked to climate change, controls should be put in place to limit emissions; these controls will also help developers reduce fuel costs. Detailed help and advice is available on the Energy Saving Trust's website (www.energysavingstrust.gov.uk).

- Vehicles or plant should not be left idling unnecessarily.
- NRMM should be well maintained. Should any emissions of dark smoke occur (except during start up) then the relevant machinery should be stopped immediately and any problem rectified before being used.
- Engines and exhaust systems should be regularly serviced according to manufacturer's recommendations and maintained to meet statutory limits/opacity tests.
- All vehicles should hold current MOT certificates where required.
- Vehicle exhausts should be directed away from the ground and positioned so they are not directed at site entrances.
- Locate plant away from the boundaries close to residential areas.

6 Conclusions

6.1 Local Air Quality Assessment

The results of this assessment indicate that the annual mean NO_2 air quality objective is likely to be exceeded at existing and proposed sensitive receptors across the study area, both at ground level and at height, with or without the proposed development. However, the annual mean NO_2 objective is only applicable at those receptors which represent relevant exposure, in this case those receptors above ground level and the new residential properties included as part of the proposed scheme. As annual mean NO_2 concentrations at proposed residential receptors are predicted to exceed national air quality objectives, it is recommended that these units are mechanically ventilated, with intake air drawn from as high a point as possible and away from sources of pollution such as busy roads

Hourly mean NO_2 and daily mean PM_{10} concentrations, which are also relevant to the residential elements of the proposed development are however predicted to be below national air quality objectives.

The gas boilers and a CHP plant associated with the proposed development are predicted to have a negligible impact on both annual and hourly mean NO_2 concentrations at existing sensitive receptors.

6.2 Construction Dust Assessment

The scale and nature of construction phase activities associated with the proposed development define the site as moderate risk with respect to risk of dust effects on human receptors. The development site lies within an AQMA and therefore the area is High sensitivity with respect to dust emissions and effects. With appropriate mitigation in place, as outlined in Section 5.4, the residual significance of any effects arising from construction-related dust emissions is slight.

Exhaust emissions from construction vehicles and plant are considered to be negligible. The number of construction vehicles using the local road network will be very small in comparison to existing traffic flows. A small number of NRMM may be required during construction. Combined with the mitigation outlined in Section 5.4 any impacts relating to exhaust emissions of NRMM are likely to be negligible.

6.3 Overall Conclusions

AECOM Ltd was commissioned to carry out an air quality assessment in support of the proposed High Holborn re-development, consisting of office and retail space and student/private residential properties. Pollutant concentrations affecting the proposed development and existing sensitive receptors were predicted using detailed dispersion modelling in order to predict the impact of air quality upon the proposed development and the impact of NO_x emissions from proposed gas boilers and a CHP plant upon existing receptors. Air quality impacts during the construction phase of the scheme were assessed qualitatively. A summary of the impacts identified during the assessment is shown in **Table 20**.

Table 20: Summary of Impacts

Phase	Aspect	Pollutant	Significance
Construction	Construction Dust	Dust	Minor Adverse (following mitigation)
	Construction Vehicles	NO_2, PM_{10}	Negligible (following mitigation)
Operation	Introduction of New Exposure to Pollution	NO_2, PM_{10}	Minor Adverse (following mitigation)
	NO_x Emissions form Gas Boilers and CHP Plant	Annual Mean NO_2	Negligible
		Hourly Mean NO_2	Negligible

Appendix A: Air Quality Objectives and Limit Values

Table 21: UK Air Quality Objectives

Pollutant	Air Quality Objective		Date to be achieved by and maintained thereafter
	Concentration	Measured as	
Benzene	16.25 µg/m^3	Running Annual Mean	31.12.2003
Benzene	5.0 µg/m^3	Annual Mean	31.12.2010
1,3-Butadiene	2.25 µg/m^3	Running Annual Mean	31.12.2003
Carbon Monoxide	10.0 mg/m^3	Maximum Daily Running 8-hour Mean	31.12.2003
Lead	0.5 µg/m^3	Annual Mean	31.12.2004
	0.25 µg/m^3		31.12.2008
Nitrogen Dioxide	200 µg/m^3 not to be exceeded more than 18 times a year	1 Hour mean	31.12.2005
	40 µg/m^3	Annual Mean	
Nitrogen Oxides (for the protection of vegetation)	30 µg/m^3	Annual Mean	31.12.2000
Particles (PM_{10}) (gravimetric)	50 µg/m^3 not to be exceeded more than 35 times a year	24 Hour Mean	31.12.2004
	40 µg/m^3	Annual Mean	31.12.2004
Particles ($PM_{2.5}$) Exposure Reduction	25 µg/m^3	Annual Mean	2020
Particles ($PM_{2.5}$) Exposure Reduction UK urban areas	Target of 15% reduction in concentrations at urban background [a]	Annual Mean	Between 2010 and 2020
Sulphur Dioxide	266 µg/m^3 not to be exceeded more than 35 times a year	15 Minute Mean	31.12.2005
	350 µg/m^3 not to be exceeded more than 24 times a year	1 Hour Mean	31.12.2004
	125 µg/m^3 not to be exceeded more than 3 times a year	24 Hour Mean	31.12.2004
Ozone	100 µg/m^3 not to be exceeded more than 10 times a year	8 Hour Mean	31.12.2005

NB: [a] 25 µg/ m^3 is a cap to be seen in conjunction with 15% reduction.

Table 22: EU Limit Values

Pollutant	Limit Value	Measured as	Date to be achieved by and maintained thereafter
Benzene	5 µg/m^3	Annual Mean	1 January 2010
Carbon Monoxide	10.0 mg/m^3	Maximum Daily 8-Hour Mean updated hourly	1 January 2005
Lead	0.5 µg/m^3	Annual Mean	1 January 2005
Nitrogen Dioxide	200 µg/m^3 not to be exceeded more than 18 times per year	1 Hour Mean	1 January 2010
	40 µg/m^3	Annual Mean	
Nitrogen Oxides (assuming as nitrogen dioxide)	30 µg/m^3 (for the protection of vegetation)	Annual Mean	19 July 2001
Ozone(Target)	120 µg/m^3 not to be exceeded more than 25 times per year	Maximum Daily Running 8-hour Mean updated hourly	1 January 2010
Particles (PM_{10}) (gravimetric)	50 µg/m^3 not to be exceeded more than 35 times per year.	24 Hour Mean	1 January 2005
	40 µg/m^3	Annual Mean	1 January 2005
Particles ($PM_{2.5}$) Exposure Reduction	Target value 25 µg/m^3	Annual Mean	2010
Particles ($PM_{2.5}$) Exposure Reduction	Target of 20% reduction in concentrations at urban background	Annual Mean	Between 2010 and 2020
Particles ($PM_{2.5}$)	25 µg/m^3	Annual Mean	2015
	20 µg/m^3 [A]	Annual Mean	2020
Sulphur Dioxide	350 µg/m^3 not to be exceeded more than 24 times per year	1 Hour Mean	1 January 2005
	125 µg/m^3 not to be exceeded more than 3 times per year	24 Hour Mean	1 January 2005
	20 µg/m^3 (for the protection of vegetation)	Annual Mean	19 July 2001

[A] Indicative limit value to be reviewed by the European Commission in 2013.

Appendix B: Figures

Figure 1: Local Air Quality Monitoring Locations

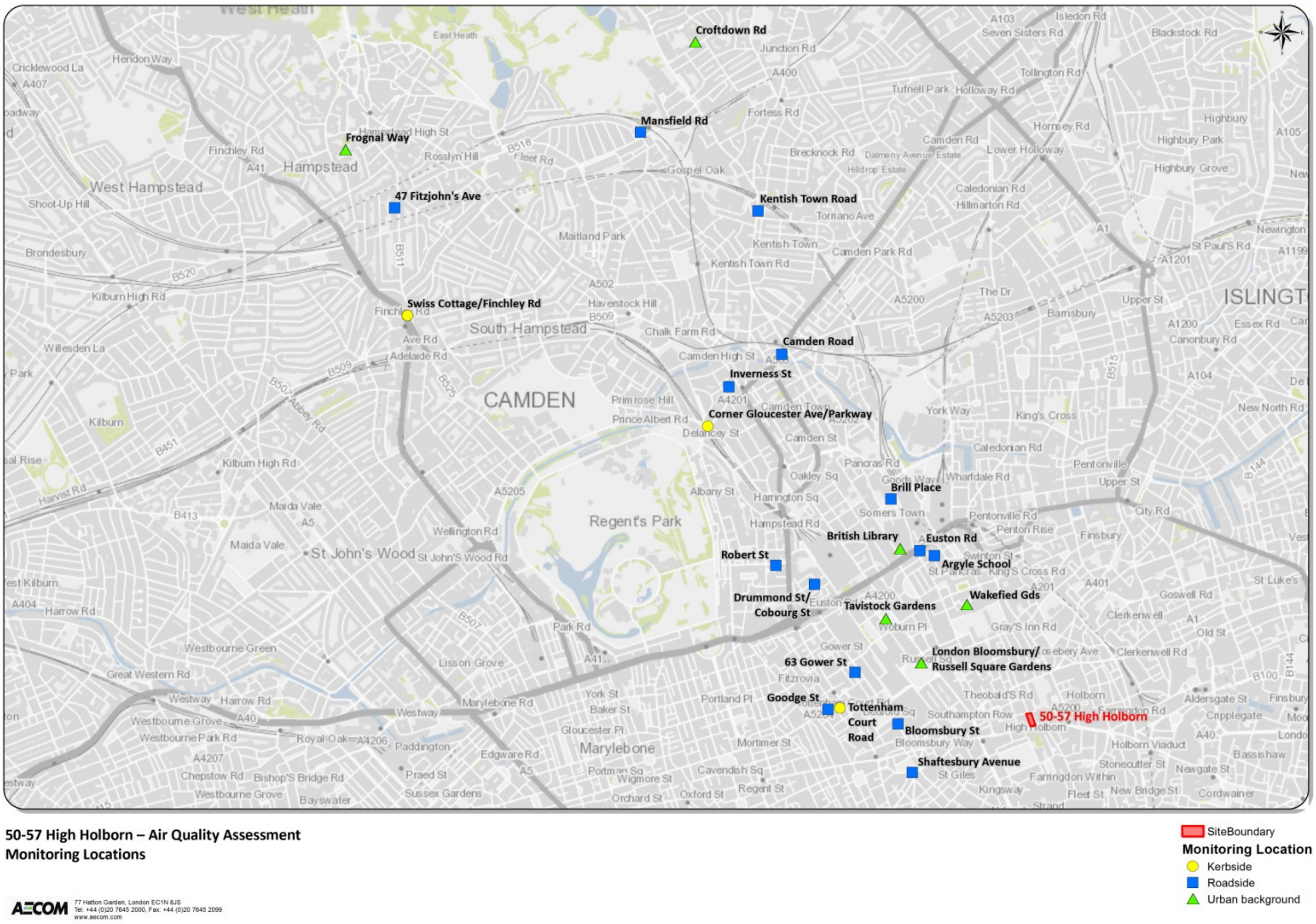
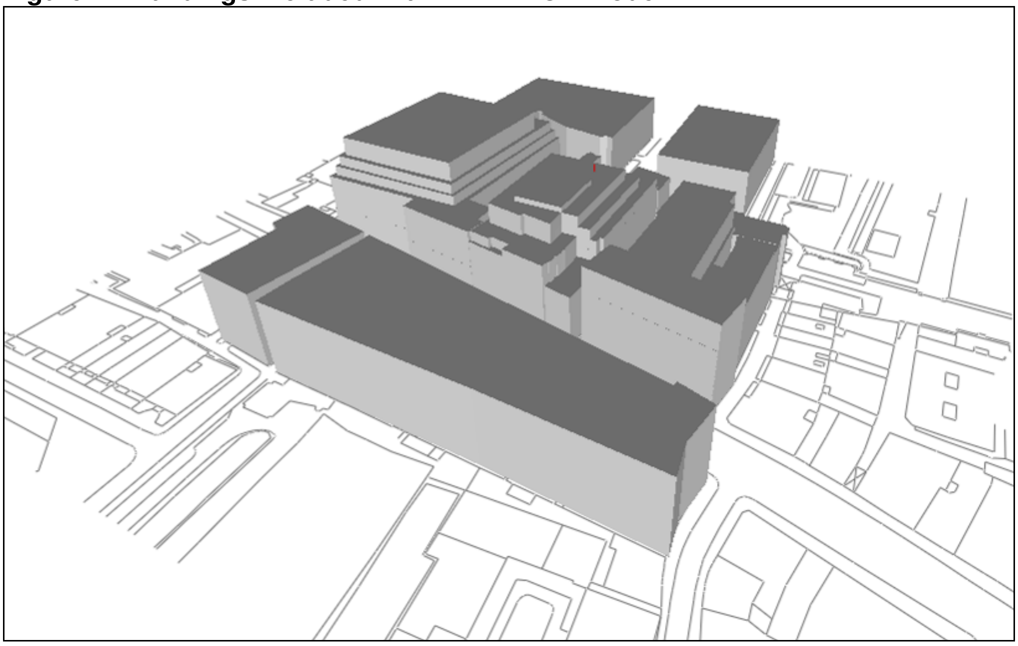
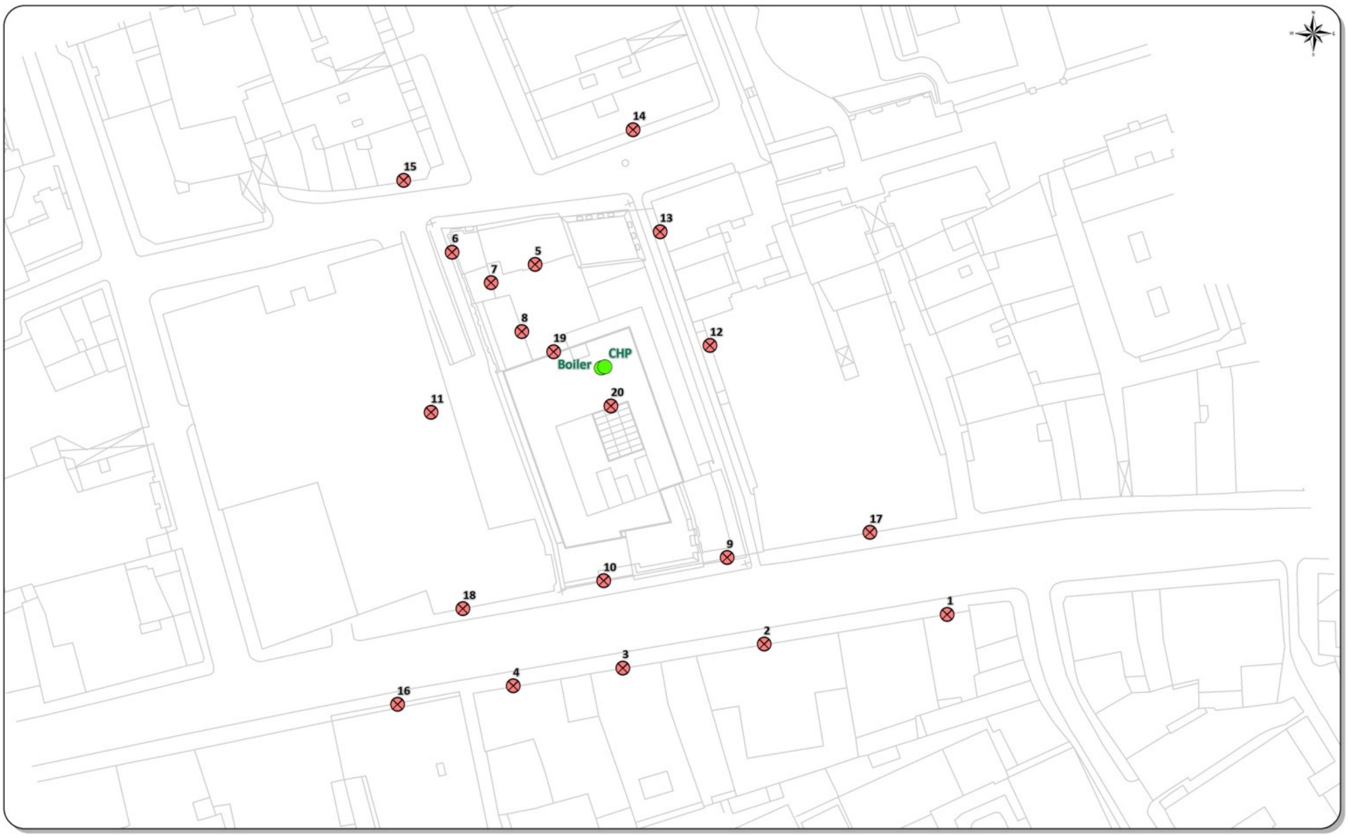


Figure 2: Buildings Included within AERMOD Model



Capabilities on project:
Environment

Figure 3: Modelled Receptor Locations



50-57 High Holborn – Air Quality Assessment
Receptor Locations

ReceptorLocation
StackLocation

AECOM 77 Hatton Garden, London EC1N 8JS
Tel: +44 (0)20 7645 2000, Fax: +44 (0)20 7645 2099
www.aecom.com

Appendix C: AAQuIRE

AAQuIRE was developed by AECOM Ltd to meet three requirements in predictive air quality studies. The first requirement was an immediate need for a system that produced results that could be interpreted easily by non-air quality specialists to allow for proper informed inclusion of air quality issues in wider fora, the main example being to allow consideration of air quality issues in planning processes. This was achieved by allowing results to be generated over a sufficiently large study area, and at an appropriate resolution, for the issue being considered. The results are also presented in a relevant format, which is normally a statistic directly comparable with an air quality criterion or set of measured data being considered. For example, the AQS PM_{10} 24-hour objective level of 50 µg/m^3 is expressed as a 90th percentile of hourly means. AAQuIRE can also produce results directly comparable with all ambient air quality standards.

The second requirement was for a system to be based, initially, on existing and well-accepted and validated dispersion models. This has two advantages. The primary one is that it avoids the need to prove a new model against the accepted models and therefore enhances acceptability. The second advantage is that when appropriate new models are developed they can be included in AAQuIRE and be compared directly with the existing models, and sets of measured data, using the most appropriate statistics.

The third requirement for AAQuIRE was a consideration of quality assurance and control. An important aspect of modelling is proper record keeping ensuring repeatability of results. This is achieved within AAQuIRE by a set of log files, which record all aspects of a study and allow model runs to be easily repeated.

The ways in which AAQuIRE and the models currently available within it operate are discussed below. The operation of AAQuIRE can be divided into five main stages. These are:

- the preparation of the input data;
- the generation of model input files;
- dispersion modelling;
- the statistical treatment of dispersion modelling results; and
- the presentation of results.

The first stage in operating AAQuIRE is to prepare the input data. The following data are needed for the year and pollutant to be modelled:

- the presentation of meteorological data expressed as occurrence frequencies for specified combinations of wind speed, direction, stability and boundary layer height;
- road system layout and associated traffic data within and immediately surrounding the study area;
- industrial stack locations and parameters; and
- a grid of model prediction locations (receptors).

The modelling is always carried out to give annual average results from which appropriate shorter period concentrations can be derived.

The second stage is the generation of the model input files required for the study. All the data collated in the first stage can be easily input into AAQuIRE, using the worksheets, drop down boxes and click boxes in the Data Manager section of the software. Data from spreadsheets can be easily pasted into worksheets, so that any complicated procedures required for data manipulation can be achieved before entry into AAQuIRE. Several diurnal and seasonal profiles can be defined for each separate source. The relevant meteorological data can also be specified at this stage.

The third stage is executing the models. The study area will usually be divided up into manageable grids and run separately using the Run Manager in AAQuIRE. The results from the separate files can be combined at a later stage. Pollutant concentrations are determined for each receptor point and each meteorological category and are subsequently combined.

The fourth stage is the statistical processing of the raw dispersion results to produce results in the relevant averaging period. Traffic sources and industrial sources can be combined at this stage provided the same receptor grid has been used for both. Background concentrations are also incorporated at this stage.

The final stage is presentation of results. Currently, the result files from the statistical interpretation are formatted to be used directly by GIS software packages, such as ArcGIS. Alternative formats are available to permit interfacing with other software packages.

Currently AAQuIRE uses the CALINE4 model for the dispersion of road-traffic emissions and AERMOD for all other sources. Both these models are fully validated and have been extensively used worldwide. These are relatively complex models designed for detailed studies of local areas, which are used within AAQuIRE for both local and larger scale studies. This is considered necessary because of the frequent importance of local effects, such as traffic junctions, in properly assessing ‘regional’ effects.

Appendix D: Construction Dust Assessment Methodology and Control

Construction Dust Impacts

The following sections outline criteria proposed by the IAQM on the assessment of air quality impacts arising from construction activities.

Assessment of risk of dust events

A site is allocated to a risk category on the basis of the scale and nature of the works and the proximity of dust-sensitive receptors. Depending on the activities being carried out, risk category designations may be required for demolition, earthworks, construction and trackout. Where there is uncertainty regarding the level of risk a precautionary approach should be taken with the higher risk category being applied.

Table 23 to **Table 26** describe the potential dust emission class criteria for each activity related to demolition and construction. In addition to these criteria, factors such as seasonality, building type, duration and scale have been considered.

Table 23: Potential Dust Emission Class Criteria for Demolition Activities

Potential Dust Emission Class	Criteria
Large	Total Building Area: > 50,000 m^3 Potentially dusty construction material (e.g. concrete) On-site crushing and screening Demolition activities: > 20 m above ground level
Medium	Total Building Area: 20,000 – 50,000 m^3 Potentially dusty construction material Demolition activities: 10 – 20 m above ground level
Small	Total Building Area: < 20,000 m^3 Materials with low potential for dust release (e.g. metal cladding or timber) Demolition activities: <10 m above ground level

Table 24: Potential Dust Emission Class Criteria for Earthworks Activities

Potential Dust Emission Class	Criteria
Large	Total site area: > 10,000 m^2 Potentially dusty soil type (e.g. clay) >10 heavy earth moving vehicle active at any one time Formation of bunds >8 m in height Total material moved >100,000 tonnes
Medium	Total site area: 2,500 – 10,000 m^2 Moderately dusty soil type (e.g. silt) 5 – 10 heavy earth moving vehicle active at any one time Formation of bunds 4 – 8 m in height Total material moved 20,000 – 100,000 tonnes
Small	Total site area: < 2,500 m^2 Soil types with large grain size (e.g. sand) < 5 heavy earth moving vehicle active at any one time Formation of bunds < 4 m in height Total material moved <20,000 tonnes Earthworks during wetter months

Table 25: Potential Dust Emission Class Criteria for Construction Activities

Potential Dust Emission Class	Criteria
Large	Total building volume > 100 000m^3 Piling, on site concrete batching, sandblasting
Medium	Total building volume 25 000 – 100 000m^3 Potentially dusty construction material (e.g. concrete) Piling, on-site concrete batching
Small	Total building volume < 25 000m^3 Construction material with low potential for dust release (e.g. metal cladding or timber)

Table 26: Potential Dust Emission Class Criteria for Trackout Activities

Potential Dust Emission Class	Criteria
Large	>100 HDV (>3.5t) trips in any one day Potentially dusty surface material Unpaved road length > 100 m
Medium	25 – 100 HDV (>3.5t) trips in any one day Moderately dusty surface material Unpaved road length 50 – 100 m
Small	< 25 HDV (>3.5t) trips in any one day Surface material with low potential for dust release Unpaved road length < 50 m

In conjunction with the potential dust emission class, the distance to the nearest dust sensitive receptor was used to derive a risk classification for the site for each dust-generating activity. The risk categories for each demolition and construction activity type are shown in **Table 27** to **Table 29**. The risk categories assume no mitigation measures are applied.

Table 27: Risk Categories for Demolition Activities

Distance to Nearest Receptor (m)[a]		Dust Emission Class		
Dust Soiling and PM_{10}	Ecological	Large	Medium	Small
<20	-	High Risk Site	High Risk Site	Medium Risk Site
20 – 100	<20	High Risk Site	Medium Risk Site	Low Risk Site
100 – 200	20 – 40	Medium Risk Site	Low Risk Site	Low Risk Site
200 – 350	40 – 100	Medium Risk Site	Low Risk Site	Negligible

[a] distance bandings are measured from the dust emission source. Where this is not known then the distance has been measured from the site boundary.

Table 28: Risk Categories for Earthworks and Construction Activities

Distance to Nearest Receptor (m)[a]		Dust Emission Class		
Dust Soiling and PM_{10}	**Ecological**	**Large**	**Medium**	**Small**
<20	-	High Risk Site	High Risk Site	Medium Risk Site
20 – 50	-	High Risk Site	Medium Risk Site	Low Risk Site
50 – 100	<20	Medium Risk Site	Medium Risk Site	Low Risk Site
100 – 200	20 – 40	Medium Risk Site	Low Risk Site	Negligible
200 – 350	40 – 100	Low Risk Site	Low Risk Site	Negligible

[a] distance bandings are measured from the dust emission source. Where this is not known then the distance has been measured from the site boundary.

Table 29: Risk Categories for Trackout Activities

Distance to Nearest Receptor (m)[a]		Dust Emission Class		
Dust Soiling and PM_{10}	**Ecological**	**Large**	**Medium**	**Small**
<20	-	High Risk Site	Medium Risk Site	Medium Risk Site
20 – 50	<20	Medium Risk Site	Medium Risk Site	Low Risk Site
50 – 100	20 – 100	Low Risk Site	Low Risk Site	Negligible

[a] distance bandings for trackout were measured from the road(s) used by construction traffic.

Receptors differ in their sensitivity to the effects of dust and emissions from demolition and construction activities. To define the overall significance of the impacts of these activities the sensitivity of the area is classified according to the criteria in **Table 30**. Professional judgement must also be applied to describe the area sensitivity.

Table 30: Criteria for Determination of Area Sensitivity

Sensitivity of Area	Human Receptors	Ecological Receptors
Very High	>100 receptors within 20 m Local PM_{10} concentrations exceeding the air quality objective(s) Contaminated materials present (e.g. gasworks) Specific sensitive receptors (e.g. hospitals, residential homes) Works continuing in one area of the site for more than 1 year	European Designated Site (e.g. SAC)
High	10-100 receptors within 20 m PM_{10} concentrations close to the objective(s) (e.g. annual mean 36-40 $\mu g/m^3$) Commercially sensitive horticultural land within 20 m (e.g. greenhouses)	National Designated Site (e.g. SSSI)
Medium	<10 receptors within 20 m Low PM_{10} concentrations (e.g. 30-36 $\mu g/m^3$)	Local Designated Site
Low	Rural or industrial area No receptors within 20 m Very low PM_{10} concentrations (e.g. <30 $\mu g/m^3$) Barriers between site and receptors (e.g. woodland)	No Designation

[a] Only if there are habitats that might be sensitive to dust.

The overall significance of the potential impacts of dust and emissions are derived from **Table 31**. The significance accounts for the sensitivity of the area and the risk categorisation of the demolition and construction activities on site.

It should be noted that **Table 31** provides significance descriptors for both unmitigated and mitigated emissions. However, the IAQM guidance requires that significance is only assigned to the impact(s) with mitigation in place. It is therefore important that mitigation measures are defined in a form suitable for implementation by means of a planning condition or legal obligation, and are included in a Dust Management Plan and/or Environmental Management Plan. For completeness, significance descriptors for unmitigated and mitigated demolition and construction phase impacts have been reported.

Table 31: Significance Criteria for Dust and PM_{10} from Demolition and Construction Activities

Sensitivity of Area	Risk of Dust Effects		
	High	Medium	Low
No Mitigation			
Very High	Substantial	Moderate	Moderate
High	Moderate	Moderate	Slight
Medium	Moderate	Slight	Negligible
Low	Slight	Negligible	Negligible
With Mitigation			
Very High	Slight	Slight	Negligible
High	Slight	Negligible	Negligible
Medium	Negligible	Negligible	Negligible
Low	Negligible	Negligible	Negligible

Table 32: Dust and Emission Control Measures

Activity	Control Measures for Medium Risk Site
Pre-site Preparation	Machinery, fuel and chemical storage and dust generating activities should not be located close to boundaries and sensitive receptors if at all possible. Erect solid barriers to site boundary.
Haul Routes	Use consolidated surfaces on roads near to residential areas. Hard surface all major haul routes through the site (e.g. use recycled rubber blocks, concrete blocks or tarmac). Regularly inspect haul routes for integrity and repair if required. When the haul route changes, re-use surface where possible.
Damping Down	Use agreed wet cleaning methods or mechanical road sweepers on all roads at least once a day or consider using fixed or mobile sprinkler systems. Clean road edges and pavements using agreed wet cleaning methods Provide hardstanding areas for vehicles and regularly inspect and clean these areas.

Activity	Control Measures for Medium Risk Site
Vehicles	All vehicles should switch off engines - no idling. Clean or wash all vehicles effectively before they leave a site if there is a risk of affecting nearby sensitive receptors. All loads entering and leaving site to be covered. Wheel wash vehicles before they leave a site. Hard surface haul routes and clean them effectively. Impose an appropriate speed limit around site.
Site entrances /Exits	No extra control measures required if there are no nearby sensitive receptors. Wash or clean all vehicles effectively before leaving the site if it is close to sensitive receptors. Ideally there should be a paved area between the wheel wash and before the public road. Provide a control zone around the site boundary to protect sensitive receptors (this could include an area of hardstanding). Provide effective vehicle cleaning and specific wheel-washing facilities at all exits; with hose pipes, adequate water supply and pressure and mechanical wheel spinners or brushes.
Mobile Crushing Plant	This section only applies to construction sites that will operate mobile crushing plant at some point. This is an inherently dusty activity and will often be on sites normally classed as medium or high risk. Notify the local authority if a crusher is to be used as it has a duty to inspect the process. Mobile crushing plants are authorised as Part B processes, even if they are only temporary. Keep a copy of the permit on-site and adhere to the conditions therein at all times. Refer to Process Guidance not PG 3/16 (04) and use best available techniques (BAT) according to the guidance at all times.

Activity	Control Measures for Medium Risk Site
Concrete Batching	As for mobile crushing plants, construction sites with concrete batching plants will often be categorised as medium or high risk. Developers following this guidance should treat such plant as authorised Part B processes, even if temporary, and employ the same level of best practice as indicated below. The local authority should be notified if a concrete batcher is to be used on site. Refer to Process Guidance note PG 3/1 (04) and carry out BAT. Wherever possible, these processes should be totally enclosed.
Excavation and Earthworks	All dusty activities should be damped down, especially during dry weather. Temporarily cover earthworks if possible. Minimise drop heights to control the fall of materials. Re-vegetate earthworks and other exposed areas to stabilise surfaces. Only remove secure covers in small areas during work and not all at once. Use hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil.
Stock Piles and Storage Mounds	Make sure that stockpiles exist for the shortest possible time. Do not build steep sided stockpiles or mounds or those that have sharp changes in shape. Whenever possible keep stockpiles or mounds away from the site boundary, sensitive receptors, watercourses and surface drains. Wherever possible, enclose stockpiles or keep them securely sheeted.
Cutting, Grinding and Sawing	All equipment should use water suppressant or suitable local exhaust ventilation systems. Use dust extraction techniques where available. All other equipment should be fitted with water suppressant systems. Use local exhaust ventilation. Service all fans and filters regularly to ensure they are properly maintained.
Chutes and Skips	Securely cover skips. Minimise drop heights to control the fall of materials. Regularly damp down surfaces with water.

Activity	Control Measures for Medium Risk Site
Scabbling	Pre-wash work surfaces, screen of work areas and vacuum up all dusty residue rather than sweeping away.
Waste Disposal / Burning	No burning of any material is permitted on site. All excess material should not be wasted, but used or safely removed from site according to appropriate legislation.
Dealing with Spillages	Use bunded areas wherever practicable. Regularly inspect the site area for spillages, have spillage kits readily available and clean spillages using agreed wet handling methods. Vacuum or sweep regularly to prevent the build up of fine waste dust material, which is spilled on the site and is designated as waste that is no longer fit for use should be dealt with in accordance with the Waste Management Licensing Regulations (WMLR), 1994. Inform the Environment Agency, London Fire and Emergency Planning Authority (LFEPA) or the Health Protection Agency (HPA) if harmful substances are spilled.
Demolition Activities	Any asbestos must be dealt with by a registered contractor at all times and removed according to appropriate regulations and approved codes of practice/HSE guidance such as HSG248 and MDHS100.
Hazardous or Contaminated Materials	Under the Control of Substances Hazardous to Health (COSHH) Regulations, 2002, developers must ensure that they take into account risks to the workforce from exposure to any harmful substances generated by work activities. Emphasis should be placed on preventing or reducing emissions at source and where this is not possible personal protective equipment may be appropriate.
Sand, Grit and Shot Blasting	Uses agreed wet processes, sheet areas to contain dust and use silica-free material.
Planing and Sanding	Use fans and/or filters, dust suppression techniques and water sprays.
Fitting Out	Fit all machinery for activities such as plastering, sanding or rendering with dust suppression/collection equipment. Vacuum all waste material.
Welding and Soldering	Follow control measures in HSE guidance notes EH54 and EH55.
Tarmac Laying and Use of Bitumen	Do not overheat bitumen and cover pots. Use great care in all processes to prevent spillages and extinguish any accidental fires immediately.

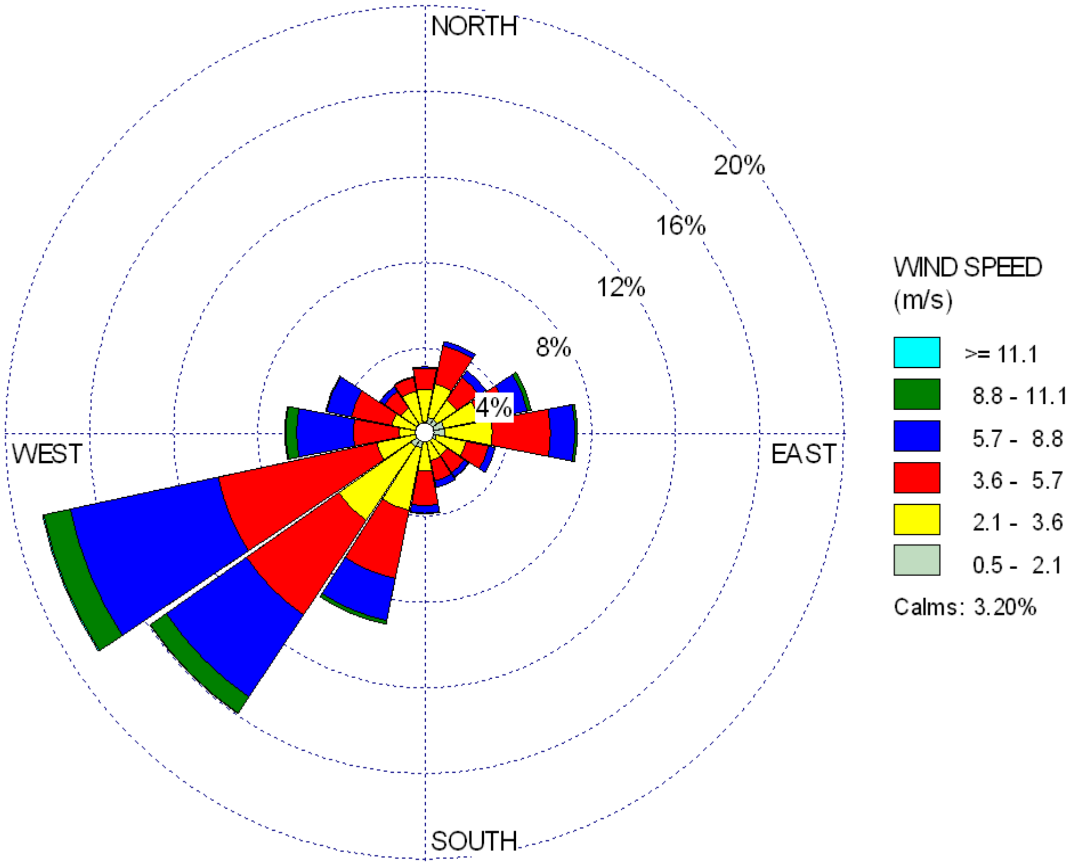
Appendix E: Meteorological Data

Meteorological data measured at London City Airport for 2011 was used for this modelling study. 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 rose. The rose consisted of 36 wind direction sectors of 10° and 6 wind speed bands.

Interpretation of Windroses

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.

Figure 4: Windrose for London City Airport 2011



Capabilities on project:
Environment