High Street, Teddington

Air Quality Assessment

On behalf of **Richmond Housing Partnership (RHP)**

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1 Introduction

1.1 Proposed Development

1.1.1 Richmond Housing Partnership (RHP) has commissioned Peter Brett Associates LLP (PBA) to undertake an air quality assessment to support a planning application for the proposed residential and commercial redevelopment of a site located in High Street, Teddington. The proposed development site is located within the boundary of the London Borough of Richmond upon Thames.

1.1.2 It is proposed to redevelop and refurbish the site for a mixed-use consisting of residential and commercial use with associated car parking.

1.2 Scope

1.2.1 This report describes existing air quality within the study area, considers the suitability of the site for residential and commercial development, and assesses the impact of construction activities on air quality in the surrounding area. The development is predicted to generate an insignificant amount of traffic to the local network - approximately 74 vehicle movements per day, and therefore the effect of development related traffic on local air quality has been scoped out of the assessment (Kronen, 2016). The main air pollutants of concern related to construction are dust and fine Particulate Matter (PM_{10}), and for road traffic are Nitrogen Dioxide (NO_2) and PM_{10}.

1.2.2 It is understood that an energy centre is not being proposed within the site. Therefore, an assessment of the impacts of energy centre related emissions on local air quality has been scoped out.

1.2.3 An assessment to evaluate if the proposed development is 'Air Quality Neutral' in terms of transport emissions has been undertaken. As the proposed development will not incorporate an energy centre within the premises, an assessment of 'Air Quality Neutral' with respect to building emissions has been scoped out.

1.2.4 The assessment has been prepared taking into account relevant local and national guidance and regulations.

1.3 Consultation

1.3.1 Consultation has been carried out with the Environmental Health Officer (EHO) at the London Borough of Richmond upon Thames, Carol Lee (e-mail 26th May 2016), to obtain the latest air quality monitoring for the Council.

2 Legislation and Policy

2.1 The Air Quality Strategy

2.1.1 The Air Quality Strategy (2007) (DETR, 2007) establishes the policy framework for ambient air quality management and assessment in the UK. The primary objective is to ensure that everyone can enjoy a level of ambient air quality which poses no significant risk to health or quality of life. The Strategy sets out the National Air Quality Objectives (NAQOs) and Government policy on achieving these objectives.

2.1.2 Part IV of the Environment Act 1995 (Environment Act, 1995) introduced a system of Local Air Quality Management (LAQM). This requires local authorities to regularly and systematically review and assess air quality within their boundary, and appraise development and transport plans against these assessments. The relevant NAQOs for LAQM are prescribed in the Air Quality (England) Regulations 2000 (Statutory Instrument, 2000) and the Air Quality (Amendment) (England) Regulations 2002 (Statutory Instrument, 2002).

2.1.3 Where an objective is unlikely to be met, the local authority must designate an Air Quality Management Area (AQMA) and draw up an Air Quality Action Plan (AQAP) setting out the measures it intends to introduce in pursuit of the objectives within its AQMA.

2.1.4 The Local Air Quality Management Technical Guidance 2016 (LAQM.TG(16); Defra, 2016), issued by the Department for Environment, Food and Rural Affairs (Defra) for Local Authorities provides advice as to where the NAQOs apply. These include outdoor locations where members of the public are likely to be regularly present for the averaging period of the objective (which vary from 15 minutes to a year). Thus, for example, annual mean objectives apply at the façades of residential properties, whilst the 24-hour objective (for PM_{10}) would also apply within the garden. They do not apply to occupational, indoor or in-vehicle exposure.

2.2 EU Limit Values

2.2.1 The Air Quality Standards Regulations 2010 (Statutory Instrument, 2010) implements the European Union's Directive on ambient air quality and cleaner air for Europe (2008/50/EC), and includes limit values for NO_2. These limit values are numerically the same as the NAQO values but differ in terms of compliance dates, locations where they apply and the legal responsibility for ensuring that they are complied with. The compliance date for the NO_2 EU Limit Value was 1 January 2010, five years later than the date for the NAQO.

2.2.2 Directive 2008/50/EC consolidated the previous framework directive on ambient air quality assessment and management and its first three daughter directives. The limit values remained unchanged, but it now allows Member States a time extension for compliance, subject to European Commission (EC) approval.

2.2.3 The Directive limit values are applicable at all locations except:

- Where members of the public do not have access and there is no fixed habitation;
- On factory premises or at industrial installations to which all relevant provisions concerning health and safety at work apply; and
- On the carriageway of roads; and on the central reservations of roads except where there is normally pedestrian access.

2.3 Planning Policy

National Policy

2.3.1 The National Planning Policy Framework (NPPF) was published in March 2012 (Department for Communities and Local Government, 2012). This set out the Government's planning policies for England and how they are expected to be applied. In relation to conserving and enhancing the natural environment, paragraph 109 states that:

"*The planning system should contribute to and enhance the natural and local environment by…. preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability.*"

2.3.2 Paragraph 124, also states that:

"Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas 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."

2.3.3 Paragraph 203 goes on to say:

"Local planning authorities should consider whether otherwise unacceptable development could be made acceptable through the use of conditions or planning obligations. Planning obligations should only be used where it is not possible to address unacceptable impacts through a planning condition."

Planning Practice Guidance

2.3.4 The Planning Practice Guidance (PPG) (Planning Practice Guidance, 2014) was published in March 2014 to support the National Planning Policy Framework. Paragraph 001, Reference 32-001-20 of the PPG provides a summary as to why air quality is a consideration for planning:

"…Defra carries out an annual national assessment of air quality using modelling and monitoring to determine compliance with EU Limit Values. It is important that the potential impact of new development on air quality is taken into account in planning where the national assessment indicates that relevant limits have been exceeded or are near the limit….The local air quality management (LAQM) regime requires every district and unitary authority to regularly review and assess air quality in their area. These reviews identify whether national objectives have been, or will be, achieved at relevant locations, by an applicable date….If national objectives are not met, or at risk of not being met, the local authority concerned must declare an air quality management area and prepare an air quality action plan…..Air quality can also affect biodiversity and may therefore impact on our international obligations under the Habitats Directive…..Odour and dust can also be a planning concern, for example, because of the effect on local amenity."

2.3.5 Paragraph 002, Reference 32-002-20140306, of the PPG concerns the role of Local Plans with regard to air quality:

"….Drawing on the review of air quality carried out for the local air quality management regime, the Local Plan may need to consider:

- *the potential cumulative impact of a number of smaller developments on air quality as well as the effect of more substantial developments;*

- *the impact of point sources of air pollution..; and*

- *ways in which new development would be appropriate in locations where air quality is or likely to be a concern and not give rise to unacceptable risks from pollution. This could be through, for example, identifying measures for offsetting the impact on air quality arising from new development including supporting measures in an air quality action plan or low emissions strategy where applicable."*

2.3.6 Paragraph 005, Reference 32-005-20140306, of the PPG identifies when air quality could be relevant for a planning decision:

"….When deciding whether air quality is relevant to a planning application, considerations could include whether the development would:

- *Significantly affect traffic in the immediate vicinity of the proposed development site or further afield. This could be by generating or increasing traffic congestion; significantly changing traffic volumes, vehicle speed or both; or significantly altering the traffic composition on local roads. Other matters to consider include whether the proposal involves the development of a bus station, coach or lorry park; adds to turnover in a large car park; or result in construction sites that would generate large Heavy Goods Vehicle flows over a period of a year or more.*

- *Introduce new point sources of air pollution. This could include furnaces which require prior notification to local authorities; or extraction systems (including chimneys) which require approval under pollution control legislation or biomass boilers or biomass-fuelled CHP plant; centralised boilers or CHP plant burning other fuels within or close to an air quality management area or introduce relevant combustion within a Smoke Control Area.*

- *Expose people to existing sources of air pollutants. This could be by building new homes, workplaces or other development in places with poor air quality.*

- *Give rise to potentially unacceptable impact (such as dust) during construction for nearby sensitive locations.*

- *Affect biodiversity. In particular, is it likely to result in deposition or concentration of pollutants that significantly affect a European-designated wildlife site, and is not directly connected with or necessary to the management of the site, or does it otherwise affect biodiversity, particularly designated wildlife sites."*

2.3.7 Paragraph 007, Reference 32-007-20140306, of the PPG provides guidance on how detailed an assessment needs to be:

"Assessments should be proportionate to the nature and scale of development proposed and the level of concern about air quality, and because of this are likely to be locationally specific."

2.3.8 Paragraph 008, Reference 32-008-20140306, of the PPG provides guidance on how an impact on air quality can be mitigated:

"Mitigation options where necessary will be locationally specific, will depend on the proposed development and should be proportionate to the likely impact….Examples of mitigation include:

- *the design and layout of development to increase separation distances from sources of air pollution;*

- *using green infrastructure, in particular trees, to absorb dust and other pollutants;*
- *means of ventilation;*
- *promoting infrastructure to promote modes of transport with low impact on air quality;*
- *controlling dust and emissions from construction, operation and demolition; and*
- *contributing funding to measures, including those identified in air quality action plans and low emission strategies, designed to offset the impact on air quality arising from new development."*

2.3.9 Paragraph 009, Reference 32-009-20140306, of the PPG provides guidance on how considerations about air quality fit into the development management process by means of a flowchart. The final two stages in the process deal with the results of the assessment:

"Will the proposed development (including mitigation) lead to an unacceptable risk from air pollution, prevent sustained compliance with EU limit values or national objectives for pollutants or fail to comply with the requirements of the Habitats Regulations." If Yes:

"Consider how the proposal could be amended to make it acceptable or, where not practicable, consider whether planning permission should be refused."

The London Plan

2.3.10 The London Plan 2015 (adopted 10th March 2015) (Greater London Authority, 2015) provides strategic planning guidance for Greater London. Each Borough's development plans must be in 'general conformity' with it.

2.3.11 The Plan includes Policy 7.14 (Improving Air Quality) which states that development proposals should:

- Promote sustainable design and construction to reduce emissions from the demolition and construction of buildings following the best practice guidance in the Greater London Authority and London Councils;
- Where biomass boilers are included, set out a detailed air quality assessment that should forecast pollutant concentrations. Permission should only be granted if no adverse impacts from biomass are identified; and
- Aim to be 'air quality neutral' and not lead to further deterioration of existing poor air quality (such as areas designated as AQMAs).

2.3.12 Boroughs and others with relevant responsibilities should also have policies that:

- Seek reductions in levels of pollutants referred to in the Government's National Air Quality Strategy having regard to the Mayor's Air Quality Strategy; and
- Take account of the findings of the Air Quality Review and Assessments and Action Plans, in particular where AQMAs have been designated.

2.3.13 The Mayor will work with strategic partners to ensure the spatial, transport and design policies of the London Plan support his Air Quality Strategy.

2.3.14 The Plan also includes Policy 8.2 (Planning Obligations) which states that the Mayor will provide guidance for boroughs and other partners on the preparation of frameworks for

negotiations on planning obligations reflecting strategic priorities including the improvement of Air Quality.

2.3.15 Supplementary Planning Guidance (SPG) (Greater London Authority, 2014) on 'Sustainable Design and Construction' adopted in April 2014 forms part of the Implementation Framework for the London Plan. For air pollution, the Mayor's Priorities are stated as:

- Developers are to design their schemes so that they are at least 'air quality neutral';
- Developments should be designed to minimise the generation of air pollution;
- Developments should be designed to minimise and mitigate against increased exposure to poor air quality;
- Developers should select plant that meets the standards for emissions from combined heat and power and biomass plants set out in Appendix 7 (of the document); and
- Developers and contractors should follow the guidance set out in the emerging Minimising dust and emissions from construction and demolition SPG when constructing their development.

2.3.16 The Sustainable Design and Construction SPG requires that air quality assessments are prepared for major developments where the development:

- is located within an AQMA;
- is likely to result in a new air pollution exceedance;
- is located within 150 metres of a sensitive receptor (schools, hospitals, care homes, nurseries, residential development);
- will bring sensitive receptors into an area of poor air quality;
- includes biomass boilers and/or combined heat and power; and
- involves waste management/treatment activities, mineral extraction or any other general industrial combustion process.

2.3.17 For major developments that meet the above criteria, an air quality assessment is required to be submitted with the planning application and include:

- a review of air quality around the development site using existing air quality monitoring and/or modelling data;
- air quality dispersion modelling data carried out in accordance with the London Councils Air Quality and Planning Guidance;
- an indication of the number of people (receptors) which will be exposed to poor air quality as a result of the development, and show their location on a map;
- an assessment of the impact on air quality during the construction phase and detailed mitigation methods for controlling dust and pollution emissions in line with the adopted SPG on The control of dust and emissions from construction and demolition;
- an outline and justification of mitigation measures associated with the design, location and operation of the development in order to reduce air pollution and exposure to poor air quality; and

- a maintenance regime for any combustion equipment or mitigation measures.

2.3.18 The Sustainable Design and Construction SPG provides guidance on:

- Minimising air quality emissions from location, transport, construction and demolition, and design and occupation;
- Protecting internal air quality;
- What is meant by 'air quality neutral';
- Emissions standards for combustion plant; and
- Offsetting provisions.

2.3.19 'Air quality neutral' applies across London as a whole and emission benchmarks have been proposed in terms of buildings' operation and transport emissions in order to meet this criteria. It is understood that the benchmark should be capable of being met without the need for significant additional mitigation. The emission benchmarks are summarised in **Appendix C.**

2.3.20 Where individual and/or communal gas fired boilers are installed in commercial and domestic buildings they should achieve a NO_x rating of less than 40mgNO_x/kWh. If the particular combustion equipment is not known at the time of the planning application, developers are required to provide a written statement of their commitment and ability to meet the emissions standards within their Air Quality Assessments. Emissions standards are provided for solid biomass boilers and CHP plants (see **Appendix D**).

2.3.21 Where developments do not meet the air quality neutral benchmarks, it is suggested that appropriate on-site mitigation measures will be required to off-set any excess in emissions. Measures could include:

- Green planting/walls and screens;
- Upgrade or abatement work to combustion plant;
- Retro-fitting abatement technology for vehicles and flues; and
- Exposure reduction.

2.3.22 In addition, as part of the Implementation Framework for the London Plan, a SPG on 'The Control of Dust and Emissions during Construction and Demolition' was published in July 2014 (Greater London Authority, 2014).

2.3.23 The SPG requires an Air Quality and Dust Risk Assessment to be submitted at the time of a planning application; with an Air Quality and Dust Management Plan submitted prior to the commencement of works.

2.3.24 The SPG provides guidance for:

- The preparation of an Air Quality and Dust Risk Assessment for construction and demolition activities, including air quality (dust) risk assessments;
- The stages of development the Air Quality and Dust Risk Assessment is to cover, that is for demolition, earthwork, construction stages and trackout (vehicles leaving the site) stages of the works;

- The identification of the potential scale (large, medium, small) of dust emissions for each stage of work;
- The identification of the level of risk due to the scale of dust emissions on soiling (dirt), health and the natural environment, depending on the duration of the activities, their intensity, the prevailing meteorological conditions, the existing levels of background pollution and the sensitivity of receptors to dust;
- Best practice methods for controlling dust and pollution control on-site and to prevent trackout;
- Recommendations for monitoring low, medium and high risk sites; and
- Early notification of new 2015 and 2020 standards for non-road mobile machinery.

2.3.25 The SPG also provides guidance for the use of Non-Road Mobile Machinery (NRMM) within London. It stipulates that from the 1st September 2015 NRMM of net power between 37kW and 560kW used in London would be required meet certain standards. These will apply to both variable and constant speed engines for both NO_x and PM. The standards are based upon emissions standards set in EU Directive 97/68/EC and in subsequent amendments. It states that:

- NRMM used on site of major development within Greater London will be required to meet Stage IIIA of the Directive as a minimum; and
- NRMM used on a site within the Central Activity Zone or Canary Wharf will be required to meet Stage IIIB of the Directive as a minimum.

2.3.26 Compliance with the NRMM standards should be secured by local authorities as a planning condition or s106 agreement. It is acknowledged in the SPG that developers may not know what equipment will be required during construction at the planning application stage, therefore as part of their Air Quality Dust Risk Assessment developers will be required to provide a written statement of their commitment and ability to meet these standards. This statement will be used by the local authority for the purposes of monitoring and enforcement.

Mayor's Air Quality Strategy

2.3.27 The Mayor's Air Quality Strategy (2010) (Greater London Authority, 2010) sets out policies to improve air quality in London and includes the following measures:

- Ensuring that public transport becomes cleaner;
- Reducing traffic growth by improving public transport and encouraging developers to make easy access to public transport in new developments; and
- Introduction of Phase 3 of the Low Emission Zone (LEZ) in 2012 to cover PM_{10} emissions from minibuses and heavier Light Goods Vehicles (LGVs), and a LEZ nitrogen oxides (NO_x) standard from 2015.

2.3.28 Policy 7 on 'Using the planning process to improve air quality' aims to ensure that no new development has a negative impact on air quality in London. It states that the Mayor will use his planning powers to:

- Develop a check list to guide boroughs and developers in the assessment of potential emissions from new developments;

- Minimise increased exposure to existing poor air quality, particularly in AQMAs and where developments are to be used by large numbers of vulnerable people;
- Ensure air quality benefits are realised through planning conditions and Section 106 agreements; and
- A package of non-transport policy measures is also proposed to reduce localised pollution sources.

Local Policy

2.3.29 The London Borough of Richmond upon Thames Local Plan sets out the priorities for the development of the borough and is used for decision making on planning applications. It consists of several planning documents and guidance. The main adopted documents the Core Strategy (2009) and the Development Management Plan (2011) are currently being reviewed and consulted, which took place between 4th January and 1st February 2016.

2.3.30 The Core Strategy (adopted on 21st April 2009), is the policy document which determines the future development of the borough over the next 15 years. It outlines the vision, the spatial strategy and key planning policies for the borough (London Borough of Richmond upon Thames, 2009). Policy CP1 on 'Sustainable Development' refers to air quality and states that:

"The policy seeks to maximise the effective use of resources including land, water and energy, and assist in reducing any long term environmental impacts of development…

1.D…Reducing environmental impact

…Local environmental impacts of development with respect to factors such as noise, air quality and contamination should be minimised…"

2.3.31 The Development Management Plan (DMP) adopted on November 2011, takes forward the Core Strategies' vision with more detailed policies for the control of development within the borough (London Borough of Richmond upon Thames, 2011). Policy DM DC 5 on 'Neighbourliness, Sun lighting and Daylighting' refers to pollution considerations when proposing a development. It states that:

"In considering proposals for development the Council will seek to protect adjoining properties from unreasonable loss of privacy, pollution, visual intrusion, noise and disturbance…"

London Borough of Richmond upon Thames Air Quality Action Plan

2.3.32 The Borough's Air Quality Action Plan (2013 update) presents the actions the Borough will take in order to help reduce key pollutants in Richmond upon Thames - Nitrogen Dioxide (NO_2) and Particulate Matter (PM_{10}) - which mainly arise from traffic and boilers. Since 2000, the whole borough has been designated an Air Quality Management Area (AQMA) for exceedances of NO_2 and PM_{10} concentrations (London Borough of Richmond upon Thames, 2013).

2.3.33 Some of actions presented in the Air Action plan are the following:

- Promote Travel Plan to businesses.
- Refuse planning consent for activities, which are likely to lead to a significant worsening of air pollution in 'hot spots' areas.
- Encourage the use of alternative fuel vehicles and encourage the development of an appropriate refuelling infrastructure.

- Promote travel choice through improvements for pedestrians, cyclists and to public transport in terms of increased capacity, reliability, accessibility and quality.
- Use of air quality monitors in schools to promote the importance of air quality and health.

3 Methodology

3.1 Existing Conditions

3.1.1 Information on existing air quality has been obtained by collating the results of monitoring carried out by the London Borough of Richmond upon Thames (LBRuT). Background concentrations for the site have been defined using the national pollution maps published by Defra. These cover the whole country on a 1x1 km grid (Defra, 2016).

3.2 Construction Impacts

3.2.1 During demolition and construction the main potential effects are dust annoyance and locally elevated concentrations of PM_{10}. The suspension of particles in the air is dependent on surface characteristics, weather conditions and on-site activities. Impacts have the potential to occur when dust generating activities coincide with dry, windy conditions, and where sensitive receptors are located downwind of the dust source.

3.2.2 Separation distance is also an important factor. Large dust particles (greater than 30 µm), responsible for most dust annoyance, will largely deposit within 100 m of sources. Intermediate particles (10-30 µm) can travel 200-500 m. Consequently, significant dust annoyance is usually limited to within a few hundred metres of its source. Smaller particles (less than 10 µm) are deposited slowly and may travel up to 1 km; however, the impact on the short-term concentrations of PM_{10} occurs over a shorter distance. This is due to the rapid decrease in concentrations with distance from the source due to dispersion.

3.2.3 The Sustainable Design and Construction SPG (the SPG) (Greater London Authority, 2014) outlines the risk evaluation to consider based on the site evaluation process set out in the Institute of Air Quality Management (IAQM) 2014 guidance on the assessment of dust from demolition and construction (Holman *et al*, 2014).

3.2.4 In accordance with the SPG, the dust emission magnitude is defined as either large, medium or small (**Table 3.1**) taking into account the general activity descriptors on site and professional judgement.

3.2.5 The sensitivity of the study area to construction dust impacts is defined as high, medium and low (**Table 3.2**), taking into account professional judgement.

Table 3.1: Criteria for Dust Emission Magnitude

Dust Emission Magnitude	Activity
Large	**Demolition** >50,000 m^3 building demolished, dusty material (e.g. concrete), on-site crushing/screening, demolition >20 m above ground level
	Earthworks >10,000 m^2 site area, dusty soil type (e.g. clay), >10 earth moving vehicles active simultaneously, >8 m high bunds formed, >100,000 tonnes material moved
	Construction >100,000 m^3 building volume, on site concrete batching, sandblasting

Dust Emission Magnitude	Activity
	Trackout >50 HDVs out / day, dusty soil type (e.g. clay), >100 m unpaved roads
Medium	**Demolition** 20,000 - 50,000 m^3 building demolished, dusty material (e.g. concrete) 10-20 m above ground level
	Earthworks 2,500 - 10,000 m^2 site area, moderately dusty soil (e.g. silt), 5-10 earth moving vehicles active simultaneously, 4 m – 8 m high bunds, 20,000 - 100,000 tonnes material moved
	Construction 25,000 - 100,000 m^3 building volume, on site concrete batching
	Trackout 10 - 50 HDVs out / day, moderately dusty surface material, 50 -100 m unpaved roads
Small	**Demolition** <20,000 m^3 building demolished, non-dusty material, <10 m above ground level, work in winter
	Earthworks <2,500 m^2 site area, non-dusty soil, <5 earth moving vehicles active simultaneously, <4 m high bunds, <20,000 tonnes material moved
	Construction <25,000 m^3, non-dusty material
	Trackout <10 HDVs out / day, non-dusty soil, < 50 m unpaved roads

Table 3.2: Area Sensitivity Definitions

Area Sensitivity	People and Property Receptors	Ecological Receptors
High	>100 dwellings, hospitals, schools, care homes within 50 m 10 – 100 dwellings within 20 m Museums, car parks, car showrooms within 50 m PM_{10} concentrations approach or are above the daily mean objective.	National or Internationally designated site within 20 m with dust sensitive features / species present
Medium	>100 dwellings, hospitals, schools, care homes within 100 m 10 – 100 dwellings within 50 m	National or Internationally designated site within 50 m with dust sensitive features / species present

Area Sensitivity	People and Property Receptors	Ecological Receptors
	Less than 10 dwellings within 20 m Offices/shops/parks within 20 m PM_{10} concentrations below the daily mean objective.	Nationally designated site or particularly important plant species within 20 m
Low	>100 dwellings, hospitals, schools, care homes 100 – 350 m away 10 – 100 dwellings within 50 – 350 m Less than 10 dwellings within 20 – 350 m Playing fields, parks, farmland, footpaths, short term car parks, roads, shopping streets PM_{10} concentrations well below the daily mean objective.	Nationally designated site or particularly important plant species 20 – 50 m Locally designated site with dust sensitive features within 50 m

3.2.6 Based on the dust emission magnitude and the area sensitivity, the risk of dust impacts is then determined (**Table 3.3**), taking into account professional judgement.

Table 3.3: Risk of Dust Impacts

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High	Medium	Low
Medium	Medium	Medium	Low
Low	Low	Low	Negligible

3.2.7 Based on the risk of dust impacts, appropriate mitigation is selected using professional judgement.

Significance Criteria

3.2.8 The construction impact significance criteria are based on the SPG. The guidance recommends that no assessment of the significance of effects is made without mitigation in place, as mitigation is assumed to be secured by planning conditions, legal requirements or required by regulations.

3.2.9 With appropriate mitigation in place, the residual effect of construction impacts on air quality is assessed as not significant.

3.3 Road Traffic Impacts

Sensitive Locations

3.3.1 Relevant sensitive locations are places where members of the public might be expected to be regularly present over the averaging period of the objectives. For the annual mean and daily mean objectives that are the focus of this assessment, the proposed locations are considered to be sensitive receptors.

3.3.2 Ten locations on the façade of the proposed building have been chosen as proposed receptors (see **Figure 1**); such receptors are described in **Table 3.4** below.

Table 3.4: Proposed Receptors Description

Proposed Receptor	Floor Level	Model Height (m)	Type
PR1	First Floor	5.5	Residential / Balcony
	Second Floor	8.5	
PR2	First Floor	5.5	Residential
	Second Floor	8.5	
PR3	First Floor	5.5	Residential
	Second Floor	8.5	
PR4	First Floor	5.5	Residential
	Second Floor	8.5	
PR5	First Floor	5.5	Residential
	Second Floor	8.5	
PR6	First Floor	5.5	Residential / Balcony
	Second Floor	8.5	
PR7	First Floor	5.5	Residential
	Second Floor	8.5	
PR8	First Floor	5.5	Residential
	Second Floor	8.5	
PR9	First Floor	5.5	Residential / Balcony
	Second Floor	8.5	
PR10	First Floor	5.5	Residential / Balcony
	Second Floor	8.5	

3.3.3 Concentrations have also been predicted at four diffusion tubes located in close proximity to the site, tube ID's 7, 45, 47 and 60 in order to verify the modelled results. The tubes were modelled at a height of 2 m for tube 7 and the rest were modelled at a height of 2.2 m (see **Appendix E** for further details on the verification method).

Impact Predictions

3.3.4 Predictions have been carried out using the ADMS-Roads dispersion model (v4.0.1.0). The model requires the user to provide various input data, including the Annual Average Daily Traffic (AADT) flow, the proportion of Heavy Duty Vehicles (HDVs), road characteristics (including road width and street canyon height, where applicable), and the vehicle speed. It also requires meteorological data. The model has been run using 2015 meteorological data from the Heathrow Airport monitoring station, which is considered suitable for this area.

3.3.5 AADT flows and the proportions of HDVs, for roads within 250 m of the proposed development site and monitoring sites used for model verification have been taken from the London

Atmospheric Emissions Inventory (LAEI). Traffic data used in this assessment is summarised in **Appendix F**.

3.3.6 Emissions were calculated using the Emission Factor Toolkit (EFT) v6.0.1, incorporated within ADMS-Roads (v4.0.1.0). The traffic data were entered into the model, along with speed data to provide combined emission rates for each of the road links entered into the model. The modelling has been verified against 2015 monitoring data as this was the most recent available. In order to take account of uncertainties relating to future year vehicle emissions, an assessment has been carried out utilising 2015 emission factors and background concentrations, thus assuming no improvement in vehicle emissions or concentrations.

Assessment Criteria

3.3.7 The NAQOs for NO_2 and PM_{10} set out in the Air Quality Regulations (England) 2000) and the Air Quality (England) (Amendment) Regulations 2002 are shown in **Table 3.5**.

Table 3.5: NO_2 and PM_{10} Objectives

Pollutant	Time Period	Objective
Nitrogen dioxide (NO_2)	1-hour mean	200µg/m^3 not to be exceeded more than 18 times a year
	Annual mean	40µg/m^3
Particulate matter (PM_{10})	24-hour mean	50µg/m^3 not to be exceeded more than 35 times a year
	Annual mean	40µg/m^3

3.3.8 The objectives for NO_2 and PM_{10} were to have been achieved by 2005 and 2004, respectively, and continue to apply in all future years thereafter. Analysis of long-term monitoring data suggests that if the annual mean NO_2 concentration is less than 60µg/m^3 then the one-hour mean NO_2 objective is unlikely to be exceeded where road transport is the main source of pollution. This concentration has been used to screen whether the one-hour mean objective is likely to be achieved (Carslaw, 2011).

Significance

3.3.9 There is no official guidance in the UK on how to assess the significance of air quality impacts of existing sources on a new development. The approach developed by Environment Protection UK (EPUK) and the Institute of Air Quality Management (IAQM) (Moorcroft and Barrowcliffe et al, 2015), considers the change in air quality as a result of a proposed development on existing receptors. However, as the proposed development is anticipated to generate an insignificant amount of traffic to the local network the significance criteria are therefore not considered relevant to this assessment.

3.3.10 The assessment has been limited to predicting air quality at the site and the significance of this is based on whether the National Air Quality Objectives for each pollutant are exceeded or not.

4 Baseline Conditions

4.1 LAQM

4.1.1 LBRuT has investigated air quality within its area as part of its responsibilities under the LAQM regime. A whole borough AQMA has been declared due to exceedances of the annual and hourly mean NO_2 objectives and the 24-hr mean for PM_{10} objectives.

4.2 Monitoring

Nitrogen Dioxide

4.2.1 LBRuT carried out monitoring of NO_2 utilising automatic monitors located across the borough, none of these are in close proximity to the proposed site. The Council has deployed 62 diffusion tubes across the area. The closest and most representative locations are described **Table 4.1** below and shown in **Figure 2**.

Table 4.1: Measured NO_2 Concentrations, 2011-2015

ID	Site Type	Within AQMA	Annual Mean (µg/m^3)				
			2011	2012	2013	2014	2015
7*	K	Y	**49**	**59**	**61**	**58**	**47**
47*	R	Y	33	**40**	**40**	36	32
60*	K	Y	-	**40**	32	26	27
45*	K	Y	**44**	**43**	**48**	**41**	35
Objective			**40**				

Exceedances of the objective highlighted in bold.
R= Roadside; K=Kerbside
2011 – 2015 provided by LBRuTs' EHO Carol Lee
*Used for model verification

4.2.2 Measured concentrations have been above the objective at monitoring site 7 over the 2011 – 2015 time period. The rest of the monitoring sites have experienced exceedences in different years over the same time period. In overall terms, NO_2 concentrations have slightly reduced since 2011.

Particulates (PM_{10})

4.2.3 There is no PM_{10} monitoring being undertaken in close proximity to the site.

4.3 Background Concentrations

4.3.1 In addition to these measured concentrations, estimated background concentrations for the site have been obtained from the national maps provided by Defra (**Table 4.2**; Defra, 2016).

4.3.2 The NO_2 background concentrations at the site are well below the relevant objectives.

Table 4.2: Estimated Annual Mean Background Concentrations

Year	Annual Mean (µg/m^3)		
	NO_x	NO_2	PM_{10}
2015	35.8	23.7	19.2
Objectives	**-**	**40**	**40**

5 Impact Assessment

5.1 Construction Impacts

5.1.1 The main potential effects during construction are dust deposition and elevated PM_{10} concentrations. The following activities have the potential to cause emissions of dust:

- Site preparation including delivery of construction material, erection of fences and barriers;
- Demolition of existing buildings on site;
- Earthworks including digging foundations and landscaping;
- Materials handling such as storage of material in stockpiles and spillage;
- Construction and fabrication of units; and
- Disposal of waste materials off-site.

5.1.2 Typically the main cause of unmitigated dust generation on construction sites is from demolition and vehicles using unpaved haul roads, and off-site from the suspension of dust from mud deposited on local roads by construction traffic. The main determinants of unmitigated dust annoyance are the weather and the distance to the nearest receptor.

5.1.3 Based on the SPG criteria (**Table 3.1**), the risk of dust emissions is considered to be small. The study area is considered to be of high sensitivity (**Table 3.2**), as there are more than 10 dwelling within 20 m of the proposed site. Appropriate mitigation corresponding to a low risk site is therefore required during the construction phase (**Table 3.3**) (see **paragraph 6.1.1**). With appropriate mitigation in place the construction impacts as described as not significant.

5.2 Road Traffic Impacts

5.2.1 Predicted concentrations at PR1 – PR10 modelled receptor locations are presented in **Appendix G**. Details of the proposed receptors are shown in **Table 3.4** (see **Figure 1**).

5.2.2 There are no predicted exceedances of the long-term annual mean NO_2 and PM_{10} concentrations at any of the proposed receptor locations at first and second floor levels.

Uncertainty

5.2.3 There are many components that contribute to the uncertainty in predicted concentrations. The model used in this assessment is dependent upon the traffic data that have been input which will have inherent uncertainties associated with them. There is then additional uncertainty as the model is required to simplify real-world conditions into a series of algorithms.

5.2.4 A disparity between the national road transport emission projections and measured annual mean concentrations of nitrogen oxides and NO_2 has been identified in recent years. Whilst projections suggest that both annual mean nitrogen oxides and nitrogen dioxide concentrations from road traffic emissions should have fallen by around 15-25% over the past 6 to 8 years, at many monitoring sites levels have remained relatively stable, or have even shown a slight increase.

5.2.5 In order to take account of uncertainties in future year vehicle emission factors, the assessment has been carried out for 2015, utilising 2015 emission factors and background concentrations. This is considered to provide a conservative assessment of concentrations on site.

5.3 Air Quality Neutral Calculations

Transport Emissions

5.3.1 The 'Air Quality Neutral' calculations for transport emissions for the proposed development are described in **Tables 5.1**, **5.2**, and **5.3** below.

Table 5.1: Proposed Development Land use/Class and Trip Generation

Land use/Class	No. dwellings	GFA (m^2)	Trips/day	Trips/annum
Residential (C3)	23	-	53	19,345
Office (B1)	-	303	21	7,665

Table 5.2: Transport Emissions Benchmarks (TEBs), Emission Factors and Average Distance Travelled for Outer London

Land use/Class	TEBs*		Emission Factors**		Average Distanced Travelled (km)
	NO_x	PM_{10}	NO_x	PM_{10}	
Residential (C3)	1,553	267	0.3530	0.0606	11.4
Office (B1)	68.5	11.8			10.8

*Units: g/dwelling/annum; **g/vehicle-km

5.3.2 The number of dwellings and TEBs for each pollutant is multiplied to calculate the benchmark emissions for the development.

5.3.3 The number of trips generated by the development are combined with the emission factors and average distanced travelled by vehicles in outer London in order to calculate the total emissions for the development. A comparison between the developments' benchmarked and total emissions are show in **Table 5.6** below.

Table 5.3: Proposed Development Benchmarks

Land use/Class	Benchmarked Emissions*		Proposed Development Emissions*		Comparison to Benchmarked Emissions*	
	NO_x	PM_{10}	NO_x	PM_{10}	NO_x	PM_{10}
Residential (C3)	35.7	6.1	77.8	13.4	+42.1	+7.3
Office (B1)	20.8	3.6	29.2	5.0	+8.4	+1.4
Total	56.5	9.7	107.1	18.4	+50.6	+8.7

*Units: kg/annum

5.3.4 The transport NO_x and PM_{10} emissions are approximately 89% above the benchmark requirements of the SPG. In essence, the emission benchmark is exceeded due to the agreed trip generation from the development being above the trip generation benchmarks contained within the SPG.

6 Mitigation

6.1 Construction

6.1.1 The following standard low risk mitigation measures from the SPG guidance are recommended. An Air Quality and Dust Management Plan should be submitted to the Local Authority prior to works commencing on site.

Site Management

- Display the name and contact details of persons accountable on the site boundary;
- Display the head or regional office information on the site boundary;
- Record and respond to all dust and air quality pollutant emissions complaints;
- Make a complaint log available to the local authority when asked;
- Carry out regular site inspections to monitor compliance with air quality and dust control procedures, record inspection results, and make an inspection log available to the local authority when asked;
- Increase site inspection frequency during prolonged dry or windy conditions and when activities with high dust potential are being undertaken; and
- Record any exceptional incidents that cause dust and air quality pollutant emissions, either on or off the site, and the action taken to resolve the situation is recorded in the log book.

Preparing and Maintaining the Site

- Plan site layout so that machinery and dust causing activities are located away from receptors, as far as possible;
- Erect solid screens or barriers around dusty activities or the site boundary at least as high as any stockpile on site;
- Fully enclose the site or specific operations where there is a high potential for dust production and the site is active for an extensive period;
- Avoid site run off of water or mud; and
- Remove potentially dusty materials from site as soon as possible.

Operating Vehicle/Machinery

- Ensure all on road vehicles comply with the London Low Emission Zone;
- Ensure all non-road mobile machinery comply with the standards; where applicable;
- Ensure all vehicles switch off engines when stationary;
- Avoid the use of diesel or petrol powered generators where possible;

- Impose and signpost a maximum speed limit of 10mph on surface haul and work areas; and
- Implement a Travel Plan that supports and encourages sustainable travel (public transports, cycling, walking, and car-sharing).

Operations

- Only use cutting, grinding and sawing equipment with dust suppression equipment;
- Ensure an adequate supply of water on site for dust suppressant;
- Use enclosed chutes and conveyors and covered skips; and
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use water sprays on such equipment where appropriate.

Waste Management

- Reuse and recycle waste to reduce dust from waste materials; and
- Avoid bonfires and burning of waste materials on site.

Demolition

- Use of soft strip inside buildings before demolition;
- Ensure effective water suppression is used during demolition operations;
- Avoid explosive blasting; and
- Bag and remove any biological debris or damp down such material before demolition.

Construction

- Avoid scabbling (roughening of concrete surfaces) if possible; and
- Ensure sand and other aggregates are stored in bunded areas and are not allow to dry out.

Trackout

- Regularly use a water-assisted dust sweeper on the access and local roads, as necessary to remove any material track on the site;
- Avoid dry sweeping of large areas;
- Ensure vehicles entering and leaving sites are securely covered to prevent escape of materials during transportation; and
- Implement a wheel washing system.

6.2 Operation

6.2.1 As predicted concentrations at residential receptor locations within the proposed development are below the air quality objectives, no further air quality mitigation measures are required for the residential properties. The site is considered suitable for future residents of the site.

6.2.2 As the development does not meet air quality neutral benchmarks for transport emissions, then in accordance with the SPG off-setting provisions should be considered such as planting green walls and / or screens with plants that absorb or suppress pollutants.

7 Conclusions

7.1.1 The air quality impacts associated with the proposed redevelopment of the site at High Street, Teddington located within the boundary of the London Borough of Richmond upon Thames have been assessed.

7.1.2 A whole borough AQMA has been declared in Richmond upon Thames due to exceedences of the annual and hourly mean NO_2 and the 24-hr mean for PM_{10} objectives.

7.1.3 The construction works have the potential to create dust. During construction it is recommended that a package of mitigation measures is put in place to minimise the risk of elevated PM_{10} concentrations and dust nuisance in the surrounding area within aAir Quality and Dust Management Plan. With mitigation in place the construction impacts are judged as not significant.

7.1.4 The long-term objectives for NO_2 and PM_{10} are not predicted to be exceeded at any of the proposed residential receptor locations modelled at first and second floor levels. Given this, the proposed development is considered suitable for residential development without the need for further mitigation measures.

7.1.5 Additional mitigation to meet the requirements of the air quality neutral criteria may be required.

Appendix A Glossary

AADT	Annual Average Daily Traffic
AQAP	Air Quality Action Plan
AQA	Air Quality Assessment
AQMA	Air Quality Management Area
BEB	Building Emission Benchmark
CAZ	Central Activity Zone
CHP	Combustion Heat and Power
DEFRA	Department for Environment, Food and Rural Affairs
Diffusion Tube	A passive sampler used for collecting NO_2 in the air
EFT	Emission Factor Toolkit
EHO	Environmental Health Officer
EPUK	Environmental Protection UK
HDV	Heavy Duty Vehicle; a vehicle with a gross vehicle weight greater than 3.5 tonnes Includes Heavy Gross Vehicles and buses
IAQM	Institute for Air Quality Management
LAEI	London Atmospheric Emissions Inventory
LAQM	Local Air Quality Management
LBRuT	London Borough of Richmond upon Thames
LEZ	Low Emission Zone
LGV	Light Good Vehicle
NAQO	National Air Quality Objective as set out in the Air Quality Strategy and the Air Quality Regulations
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides, generally considered to be nitric oxide and NO_2. Its main source is from combustion of fossil fuels, including petrol and diesel used in road vehicles
NPPF	National Planning Policy Framework
NRMM	Non-Road Mobile Machinery
PM_{10}	Small airborne particles less than 10μm in diameter
PPG	Planning Practice Guidance

TEB	Transport Emission Inventory
Receptor	A location where the effects of pollution may occur
SPG	Supplementary Planning Guidance

Appendix B References

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Statutory Instrument 2010, No. 1001, '*The Air Quality Standards Regulations 2010'* HMSO, London

Appendix C Benchmarks

C.1 Air Quality Neutral Emissions Benchmarks for Buildings

C.1.1 The following table provides the Building Emissions Benchmarks based on the gross floor area for each type of development class.

Table C.1: 'Air Quality Neutral' Emissions Benchmarks for Buildings (BEBs)

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

The gross floor area (GFA) is used to define the area.

C.2 Air Quality Neutral Emissions Benchmarks for Transport

C.2.1 The following table provides the Transport Emissions Benchmarks based on the gross floor area and the location of the development.

Table C.2: 'Air Quality Neutral' Emissions Benchmarks for Transport (TEBs)

Land Use	CAZ	Inner	Outer
NO_x (g/m^2/annum)			
Retail (A1)	169	219	249
Office (B1)	1.27	11.4	68.5

Land Use	CAZ	Inner	Outer
NO_x (g/dwelling/annum)			
Residential (C3)	234	558	1553
PM_{10} (g/m^2/annum)			
Retail (A1)	29.3	39.3	42.9
Office (B1)	0.22	2.05	11.8
PM_{10} (g/dwelling/annum)			
Residential (C3,C4)	40.7	100	267

Appendix D Emissions Standards

D.1.1 Developments are to meet these emission standards along with the 'air quality neutral' benchmark values. Where meeting these emission standards still does not allow the air quality neutral benchmarks to be met, further reduction or offsetting measures would be required.

D.1.2 The emission standards are 'end-of-pipe' concentrations expressed at specific reference conditions for temperature, pressure, oxygen and moisture content. Compliance with these standards should be demonstrated based on monitoring undertaken on the actual installed plant or, where this does not exist at planning application stage, based on manufacturer guaranteed performance levels supported by type approval monitoring undertaken by the equipment supplier. At the very least, a statement of intent to only include combustion plant within the development that meets these standards must be made at application stage. Providing further details on actual installed combustion plant and emissions performance prior to full operation of the development should be made compulsory by way of planning condition. It is not permissible for emission factors (e.g. g/kWh, g/GJ etc) to be converted into an equivalent concentration for compliance purposes.

D.1.3 To deliver both reductions in carbon dioxide emissions and improve air quality a tiered approach has been developed for applicable emission standards. This approach is based upon differentiation according to the baseline air quality in the area of development and will be dependent upon whether or not the development falls into the two tiers defined below.

Table D.1: Emission Standards for Solid Biomass Boilers and CHP Plant in the Thermal Input range 50kWth – 20 MWth

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

D.1.4 The emission standards below are target minimum standards. If an assessment indicates that significant air quality effects may occur even when meeting the emission standards, additional measures (such as stack height increase, enforcement of more stringent standards etc.) should be considered in order to produce an acceptable level of impact.

Table D.2: Emission Standards for Solid Biomass Boilers and CHP Plant in the Thermal Input Range 50kWth to less than 20MWth for development in Band A

Combustion Applicance[A]	Pollutant / Parameter	Emission Standard at Reference O_2 (mg Nm^{-3})	Equivalent Concentration at 0% O_2 (mg Nm^{-3})	Likely Technique Required to Meet Emissions Standard
Spark ignition engine (natural gas/biogas)[B]	NO_x	250	329	Advanced lean burn operation (lean burn engines) NSCR (rich burn engines)

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

[A] Combustion appliances operating less than 500 hours per annum are exempt from these standards
[B] Emission standard quoted at reference conditions 273K, 101.3kPa, 5% O_2, dry gas
[C] Emission standard quoted at reference conditions 273K, 101.3kPa, 15% O_2, dry gas
[D] Emission standard quoted at reference conditions 273K, 101.3kPa, 6% O_2, dry gas
[E] The stack heat release can be calculated as per equation (3) in the D1 guidance note:

$$Q = \frac{V\left(1-\frac{283}{T}\right)}{2.9}$$

Where:
Q= Stack heat release (MW)
V = Volume flow of stack gases at discharge conditions (Am^3s^{-1})
T = Discharge temperature (K)
N.B. Stacks should discharge vertically upwards and be unimpeded by any fixture on top of the stack (e.g., rain cowls, 'China-man Hats')

Table D.3: Emission Standards for Solid Biomass Boilers and CHP Plant in Thermal Input Range 50kWth to less than 20MWth for development in Band B

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

[A] Combustion appliances operating less than 500 hours per annum are exempt from these standards
[B] Emission standard quoted at reference conditions 273K, 101.3kPa, 5% O_2, dry gas
[C] Emission standard quoted at reference conditions 273K, 101.3kPa, 15% O_2, dry gas
[D] Emission standard quoted at reference conditions 273K, 101.3kPa, 6% O_2, dry gas
[E] The stack heat release can be calculated as per equation (3) in the D1 guidance note:

$$Q = \frac{V\left(1-\frac{283}{T}\right)}{2.9}$$

Where:
Q= Stack heat release (MW)
V = Volume flow of stack gases at discharge conditions (Am^3s^{-1})
T = Discharge temperature (K)

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

Appendix E Model Verification

Nitrogen Dioxide

Most nitrogen dioxide is produce in the atmosphere by the reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emission of nitrogen oxides (NO_x = NO + NO_2). The model has been run to predict the 2015 annual mean road-NO_x contribution at four roadside and kerbside monitoring locations in close proximity to the proposed development (described in **Table 4.1**). Diffusion tubes 7, 47 and 45 were modelled adding a canyon effect with canyon heights of 7 m, 13 m and 12 m respectively.

The model output of road-NO_x has been compared with the 'measured' road-NO_x, which was calculated from the measured NO_2 concentrations and the adjusted background NO_2 concentrations within the NO_x from NO_2 calculator published by Defra.

A primary adjustment factor was determined as the slope of the best fit line between the 'measured' road contribution and the model derived road contribution, forced through zero (**Figure E.1**). This factor was then applied to the modelled road-NO_x concentration for each monitoring site to provide adjusted modelled road-NO_x concentrations. The total NO_2 concentrations were then determined by combining the adjusted modelled road-NO_x concentrations with the predicted background NO_2 concentration within the NO_x from NO_2 calculator. A secondary adjustment factor was finally calculated as the slope of the best fit line applied to the adjusted data and forced through zero (**Figure E.2**).

The following primary and secondary adjustment factors have been applied to all modelled NO_2 data:

Primary adjustment factor: 3.6016

Secondary adjustment factor: 0.9739

The results imply that the model was under-predicting the road-NO_x contribution. This is a common experience with this and most other models. The final NO_2 adjustment is minor.

Figure E.3 compares final adjusted modelled total NO_2 at each of the monitoring sites, to measured total NO_2, and shows the 1:1 relationship, as well as ±10% and ±25% of the 1:1 line. All of the monitoring sites lie within the ±25% line.

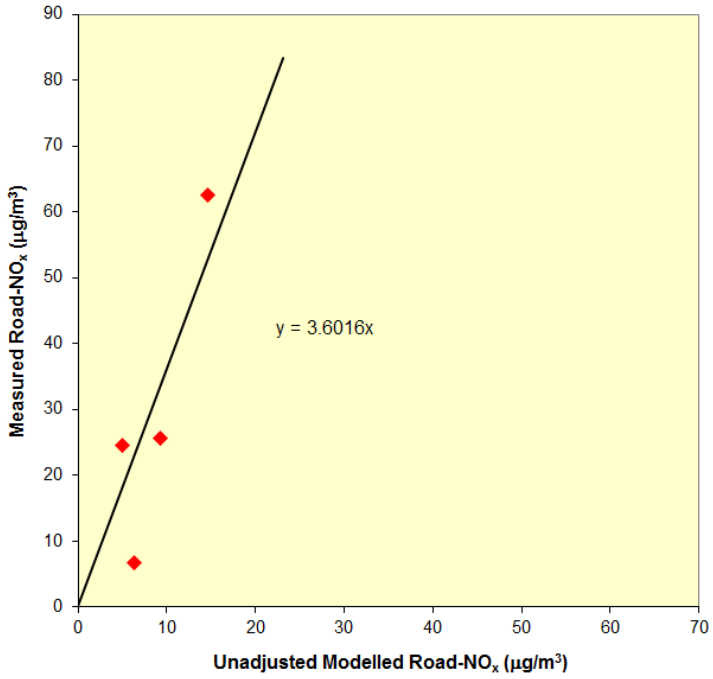


Figure E.1: Comparison of Measured Road-NO_x with Unadjusted Modelled Road-NO_x Concentrations

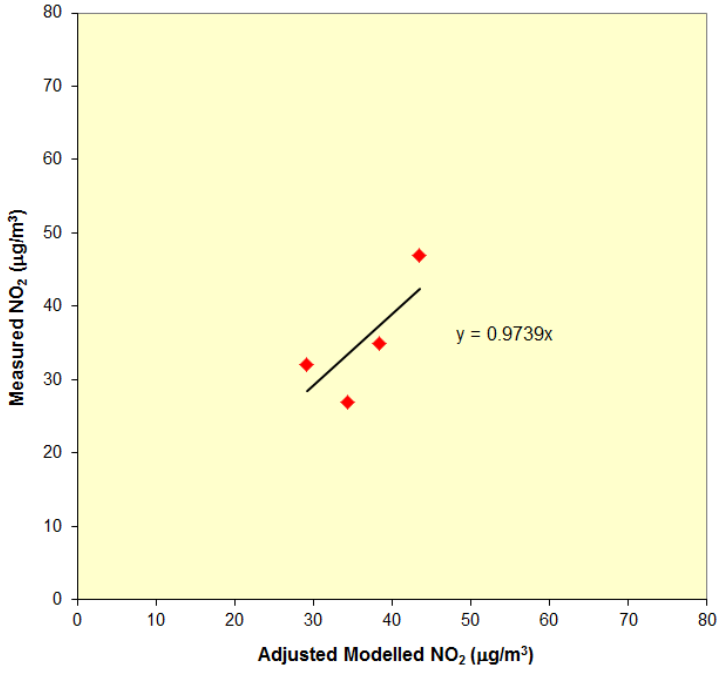


Figure E.2: Comparison of Measured NO_2 with Primary Adjusted Modelled NO_2 Concentrations

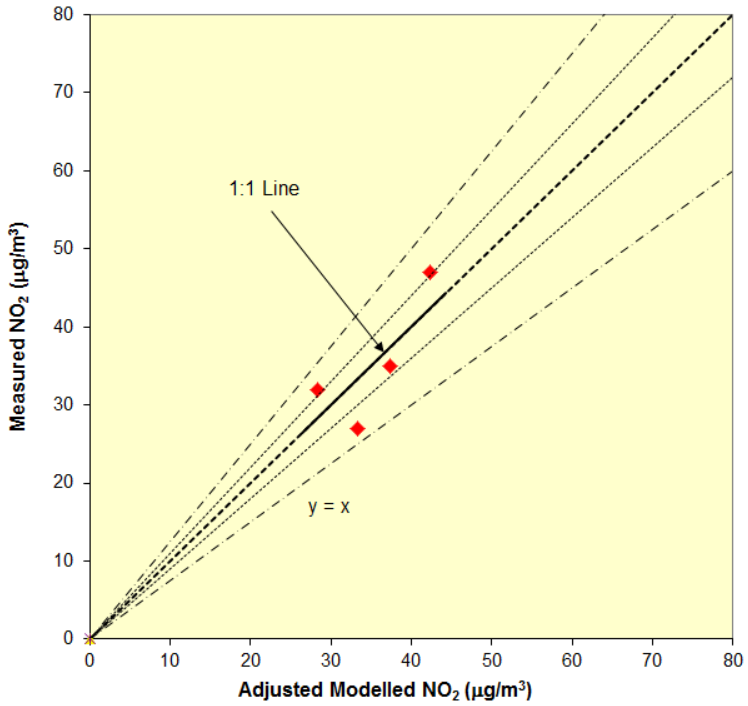


Figure E.3: Comparison of Measured NO_2 with Fully Adjusted Modelled NO_2 Concentrations

PM_{10}

No monitoring of PM_{10} is carried out in proximity to the development site. The primary adjustment factor calculated for NO_2 concentrations has therefore been applied to the modelled road-PM_{10} concentrations.

Appendix F Traffic Data

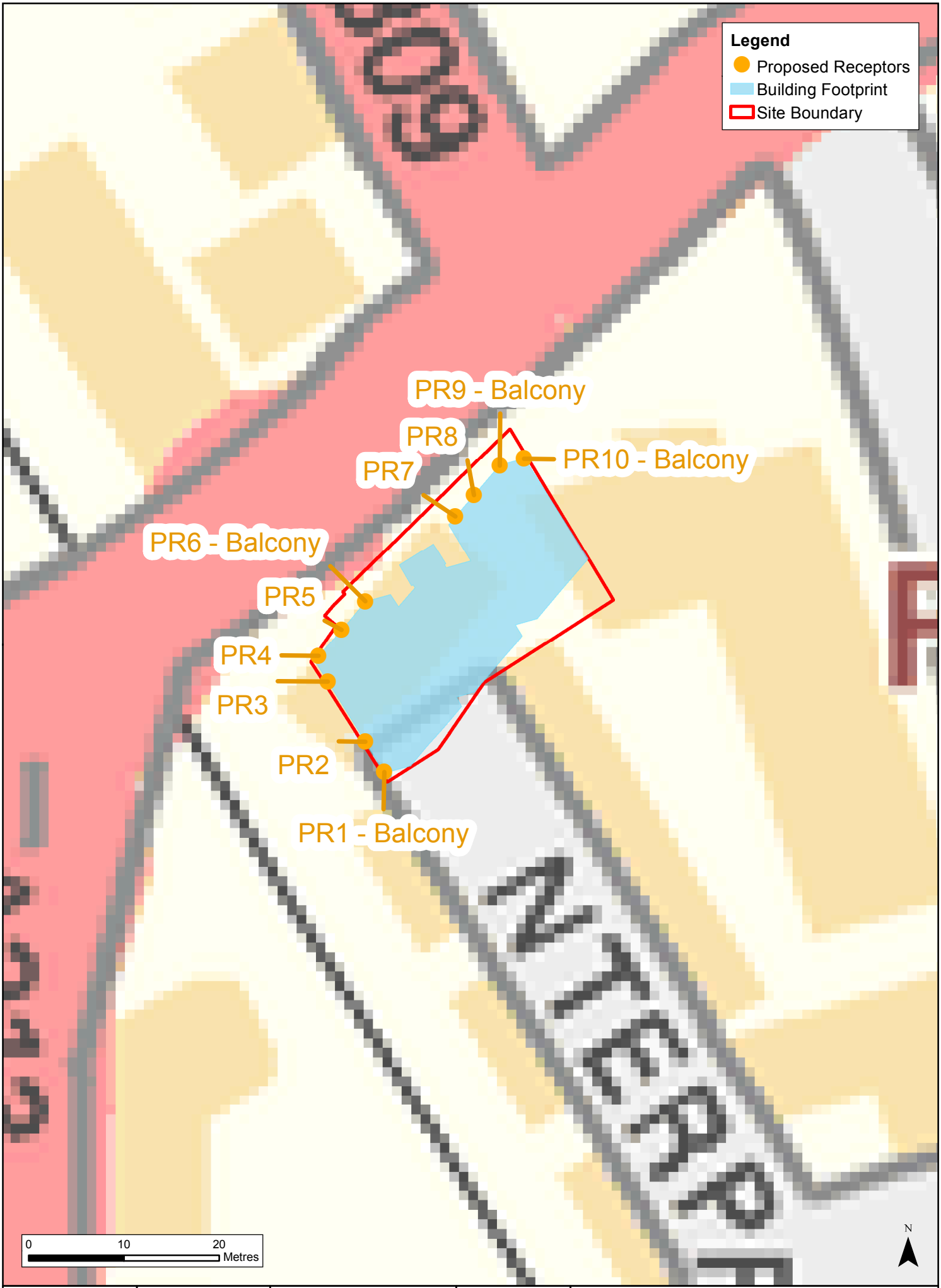
Location	2015	
	AADT	%HDV
High Street	12,528	7
Waldegrave Road	12,075	4
High Street (between roundabouts)	19,787	7
High Street (west of roundabout)	19,811	7
Park Road	9,448	3
The Causeway	123	73
Church Road	5,393	2
Broad Street	19,901	7
Queen's Road	3,3359	5
Hampton Road	19,296	5
Stanley Road	8,640	9

Appendix G Predicted Concentrations

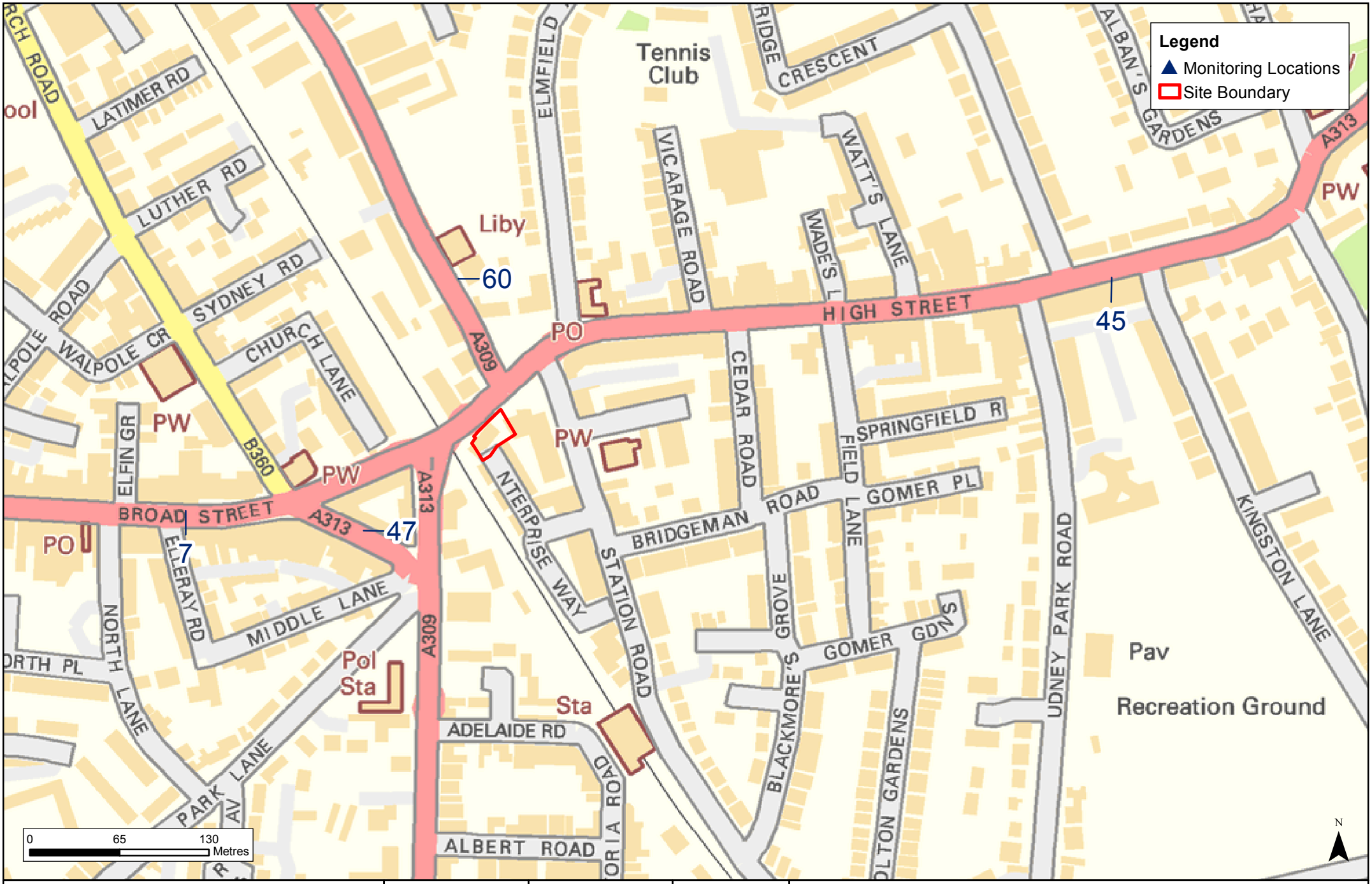
Table G.1 – (Part 1): Predicted Annual Mean NO_2 and PM_{10} Concentrations at Proposed Receptors, (2015)

Receptor	Annual Mean (µg/m^3)			
	NO_2		PM_{10}	
	First Floor (5.5 m)	Second Floor (8.5 m)	First Floor (5.5 m)	Second Floor (8.5 m)
PR1	31.0	29.3	20.2	20.0
PR2	31.7	29.8	20.3	20.0
PR3	33.9	30.8	20.6	20.2
PR4	35.0	31.2	20.7	20.2
PR5	34.9	31.0	20.7	20.2
PR6	34.7	30.8	20.7	20.2
PR7	34.1	30.0	20.6	20.1
PR8	34.1	29.9	20.6	20.1
PR9	34.3	29.9	20.6	20.0
PR10	33.9	29.8	20.6	20.0
Objective	**40**			

Appendix H Figures



pba peterbrett	Richmond Housing Partnership (RHP)	Contains Ordnance Survey Data © Crown Copyright and Database Right 2016	1:500 @ A4 30/06/2016 Drawn: YO Checked: GH	**High Street, Teddington** Air Quality Receptors	Figure 1 | Rev A



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Informer House, Teddington

Air Quality Monitoring Locations

Figure 2 | Rev A

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