

7. NOISE & VIBRATION

Introduction

7.1 This chapter of the ES assesses the likely significant effects of the Development on the environment in respect of Noise & Vibration. This chapter has been prepared by RBA Acoustics Ltd. The assessment team are members of the following professional bodies:

- Institute of Acoustics
- Association of Noise Consultants
- Institute of Environmental Management and Assessment

7.2 This chapter describes the methods used to assess the effects; the baseline conditions currently experienced at the Site and in the surrounding area; likely future conditions; the mitigation measures required to prevent, reduce or offset any significant adverse effects; the likely residual effects after these measures have been adopted, and; cumulative effects considering other local consented developments.

7.3 A glossary of acoustic terminology is included in Appendix 7.1.

Policy Context

National Planning Policy Frameworkⁱ

7.4 Published in February 2019, the National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these are expected to be applied. Reference to noise is made in in Section 16: Conserving and enhancing the natural environment, paragraph 170 of the NPPF, which states that:

"Planning policies and decisions should contribute to and enhance the natural and local environment by:

[...]

(e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basing management plans."

4.1. Noise is also referenced within the ground conditions and pollution sub-section within Section

15: Conserving and enhancing the natural environment:

"180. Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

*Mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;
Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason."*

Noise Policy Statement for Englandⁱⁱ

7.5 Reference is made in the NPPF to the Department for Environment, Food and Rural Affairs (DEFRA) 2010 *Noise Policy Statement for England* (NPSfE). The NPSfE is intended to apply to all forms of noise other than that which occurs in the workplace, and includes environmental noise and neighbourhood noise in all forms. The NPSfE advises that the effect of noise should be assessed on the basis of negative and significant negative effect, but does not provide any specific guidance on assessment methods or limit sound levels. This lack of numeric limit sound levels is a direct consequence of the advice also contained in the NPSfE which is that it is not possible to have "*a single objective noise-based measure that is applicable to all sources of noise in all situations*".

7.6 It further advises that the sound level at which a negative effect occurs is "*likely to be different for different noise sources, for different receptors and at different times*". In the absence of specific guidance within the NPPF and NPSfE for the assessment of environmental noise, it is considered appropriate to base assessment on LPA requirements, current British Standards and national and international guidance (as described later in this Chapter). However, one noteworthy advisory point in the NPSfE is the need to place into context any general requirements that increases in ambient noise should be 'minimised'. In this regard the NPSfE states:

"Of course, taken in isolation and to a literal extreme, noise minimisation would mean no noise at all. In reality, although it has not always been stated, the aim has tended to be to minimise noise as far as is reasonably practical... the application of the NPSE should enable noise to be considered alongside other relevant issues and not to be considered in isolation. In the past, the wider benefits of a particular policy, development or other activity may not have been given adequate weight when assessing the noise implications".

Planning Practice Guidanceⁱⁱⁱ

7.7 The national Planning Practice Guidance (PPG) provides advice on how *'planning can manage potential noise impacts in new development'*, providing guidelines that in line with those provided in NPPF. The PPG states that planning authorities should take account of the local environment with regards to acoustics and in doing so make the following considerations:

- *'whether or not a significant adverse effect is occurring or likely to occur;*
- *whether or not an adverse effects is occurring or likely to occur; and*
- *whether or not a good standard of amenity can be achieved.'*

7.8 Several factors should be considered in determining whether the noise is a concern. These include:

- The absolute noise level of the source;
- The existing ambient noise climate;
- The time of day;
- The frequency of occurrence;
- Duration of the noise;
- Character of the noise; and
- Cumulative effect of the noise

7.9 The PPG provides guidance on mitigation of noise effects in residential development, highlighting that effects may be reduced where residents have access to a relatively quiet façade as part of their dwelling or a relatively quiet amenity space (be it private, shared or public). The guidance also introduced the concepts of No Observed Adverse Effect Level (NOAEL), and Unacceptable Adverse Effect Level (UAEL). Table 7.1 provides some context for these terms:

Table 7.1: Planning Practice Guidance

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No effect	No Observed Effect (NOEL)	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect (NOAEL)	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up	Observed Adverse Effect	Mitigate and reduce to a

Perception	Examples of Outcomes	Increasing Effect Level	Action
	volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	(LOAEL)	minimum
Significant Observed Adverse Effect Level			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect (SOAEL)	Avoid through use of appropriate mitigation whilst taking into account the social and economic benefit
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect (UAEL)	Prevent through use of appropriate mitigation

Regional Planning Policy

The London Plan – The Spatial Development Strategy for London – Consolidated with Alterations since 2011 (2016)^{iv}

7.10 The London Plan has been updated since 2011 to ensure its continuing relevance to government guidance and national legislation that has been published since its first edition. The Plan sets a framework for future development of London, with several policies related to the management of noise in new developments.

- Policy 3.2: Addressing health and health inequalities – which require working to address significant health issues such as those created by or affected by noise levels in an area, and monitor policies / interventions for their impact on health;
- Policy 5.3: Sustainable design and construction – which requires that developments implement the minimising of noise pollution into design principles;
- Policy 7.6: Architecture – that states that architecture should make a positive contribution to an area, and consequently new developments should be of the highest architectural quality, including methods and materials to minimise noise levels;
- Policy 7.15: Reducing and managing noise, improving and enhancing the acoustic environment and promoting appropriate soundscapes – which requires noise to be

managed in order to encourage the right acoustic environment and to promote good health and a good quality of life within the wider context of achieving sustainable development; and

- Policy 7.17: Metropolitan Open Land – which requires the overall accessibility and quality of open land to be improved which includes maintaining appropriate noise levels when considering new development.

Sustainable Design and Construction Supplementary Guidance^v

7.11 The Sustainable Design and Construction Supplementary Planning Guidance provides guidance on key noise related areas and makes reference to the following London Plan policies:

- London Plan Policies 3.2, 7.15: *'Areas identified as having positive sound features or as being tranquil should be protected from noise'*; and
- London Plan Policies 3.2, 5.3, 7.6 7.15: *'Noise should be reduced at source, then designed out of a scheme to reduce the need for mitigation measures.'*

City Soundings: The Mayor's London Ambient Noise Strategy (2004)^{vi}

7.12 London Ambient Noise Strategy aims to minimise the adverse effects of noise on people living in, working in and visiting London by using the best available practices and technologies within a sustainable development framework. The Strategy aims to work towards more compact city development while minimising noise. This requires careful consideration of the adverse effects of noise on, from, within or in proximity to a development,

Draft London Plan (2017)^{vii}

7.13 While currently in draft and not formally published, the forthcoming new London Plan also contains numerous policies and guidance relating to noise and acoustic design, including the following key extracts:

- (Draft) New London Plan Policy 3.1.3: *'Measures to design out exposure to poor air quality and noise from both external and internal sources, should be integral to development proposals and be considered early in the design process. Characteristics that increase pollutant or noise levels, such as poorly-located emission sources, street canyons and noise sources should also be designed out wherever possible'*;
- Specifically related to single aspect dwellings, (Draft) policy 3.4.5: *'Single aspect dwellings [...] that are exposed to noise levels above which significant adverse effects on health and*

- quality of life occur should not be permitted*;
- (Draft) Policy D12 – Agent of Change: *'Development proposals should manage noise and other potential nuisances by:*
 - *ensuring good design mitigates and minimises potential impacts of noise (nuisances) generated by existing uses and activities located in the area;*
 - *exploring mitigation measures early in the design stage, with necessary and appropriate provisions including ongoing and future management of mitigation measures secured through planning obligations;*
 - *separating new noise-sensitive development where possible from existing noise-generating businesses and uses through distance, screening, internal layout, sound-proofing, and insulation and other acoustic design measures.*

Local Planning Policy

- 7.14 London Borough of Waltham Forest (LBWF)'s Development Management Strategies of the Local Plan^{viii} contain some important guidance regarding the control of noise in the borough, including Policy DM24 – Environmental Protection (Air and Noise). The policy is worded as follows:

"Noise Pollution and Vibration: Noise sensitive uses such as residential should be located away from major sources of noise pollution and vibration, unless appropriate mitigation can be provided. In assessing if reasonable levels of noise can be achieved, regard should be had to the noise exposure categories listed.. Noisy new developments should normally be located away from noise sensitive uses, and should demonstrate that there is no cumulative increase in noise pollution to sensitive receptors. All major developments should aim to minimise the adverse impacts of noise through sensitive design, management and operation."

- 7.15 The noise exposure categories mentioned in the policy above refer in turn to the now unused national policy based Planning Practice Guidance 24: Planning and Noise (PPG 24). As the LBWF document notes, this guidance was not replaced with any other technical method at a national planning policy level and its use at local level is therefore justified. However, the approach taken for this assessment has been to use available British Standard and World Health Organisation guidance (referenced later) rather than the now unused PPG 24.
- 7.16 For consideration, a high level assessment indicates that the worst affected parts of the site would fall into Category C, which is defined as:

"Planning permission should not normally be granted. Where it is considered that permission should be given, for example because

there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise."

- 7.17 In the case of this assessment, configurations for glazing and ventilation have been provided that would provide a commensurate level of protection against noise, and these conditions being upheld for any future occupation of the Proposed Development could be controlled through condition referring to these configurations.
- 7.18 While still in its consultation draft, LBWF's Draft Local Plan (2019)^x document also contains specific local planning policy regarding noise and other acoustic matters. This draft document contains important guidance regarding the Borough's approach to planning of noise and vibration issues.
- 7.19 Section 9.18 of 'Building a Resilient and Creative Economy' of the draft document contains the following text: *The mixing of employment and non-employment uses could sometimes create adverse conditions for neighbouring occupiers. For example, the provision of new homes and other noise-sensitive development should not result in unreasonable restrictions being placed on existing industrial uses. As a result, the local plan places the responsibility for addressing the impact of noise and other conditions on new development in line with the 'Agent of Change Principle'. This means that where noise sensitive developments are proposed close to existing noise generating industries, the new development must be designed in a way which protects the occupiers from noise impacts, so that existing industrial uses are not threatened. Further to the 'Agent of Change Principle', specific design mitigation's should be adopted to prevent issues relating to the safety, security and layout of employment sites.*

Assessment Criteria

Construction Phase Noise and Vibration

British Standard 5228-1:2008^x

- 7.20 BS 5228-1 (Noise) provides practical information on construction noise reduction measures, and promotes a 'Best Practice Means' approach to noise control. The calculation method provided in BS 5228-1 is based on the number and types of equipment operating, their associated sound levels, operational times, and the distance to receptors, together with the effects of any screening.
- 7.21 A qualitative assessment of construction noise and vibration effects following BS 5228

guidelines will be undertaken. Construction noise is subject to local authority control under provisions in the Control of Pollution Act 1974 (COPA)^{xi}.

- 7.22 Annex E of BS 5228-1 provides example criteria for the assessment of potential significance of construction noise effects. 'Example Method 1 – The ABC Method' has been adopted for the purposes of this assessment and the methodology is outlined in Table 7.2.

Table 7.2: BS 5228-1 ABC Method

Assessment Category and Threshold Value Period	Threshold value, in decibels (dB) ($L_{Aeq, T}$)		
	Category A ^{A)}	Category B ^{B)}	Category C ^{C)}
Night-time (23.00–07.00)	45	50	55
Evenings and weekends ^{D)}	55	60	65
Daytime (07.00–19.00) and Saturdays (07.00–13.00)	65	70	75
<p><i>NOTE 1 A potential significant effect is indicated if the $L_{Aeq, T}$ noise level arising from the Site exceeds the threshold level for the category appropriate to the ambient noise level.</i></p> <p><i>NOTE 2 If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq, T}$ noise level for the period increases by more than 3 dB due to site noise.</i></p> <p><i>NOTE 3 Applied to residential receptors only.</i></p>			
<p><i>A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.</i></p> <p><i>B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.</i></p> <p><i>C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.</i></p> <p><i>D) 19.00–23.00 weekdays, 13.00–23.00 Saturdays and 07.00–23.00 Sundays.</i></p>			

- 7.23 Recommended Peak Particle Velocity (PPV) vibration limits for transient excitation for different types of buildings are provided in BS 5228-2 (Vibration) and presented in Table 7.3. Where vibration experienced at structures does not exceed the values shown, this would be considered to be a non-significant effect. Where construction vibration exceeds the criteria, cosmetic damage to buildings is considered to be likely and the effect would be significant with no further scale.

Table 7.3: PPV limits for cosmetic damage to structures

Type of building	Peak PPV in frequency range of 4 Hz to 15 Hz	Peak PPV in frequency range of 15 Hz and Above
Reinforced or framed structures	50 mm/s at 4 Hz and above	
Industrial and heavy commercial buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz.	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above.

- 7.24 Table 7.4 details PPV levels and their potential impact on humans as per BS 5228-2. This provides a simple method of determining annoyance associated with vibration. A semantic scale for determining the magnitude of effects has also been provided.

Table 7.4: PPV limits for human responses

PPV level	Impact	Magnitude of impact
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.	Very low
0.3 mm/s	Vibration might be just perceptible in residential environments.	Low adverse
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.	Medium adverse
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.	High adverse

Operational Phase Noise Standards and Guidance

World Health Organisation: Environmental Noise Guidelines^{xii}

- 7.25 This World Health Organisation (WHO) document sets out to define “*recommended exposure levels for environmental noise in order to protect population health*”. The guidance documents relates specifically to external noise levels, and recommends that “*all CNG (WHO Community Noise Guidelines, 1999) indoor guideline values and any values not covered by the current guidelines (such as industrial noise and shopping areas) should remain valid*”. We therefore make reference to the WHO Community Noise Guidelines for recommendations on internal noise levels.
- 7.26 The WHO document “Guidelines for Community Noise” describes guideline levels that are “*essentially values for the onset of health effects from noise exposure*”. A table of guideline values is included, relating to adverse health effects, referred to as any temporary or long term deterioration in physical, psychological, or social functioning that is associated with noise exposure. The following is an extract from the Table 4.1: Guideline values for community noise in specific environments, as stated in the WHO document.

Table 7.5: Guideline Values for Community Noise

Specific Environment	Critical Health Effect(s)	L _{Aeq} (dB)	Time Base (hours)	L _{Amax,f} (dB)
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night-times	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60

British Standard 8233:2014^{xiii}

- 7.27 BS 8233:2014 Guidance on Sound insulation and noise reduction for buildings, draws on the results of research and experience to provide information on achieving internal acoustic environments appropriate to their functions. The noise level values given are in terms of an average (L_{Aeq}) level. The standard advises internal ambient noise levels for achieving suitable resting and sleeping conditions within residential properties as set out in Table 7.6.

Table 7.6: BS 8233:2014 Residential Criteria

Room	07:00 to 23:00	23:00 to 07:00
Living Rooms	35 dB $L_{Aeq,16hour}$	--
Dining Room/area	40 dB $L_{Aeq,16hour}$	--
Bedrooms	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

ProPG: Planning and Noise, 2017^{xiv}

- 7.28 The Institute of Acoustics, the Association of Noise Consultants and the Chartered Institute of Environmental Health have joined to produce a Professional Practice Guidance (ProPG) focussing on noise sensitive development. The ProPG has been produced to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England. ProPG provides planning guidance for the consideration of new residential development that will be exposed predominantly to airborne noise from transport sources. The document provides advice on how guidance within BS 8233:2014 and WHO Guidelines for Community Noise may be applied to improve in the consistency and quality of plan-making and decision-taking in relation to acoustic matters.

British Standard 4142:2014^{xv}

- 7.29 BS 4142:2014 'Method for Rating Industrial Sound Affecting Mixed Residential and Industrial Areas' has been considered for matters related to noise emissions from fixed external plant associated with a development. This standard can be used for assessing the effect of noise from mechanical services plant. The method compares the difference between the 'rating level' of the new sound source, with the 'background level' at the receptor position. This method is described in more detail in the Assessment Methodology section of this chapter.

British Standard 7445-2:1991^{xvi}

- 7.30 BS 7445 'Description and Measurement of Environmental Noise' defines the parameters, procedures and instrumentation requirements for noise measurement and analysis.

Calculation of Road Traffic Noise (CRTN)^{xvii}

- 7.31 CRTN describes procedures for traffic noise calculation and is suitable for environmental assessments of schemes where road traffic noise may have an impact.

Design Manual for Road and Bridges (DMRB)^{xviii}

- 7.32 DMRB, produced by the Highways Agency, provides guidance on the appropriate level of assessment to be used when assessing the noise and vibration impacts arising from all road projects, including new construction, improvements and maintenance.

Institute of Environmental Assessment Guidance Note No. 1, 1993^{xix}

- 7.33 This document recommends assessment where traffic flows will increase by more than 30%, (or the number of heavy goods vehicles (HGVs) will increase by more than 30%), and where specifically sensitive areas experience traffic flow increases of 10% or more. The guidance indicates that projected changes in traffic of less than 10% create no discernible environmental impact.

Vibration Standards and Guidance

- 7.34 It is necessary to consider two sets of criteria when assessing vibration induced by trains on the mainline railway and its potential impact on new dwellings. Not only can groundborne vibration be perceived as tactile vibration, but may also result in structureborne re-radiated noise. When assessing vibration and re-radiated noise levels generated by either surface or underground train movements, reference should be made to the following guidelines.

British Standard 6472-1:2008^{xx}

- 7.35 BS 6472-1:2008 "Guide to Evaluation of Human Exposure to Vibration in Buildings Part 1: Vibration sources other than blasting" provides guidance on predicting human response to vibration in buildings over the frequency range 0.5Hz to 80Hz. BS 6472 is based on the evaluation of vibration measurements with regards to adverse comment from occupants, rather than criteria relating to health and safety or structural damage.

Table 7.7: BS 6472 Human annoyance responses to VDV

Place and Time	Low probability of adverse comment ($m/s^{-1.75}$)	Adverse comment possible ($m/s^{-1.75}$)	Adverse comment probable ($m/s^{-1.75}$)
Residential Buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential Buildings 8h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

- 7.36 These values can be used for both vertical and horizontal vibration, provided that they are calculated according to the appropriate frequency weightings.
- 7.37 Additional guidance in BS 6472-1:2008 is given on the thresholds of perception of continuous whole-body vibration. Although it is recognised that thresholds vary widely among individuals the standard defines broad categories of thresholds of perception; as stated below:
- 7.38 Approximately half the people in a typical population, when standing or seated, can perceive a vertical weighted peak acceleration of $0.015m/s^2$. The weighting used is W_b . A quarter of the people would perceive a vibration of $0.01m/s^2$ peak, but the least sensitive quarter would only be able to detect a vibration of $0.02m/s^2$ peak or more. Perception thresholds are slightly higher for vibration duration of less than about 1s.

Re-radiated Noise

- 7.39 There are no specific UK or international standards that define when groundborne noise becomes significant. As a result there are no formal criteria against which assessment of groundborne noise inside residential buildings can readily be made.
- 7.40 It is commonly accepted that vibration levels resulting in re-radiated noise levels of up to 35 dBA $L_{max(s)}$ should not result in nuisance or complaints, whilst levels above 40 dBA $L_{max(s)}$ will make complaints likely. $L_{max(s)}$ re-radiated noise levels between 35 dBA and 40 dBA are considered perceptible but not a cause of complaint.
- 7.41 In addition, recent rail transit systems (Jubilee Line Extension, Crossrail and Channel Tunnel Rail Link) have adopted a re-radiated noise criterion of 40 dBA $L_{max(s)}$ for residential buildings potentially affected by train induced vibration in order to ensure a low degree of impact. We would therefore advise a 40 dBA $L_{max(s)}$ criterion be adopted for the residential areas in order to ensure minimal likelihood of complaint from re-radiated noise.
- 7.42 The proposed Development will also be affected by airborne noise (as the rail lines are overground) where a criterion of 45 dBA $L_{max(f)}$ has been adopted. Airborne noise impact is

covered by the noise criteria outlined above.

Assessment Methodology

Overview

- 7.43 Noise and vibration surveys have been undertaken in the period Thursday 5 March to Monday 9 March 2020 to establish the baseline ambient conditions at the Site and nearby sensitive receptors. The surveys were undertaken before the effect of the Coronavirus pandemic had significantly affected public transport, road traffic flows and aviation. The survey results are therefore considered to be representative of 'normal' operational baseline conditions, though the guidance provided in the Assumptions and Limitations section of this chapter should still be considered.
- 7.44 Effects have been considered during the construction and operational phase of the Development.
- 7.45 Effects from noise and vibration impacts arising from construction works have been discussed, though a detailed assessment of construction activity has been scoped out of this assessment. Due to projected low volumes of construction related traffic associated with the Development, and relatively high traffic flows on the local road network, effects from increases in noise levels as a result of construction phase traffic have also been scoped out of this assessment.
- 7.46 Effects from building services and fixed plant noise associated with the Development have been assessed based on currently available information.
- 7.47 In addition, an assessment of the suitability of the Site for the proposed usages of the Development has been undertaken to enable the identification of appropriate design properties of the building necessary to achieve relevant assessment criteria. The assessment, including noise modelling, has been based on architectural drawings for the application. More details are included in the following sections of this Chapter.
- 7.48 Baseline noise and vibration surveys were undertaken to establish the baseline noise environment around the Site. Unattended noise monitoring was undertaken at two locations, referred to as N1 and N2. Further attended 'spot' noise measurements were undertaken at two locations, referred to as n3 and n4. Attended vibration monitoring was also undertaken at two locations, referred to as V1 and V2. Noise and vibration monitoring locations are described in Table 7.8 and presented in the Figures of Appendix 7.2. These locations were subjectively selected as they were considered (based on professional experience) to provide

information on noise and vibration levels at the Site and at nearby sensitive receptors. All monitoring was undertaken in the period from Thursday 5 March to Monday 9 March 2020 (see Appendix 7.2 for survey details, including location and timings of all measurements). Surveys were timed to be representative of normal, non-holiday weekday conditions during regular operation of the adjacent mainline railway.

- 7.49 The baseline noise surveys were undertaken in accordance with best practice as specified in BS 7445: Part 2. The sound level meters log environmental noise measurement parameters including average ambient (L_{Aeq}), maximum (L_{Amax}) and background (L_{A90}) noise levels.

Table 7.8: Noise and Vibration Monitoring Locations

Reference	Type	Description
N1	Noise (unattended)	Measurements were taken at the eastern site boundary overlooking the Overground railway lines, which run between Chingford and Liverpool Street. The microphone was attached to a Homebase container and elevated to a height of 12m on a pole, in order to have adequate line of sight to the train tracks.
N2	Noise (unattended)	Measurements were taken with the microphone on the southern site boundary overlooking Forest Road. The microphone was attached to the fence surrounding the Homebase site boundary and elevated to a height of approximately 2.5m.
n3	Noise (attended)	Measurements were taken at Fulbourne Road (n3) and at the western site boundary nearest this road (n4) in order to determine noise levels from Fulbourne Road affecting the western site façades.
n4	Noise (attended)	
V1	Vibration	Measurements were undertaken on a steel block bonded to existing concrete hardstanding on-site. This location was in the north-eastern corner of the Site approximately 20m from the railway line and level with the railway line.
V2	Vibration	Measurements were undertaken on a steel block bonded to an existing concrete hardstanding on site. This location is on the eastern façade, approximately 20m from the railway line, and parallel with measurement Position V1.

Methodology for Assessment of Internal Noise Levels within Development

- 7.50 Measured data from the surveys and 3D modelling of the Site has been used to predict noise levels across the Development. Further details of the modelling methodology are included in Appendix 7.3. Predictions of noise levels have been modelled for façades of the buildings included in the Application.
- 7.51 It has been confirmed that external façades of the of the Development buildings would be designed to ensure provision of suitable internal noise conditions in accordance with BS 8233, WHO guidelines and LBWF's requirements, as detailed in the Assessment Criteria section above. The design criteria for internal ambient noise levels are therefore adopted as follows:

Bedroom	Night-time (23:00-07:00)	30 dB L_{Aeq} *45 dB $L_{Amax,f}$
Living Rooms	Daytime (07:00-23:00)	35 dB L

*Further notes are provided on criteria for $L_{Amax,f}$ below

- 7.52 The guidance provided by the WHO states that, "For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10-15 times per night."

Building Services and Plant Noise

- 7.53 It is understood that the requirements of the LBWF Environmental Health Department regarding new building services plant are as follows;

"The noise of all new plant shall be 10dB(A) below the underlying background noise level (L_{A90}) during the time of plant operation at a position one metre external to the nearest noise sensitive premises. The underlying background L_{A90} shall be determined in the absence of the new plant noise. This assessment must be completed in accordance with BS4142: 2014 Method for rating industrial noise affecting mixed residential and industrial areas."

- 7.54 The basis of the assessment procedure in BS 4142:2014 is a comparison between the background noise level in the vicinity of residential receptor locations and the rating level of the noise source under consideration. The relevant parameters in this instance are as follows:

- Background Sound Level, $L_{A90,T}$, defined in the Standard as the 'A-weighted sound pressure level that is exceeded by the residual sound for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels'.
- Specific Sound Level, $L_{Aeq,Tr}$, the 'equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T_r '; and
- Rating Level, $L_{Ar,Tr}$, the specific sound level plus any adjustment made for the characteristic features of the sound'.

- 7.55 BS 4142 allows for, as an absolute worst case, a cumulative +15 dB correction to be applied to the specific sound level based upon the presence or expected presence of the following:

- Tonality – up to +6 dB penalty;
- Impulsivity – up to +9 dB penalty (this can be summed with tonality penalty); and

- Other sound characteristics (neither tonal nor impulsive but still distinctive) – +3 dB penalty.
- 7.56 BS 4142 provides guidance as to the likely response from sensitive residential receptors to new fixed noise sources (e.g. building plant or services) through comparison of the rating level of the new noise source with the existing background level. The higher the rating noise level in comparison to the background noise level, the greater the likelihood of complaints arising. BS 4142 requires separate analysis for day and night time periods.
- 7.57 Where the nearest noise sensitive receptors to the plant locations are the windows of the residences that form part of the Development, more relevant criteria have been developed based on guidance from applicable industry standards.
- 7.58 It is proposed that maximum emission limits that would result in acceptable internal noise levels in the flats (namely, the bedrooms) in the event of partially open windows. BS 8233:2014 provides guidance on suitable internal noise levels of 35dB $L_{Aeq,16hr}$ (daytime) and 30dB $L_{Aeq,8hr}$ (night-time), as detailed in the above section. A level of 5dB below these internal noise criteria is recommended.
- 7.59 Based on the sound reduction given by a partially open window as outlined in BS 8233:2014, internal noise levels are anticipated to be approximately 15dB lower than external noise levels. Is it therefore proposed that cumulative noise emissions from mechanical services plant to the nearest proposed development receptors should be below the levels detailed in Table 7.9 below.

Table 7.9: Plant Noise Emission Limits to Development Receptors

Measurement Position	L_{Aeq} Noise Level limit of all operating plant (dB) at 1m from the nearest proposed Receptor	
	Daytime (07:00 – 23:00 hours)	Night-time (23:00 – 07:00 hours)
All Development Windows	45	40

Methodology for Determining Sensitive Receptors

- 7.60 Potential sensitive receptors (i.e. buildings whose occupants may be disturbed by adverse noise and vibration levels and structures that are sensitive to vibration) have been taken into consideration when assessing the potential impacts associated with noise and vibration levels from the construction and operational phases of the Development.
- 7.61 Receptor locations have been subjectively selected at which noise effects have been assessed

and are deemed to be representative of the nearest noise sensitive receptors to the Site. It is considered that, if noise levels are suitably controlled at the key receptors identified, then noise levels will correspondingly be suitably controlled at all sensitive receptors (i.e. residential, commercial) within the surrounding area of the Site. The identified receptors are described and listed in Table 7.15 of this chapter.

Assessing Significance

- 7.62 The magnitude of impacts from noise and vibration will be determined based on the criteria provided in Table 7.10.

Table 7.10: Methodology for Assessing Magnitude

Magnitude of Impact	Criteria for assessing impact
Major	Total loss or major/substantial alteration to key elements/features of the baseline (pre-Development) conditions such that the post Development character/composition/attributes will be fundamentally changed.
Moderate	Loss or alteration to one or more key elements/features of the baseline conditions such that post Development character/composition/attributes will be materially changed.
Minor	A minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible/detectable but not material. The underlying character/composition/attributes of the baseline condition will be similar to the pre-Development circumstances/situation.
Negligible	Very little change from baseline conditions. Change barely distinguishable, approximating to a 'no change' situation.

- 7.63 The sensitivity of an existing receptor to noise and vibration impacts is based on the scale in Table 7.11.

Table 7.11: Methodology for Determining Impact Sensitivity

Magnitude of Impact	Criteria for assessing impact
High	The receptor/resource has little ability to absorb change without fundamentally altering its present character, or is of international or national importance.
Moderate	The receptor/resource has moderate capacity to absorb change without significantly altering its present character, or is of high importance.
Low	The receptor/resource is tolerant of change without detriment to its character, or is of low importance.

- 7.64 The significance of an environmental effect is determined by the interaction of magnitude and sensitivity. The Effect Significance Matrix is set out in Table 7.12.

Table 7.12: Effect Significance Matrix

Magnitude	Sensitivity		
	High	Moderate	Low
Major	Major Adverse / Beneficial	Major – Moderate Adverse / Beneficial	Moderate – Minor Adverse / Beneficial
Moderate	Major – Moderate Adverse / Beneficial	Moderate – Minor Adverse / Beneficial	Minor Adverse / Beneficial
Minor	Moderate – Minor Adverse / Beneficial	Minor Adverse / Beneficial	Minor Adverse / Beneficial - Negligible
Negligible	Negligible	Negligible	Negligible

Limitations and Assumptions

Assumptions of External Building Fabric Analyses

7.65 The assessment of the internal noise levels has made the following assumptions for the analyses of external building fabric:

- **Drawings** - The assessment has been based on the information provided in the architectural drawings included in Chapter 3 of this document.
- **Noise levels** - The assessment has been based on the measured noise levels as detailed in the relevant sections of this Chapter.
- **Room absorption** - The bedrooms are assumed to be acoustically “soft” with carpets, curtains and other soft furnishings. The living rooms are assumed to be less acoustically absorptive (with a hard floor finish, although with furnishings).
- **External wall** - External non-glazed areas are to comprise the following:
 - Brickwork
 - Cavity with thermal insulation
 - Metsec type metal framing with Rockwool infill
 - 2x layers of plasterboard internally

7.66 As such, sound reduction indices equating to an overall weighed sound reduction index (R_w) of 59 dBA have been assumed for all non-glazed façade areas comprising the above construction:

7.67 **Ventilation** - It is understood the ventilation strategy has not yet been finalised for this project. As such this report will provide guidance on the acoustic performance of trickle ventilators, if a natural ventilation strategy is to be decided upon. Otherwise it has been assumed a mechanical ventilation system, such as MVHR (ADF System 4), will be utilised. In this case, we have assumed that external noise break-in to the bedrooms and living rooms via the ventilation system will be negligible (when compared to the glazing) due to the fully

ducted nature of the system. It should be noted the trickle ventilators (or MVHR system) provide background trickle ventilation only and that windows are to generally be openable to provide rapid or purge ventilation. During those periods where windows are opened for purge/rapid ventilation, noise levels will naturally be increased internally.

Assumptions of Operational Vibration Assessment

7.68 Vibration levels presented in the graphs in Appendix 7.2 are as measured within the ground. In order to estimate the resultant vibration levels and re-radiated noise levels within the proposed building, the following assumptions have been made:

7.69 **Prediction procedures** – Calculations have been based on previous research undertaken by RBA Acoustics on building response to groundborne vibration within a variety of different building frame types. The empirical prediction procedures as detailed within the following references have also been used in the calculations:

- “A Prediction Procedure for Rail Transportation Groundborne Noise and Vibration” – Nelson and Saurenman: Transportation Research Record 1143.
- “Handbook of Urban Rail Noise and Vibration Control” – Nelson, Saurenman, Wilson: US Department of Commerce – National Technical Information Services – February 1982.

7.70 **Drawings** - Assessment has been based on the layout and building types provided in the architectural drawings included in this ES.

7.71 **Proposed building structure** – Assessment has been based on the following information provided by the Applicant:

- Substructure: Foundations will be piled for all blocks and houses
- Superstructure: Superstructure will be formed from in situ concrete for all blocks

Limitations and Uncertainty

7.72 Prediction and modelling of sound levels will always have an associated degree of uncertainty. Whilst best endeavours have been made to minimise that uncertainty in this work, it is unavoidable that some remains.

7.73 In addition, any measurement of existing ambient or background baseline sound levels will be subject to a degree of uncertainty. Environmental sound levels vary between days, weeks,

and throughout the year due to variations in source levels and conditions, meteorological effects on sound propagation and other factors. Hence, any measurement survey can only provide a sample of the ambient levels. Every effort is made to ensure that measurements are undertaken in such a way as to provide a representative sample of conditions, such as avoiding periods of adverse weather conditions, rail strikes and school holiday periods (which are often considered to result in atypical sound levels). However, a small degree of uncertainty will always remain in the values taken from such a measurement survey.

- 7.74 The measured $L_{A90,T}$ background noise level is used to define design criteria for fixed plant associated with the proposed development. Background noise levels may change in the period between the survey and the opening year; however, as the $L_{A90,T}$ background noise level is a statistical value based on a range of measured noise data, it is not possible to predict future background noise levels with any degree of accuracy. It is considered that background noise levels are unlikely to reduce in the intervening period between the baseline survey and the projected opening year. Consequently, it is considered that the derived design criteria provide suitable noise thresholds for future scenarios.

Baseline Conditions

Noise Survey

- 7.75 The baseline noise survey was undertaken in March 2020 to establish the baseline noise environment around the Site, as detailed in the Assessment Methodology section of this Chapter and in Appendix 7.2. Weather conditions during surveys were mostly dry with negligible wind and thus considered conducive for noise monitoring. The noise levels measured are shown as time-histories on the attached graphs in the Figures in Appendix 7.2.
- 7.76 The period averaged L_{Aeq} noise levels measured are summarised in Table 7.13, along with typical L_{AFmax} levels measured during the night time.

Table 7.13: Baseline Noise Survey Results, L_{Aeq} and L_{AFmax}

Measurement Position	Average L_{Aeq} period Noise Level (dB)		L_{AFmax} (dB)
	Daytime (07:00 – 23:00 hours)	Night-time (23:00 – 07:00 hours)	Night-time (23:00 – 07:00 hours)
N1	62	57	81
N2	71	66	83
n3	57*	n/a	n/a
n4	72*	n/a	n/a

*Based on short term attended measurements (see Appendix 7.2 for further details)

- 7.77 The minimum background noise levels ($L_{A90,15 \text{ mins}}$) at each measurement position are

summarised in Table 7.14. This data will be used to set plant noise emission criteria for use in the assessment of noise emissions from any proposed plant at the Development.

Table 7.14: Baseline Noise Survey Results, LA90

Measurement Position	Minimum LA90, 15mins Noise Level during period (dB)	
	Daytime (07:00 – 23:00 hours)	Night-time (23:00 – 07:00 hours)
N1	48	43
N2	54	43
n3	53	n/a
n4	57	n/a

Vibration Survey

- 7.78 The baseline vibration survey was undertaken in March 2020 to establish vibration levels from trains passing on the nearby London Overground railway. Detailed methodology and results of vibration monitoring are presented in Appendix 7.2.
- 7.79 The groundborne vibration levels for a number of passenger train passbys have been analysed into third-octave bands and the data summarised on the attached graphs in the Figures in Appendix 7.2. The graphs present the maximum (root mean square) vertical and horizontal vibration levels measured at each position for the individual train passbys.

Sensitive Receptors

- 7.80 The nearest noise sensitive receptors to the Site have been selected for assessment and the sensitivity of these receptors has been identified in accordance with the method described in the Determining Sensitive Receptors section of this Chapter. Each receptor has been assigned a measurement location for the purposes of the assessment, where the intention is to apply appropriate noise level data at each receptor location for assessment purposes. Sensitive receptors that have been considered in the assessment are presented described in Table 7.15.

Table 7.15 -Sensitive Receptors

Receptor	Receptor Address	Corresponding Measurement Location	Receptor Type
R1	Hawker Place	N1	Residential
R2	1-43 Hale End Road	N1	Residential
R3	822-848 Forest Road	N2	Residential
R4	Wood Street Library	N2	Community
R5	1-45 Fulbourne Road	n4	Residential
R6	Willow House, Fulbourne Road	n4	Commercial

Likely Significant Effects

Construction Phase Noise and Vibration

- 7.81 In the absence of detailed information on construction programming and methods of working, the temporary construction noise effects have been assessed qualitatively, based on the indicative construction methodology and phasing information set out in Chapter 5 of this ES.
- 7.82 Construction work of any type that involves heavy plant activity will generate noise, which may result in complaints if sensitive scheduling and control of works is not exercised. The noise levels generated by construction activities and experienced by nearby sensitive receptors, such as residential properties, depends upon a number of variables, the most significant of which are:
- The noise generated by plant or equipment used on site, generally expressed as sound power levels (L_w);
 - The periods of operation of the plant on the site, known as its 'on-time';
 - The distance between the noise source and the receptor; and
 - The attenuation of sound due to ground absorption, air absorption and barrier effects.
- 7.83 In order to evaluate noise effects during the construction phase it is necessary to have knowledge of the various activities that will be undertaken. Site preparation and construction contractors may use different working methods and plant to achieve the same ends. An accurate construction noise and vibration impact assessment is not normally possible until appointment of the approved contractor with knowledge of the exact working routine and plant schedule.
- 7.84 However, during the construction phase the use of plant, and the likely noise impact thereof, should be determined following the guidance detailed in BS 5228 and, where necessary, mitigation should be provided. Moreover, should complaints be received from local residents, LBWF would determine whether the best practicable means are being applied. Should this not be the case, action under the Control of Pollution Act may be taken. Therefore, best practicable means will need to be employed to ensure that noise levels are minimised. An outline of mitigation measures to minimise construction impacts is presented in the Mitigation section of this Chapter.
- 7.85 Following the BS 5228-1 ABC Method criteria, threshold values for significant noise impacts at surrounding sensitive receptors have been derived from the survey results. Applicable ABC

Method threshold values during daytime periods have been summarised in Table 7.16 below. Note that construction works would only normally take place during the hours of 08:00 and 18:00 on weekdays and 08:00 – 13:00 on Saturdays as per LBWF requirements. Any evening or night-time works would be limited to exceptional circumstances and/or with prior approval by LBWF. Chapter 5 details that this is unlikely to change due to situations concerning the Coronavirus pandemic.

Table 7.16 -BS 5228-1 ABC Method Threshold Values (Daytime Periods)

Receptor	BS 5228-1 ABC Method Threshold Values Daytime (08.00–18.00) and Saturdays (08.00–13.00)			
	Measured Level L_{Aeq}	Ambient Level L_{Aeq} Rounded to Nearest 5 dB	ABC Category	Threshold Value
R1	63	65	B	70
R2	63	65	B	70
R3	71	70	A	75
R4	71	70	A	75
R5	72	70	A	75
R6	72	70	A	75

- 7.86 Clearly noise levels will vary at the nearest sensitive receptors depending on the location of the construction plant and the construction phase (e.g. site clearance, substructure, superstructure, fit-out). It is considered that noise impacts are likely to be greatest during the early stages of construction, where demolition and groundwork are required.
- 7.87 Without any mitigation measures in place it is not unreasonable to assume that construction noise levels from the site experienced at these sensitive receptors will frequently be greater than 75 dB. As such, and given the High sensitivity of the mostly residential surrounding receptors, the significance of construction noise effects may result in temporary, short term impacts of Major-Moderate adverse significance at sensitive receptors when they are located in close proximity to individual works sites.
- 7.88 In practice, construction noise levels and resulting impacts are likely to vary during the different construction phases of the project depending upon the location of work sites and proximity of receptors. Furthermore, best practicable means of mitigation will further assist in minimising construction noise effects.
- 7.89 The nature of construction work means that the worst-case scenario with the plant working at its closest approach may exist for only a matter of days or even hours and there would be regular periods, even during the course of a single day, when the assumed higher impact plant would not be in operation during breaks or changes of working routine. However, until the contractor is appointed and the actual (rather than assumed) method of working is specified, detailed recommendations to reduce the predicted worst-case construction noise to

the closest residential and other noise sensitive buildings cannot be formulated.

- 7.90 BS 5228-2 indicates that vibration effects generated by piling activities depends on the type of piling, ground conditions, and receptor distance. It has been confirmed by the Applicant that low impact piling methods will be used, most likely to be CFA piling methods, if Site conditions are suitable. Given also the separation distance between the required locations for piling and existing sensitive receptors, it is considered that vibration from any potential piling works at existing sensitive receptors will be of Minor Negligible magnitude, and temporary in nature. Similarly, based mainly on the selection of low impact piling methods such as CFA and the layout of the Site, it is considered that vibration from any potential piling works at future sensitive receptors built as part of the Development will also be of Minor adverse or Negligible magnitude.

Construction Traffic (HGV) Noise

- 7.91 Based on the information provided in Chapter 5 of this document, there is predicted to be minimal increase in road traffic flows in the areas surrounding the proposed development during construction. Table 7.17 indicates the predicted traffic flow increase along with the associated noise level increases.

Table 7.17 -Traffic Noise with Proposed Construction Traffic

Link	Traffic Flow (AAWT), No Construction		Traffic Flow (AAWT), with Construction		Noise Level Increase (dBA)
	Number of Vehicles	% HGVs	Number of Vehicles	% HGVs	
Forest Road - A503 EB	9357	2	9407	2	0 dB
Forest Road - A503 WB	11993	1	12043	1	0 dB
Fulbourne Road - B160 NB*	5735	1	5785	2	0 dB
Fulbourne Road - B160 SB*	6013	1	6063	2	0 dB

- 7.92 It can be seen from the table above that the effect of construction traffic will be 0 dB on all links, which can be considered to be a Negligible effect on noise affecting the surrounding environment and receptors. With reference to the IEMA Guidance Note 1, a change in the percentage of HGV's of 30% would be required to result in any significant effect. It is clear from the data above that this is not the case.

Completed Development

Operational Phase Noise – Internal Noise Levels

- 7.93 As outlined in the Methodology for Assessment of Internal Noise Levels within Development, assessments have been made following guidance from BS 8233, WHO and Local Authority guidance. With regards to these guidance sources, the glazing configurations and ventilator types detailed in the External Building Fabric assessment in Appendix 7.2 would prove commensurate with achieving the sound insulation performance specifications required such that effects on residents of the Proposed Development would be Negligible..

Operational Phase Noise – Noise from External Fixed Plant

- 7.94 Table 7.18 presents the recommended operational noise limits at nearby sensitive receptors for proposed building services plant. These operational noise limits were derived from the background noise measurements presented in Table 7.14 and the methodology for assessing noise from fixed plant described previously in this chapter, including LBWF's requirements. Provided the noise limits presented in Table 7.18 are not exceeded, the noise rating level of building services will be 10 dB below the lowest measured background level noise. This is considered to be a barely distinguishable change and therefore will be equivalent to a Negligible impact magnitude, which, will be equivalent to a Negligible effect at all sensitive receptors.

Table 7.18: Plant Noise Thresholds

Receptor	Daytime (07:00-23:00) Operational Noise Limit $L_{Aeq,1h}$ dB	Night time (23:00-07:00) Operational Noise Limit $L_{Aeq,15\text{ minutes}}$ dB
R1	38	33
R2	38	33
R3	44	33
R4	44	33
R5	47	33
R6	47	33

- 7.95 Should the nature of the noise from the building services be tonal, impulsive or intermittent then the relevant 'penalty' / correction will be applied in line with BS 4142 to ensure that the resultant rating level meets the criteria identified above.
- 7.96 An important aspect of the BS 4142 assessment method is that sound sources should be considered in the context of the residual noise environment. Therefore, once the details of building services plant are confirmed during the detailed design stage, appropriate mitigation measures can be specified in the context of BS 4142 considering the proposed noise sources

in context.

Completed Development Traffic Noise

7.97 Changes in 18-hour traffic noise levels have been calculated in line with CRTN guidance. Table 7.19 presents the traffic noise assessment for the Development.

Table 7.19 -Traffic Noise with Proposed Development Traffic

Link	Traffic Flow (AAWT), Opening Year No Development		Traffic Flow (AAWT), Opening Year With Development		Noise Level Increase (dBA)
	Number of Vehicles	% HGVs	Number of Vehicles	% HGVs	
Forest Road - A503 EB	9357	2	9374	2	0 dB
Forest Road - A503 WB	11993	1	12032	1	0 dB
Fulbourne Road - B160 NB*	5735	1	5852	1	0 dB
Fulbourne Road - B160 SB*	6013	1	6138	2	0 dB

7.98 It can be seen from the table above that the effect of development traffic will be 0 dB on all links, which can be considered to be a Negligible effect on noise affecting the surrounding environment and receptors.

Operational Phase Vibration

Tactile Vibration – Vibration Dose Values

7.99 Table 7.20 details the predicted VDV_{b,Day} and VDV_{b,Night} for both the daytime and night-time periods. Levels have been predicted within the first suspended residential floor slabs, which are generally acknowledged as having the highest levels of vibration. Only the vertical axis has been considered as the floor structures will vibrate predominantly in this axis.

Table 7.20 – Predicted Vdv_{b,Day} and Vdv_{b,Night}

Measurement Position	Period	Vertical VDV (m/s ^{-1.75})	BS 6472	
			Low Probability of Adverse Comment (m/s ^{-1.75})	Adverse comment possible (m/s ^{-1.75})
V1	Day	0.049	0.2 – 0.4	0.4 - 0.8
	Night	0.032	0.1 – 0.2	0.2 - 0.4
V2	Day	0.062	0.2 – 0.4	0.4 - 0.8
	Night	0.041	0.1 – 0.2	0.2 - 0.4

7.100 Please note that vibration levels would typically decrease as one moves up through the

building. Our calculations indicate that the VDV associated with train movements during both the day and night-time periods are likely to result in a “low probability of adverse comment” for Positions V1 & V2.

- 7.101 It should also be noted that there is a general consensus that the night time VDV range of 0.1-0.2 is considered to be overly relaxed and recent technical forums have presented a number of case studies where lower VDV values have resulted in complaints as the vibration was clearly perceptible by residents. However, the predicted levels are significantly lower than this range and effects are therefore still expected to be Negligible.

Perception Values

- 7.102 Worst-case vertical weighted peak acceleration levels within units close to each measurement position are given in Table 7.21 below.

Table 7.21 – Predicted Perception Level

Measurement Position	Predicted perception range (m/s ²)
V1	0.002
V2	0.003

- 7.103 As noted in BS 6472, approximately half of the people in a typical population, when standing or seated, can perceive a vertical weighted peak acceleration of 0.015m/s². The values in Table 7.21 above are considerably lower than these values. As such it is reasonable to assume that peak vibration levels will not cause disturbance to residents. This effect is therefore considered to be Negligible and not considered to be sufficient to warrant any mitigation measures.

Re-Radiated Noise Levels

- 7.104 Table 7.22 presents the range of predicted re-radiated L_{max(s)} noise levels from train passbys.

Table 7.22 – Predicted Re-Radiated Noise Levels

Measurement Position	Noise Levels (dBA)	Proposed Criterion (dBA)
V1	11 - 36	40
V2	12 - 36	40

- 7.105 Re-radiated noise levels would typically decrease as one moves up through the building by between 1 dBA and 3 dBA per floor level. Levels predicted for blocks in the proximity of Positions V1 and V2 are expected to be significantly below the 40 dBA criterion. This effect is considered to be Negligible and mitigation measures are therefore not necessary.

Mitigation Measures

Construction Phase

- 7.106 Although the construction phase is proposed to extend over a period of approximately four and a half years in respect of the whole Site, the dispersed nature of the required works and the works programme would mean that the impact on individual existing properties would be for shorter periods.
- 7.107 In addition, there is a separate legislative regime specifically in place to control noise from construction sites, in the form of Sections 60 and 61 of COPA and this may be used to ensure that the noise impact of the construction phase is minimised. 'Best Practicable Means' (as per COPA) will be adopted in order to mitigate against the construction phase noise effects at surrounding sensitive receptors.
- 7.108 Mitigation measures will help to further reduce the scale of the effects on the environment. The preferred approach is to reduce noise levels (where possible), but with due regard to practicality. Sometimes, a greater noise level may be acceptable if the overall construction time and therefore length of disruption is reduced.
- 7.109 As plant selections and working procedures have yet to be finalised, exact mitigation measures cannot yet be detailed. However, the following mitigation measures have been prepared in order to provide a methodology for controlling noise emissions during works such that noise limits may be adhered to during the construction works programme. BS 5228 is a useful reference document and provides additional advice for mitigation measures. Below are some example mitigation measures from BS 5228:
- Unnecessary revving of engines will be avoided and equipment will be switched off when not in use;
 - Internal haul routes will be kept well maintained;
 - Rubber linings in, for example, chutes and dumpers will be used to reduce impact noise;
 - Drop heights of materials will be minimised;
 - Plant and vehicles will be sequentially started up rather than all together;
 - Effective exhaust silencing systems or acoustic engine covers will be used as appropriate;
 - As far as reasonably practicable, sources of significant noise will be enclosed;
 - Plant will always be used in accordance with manufacturers' instructions. Care will be taken to site equipment away from noise-sensitive areas. Where possible, loading and unloading will also be carried out away from such areas;

- Regular and effective maintenance by trained personnel will be undertaken to keep plant and equipment working to manufacturers specifications; and
- Screening e.g. noise barriers and blinds will be used as appropriate.

7.110 A risk assessment identifying the probability of vibration from any piling activities will also be carried out prior to commencement of construction activities, to determine the need for periodic or continuous vibration monitoring. All piling works will use CFA methods where site conditions allow, which will be unlikely to cause vibration disturbance or damage at surrounding sensitive receptors. Should the need arise, however, additional means of mitigating potential effects will be considered as the construction arrangements are developed further. It is likely that the magnitude of the potential vibration effects can be reduced, and possibly avoided altogether, as a result of these further considerations.

7.111 Construction works noise will be managed to reduce impacts, and mitigation measures will be documented within a Construction Environmental Management Plan (CEMP) which will also be secured by way of planning condition.

7.112 Working hours on the Site will be agreed with the relevant local authority through the CEMP. However, it is expected that the standard hours of work for LBWF will be adhered to. These are as follows: 08.00 to 18.00 hours Monday to Friday; 08.00 to 13.00 hours on Saturdays; no noisy works permitted outside of these hours or on Sundays or Bank Holidays (with exceptions that would be controlled by the Section 61 mechanism). All work outside these hours will be subject to prior agreement of, and/or reasonable notice to the relevant local authorities. Night-time working will be restricted to exceptional circumstances.

Completed Development

Internal Noise Levels (Future Occupants of the Development)

7.113 External noise levels affecting future occupants of the Development and the need to provide a suitable internal ambient noise environment for the proposed uses will be considered as part of the final design of the Development buildings. Façade configurations, including glazing and ventilation specifications, will be finalised for all blocks of the Development during the detailed design.

7.114 Recommendations for glazing and ventilation configurations have been provided in this chapter (with more detail in Appendix 7.2). This assessment indicates that, at façades directly exposed to Forest Road to the south, high specification double glazing with PVB acoustic

lamine and high specification acoustically rated 'through the frame' trickle ventilators will be required. Other parts of the Development will also require acoustically rated medium specification double glazing and rated 'through the frame' trickle ventilators. Standard thermal double glazing with differing pane thicknesses and standard trickle ventilators will be sufficient for quieter façades of the Development.

Vibration from Railway (Future Occupants of the Development)

7.115 Given the low magnitude of vibration measured on site, no mitigation measures are considered necessary for vibration effects during the operational phase of the Development.

Noise from External Fixed Plant

7.116 The specification of plant machinery with low noise emission and properly attenuated supply and extract terminations will help to ensure that noise emissions are minimised. The use of enclosures, local screening, mufflers and silencers will also be used as appropriate.

7.117 Building services and fixed plant will be designed to achieve appropriate operational noise limits following LBWF's requirements. Noise emissions from building plant will be controlled through planning condition and considered during detailed design in order to ensure that operational noise does not exceed a Negligible impact/effect level at sensitive receptors.

Residual Effects

Construction Phase

7.118 Given the context of the construction works in a densely populated urban context, there will likely be temporary impacts on existing local sensitive receptors. However, construction noise and vibration will be mitigated through Best Practicable Means (as defined by Section 72 of COPA) and careful management which will be controlled and agreed through a CEMP. Consequently, construction phase works are anticipated to result in temporary, short term impacts, and can be limited to an effect of Moderate - Minor Adverse significance.

Completed Development

7.119 With appropriate noise control measures adopted for building services and an overall plant strategy that achieves the operational noise limits specified by LBWF, it is considered that noise effects of operational building services and plant noise can be limited to an effect of Negligible significance.

7.120 It is considered that through the use of appropriate glazing and ventilation design strategies, ambient noise affecting future occupants of the Development can be controlled to meet relevant guidelines and LBWF's criteria. Assessments of ambient and predicted future vibration levels affecting the site demonstrate that vibration levels will not exceed relevant criteria for proposed usage.

Cumulative Effects

Construction Phase

7.121 It is considered that any overlapping of construction phases between the Development and other nearby development schemes will have the greatest potential to contribute to cumulative effects. During the construction phases, potential effects exist for the sensitive receptors within the immediate local surroundings.

7.122 The introduction of site hoardings, use of Best Practice Methods to be documented in individual contractors' CEMPs, adherence to pre-determined HGV traffic routes (see Chapter 5 Construction Methodology and Phasing for details, and compliance with the mitigation measures detailed within this Chapter will reduce these interactions as far as possible.

7.123 The contractors will liaise with LBWF (and neighbouring authorities, where applicable) in order to establish working guidelines to reduce the effects of cumulative construction works noise and vibration. Where necessary, the contractors shall seek to undertake regular liaison meetings and reviews with neighbouring construction sites to plan works so that they do not cause unnecessary disruption.

7.124 Provided the above measures are followed, cumulative construction noise and vibration effects will be Moderate - Minor Adverse and temporary in nature.

Completed Development

7.125 It is expected that building services noise from nearby developments will be designed to achieve appropriate operational noise limits so as to not attribute additional noise to the area i.e. 'background creep', which would avoid any significant adverse effects to noise-sensitive receptors in the area. Note that control and mitigation of noise effects from surrounding development will be the responsibility of the individual operator. Provided services plant from nearby developments are designed to achieve appropriate operational noise limits, it is considered that cumulative building services noise would be of Negligible significance.

Summary

- 7.126 This Chapter of the ES assesses the likely significant impacts of the Development with respect to noise and vibration. This Chapter describes the methods used to assess the impacts; the baseline conditions currently existing at the Site and in the surrounding area; the mitigation measures required to prevent, reduce or offset any significant adverse impacts; and the likely residual impacts after these measures have been adopted.
- 7.127 A baseline noise and vibration survey has been undertaken in March 2020. The survey was undertaken to establish the baseline noise and vibration environment across the Site and at nearby sensitive receptors.
- 7.128 Impacts have been considered during the construction and operation phases of the Development. In particular, the Chapter considers:
- the suitability of the Site for its proposed usage in terms of ambient noise and vibration levels;
 - potential impacts in terms of noise and vibration effects from construction works affecting nearby sensitive receptors
 - Noise from building services and plant associated with the Development during operation
- 7.129 Some temporary adverse effects during the construction phase are anticipated. However, construction noise and vibration will be mitigated through appropriate means which will be secured through a CEMP. Residual effects are anticipated to result in temporary, short term impacts, and can be limited to an effect of Moderate-Minor Adverse significance.
- 7.130 Through the use of appropriate noise control measures in order to achieve the specified operational noise limits, it is considered that noise effects of operational building services and plant noise can be limited to an effect of Negligible significance.
- 7.131 It is considered that through the use of appropriate design measures such as glazing specifications and façade insulation design, ambient noise affecting future occupants of the Development can be controlled in order that the Site is suitable for its proposed use. Ambient and predicted future vibration levels at the Site have been assessed and do not exceed relevant criteria relating to the Development's proposed usage.
- 7.132 Changes in road traffic noise levels on the local road network due to the introduction of the Development have been assessed and are summarised to be limited to Negligible significance.

7.133 Table 7.23 contains a summary of the likely significant effects of the Development.

Table 7.23: Table of Significance – Noise & Vibration

Potential Effect	Nature of Effect (Permanent/ Temporary)	Significance (Major/Moderate/Minor) (Beneficial/Adverse/ Negligible)	Mitigation / Enhancement Measures	Geographical Importance*							Residual Effects (Major/Moderate/ Minor) (Beneficial/Adverse/ Negligible)
				I	UK	E	R	C	B	L	
Construction											
Construction noise	Temporary	Major - Moderate Adverse	Control through Section 61 agreement. Best practicable means from COPA. Mitigation measures as advised in BS 5228. Controlled through CEMP.							x	Moderate - Minor Adverse
Construction vibration	Temporary	Major - Moderate Adverse	Piling strategy to select low impact methods. Mitigation measures as advised in BS 5228. Controlled through CEMP.							x	Minor Adverse - Negligible
Construction traffic on local network	Temporary	Negligible	n/a							x	Negligible
Completed Development											
Building services noise	Permanent	Major - Moderate Adverse	Plant strategy to be designed to meet LBWF requirements. Attenuators/ enclosures / screens/ other mitigation where required							x	Negligible
Vibration and re-radiated noise from railways affecting future occupants of Development	Permanent	Negligible	n/a							x	Negligible
Changes to traffic flows on local network	Permanent	Negligible	n/a							x	Negligible
Cumulative Effects											
<i>Construction</i>	Temporary	Major - Moderate Adverse	Clear hoarding lines. Individual BPM/CEMPs/liaison meetings and reviews where necessary.							x	Moderate - Minor Adverse

<i>Operation</i>	Permanent	Major - Moderate Adverse	Individual control measures to avoid 'background creep'.						x		Negligible
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***Geographical Level of Importance**

I = International; UK = United Kingdom; E = England; R = Regional; C = County; B = Borough; L = Local

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