Chapter 12: Noise and Vibration

Land off Dukes Park, Woodbridge

ENVIRONMENTAL STATEMENT

November 2015

12.1 INTRODUCTION

12.1.1 This chapter assesses the noise and vibration impacts of the proposed development. In particular it considers:

- The potential effects of noise and vibration from the construction of the proposed development on existing sensitive receptors;
- The potential impact of changes in noise at existing sensitive receptors during the operational phase of the Project; and,
- The potential impact of existing noise sources on the proposed noise sensitive areas of the Project. Sources of noise include; road traffic on B1438, Top Street, Sandy Lane and the distant A12 to the north of the site; industrial noise from the Bridge Farm Business Park off Sandy Lane and the Waste Water Treatment Works to the south of the site; distant noise from Foxhall Stadium located approximately 5km to the south west of the site; and, noise and vibration from passing trains on the Norwich to Ipswich railway line adjacent to the southern site boundary.

12.1.2 The chapter describes the methods used to assess the noise and vibration impacts, the current baseline conditions at, and in the vicinity of, the proposed development, the potential direct and indirect impacts of the Project arising from noise and vibration, and the mitigation measures required to prevent, reduce, or offset the impacts and the residual impacts. It has been written by Wardell Armstrong LLP.

12.2 METHODOLOGY

12.2.1 The assessment considers the following potential noise impacts:

- The potential noise and vibration impacts of the construction phase impacts have been assessed in accordance with British Standard 5228:2009+A1:2014 “Code of Practice for noise and vibration control on construction and open sites – Parts 1&2” (BS5228) and BRE Controlling particles, vapour and noise pollution from construction sites, Parts 1 to 5, 2003;
- The potential impact of noise from development-generated vehicles on existing and proposed sensitive receptors on and in the vicinity of the proposed development. The current and future traffic noise levels at a number of sensitive receptors; both with and without the Project in place, have been predicted using the calculation procedures set out in the Department of Transport’s memorandum, “Calculation of Road Traffic Noise” (CRTN), 1988; and,
- The potential impacts of the existing sources of noise, on proposed residential areas of the Project, have been assessed with reference to ‘National Planning Policy Framework 2012’ (NPPF), Noise Policy Statement for England, Planning Practice Guidance – Noise, The World Health Organisation Guidelines for Community Noise 1999 (WHO), British Standard 8233 “Guidance on sound insulation and noise reduction for buildings” (2014) and British Standard 6472-1:2008 Guide To Evaluation of Human Exposure to Vibration in Buildings.

Criteria for Significance of Impact

12.2.2 The significance of an environmental impact will be determined not only by the magnitude of the impact but also by the sensitivity of the receptor, as shown in Tables 12.1.

Table 12.1; Methodology for Determining Sensitivity	
Sensitivity	**Description**
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, is of low or local importance.

12.2.3 The sensitivities of the receptor locations have been determined in accordance with Table 12.2 below;

Table 12.2; Noise Magnitude of Effects	
Sensitivity	**Receptor Type**
High	Groups of 10 or more properties, schools, or SSSI
Medium	Individual residential properties
Low	Residential properties, where occupants have an interest in the development, commercial and business uses, and amenity
Negligible	Industrial premises

12.2.4 The significance of an environmental impact for both construction noise, road traffic noise and on site operational noise is determined by the interaction of magnitude and sensitivity. The Impact Significance Matrix used in this assessment is shown in Table 12.3.

Table 12.3; Impact Significance Matrix				
Magnitude	**Sensitivity**			
	High	**Moderate**	**Low**	**Negligible**
Large / Large Beneficial	Very Substantial	Substantial	Moderate	None
Medium / Medium Beneficial	Substantial	Substantial	Moderate	None
Small / Small Beneficial	Moderate	Moderate	Slight	None
Negligible	None	None	None	None

12.2.5 The threshold between insignificant and significant lies between “Moderate” and “Substantial” as identified within Table 11.12. Moderate impacts might be noticeable and intrusive but may cause a small change in behaviour. Substantial impacts might be noticeable and disruptive, and might cause a material change in behaviour or attitude.

12.3 PLANNING POLICY CONTEXT

National

National Planning Policy Framework (March 2012)

12.3.1 In March 2012 the 'National Planning Policy Framework' (NPPF) was introduced as the current planning policy guidance within England. Paragraph 123 of the NPPF states:

12.3.2 'Planning policies and decisions should aim to:

- avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;
- mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions;
- recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and
- identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.'

12.3.3 With regard to 'adverse impacts' the NPPF refers to the 'Noise Policy Statement for England' (NPSE), which defines three categories, as follows:

- 'NOEL – No Observed Effect Level

  This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

- LOAEL – Lowest Observed Adverse Effect Level

  This is the level above which adverse effects on health and quality of life can be detected.

- SOAEL – Significant Observed Adverse Effect Level

  This is the level above which significant adverse effects on health and quality of life occur'.

12.3.4 The first aim of the NPSE states that significant adverse effects on health and quality of life should be avoided. The second aim refers to the situation where the impact lies somewhere between LOAEL and SOAEL, and it requires that all reasonable steps are taken to mitigate and minimise the adverse effects of noise. However, this does not mean that such adverse effects cannot occur.

12.3.5 The National Planning Practice Guidance (NPPG) provides further detail about how the effect levels can be recognised. Above the NOEL noise becomes noticeable, however it has no adverse effect as it does not cause any change in behaviour or attitude. Once noise crosses the LOAEL threshold it begins to have an adverse effect and consideration needs to be given to mitigating and minimising those effects, taking account of the economic and social benefits being derived from the activity causing the noise. Increasing noise exposure further might cause the SOAEL threshold to be crossed. If the exposure is above this level the planning process should be used to avoid the effect occurring by use of appropriate mitigation such as by altering the design and

layout. Such decisions must be made taking account of the economic and social benefit of the activity causing the noise, but it is undesirable for such exposure to be caused. At the highest extreme the situation should be prevented from occurring regardless of the benefits which might arise. Table 12.4 summarises the noise exposure hierarchy.

Table 12.4; **Noise Exposure Hierarchy**

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No Effect	No Observed Effect	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	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 volume of television; speaking more loudly; closing windows for some of the time because of the noise. Potential for non-awakening sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
		Significant Observed Adverse Effect Level	
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. having to keep windows closed most of the time, avoiding certain activities during periods of intrusion. 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	Avoid
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	Prevent

Noise from Earthworks and Construction Phase Activities

12.3.6 The activities associated with the earthworks and construction phase of the proposed development will have the potential to generate noise and create an impact on the surrounding area.

12.3.7 Guidance on the prediction and assessment of noise from development sites is given in British Standard 5228 -1:2009+A1:2014 “Code of Practice for noise and vibration control on construction

and open sites – Part 1: Noise" (BS5228-1), and BRE Controlling particles, vapour and noise pollution from construction sites, Parts 1 to 5, 2003.

12.3.8 Construction noise can have disturbing effects on the surrounding neighbourhood. The effects are varied and are complicated further by the nature of the site works, which will be characterised by noise sources which will change location throughout the construction period. The duration of site operations is also an important consideration. Higher noise levels may be acceptable if it is known that the levels will occur for a limited period.

12.3.9 For the purposes of this assessment, the occupants of residential properties in the vicinity of the site are considered to be the receptors most likely to be affected by the construction phases of the Project. Details of the receptors are set out in Table 12.5, and shown in Drawing 12.1.

Table 12.5; Existing Noise Sensitive Receptor Locations (Construction)

Receptor	Address	Receptor Type	Grid Ref		Bearing from Site	Approximate Distance to Site Boundary
			Easting	Northing		
CESR1	Timbertops, Dukes Park, Woodbridge	Residential	625781	248076	North east	5m
CESR2	11 Dukes Park, Woodbridge	Residential	625807	247908	East	5m
CESR3	Telegraph Cottage, Sandy Lane, Martlesham	Residential	625988	247808	East	5m
CESR4	Bridge Farm East, Top Street, Martlesham	Commercial	625455	247687	South west	5m

12.3.10 The enabling and construction works will be restricted to daytime hours, defined by the local authority. The appropriate category value has been determined for the sensitive receptors in the immediate vicinity of the site, based on the ambient noise levels measured during the daytime period, as detailed in Table 12.14. Details of the noise survey carried out at the sensitive receptors are set out in this chapter.

12.3.11 In addition to the guidance from the local authority, the Control of Pollution Act 1974 (COPA 1974) gives the local authority power to serve a notice under Section 60 imposing requirements as to the way in which works are to be carried out. This could specify times of operation, maximum levels of noise which should be emitted and the type of plant which should or should not be used.

12.3.12 However it might be preferable for the chosen contractor to obtain prior consent under Section 61 of COPA 1974. Section 61, enables anyone who intends to carry out works to apply to the local authority for consent. Under Section 61 the local authorities and those responsible for construction work, have an opportunity to settle any problems, relating to the potential noise, before work starts.

12.3.13 In addition to COPA 1974, BS5228-1 provides guidance on significance criteria for assessing the potential noise impacts associated with the construction phase of large projects. For the purposes of this noise assessment, the noise likely to be generated by the earthworks and construction phase, have been assessed against significance criteria established, using the BS5228-1 ABC Method.

12.3.14 The ABC method for determining significance criteria requires the ambient noise levels at existing sensitive receptors to be determined. The ambient noise levels at each existing receptor location are then rounded to the nearest 5dB(A) to determine the appropriate threshold value in accordance with the category value, A B or C, as detailed in Table 12.6.

***Table 12.6;* Thresholds of Significant Impact from Construction Noise at Residential Receptors in accordance with the ABC Method of BS5228-1**			
Assessment Category and Threshold Value Period (L_{Aeq})	**Threshold Value, in decibels (dB)**		
	Category A *1	**Category B *2**	**Category C *3**
Daytime (0700 to 1900 hours) and Saturdays (0700 to 1300 hours)	65	70	75
*1 Category A: Threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than this value.			
*2 Category B: Threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as Category A values.			
*3 Category C: Threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than Category A values.			

12.3.15 The noise level likely to be generated at the receptor during the construction phase, i.e. the ambient noise level plus construction noise, is then compared to the appropriate category value. If the noise level is greater than the appropriate category value, a significant noise impact may be registered.

12.3.16 For the purposes of this chapter it is possible to estimate the degree of impact from the site works (earthworks and construction), according to the suggested standards, by reference to the time periods during which noise levels may occur in excess of the quoted values. These levels can be seen in Table 12.7**.**

Table 12.7; Construction Noise Assessment Significance Criteria	
Magnitude of Impact	**Criteria for assessing Construction Noise Impact**
Major	Noise levels exceed the Assessment Category threshold level for the duration of the construction works.
Moderate	Noise levels exceed the Assessment Category threshold level for periods of more than one month, but for significantly less than the whole duration of the construction works.
Minor	Noise levels exceed the Assessment Category threshold level for periods of less than one month.
Negligible / Not significant	Noise levels do not exceed the Assessment Category threshold level during any period.

12.3.17 The daytime measured noise levels, from the baseline noise survey representative of the existing sensitive receptors have been provided below in Table 12.8.

Table 12.8; **Construction Noise Assessment Criteria**				
Receptor	**Average Measured Noise Levels (dB $L_{Aeq\ 20\ minutes}$)**	**Ambient Noise Level Rounded to the nearest 5dB(A) (dB $L_{Aeq\ 20\ minutes}$)**	**Appropriate Category Value A, B or C in accordance with BS5228-1**	**Noise Level above which activities of the Construction Phase may cause a significant impact at the Receptor (dB L_{Aeq})**
CESR1 (Monitoring Location 1)	57	55	A	65
CESR2	N/A	<65	A	65
CESR3 (Monitoring Location 2)	N/A	<65	A	65
CESR4	46	45	A	65

12.3.18 Noise monitoring was conducted during what is considered to be peak traffic times, levels are below the threshold of Category A and therefore all other existing receptors, which are located further from any off-site noise sources are likely to be below Category A, 65dB(A).

12.3.19 At the time the noise survey was carried out, 24th April 2014, Wardell Armstrong had not been instructed to carry out a construction noise assessment. Noise monitoring was therefore only carried out in the vicinity of nearby potential noise sources and therefore was not carried out in the vicinity of CESR2 and CESR 4. We can assume, however, that because CESRs 2 and 4 are located further away from off-site noise sources, that the ambient noise levels in the vicinity of these receptors will be less than those measured at the nearest noise sources. Therefore we can categorise the Thresholds of Significant of Impact from Construction Noise as the lowest value, Category A, as shown in Table 12.8 above.

12.3.20 The noise assessment for the construction phase details baseline daytime noise levels measured at sensitive receptor locations and outlines the main construction activities that could give rise to noise impacts at receptors in the vicinity of the proposed development. It also sets out details of 'best practice' management and control measures to ensure that impacts are minimised as far as possible.

Noise from Construction Vehicles

12.3.21 In addition to the earthworks and construction activities, construction vehicle movements to and from the proposed development have the potential to generate noise at existing sensitive receptors, in the immediate vicinity of the local road network.

12.3.22 At this stage, detailed traffic data relating to the likely numbers of construction vehicles is not available. However, the number of construction vehicles is not considered to be significant, relative to the existing flows on the major road links surrounding the Project. It is therefore considered that the level of road traffic noise at sensitive receptor locations will not change significantly due to construction vehicles during the construction phases of the Project, and this impact has not therefore been considered further.

Vibration from Construction Plant and Vehicles

12.3.23 Work involving heavy plant on an open site is likely to generate vibration, which may, in certain circumstances, propagate beyond the boundary of the site. In situations where particularly heavy plant, vibrating compaction equipment or piling rigs are being used close to the site boundary, nearby properties may experience ground-borne vibration.

12.3.24 The existing sensitive receptors most likely to be affected by vibration generated by the earthworks and construction phase works of the Project are detailed in Table 12.5.

12.3.25 Guidance on the assessment of vibration from development sites is given in British Standard 5228 -2:2009 "Code of Practice for noise and vibration control on construction and open sites – Part 2: Vibration" (BS5228-2). BS5228-2 2009+A1:2014 indicates that vibration can have disturbing effects on the surrounding neighbourhood; especially where particularly sensitive operations may be taking place. The significance of vibration levels which may be experienced adjacent to a site is dependent upon the nature of the source.

12.3.26 It is not possible to mitigate vibration emissions from an open site. It is important therefore to examine the proposed working method to ascertain what, if any, operations would be likely to cause unacceptable levels of vibration at nearby sensitive locations. It is possible that these operations could be modified to reduce their vibration impacts.

12.3.27 BS5228-2 indicates that the threshold of perception is generally accepted to be between a peak particle velocity (PPV) of 0.14 and 0.3mm/sec. In an urban situation it is unlikely that such vibration levels would be noticed. BS5228 also indicates that it is likely that vibration of 1.0 mm/s in residential environments will cause complaint, but can be tolerated if prior warning and explanation have been given to residents. The standard also indicates that 10 mm/s is likely to be intolerable for any more than a very brief exposure to this level.

12.3.28 The Highways Agency Research report No. 53 "Ground Vibration caused by Civil Engineering Works" 1986 suggests that, when vibration levels from an unusual source exceed the human threshold of perception, complaints may occur. The onset of complaints due to continuous vibration is probable when the PPV exceeds 3mm/sec.

12.3.29 British Standard BS6472: 2008 "Guide to Evaluation of human exposure to vibration in buildings. Part 1: Vibration sources other than blasting" (BS6472-1) suggests that adverse comments or complaints due to continuous vibration are rare in residential situations below a PPV of 0.8mm/sec. Continuous vibration is defined as "vibration which continues uninterrupted for either a daytime period of 16 hours or a night-time period of 8 hours". The proposed earthworks and construction works at the site will not cause continuous vibration as defined in BS6472-1.

12.3.30 Human perception of vibration is extremely sensitive. People can detect and be annoyed by vibration before there is any risk of structural damage. Cases where damage to a building has been attributed to the effects of vibration alone are extremely rare; even when vibration has been considered to be intolerable by the occupants.

12.3.31 It is not possible to establish exact vibration damage thresholds that may be applied in all situations. The likelihood of vibration induced damage or nuisance will depend upon the nature of the source, the characteristics of the intervening solid and drift geology and the response pattern of the structures around the site. Most of these variables are too complex to quantify accurately

and thresholds of damage, or nuisance, are therefore conservative estimates based on a knowledge of engineering.

12.3.32 Where ground vibration is of a relatively continuous nature, there is a greater likelihood of structural damage occurring, compared to transient vibration; for example that caused by transiting vehicles.

12.3.33 BS5228-2 2009 suggests that the onset of cosmetic damage is 15mm/sec (15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz for residential or light commercial type buildings).

12.3.34 The adverse residual impacts are assessed against the categories set out in Table 12.9.

Table 12.9; Construction Vibration Assessment Significance Criteria

Magnitude of Impact	Criteria for Assessing Construction Vibration impact
Major Adverse	> 10mm per sec. Vibration likely to be intolerable for more than brief exposure. Approaching the level at which cosmetic damage may occur in light structures.
Moderate Adverse	5mm - 10mm per second. Tolerance less likely even with prior warning and explanation.
Minor Adverse	1mm – 5mm per second. Complaints are likely, but can be tolerated if prior warning and explanation given.
Negligible	<1mm per second. Below level at which complaints are likely.

Road Traffic Noise and Existing Sensitive Receptors

12.3.35 The operational phase of the Project will generate additional traffic movements on the existing road network. Additional vehicle movements have the potential to increase road traffic noise levels at existing receptors located adjacent to the main routes to and from the development site.

12.3.36 The current and future road traffic noise levels at a number of existing sensitive receptors; both with and without the development in place, have been predicted using the calculation procedures set out in CRTN. The memorandum was prepared to enable entitlement under the Noise Insulation Regulations 1975 to be determined; but it is stated in the document, that the guidance is equally appropriate for the calculation of traffic noise for land use planning purposes.

12.3.37 For this noise assessment, CRTN has been used to determine the noise levels at existing sensitive receptors detailed in Table 12.10.

Table 12.10; Existing Noise Sensitive Receptor Locations (Operational)						
Receptor	**Address**	**Receptor Type**	**Grid Ref**		**Bearing from Site**	**Approximate Distance to Site Boundary**
			Easting	**Northing**		
OESR1	11 Clayton Court, Woodbridge	Residential	625589	248228	North	220m
OESR2	12 Crane Close, Woodbridge	Residential	625734	248089	North east	20m
OESR3	Telegraph Cottage, Sandy Lane, Martlesham	Residential	625988	247808	East	5m
OESR4	1 Top Street, Martlesham	Residential	625356	247749	West	40m

12.3.38 The traffic information for the Project has been derived from the work undertaken by Hydrock and has been provided as 18 hour AAWT flows. HGV percentage flows and speed limits have also been provided.

12.3.39 Impacts will also be felt at receptors adjacent to and beyond those listed above. However impacts at these receptors will be less than at the listed receptors.

12.3.40 The changes in road traffic noise levels have been assessed against a set of significance criteria. The criteria shown in Table 12.11 are based upon guidance contained within the Design Manual for Roads and Bridges, Volume 11, Section 3, Part 7, 2011 (DMRB) for the assessment of changes in road traffic noise. The criteria do not relate to the actual existing noise levels (i.e. traffic noise due to current residential development) but only the predicted changes.

***Table 12.11;* Road Traffic Noise Assessment Significance Criteria**	
Magnitude of Impact	**Criteria for Assessing Road Traffic Noise**
Major Adverse	> 10.0 dB increase in traffic noise (equating to a clearly perceptible increase in the loudness of noise).
Moderate Adverse	5.0 – 9.9 dB increase in traffic noise (equating to an increase in the loudness of the noise which is at or about the threshold of perception)
Minor Adverse	3.0 – 4.9 dB increase in traffic noise
Negligible	0.1 – 2.9 dB increase in traffic noise.

Road Traffic Noise and Proposed Sensitive Receptors

12.3.41 In addition to existing sensitive receptors, a road traffic noise assessment has been carried out for proposed sensitive receptors to assess the noise impact of the existing flows and development led traffic on proposed dwellings.

12.3.42 The future road traffic noise levels at two proposed sensitive receptors with the Project in place, have also been predicted using the calculation procedures set out in CRTN.

12.3.43 Noise from existing and development led traffic has been predicted using the methodology described for the proposed sensitive receptors described in Table 12.12 below, and shown on Drawing 12.1.

Table 12.12; **Proposed Sensitive Receptor Locations**				
Receptor	**Receptor Type**	**Location**	**Grid Ref**	
			Easting	**Northing**
PSR1	Residential	Northern part of the site adjacent to B1438	625751	248060
PSR2	Residential	North western part of the site adjacent to Top Street	625537	247863
PSR3	Residential	South eastern part of the site adjacent to Sandy Lane	625936	247722
PSR4	Residential	Southern part of the site adjacent to the railway line	625689	247652

Rail Noise and Proposed Sensitive Receptors

12.3.44 A rail noise assessment has been carried out for proposed sensitive receptors in the southern part of the site closest to the rail line, to assess the noise impact of the existing rail movements on proposed dwellings.

12.3.45 The existing rail traffic noise levels at proposed sensitive receptors have been predicted using the calculation procedures set out in Department of Transport Technical Memorandum 'Calculation of Railway Noise' 1995 (CRN). The calculation procedure uses a combination of the measured residual noise levels (i.e. noise levels in the absence of trains), the total number of train passes (during the daytime and night-time periods), and a sound exposure level (SEL) of a typical train using the line, to calculate daytime and night time ambient noise levels with all train movements included.

12.3.46 Noise from existing and development led traffic has been predicted using the methodology described for the proposed sensitive receptors described in Table 12.12 below. Details of the measurements and calculations carried out to determine the average daytime and night time train noise levels are set out in full in Appendix 12.1. Details of train movements observed during the survey are included as Appendix 12.2.

Vibration from Rail Movements and Proposed Sensitive Receptors

12.3.47 Human perception of vibration is extremely sensitive. People can detect and be annoyed by vibration long before there is any risk of structural damage. Cases where damage to a building has been attributed to the effects of vibration alone are extremely rare, even when vibration has been considered to be intolerable by the occupants.

12.3.48 It is not possible to establish exact vibration damage thresholds that may be applied in all situations. The likelihood of vibration induced damage or nuisance will depend upon the nature of the source, the characteristics of the intervening solid and drift geology and the response pattern of the structures around the site. Most of these variables are too complex to quantify accurately

and thresholds of damage, or nuisance, are therefore conservative estimates based on a knowledge of engineering.

12.3.49 Where ground vibration is of a relatively continuous nature, there is a greater likelihood of structural damage occurring, compared to transient vibration; for example that caused by passing trains.

12.3.50 With regard to structural response to vibration it is known that actual damage to structures or their finishes due solely to vibration is rare, and that where damage is noted it is often incorrectly ascribed to vibration.

12.3.51 The response of a building to vibration depends upon the type of foundation the building has, the underlying ground conditions, the building construction and the state of repair of the building.

12.3.52 BS6472-1 (2008) provides guidance regarding the significance of Vibration Dose Value (VDV) within buildings in terms of human response, as detailed in Table 12.13.

Table 12.13; Vibration dose value ranges which might result in various probabilities of adverse comment within residential buildings

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 16 h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

*Below these ranges adverse comment is not expected

**Above these ranges adverse comment is very likely

Guidance Noise Levels at Proposed Sensitive Receptors

12.3.53 The Noise Policy Statement for England refers to the World Health Organisation (WHO) when discussing noise impacts. The WHO Guidelines for Community Noise 1999 suggest guideline values for internal noise exposure which take into consideration the identified health effects and are set, based on the lowest effect levels for general populations. Guideline values for annoyance which relate to external noise exposure are set at 50 or 55 dB(A), representing day time levels below which a majority of the adult population will be protected from becoming moderately or seriously annoyed respectively.

12.3.54 The following guideline values are suggested by WHO:

- 35 dB $L_{Aeq,(16\ hour)}$ during the day time in noise sensitive rooms;
- 30 dB $L_{Aeq,(8\ hour)}$ during the night time in bedrooms;
- 45 dB $L_{Amax,(fast)}$ during the night time in bedrooms; and,
- 55 dB $L_{Aeq,(16\ hour)}$ to protect majority of population from becoming seriously annoyed.

12.3.55 British Standard 8233 “Guidance on sound insulation and noise reduction for buildings” 2014 bases its advice on the WHO Guidelines. In addition, for internal noise levels it states;

“Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved.”

12.3.56 Furthermore, with regard to external noise, the Standard states;

"For traditional external areas that are used for amenity space such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$ with an upper guidance value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognised that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited".

12.3.57 The NPPG summarises the approach to be taken when assessing noise. It accepts that noise can override other planning concerns, but states:

"Neither the Noise Policy Statement for England nor the National Planning Policy Framework (which reflects the Noise Policy Statement) expects noise to be considered in isolation, separate from the economic, social and other environmental dimensions of proposed development".

Local Policy

12.3.58 Consultation has taken place with Liz Beighton of Suffolk Coastal District Council prior to this assessment, who provided a scoping opinion on the Environmental Impact Assessment for this project. With regards to noise and vibration, the following points were raised:

- The EIA should assess the cumulative and indirect environmental impacts, and the relationship between them, with respect to traffic and transport; as noted in the National Planning Policy Practice Guidance.
- The proposed development to the north of the site on land which is currently occupied by Woodbridge Town Football Club should be considered during this assessment.
- All road traffic noise calculations should be carried out in accordance with the Department of Transports 'Calculation of Road Traffic Noise'.
- An assessment of cumulative road traffic noise impacts should be carried out using criteria contained within the 'Design Manual for Roads and Bridges', Volume 11, Section 3, Part 7 'Noise and Vibration'.
- The application should include a noise survey and assessments of noise from the adjacent rail line and road traffic on the A12. A full acoustic assessment may not be necessary and necessary justification should be given in this case.
- The impact of noise and disturbance from Foxhall Stadium upon any future residents of the proposed development should be considered.
- The impact of road traffic noise on existing and future residents should be considered.
- Assessment of noise and vibration during construction should be included.

12.4 BASELINE CONDITIONS

Desk Study

12.4.1 The potential major sources of noise contributing to baseline conditions were identified through a desktop study of the site and surrounding land uses using available maps and aerial photography. Road traffic noise from the surrounding local road network, including the B1438, Top Street, Sandy Lane and the A12 and, noise and vibration from passing trains on the Norwich to Ipswich railway line adjacent to the southern site boundary, were considered to be potential sources of noise and vibration affecting the development site. Other potential sources of noise include the Bridge farm Business Park off Sandy Lane and the Waste Water Treatment Works to the south of the site as well as distant noise from Foxhall Stadium located approximately 5km to the south west of the site. The potential existing sensitive receptor locations and the proposed locations for on-site noise measurement have been identified as those most likely to be affected by the proposed development.

Noise Survey

12.4.2 Attended noise measurements were taken at four monitoring locations, which are considered to be representative of proposed residential receptors nearest to the dominant noise sources. The monitoring locations are as follows, and are shown on Drawing Number LE12277-001:

- Monitoring Location 1: In the north of the site, adjacent to the site boundary with the B1438 Ipswich Road.
- Monitoring Location 2: In the east of the site, adjacent to the Sandy Lane.
- Monitoring Location 3: In the south of the site, adjacent to the boundary with the Norwich to Ipswich railway line.
- Monitoring Location 4: In the west of the site, adjacent to Top Street.

12.4.3 Attended noise monitoring was carried out during the following period:

- Between 16:01 and 18:06 hours on the 24th April 2014. This time period is considered to be representative of the highest ambient noise levels, (mainly transportation noise) during the evening rush hour period (1600-1800).
- Between 05:09 and 09:37 hours on the 25th April 2014. This time period is considered to be representative of the highest ambient noise levels, (mainly transportation noise) during the night-time period (0500-0700) and the daytime rush hour period (0700-0900).

12.4.4 The noise measurements were made using a Class 1, integrating sound level meter. The sound level meter was mounted vertically on a tripod 4m above the ground during night time monitoring (to measure noise levels at bedroom window height), and 1.2m above the ground during daytime monitoring (to measure noise levels at ground floor window height and in gardens).

12.4.5 All noise monitoring took place during dry and calm weather conditions. The sound level meter was calibrated to a reference level of 94dB at 1kHz both before, and on completion of, the noise survey. No drift in calibration was measured during the survey.

12.4.6 For the purpose of this assessment daytime hours are taken to be 0700 to 2300 hours and night-time hours to be 2300 to 0700 hours.

12.4.7 A-weighted L_{eq} noise levels were measured to comply with the requirements of WHO. A-weighted L_{90} and L_{10} noise levels, together with the maximum and minimum sound pressure levels, were also measured to provide additional information. The measured noise levels are set out in full in Appendix 12.1.

12.4.8 The measured daytime and night time noise levels at Monitoring Location 3 have been adjusted to include scheduled train movements using the methodology contained in the Department of Transport technical memorandum 'Calculation of Railway Noise' 1995 (CRN). The calculation procedure uses a combination of the measured residual noise levels (i.e. noise levels in the absence of trains), the total number of train passes (during the daytime and night-time periods), and a sound exposure level (SEL) of a typical train using the line, to calculate daytime and night time ambient noise levels with all train movements included.

12.4.9 The Electronic National Rail Timetable (ENRT) valid from 18th May 2015 indicates that there are typically 31 movements of passenger trains along the Norwich to Ipswich railway line during the day and 2 movements during the night.

12.4.10 The Rail Working Time Table (WTT), May 2015, does not indicate any timetabled movements of freight train on the line, however during the noise survey, 1 freight train was witnessed along the railway line. Therefore, to be robust, it has been estimated that 5 freight train movements occur during the daytime and 1 freight train movement during the night time has been included.

12.4.11 Details of the measurements and calculations carried out to determine the average daytime and night time train noise levels are set out in full in Appendix 12.1. Details of train movements observed during the survey are included as Appendix 12.2.

12.4.12 Attended noise monitoring allows observations and detailed notes to be made of the significant noise sources which contribute to each of the measured levels. The observations identified the following:

Road Traffic Noise: Noise from road traffic on the B1438 Ipswich Road, the A12, Sandy Lane and Top Street, were audible at monitoring locations throughout the noise survey. A reduction in the level of road traffic noise was noted during the night time.

Rail Traffic Noise: Noise from the passage of passenger trains and a freight train on the Norwich to Ipswich railway line to the south of the site boundary.

Birdsong: Birdsong was audible at all locations during the daytime and night-time periods.

Other Sources: Other contributing noise sources included high level aircraft.

12.4.13 During the time of the noise survey no noise was audible from the operations at Bridge Farm Business Park, adjacent to the south western boundary. The commercial units on Sandy Lane and the Waste Water Treatment Works to the south of the site were also not audible on site at any point during the survey. Therefore, these noise sources have not been considered further.

Vibration Survey

12.4.14 Vibration measurements were carried out on compacted ground at one location, Vibration Location 1, approximately 10m from the southern site boundary adjacent to the railway line as shown on Drawing 12.1. This location is considered representative of the proposed residential dwellings closest to the railway line.

12.4.15 Attended vibration monitoring allows observations and detailed notes to be made of the significant sources which contribute to each of the measured levels of vibration and noise.

12.4.16 The vibration measurements were taken using a Vibrock V901-2 dual channel vibration recorder version with whole body vibration transducer. The vibration level, expressed in terms of vibration dose value (VDV) was measured for 16 hour daytime (0700-2300hrs) and 8 hour night-time (2300-0700) periods.

12.4.17 Vibration measurements have been carried out between 05:22 and 09:48 on the 25th April 2014, to capture the morning peak transportation times.

Existing Noise Levels

12.4.18 The measured noise levels for each monitoring location have been divided into daytime (07:00-23:00 hours) and night-time (23:00-07:00 hours) categories. The individual levels have been arithmetically averaged and then rounded up to give a single daytime and night-time level for each location. The results for each of the monitoring locations are presented in Table 12.14.

Table 12.14: Average Daytime and Night-time Noise Levels (Figures in dB)

Monitoring Location	Time	Average Measured Noise Level L_{Aeq}
1	0700-2300	57
	2300-0700	52
2	0700-2300	46
	2300-0700	48
3	0700-2300	56
	2300-0700	56
4	0700-2300	57
	2300-0700	50

12.4.19 The maximum noise levels measured during each night-time period of the survey, at each of the monitoring locations, are summarised in Table 12.15.

Table 12.15:Summary of the Maximum Night-time Noise Levels

Monitoring Location	Maximum Measured Noise Level $L_{AF, max}$ (dB(A))
1	66
2	61
3	83
4	67

12.4.20 Based on the results obtained, a robust assessment can be made of the noise levels at the site and of the mitigation measures necessary to achieve the required internal daytime and night-time, and external daytime noise levels at the development site.

12.5 POTENTIAL EFFECTS

Construction Phase Assessment

Noise from Earthworks and Construction Phase Activities

12.5.1 During the earthworks and construction phase, any work carried out at the Project is likely to generate noise that may propagate beyond the proposed development boundary.

12.5.2 At this stage, detailed information regarding the nature and timescales of activities likely to take place during the earthworks and construction phase are not known. Activities on the site, which could give rise to construction noise impacts include (but are not limited to):

- Site preparation i.e. ground excavation, levelling of ground, trenching, trench filling, unloading and levelling of hardcore and compacting filling; and
- Construction of the proposed redevelopment including piling, construction of access roads, fabrication processes e.g. planing, sanding, routing, cutting, drilling and laying foundations.

12.5.3 The contractor undertaking the enabling and construction works has not yet been appointed. However, it is considered that the enabling and construction works are likely to be restricted to daytime hours, i.e. between 08:00 and 17:00 hours Monday to Friday and 09:00 to 12:00 hours on a Saturday, with no work on Sunday and Bank Holidays. Based on the ambient noise levels measured during the daytime period, the appropriate category value has been determined for each of the sensitive receptors, as detailed in Table 12.5.

12.5.4 The earthworks and construction phase activities have the potential to generate short term increases in noise levels, above those recommended in BS5228-1. The levels of noise received at the receptors closest to the proposed development would depend on the sound power levels of the machines used, the distance to the properties, the presence of screening or reflecting surfaces and the ability of the intervening ground to absorb the propagating noise.

12.5.5 The nearest noise sensitive receptors to the Project, as detailed in Table 12.5, will vary depending on the phase of the Project under construction. Given the potentially small distances between the construction activities and residential dwellings, noise levels at the receptors may occur above those detailed in Table 12.8. Proposed receptors which become occupied before the completion of the construction phase of the Project would experience a similar noise impact. The noise generated by the earthworks and construction phases of the Project may therefore exceed Category A in BS5228 at the existing and proposed sensitive receptors located in the immediate vicinity of the construction phases of the Project.

12.5.6 The noise impact of the construction phase on existing and proposed residential properties is **moderate** to **minor adverse.**

12.5.7 It is therefore recommended that mitigation measures be put in place that will reduce the scale of the potential effect. Details can be found in the mitigation section of this chapter.

Vibration from Earthworks and Construction

12.5.8 Wardell Armstrong's archives contain field trial measurements of ground vibration associated with types of plant likely to be used at the proposed development. The representative, measured

levels, made by Wardell Armstrong using a Vibrock B801 Digital Seismograph, are set out in Table 12.16.

Table 12.16: Measured Vibration Levels of Plant Under normal Operating Conditions

Plant Type	Distance from Source		
	10m (mm/s)	20m (mm/s)	30m (mm/s)
25-30 tonne excavator	0.175	0.075	Background
25 tonne dumptruck (Volvo A25) Loaded Empty	 1.000 0.225	 0.150 0.050	 Background Background
Dozer	1.050	0.400	Background
Vibrating roller Drum Vibrator on Vibrator off	 4.470 0.500	 3.270 0.150	 2.350 0.050
Loading shovel	1.025	0.150	Background

12.5.9 The nearest sensitive properties to the proposed construction works, as detailed in Table 12.5 of this chapter, will vary depending on the phase of the Project under construction. The sensitive receptors could include proposed dwellings which become occupied before the completion of the construction phase of the Project. As a worst case scenario, earthworks and construction works may potentially take place at a distance of approximately 5 metres from existing and proposed residential properties.

12.5.10 At this distance, it is possible that vibration due to the operation of various construction plant, and in particular a vibratory roller, may be above the threshold of complaint. However, the vibration levels are highly unlikely to be above the threshold of structural damage. It is possible that residential properties would therefore potentially experience some adverse impact. However these would be transient only and for very limited periods during the works, i.e. when activities take place at the Project boundaries.

12.5.11 In addition to the earthworks and construction works described, it is possible that piling will be required. At this time, the type(s) of piling which would be used at various locations across the site, is not known and it is likely that the contractor responsible for undertaking the works at the site would decide the method of piling.

12.5.12 BS5228-2 recognises that the most common form of vibration associated with piling is the intermittent type derived from conventional driven piling. The intensity of vibration disturbance, which may be registered at a receptor, will be a function of many factors. These are set out in BS5228-2 and include:

- Energy per blow or cycle;
- Distance between source and receptor;
- Soil structure interaction i.e. nature of connection between soil and structure being monitored; and
- Construction of structure and location of measuring points e.g. soil surface, building foundation and internal structural element.

12.5.13 As the responsible contractor has not yet been appointed, detailed information regarding the above is not known. It is not therefore possible to assess the potential impacts of vibration generated by piling.

12.5.14 The vibration impact of the construction works at existing and proposed residential receptors is **minor** to **moderate adverse**.

12.5.15 The receptors likely to be affected by piling will vary depending of the phase of the Project under construction. Once the precise building locations, ground conditions for each location and type(s) of piling are confirmed, vibration levels could be estimated and recommendations for control made as appropriate. Mitigation measures are discussed within the mitigation section of this chapter.

Operational Phase Assessment

Road Traffic Noise and Existing Sensitive Receptors

12.5.16 CRTN predictions have been carried out to assess any potential changes in road traffic noise at existing receptor locations due to the operational phase of the proposed development.

12.5.17 The noise levels at each of the receptors considered have been assessed by comparing the noise levels predicted for the following scenarios;

Scenario 1: 2015 Base year;

Scenario 2: 2025 Future year baseline;

Scenario 3: 2025 Future year with committed developments; and,

Scenario 4: 2025 Future year with committed developments and the proposed development.

12.5.18 The predicted noise levels are detailed in Table 12.17 below.

Table 12.17:Predictions for the 2015 and 2025 "Without Development" and "With Development" Scenarios and Changes in Predicted Road Traffic Noise Levels

Existing Sensitive Receptor Number	Predicted $L_{10\ 18hour}$ dB(A) at the façade of the Receptor				Change in Predicted Road Traffic Noise Levels Between Scenarios (Figures in dB(A))	
	Scenario 1: 2015 Base year	Scenario 2: 2025 Future year baseline	Scenario 3: 2025 Future year with committed developments	Scenario 4: 2025 Future year with committed developments and the Project	2 - 4	3 - 4
ESR1	73	73	74	73	0	-1
ESR2	68	69	69	69	0	0
ESR3	56	57	59	59	2	0
ESR4	74	75	76	76	1	0

12.5.19 The changes in noise levels have been assessed against the significance criteria contained in Table 12.11. The results show that there will be no increases in noise level between 2025 baseline (Scenario 2) and 2025 with the development and committed developments (Scenario 4) at ESRs 1 and 2, and an increase of up to 2dB at ESRs 3 and 4. In accordance with the significance criteria detailed within Table 12.11, the increase in road traffic noise will be between

negligible and **none** at existing receptors. The results also show that there will be no increase in noise level at any existing receptor between 2025 with committed developments (Scenario 3) and 2025 with the development and committed developments (Scenario 4) at existing sensitive receptors. This shows that the cumulative impact of committed developments and the proposed development will be **negligible**, however this impact is caused by road traffic associated with committed developments. The magnitude of cumulative impact in accordance with the IEMA guidelines is regarded as **not significant**.

12.5.20

12.5.21 The greatest change in noise level as a result of the proposed development at ERSs will be at ESR1, where a reduction in noise level of 1dB is predicted to happen as a result of the proposed development. In accordance with the significance criteria detailed within Table 12.11, this increase in road traffic noise will be **none** at existing receptors. The magnitude of impact in accordance with the IEMA guidelines is regarded as **not significant**.

12.5.22 The prediction calculations in CRTN can be found in Appendix 12.4.

Road Traffic Noise at Proposed Sensitive Receptors

12.5.23 Noise prediction calculations using CRTN have also been carried out to determine the future levels of road traffic noise at the residential areas of the proposed development.

12.5.24 The noise levels predicted to occur in the 2025 'With Development' scenario are higher than those recorded during the noise survey. Furthermore changes in traffic flows along the local road network will occur between when the noise survey was carried out and the predicted opening year of the development (2025). Therefore the predicted noise levels for the 2025 'With Development' scenario are considered to be more representative, and form a robust assessment of the future noise environment at the proposed development site.

12.5.25 The noise level calculations using CRTN are presented as $L_{A10,18hour}$. This has been converted to an $L_{Aeq,16hour}$ and $L_{Aeq,8hour}$ using the methodology in Transport Research Laboratory Converting the UK traffic noise index $L_{A10,18h}$ to EU noise indices for noise mapping (TRL) guidance document.

12.5.26 A site masterplan was not available at the time of writing, therefore the nearest proposed sensitive receptor has been based on the development framework provided by FPCR.

12.5.27 The results of the prediction calculations for 2025 (with proposed development traffic in place, i.e. Scenario 3) is shown in Table 12.18.

Table 12.18: CRTN Predictions for the 2025 "With Development" Scenarios at Proposed Sensitive Receptors

Proposed Sensitive Receptor Number	Predicted $L_{10,18hour}$ dB(A)	Predicted $LAeq_{,16hour}$ dB(A)	Predicted $L_{Aeq,8hour}$ dB(A)
PSR1	66	64	56
PSR2	69	67	58
PSR3	60	58	50

12.5.28 Night time maximum, $L_{AF,\ max,}$ noise levels are taken from measured noise date presented in Table 12.15.

Rail Noise at Proposed Sensitive Receptors

12.5.29 The development framework indicates that proposed sensitive receptors (PSR4) could be located in the vicinity of the existing rail line. The calculation methodology in CRN has been used to predict the daytime noise level at the representative location of proposed sensitive receptors in the southern part of the site (PSR4).

12.5.30 Predicted noise levels at PSR4 have been based on measurements of passing trains, the measured sound exposure levels, the residual noise levels in the southern part of the site and the current train timetable for the Norwich to Ipswich rail line. There is no direct line of sight to the existing road network in the southern part of the site therefore rail noise is likely to remain the dominant source of noise in this location.

12.5.31 The results of the prediction calculations are shown in Table 12.19.

Table 12.19: CRN Predictions at Proposed Sensitive Receptor 4

Proposed Sensitive Receptor Number	Predicted $L_{Aeq,16hour}$ dB(A) at the Receptor	Predicted $L_{Aeq,8hour}$ dB(A) at the Receptor
PSR4	53	50

12.5.32 Night time maximum, $L_{AF,\ max,}$ noise levels are taken from measured noise date presented in Table 12.15.

External Daytime Noise Levels at Proposed Residential Properties

12.5.33 The calculated noise levels for the proposed sensitive receptors (PSRs) in Tables 12.18 and 12.19 have been used in conjunction with the measured $L_{AF,\ max}$ noise levels shown in Tables 12.15 during the night time to calculate the sound attenuation required to achieve external daytime guideline noise levels.

12.5.34 Noise levels in external living areas of the proposed dwellings have been assessed in accordance with the guideline noise levels for external living areas:

- 55dB $L_{Aeq,T}$ should be considered as the upper guideline value for external living areas.

12.5.35 Table 12.20 details the attenuation required proposed sensitive receptors, in order to achieve 55dB(A) in outdoor living areas. Daytime noise levels at PSRs 1, 2 and 3 are taken from Tables 12.18 and 12.19.

Table 12.20: Calculated Daytime Noise Levels in Outdoor Areas of Proposed Sensitive Receptors		
Proposed Sensitive Receptor Location	**Daytime Noise Level (Figures in dB(A))**	**Attenuation Required to Achieve 55dB(A) (Figures in dB(A))**
PSR1 - Residential properties in the northern part of the site, nearest to the B1438 (i.e. Monitoring Location 1)	64	9
PSR2 - Residential properties in the north western part of the site, nearest to the northern section of Top Street (i.e. Monitoring Location 4)	67	12
PSR3 - Residential properties in the south western part of the site, nearest Sandy Lane (i.e. Monitoring Location 2)	58	3
PSR4 - Residential properties in the southern part of the site, nearest to the rail line (i.e. monitoring location 3)	53	0

12.5.36 Table 12.20 shows that the WHO guideline value of 55dB, L_{Aeq} will be exceeded in outdoor living areas at PSRs 1, 2 and 3. Therefore, mitigation measures will be required for proposed residential dwellings nearest to the B1438, Top Street and Sandy Lane.

12.5.37 Noise levels at proposed sensitive receptors in the southern part of the site, closest to the rail line, wil be below the WHO guideline value of 55dB L_{Aeq}, therefore no mitigation measures will be required for proposed gardens in this area.

Internal Daytime Noise Levels at Proposed Residential Properties

12.5.38 The daytime predicted noise levels, as detailed in Tables 12.18 and 12.19 have been used to determine the noise levels likely at the façades of properties in the vicinity of the monitoring locations and off site noise sources during the daytime period.

12.5.39 Before internal noise levels can be calculated 3dB(A) must be added to the free-field measured levels to allow for the reflection of noise from the proposed housing facades when the buildings are in place.

12.5.40 The calculated noise levels at the façades of the proposed dwellings, together with the level of attenuation required to achieve 35dB L_{Aeq} in the living room and bedroom areas during the daytime, are summarised in Table 12.21.

Table 12.21: Façade Noise Level at Properties in the Vicinity of the Monitoring Locations and Level of Attenuation Required to Achieve the Internal Daytime Noise Limit		
Proposed Sensitive Receptor	**Noise Level at the Façade of the Property $L_{eq,16hour}$ (dB(A))**	**Level of Attenuation Needed To Achieve Guideline Noise Levels (dB(A))**
PSR1 - Residential properties in the northern part of the site, nearest to the B1438 (i.e. Monitoring Location 1)	67	32
PSR2 - Residential properties in the north western part of the site, nearest to the northern section of Top Street (i.e. Monitoring Location 4)	70	35
PSR3 - Residential properties in the south western part of the site, nearest Sandy Lane (i.e. Monitoring Location 2)	61	26
PSR4 - Residential properties in the southern part of the site, nearest to the rail line (i.e. monitoring location 3)	56	21

12.5.41 The facades of the properties further into the site will be at a greater distance from off-site noise sources such as roads and the rail line to the south, and will also be protected by the buildings themselves and/or screened by other buildings. It is considered that the noise levels at these facades, and therefore the level of attenuation the facades would need to provide to achieve 35dB L_{Aeq} in the living room areas, will be less than those detailed in Table 12.21.

12.5.42 Mitigation measures and glazing recommendations are discussed further later in the mitigation section of this chapter.

Internal Night Time Noise Levels at Proposed Residential Properties

12.5.43 The night time predicted noise levels, as detailed in Tables 12.18 and 12.19 have been used in conjunction with the measured night time maximum noise levels presented in Table 12.15, to determine the noise levels likely at the façades of properties in the vicinity of the monitoring locations and off site noise sources during the night time period.

12.5.44 Before internal noise levels can be calculated 3dB(A) must be added to the free-field measured levels to allow for the reflection of noise from the proposed housing facades when the buildings are in place.

12.5.45 The calculated noise levels at the façades of the dwellings, together with the level of attenuation required to achieve 30dB L_{Aeq} and 45dB $L_{Af,Max}$ in the bedrooms, are summarised in Table 12.22.

Table 12.22: Façade Noise Level at Properties in the Vicinity of the Monitoring Locations and Level of Attenuation Required to Achieve the Internal Night-time Noise Limit			
Proposed Sensitive Receptor	**Noise Level at the Façade of the Property $L_{eq,8hour}$**	**Measured Maximum Value (dB(A))**	**Level of Attenuation Needed To Achieve 'Good' Standard in Accordance with BS8233**
PSR1 - Residential properties in the northern part of the site, nearest to the B1438 (i.e. Monitoring Location 1)	59	69	29
PSR2 - Residential properties in the north western part of the site, nearest to the northern section of Top Street (i.e. Monitoring Location 4)	61	70	31
PSR3 - Residential properties in the south western part of the site, nearest Sandy Lane (i.e. Monitoring Location 2)	53	64	23
PSR4 - Residential properties in the southern part of the site, nearest to the rail line (i.e. monitoring location 3)	53	86	41

12.5.46 The facades of the properties further into the site will be at greater distance from the road, and will also be protected by the buildings themselves and/or screened by other buildings. It is considered that the noise levels at these facades, and therefore the level of attenuation the facades would need to provide to achieve the 30dB L_{Aeq} and 45dB $L_{Af,max}$ in the bedrooms, will be less than those detailed in Table 12.22.

12.5.47 Mitigation measures will be required in the final design, and are detailed within the mitigation section of this chapter.

Vibration and Proposed Sensitive Receptors

12.5.48 The measured vibration levels are summarised in Table 12.23 below, and shown in Appendix 12.3.

Table 12.23; Measured Vibration Levels at Vibration Monitoring Location 1 (VDV)

Time	VDV		
	X	Y	Z
0500-0600	0.020	0.014	0.018
0600-0700	0.017	0.015	0.013
0700-0800	0.013	0.015	0.013
0800-0900	0.013	0.015	0.013
0900-1000	0.016	0.015	0.013
8 Hour VDV (2300-0700)	**0.031**	**0.025**	**0.026**
16 Hour VDV (0700-2300)	**0.028**	**0.030**	**0.026**

12.5.49 BS6472-1 (2008) provides guidance regarding the significance of VDV values in terms of human response. The highest 8 hour VDV measured at the site was 0.031m/s and the highest 16 hour VDV measured was 0.030 m/s. These vibration levels are below the threshold for low probability of adverse comment in accordance with BS6472-1 (2008), as detailed in Table 12.23. It should be noted that the VDV within the proposed buildings will depend upon the underlying ground conditions, foundations and final construction details of the building, however due to the low existing vibration levels, vibration impacts from the Norwich to Ipswich line are not anticipated.

12.6 PROJECT DESIGN

12.6.1 This section describes the measures which are required to mitigate any significant environmental impacts.

Construction Phase Assessment

Noise from Earthworks and Construction

12.6.2 To reduce the potential impact of noise levels generated by the construction phase of the Project, at existing receptor locations in the immediate vicinity of the site, mitigation measures will be required.

12.6.3 Best working practice will be implemented during each phase of the earthworks and construction works at the site. The construction works will follow the guidelines in BS5228-1 and the guidance in BRE Controlling particles, vapour and noise pollution from construction sites, Parts 1 to 5, 2003.

12.6.4 The following measures will be put in place to minimise noise emissions:

- When works are taking place within close proximity to those sensitive receptors identified, screening of noise sources by temporary screen may be employed;
- All plant and machinery should be regularly maintained to control noise emissions, with particular emphasis on lubrication of bearings and the integrity of silencers;
- Site staff should be aware that they are working adjacent to a residential area and avoid all unnecessary noise due to misuse of tools and equipment, unnecessary shouting and radios;
- A further measure to reduce noise levels at the sensitive receptors would include, as far as possible, the avoidance of two noisy operations occurring simultaneously in close proximity to the same sensitive receptor;
- Adherence to any time limits imposed on noisy works by the local authority;
- Implement set working hours during the week and at weekends;
- Ensure engines are turned off when possible; and
- Should earthworks/earthworks and construction activities need to be carried out during night-time hours, the local authority could include a planning condition which requests advance notice and details of any night working to provided.

12.6.5 Once the best working practices detailed in the mitigation section of this chapter are implemented the residual noise impacts associated with the earthworks and construction phase will be **negligible**, with only brief periods of **minor adverse impacts** likely in the short term at local level.

Vibration from Earthworks and Construction

12.6.6 BS5228-2 recognises that the most common form of vibration associated with piling is the intermittent type derived from conventional driven piling.

12.6.7 To minimise the potential for vibration to be generated by any necessary piling it is recommended that careful consideration is given to the type of piling to be used. For example auger bored piles would be preferable to driven piles with regards to a reduced potential for noise and vibration to be generated. However, it is recognised that the piling process will need to be selected on the basis of the strata to be encountered, the loads to be supported and the economics of the system.

12.6.8 The receptors likely to be affected by piling will vary depending of the phase of the Project under construction. Once the precise building locations, ground conditions for each location and type(s) of piling are confirmed, vibration levels could be estimated and recommendations for control made as appropriate.

12.6.9 To keep ground borne vibration to a minimum the following measures, as referred to in BS5228-2, should be put in place:

- Substitution: Where reasonably practicable, plant and or methods of work likely to cause significant levels of vibration at the receptors identified, should be replaced by less intrusive plant/methods of working; and
- Vibration Isolation of plant at source: This may prove a viable option where the plant is stationary (e.g. a compressor, generator) and located close to a receptor.

12.6.10 There are a number of measures which can be implemented, depending upon the type of piling chosen. BS5228-2 indicates that mitigation might include: use of alternative methods, removal of obstructions, provision of cut-off trenches, reduction of energy input per blow, reduction of resistance to penetration. Continuous flight augering would cause minimal vibration even when very close to the piling operation.

12.6.11 As the construction programme and methodologies become more defined it is suggested that earthworks and construction vibration be reconsidered and that a detailed strategy for control be implemented.

12.6.12 Once the best working practices detailed in the mitigation section of this chapter are implemented, the residual vibration impacts associated with the earthworks and construction phase will be **minor adverse** at local level.

Operational Phase Assessment – Existing Sensitive Receptors

12.6.13 The changes in road traffic noise due to the development generated traffic have been assessed at a number of existing sensitive receptors. The assessment confirms that in accordance with the significance criteria included Table 12.3, there will be no increase in road traffic noise between 2025 without the proposed development and 2025 with the proposed development, i.e. Scenario 2, and Scenario 3, at the existing sensitive receptors and therefore the impact will be **none** with a magnitude that is **not significant** in the long term.

Operational Phase Assessment – General Noise Levels

12.6.14 The results of the noise assessment, for the proposed residential areas of the development, indicate that noise mitigation measures would need to be incorporated into the proposed site design to ensure that the required noise levels are achieved within outdoor living areas, living rooms and bedrooms.

External Living Areas

12.6.15 The noise levels, as detailed in Table 12.20, indicate that mitigation is required to achieve the WHO guideline noise levels in outdoor living areas in the vicinity of the B1438, Top Street and Sandy Lane. Properties located nearest to the rail line in the southern part of the site however, will not require any mitigation.

12.6.16 Noise can be effectively mitigated within outdoor living areas by positioning gardens on the screened side of dwellings, to ensure that there is no direct line of sight to off-site noise sources. This is likely to provide sufficient attenuation to achieve the required 55dB L_{Aeq} within outdoor living areas in the northern, north western and south eastern parts of the site, in the vicinity of the B1438, Top Street and Sandy Lane respectively.

12.6.17 Alternatively noise levels can be mitigated in garden areas situated in the northern part of the site, by constructing a noise barrier or bund, at least 2m high, between the B1438 and garden areas, assuming garden areas are positioned at least 15m from the carriageway of the B1438.

12.6.18 Noise levels can be mitigated within external living areas in the north western part of the site, closest to Top Street by constructing a 3 m barrier or bund between Top Street and outdoor living areas, assuming that garden areas are positioned at least 20m from the carriageway of Top Street

12.6.19 Outdoor living areas in the south eastern part of the site could achieve the required 55dB L_{Aeq} within outdoor living areas by constructing a noise barrier between Sandy Lane and garden areas of at least 1.5m in height, assuming the closest gardens are situated at least 10m from the carriageway of Sandy Lane.

12.6.20 Properties further into the site will be screened by the proposed residential buildings themselves and would therefore be likely to achieve the required daytime noise levels.

12.6.21 Mitigation requirements will depend upon the detailed design of the proposed development and upon the local topography. Final mitigation measures can be provided, on a plot by plot basis, at the detailed design stage.

Glazing Requirements

Daytime Noise Sensitive Rooms

12.6.22 When assessing daytime noise levels in noise sensitive rooms, the noise attenuation provided by the overall building facade should be considered. To mitigate noise levels, the composition of the building facade can be designed to provide the level of attenuation required. Glazing is generally the building element which attenuates noise the least, so the proportion of glazing in a building facade is an important consideration when assessing overall noise attenuation.

12.6.23 In the absence of design details for the building facades, it has been assumed that the glazing to noise sensitive rooms would comprise about 25% of the facade area. To calculate the overall attenuation provided by this percentage of glazing in a brick or block facade, a non-uniform partition calculation can be used.

12.6.24 The calculation combines the different degrees of attenuation of the wall element and the window element. A facade element comprising solid brick or blockwork, will attenuate by 45dB (British

Standard 8233: "Guidance on sound insulation and noise reduction for buildings" 2014) whereas standard double glazing will attenuate road traffic noise by 26-29dB(A) (BRE Digest 379 "Double glazing for heat and sound insulation"). The overall noise attenuation provided by this combination is, therefore, between 32dB(A) and 35dB(A).

12.6.25 The noise attenuation requirements for living rooms in properties in different areas of the site are summarised in Table 12.21. The requirements indicate that standard thermal double glazing would ensure that internal noise levels are met with the windows around the edges of the site, closest to off-site noise sources. However, with windows open, the attenuation provided by the façade will be approximately 15dB(A). This would allow the recommended internal noise limit in living rooms nearest to off-site noise sources to be exceeded.

12.6.26 On occasions this may be acceptable to the resident, but when quiet conditions are required, the resident should be able to close the windows whilst maintaining adequate ventilation. Some form of acoustic ventilation would therefore need to be installed in some of the living rooms and bedrooms. Alternatively, to meet the required noise levels, noise sensitive rooms could be located on the screened side of dwellings could be located on the screened side of the proposed buildings, away from the main source of noise.

12.6.27 Proposed dwellings further into the site, will be protected by the buildings themselves and/or screened by other buildings, from the main sources of noise. These façades are likely to achieve 35dB L_{Aeq} in living rooms which can be provided by standard thermal double glazing, even with windows open.

12.6.28 Glazing requirements will be confirmed, on a plot by plot basis, at the detailed design stage.

Bedroom Areas

12.6.29 The noise attenuation requirements for bedrooms across the site areas are summarised in Table 12.22. The requirements indicate that standard thermal double glazing, would ensure that the internal noise limits are met with windows closed for bedrooms in the northern, south eastern and north western parts of the site, with a with direct line of sight to the B1438, Sandy Lane and Top Street.

12.6.30 Bedrooms in the southern part of the site will require enhanced acoustic glazing to ensure that night time maximum noise levels, $L_{AF,max}$, do not exceed the guideline value of 45dB. 10/12/6 thermal insulating units or equivalent will provide sufficient attenuation of noise within bedrooms, closest to the railway line to the south, during the night time period.

12.6.31 However, with windows open, the attenuation provided by the façade will be approximately 15dB(A). This would allow the recommended internal noise limit to be exceeded in bedrooms around the edges of the site closest to off-site noise sources.

12.6.32 Acoustic ventilation would therefore need to be installed in some of the bedrooms nearest to off-site-noise sources. Alternatively, to meet the required noise levels, bedrooms could be located on the screened side of proposed buildings, facing away from the main sources of noise.

12.6.33 Proposed dwellings further into the site, will be protected by the buildings themselves and/or screened by other buildings, from the main sources of noise.. These façades are likely to achieve 30dB L_{Aeq} in bedrooms which can be provided by standard thermal double glazing, even with windows open.

12.6.34 Glazing requirements will be confirmed, on a plot by plot basis, at the detailed design stage.

Acoustic Ventilation Requirements

12.6.35 It is recommended that the acoustic ventilation proposed at the site should, as a minimum, comply with Building Regulations 2010 Approved Document F1 Means of Ventilation and British Standard BS5925 1991: "Code of Practice for Ventilation Principles and Designing for Natural Ventilation".

12.6.36 The implementation of the recommended glazing together with acoustic ventilation should ensure that the required internal day and night-time noise limits in proposed dwellings, with a direct line of sight of the main noise sources, are met.

12.6.37 The façades of some of the proposed buildings may be protected by the buildings themselves and/or screened by other buildings depending upon the final site layout. Acoustic ventilation may not need to be installed in the bedrooms.

12.6.38 The requirement for acoustic ventilation would need to be confirmed once a detailed design layout is available.

12.7 ASSESSMENT OF EFFECTS

Construction Phase

12.7.1 The activities carried out during the earthworks and construction phase of the Project will have the potential to generate short term increases in noise levels above the recommended noise limits, set in accordance with current guidance, at existing and proposed sensitive receptors surrounding the site. The use of heavy plant associated with the earthworks and construction works also has the potential to give rise to groundborne vibration.

12.7.2 Given the small distances between the construction activities and the nearest proposed sensitive receptors, some sensitive receptors may experience minor adverse noise and vibration impacts in the short term. This would occur temporarily and only for short periods.

Road Traffic Noise and Existing Sensitive Receptors

12.7.3 There will be a maximum increase in road traffic noise of 2dB at existing receptors as a result of the proposed development and committed developments. The cumulative impact will therefore be between **negligible** and **none** at existing receptors.

12.7.4 There will be no increase in road traffic noise at existing sensitive receptors as a result of development led road traffic, and therefore the impact associated with the Project will be **none**.

Proposed Sensitive Receptors and General Noise

12.7.5 Mitigation measures, are required to meet WHO noise limits, in outdoor living areas situated in the northern, south eastern and north western parts of the development site, closest to the B1438, Sandy Lane and Top Street, respectively.

12.7.6 Noise can be effectively mitigated within outdoor living areas by positioning gardens on the screened side of dwellings, to ensure that there is no direct line of sight to off-site noise sources. This is likely to provide sufficient attenuation to achieve the required 55dB L_{Aeq} within outdoor living areas in the northern, north western and south eastern parts of the site, in the vicinity of the B1438, Top Street and Sandy Lane respectively.

12.7.7 Alternatively noise levels can be mitigated in garden areas situated in the northern part of the site, by constructing close boarded fencing, at least 2m high, between the B1438 and garden areas, assuming garden areas are positioned at least 15m from the carriageway of the B1438.

12.7.8 Noise levels can be mitigated within external living areas in the north western part of the site, closest to Top Street by constructing a 3 m barrier or bund between Top Street and outdoor living areas, assuming that garden areas are positioned at least 20m from the carriageway of Top Street.

12.7.9 Outdoor living areas in the south eastern part of the site could achieve the required 55dB L_{Aeq} within outdoor living areas by constructing close boarded fencing between Sandy Lane and garden areas of at least 1.5m in height, assuming the closest gardens are situated at least 10m from the carriageway of Sandy Lane.

12.7.10 The noise assessment indicates that standard thermal double glazing would ensure that internal noise limits are met in living rooms and bedrooms across the development site, with the windows

closed, with the exception of bedrooms situated in the southern part of the site closest to the rail line.

12.7.11 Bedrooms in the southern part of the site will require enhanced acoustic glazing to ensure that night time maximum noise levels, $L_{AF,max}$, do not exceed the guideline value of 45dB. 10/12/6 thermal insulating units or equivalent will provide sufficient attenuation of noise within bedrooms, closest to the railway line to the south, during the night time period.

12.7.12 However, with the windows open the attenuation provided by the façade would allow the internal noise limits to be exceeded in living rooms and bedrooms located nearest to off-site noise sources such as the A12, the B1438, Sandy Lane and Top Street. .

12.7.13 Acoustic ventilation will therefore need to be installed in living rooms located nearest to, and with a direct line of sight of off-site noise sources.

12.7.14 In addition, acoustic ventilation will also need to be installed in bedrooms located nearest to, and with a direct line of sight to off-site noise sources.

12.7.15 At this stage, a detailed site layout has not yet been confirmed. Glazing and ventilation requirements will need to be confirmed once a detailed design layout is available

12.8 RESIDUAL EFFECTS

Construction Phase

12.8.1 To minimise the potential impact of construction works, mitigation measures would be put in place. These will include restrictions on working hours, the implementation of temporary screening where possible, and best working practices.

12.8.2 In addition to earthworks and construction it is possible that piling will be required. At this stage detailed information regarding the type of piling has not been confirmed. To minimise the potential for vibration to be generated by piling it is recommended that careful consideration be given to the type of piling used.

12.8.3 With the implementation of best working practice and restriction on working hours, the noise and vibration impacts of earthworks and construction phases, will be generally **negligible**, with only brief periods of **minor to moderate adverse** impacts likely in the short term at local level.

Operational Phase

Existing Sensitive Receptors

12.8.4 There may be an increase at existing sensitive receptors as a result of the proposed development and committed developments between 0 and 2dB. However there is no increase in road traffic noise at existing sensitive receptors from development led traffic associated with the Project when considering future operational years. Noise levels have been calculated following the methodology in CRTN, the change in noise will be **none** at existing sensitive receptors.

Proposed Residential Receptors – General Noise

12.8.5 Mitigation measures are required to meet WHO guideline noise values, in outdoor living areas in the northern, south eastern and north western parts of the site as detailed in Section 12.6 of this report.

12.8.6 To meet internal guidance noise levels standard glazing should be installed within living rooms and bedrooms across the site with the exception of bedrooms situated in the southern part of the site, which will require enhanced acoustic glazing as specified in Section 12.6. Acoustic ventilation will be required for living rooms and bedrooms located around the edges of the site, nearest to off-site noise sources including the B1438, Sandy Lane and Top Street.

12.8.7 With mitigation measures in place it is considered that the impact of the existing noise sources on the proposed noise sensitive areas of the Project will be **negligible** in both the long and short term.

12.9 STATEMENT OF EFFECTS

Construction Phase Assessment – Noise and Vibration

12.9.1 The significance of noise and vibration effects from earthworks and construction is considered to be **negligible**, with site specific mitigation measures in place. However, the construction operations may have a short term, **minor to moderate adverse** impact at sensitive receptors located in the immediate vicinity of the construction phases over the Project site.

Operational Phase Assessment

Existing Sensitive Receptors

12.9.2 The increase in noise due to development led road traffic associated with the Project at the existing sensitive receptors adjacent the local road network in the immediate vicinity of the site, will be **none**.

Proposed Residential Receptors

12.9.3 Once the mitigation measures detailed in Section 12.6 have been implemented, the residual impact of road traffic noise and rail noise from the local road and rail networks, including the proposed development access roads, will meet all the required internal and external noise standards and have a **negligible** impact on future residents.