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**GLADMAN DEVELOPMENTS LTD**

**Land adjacent to Duke's Park, Woodbridge, Suffolk**

**Noise and Vibration Assessment Report**

**November 2015**

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**GLADMAN DEVELOPMENTS LTD**

# Land adjacent to Duke's Park, Woodbridge, Suffolk

## Noise and Vibration Assessment Report

**November 2015**

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**APPENDICES**



**DRAWINGS**

# 1 INTRODUCTION

1.1.1 By email instruction dated the 6th March 2014, from Ms Emma Tutton of Gladman Developments Limited, Wardell Armstrong LLP was commissioned to undertake a noise and vibration assessment to support an outline planning application for a proposed residential development at land adjacent to Duke's Park, Woodbridge, Suffolk.

1.1.2 The proposed development site is located to the south west of Woodbridge and currently comprises agricultural land. The site is bordered to the north by Ipswich Road and a small number of existing residential properties on Duke's Park. To the east, the site is bordered by one existing residential property, Sandy Lane and open land beyond. To the south, the site is bordered by the Ipswich to Lowestoft railway line; with open land, commercial units on Sandy Lane and a waste water treatment works beyond. To the west, the site is bordered by Bridge Farm Business Park, a small number of existing residential properties, Top Street, and the A12 beyond to the north west.

1.1.3 The proposed development is detailed on the Development Framework (6106-L-01_N) prepared by Gladman Developments.

1.1.4 The noise and vibration assessment report has been prepared in support of the outline planning application for the proposed residential development. The report assesses the results of a noise and vibration survey carried out in accordance with current guidance and includes recommendations for noise and vibration mitigation as appropriate.

# 2 ASSESSMENT METHODOLOGY

## 2.1 Consultation and Scope of Works

2.1.1 Prior to carrying out the noise assessment, the potential impacts of the proposed development and general principles of the assessment methodology were sent to Mr Daniel Kinsman, Environmental Health Officer at Suffolk Coastal District Council. Mr Kinsman agreed that he was satisfied with our proposal. However, Mr Kinsman commented that he would like to see some survey data for one additional period of the night-time, between the hours of midnight and 2am.

2.1.2 At the time of the noise survey, Mr Kinsman's comments had not been received and as such this additional 'quiet night' period has not been surveyed. However, survey periods are usually chosen which represent the worst case levels of transportation noise, and as such a robust assessment can still be made.

2.1.3 The scope of the noise assessment is based upon our experience of other similar developments and includes consideration of noise at the sensitive areas of the existing area and the proposed development, i.e. existing and proposed residential areas. The assessment specifically identifies the potential impact that future transportation infrastructure might impose on the proposed development.

2.1.4 The noise and vibration assessment takes into account current guidance, as detailed below:

- National Planning Policy Framework, 2012 (NPPF);
- Noise Policy Statement for England, 2010 (NPSE);
- Planning Practice Guidance - Noise, 2014 (PPG);
- The World Health Organisation Guidelines for Community Noise 1999 (WHO 1999);
- British Standard 8233: 2014 Guidance on Sound Insulation and noise reduction for buildings (BS8233);
- British Standard 6472 Part 1 - 2008, "Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting (BS6472-1);
- Department of Transport technical memorandum Calculation of Rail Noise, 1995 (CRN).
- Department of Transport technical memorandum. *Calculation of Road Traffic Noise 1988 (CRTN*;

- TRL Limited Converting the UK traffic noise index $L_{A10,18h}$ to EU noise indices for noise mapping document;
- Design Manual for Roads and Bridges, Volume 11, Section 3, Part 7, 2011 (DMRB);
- BRE Controlling particles, vapour and noise pollution from construction sites, Parts 1 to 5, 2003;
- 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); CRN
- British Standard 5228-2:2009 +A2:2014 "Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration" (BS5228-2).

## 2.2 Noise and Vibration Survey

2.2.1 As part of this assessment, Wardell Armstrong LLP has carried out an attended noise and vibration survey to assess the current ambient noise and vibration levels at proposed receptor locations. The survey is discussed in Section 3 of this report.

2.2.2 The likely sources of noise and vibration are; road traffic noise, noise and vibration from passing trains on the Ipswich to Lowestoft railway line, and industrial noise from the existing operations off Sandy Lane, Bridge farm Business Park and he Waste Water Treatment Works.

## 2.3 Guidance

***National Planning Policy Framework***

2.3.1 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:

*'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.'

2.3.2 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'.

2.3.3 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.

2.3.4 The Planning Practice Guidance (PPG) 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 1 summarises the noise exposure hierarchy.

**Table 1: National Planning Practice Guidance noise exposure hierarchy**

| Perception | Examples of Outcomes | Increasing Effect Level | Action |
|---|---|---|---|
| **Not noticeable** | No Effect | No Observed Effect | No specific measures required |
| | | No Observed Effect Level | |
| **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 |

2.3.5 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.

2.3.6 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
- 50 dB $L_{Aeq}$ (16 hour) to protect majority of population from becoming moderately annoyed
- 55 dB$L_{Aeq}$ (16 hour) to protect majority of population from becoming seriously annoyed

2.3.7 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."

2.3.8 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".

2.3.9 The PPG 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".

***Noise from Earthworks and Construction Phase Activities***

2.3.10 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.

2.3.11 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.

2.3.12 For the purposes of this assessment, the occupants of the closest residential properties in the vicinity of the proposed development site are considered to be the receptors most likely to be affected by the construction phases of the proposed development. A noise impact may be felt at all other existing sensitive receptors, but it will be less than at the assessed locations. Details of the receptors are set out in Table 2.

**Table 2: 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 |

2.3.13 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 3. Details of the noise survey carried out at the sensitive receptors are set out in this chapter.

2.3.14 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.

2.3.15 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.

2.3.16 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.

2.3.17 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 3.

**Table 3: 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 (LAeq) | 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. | | | |

2.3.18 The noise level likely to be generated at the receptors 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.

***Vibration from Construction Plant and Vehicles***

2.3.19 Work involving heavy plant on an open site is likely to generate vibration and nearby properties may experience ground-borne vibration.

2.3.20 Guidance on the assessment of vibration from development sites is given in British Standard 5228 -2:2009 +A2:2014 "Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration" (BS5228-2). BS5228-2 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.

2.3.21 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.

2.3.22 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. BS5228-2 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.

2.3.23 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.

2.3.24 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.

2.3.25 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.

2.3.26 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.

2.3.27 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.

2.3.28 BS5228-2 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).

**Department of Transport's memorandum, "Calculation of Road Traffic Noise" (CRTN), 1988**

2.3.29 The operational phase of the development will generate additional traffic movements on the existing road network. These 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.

2.3.30 The current and future traffic noise levels at a number of sensitive receptors; both with and without the development in place, have been predicted using the procedures set out in the Department of Transport's memorandum, "Calculation of Road Traffic Noise" (CRTN), 1988. 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.

2.3.31 The procedures outlined in CRTN assume typical traffic and noise propagation conditions that are consistent with moderately adverse wind velocities and directions during specified periods. In CRTN, all noise levels can be expressed in terms of the index $L_{10\ (18\ hour)}$ dB(A).

2.3.32 The data used in the road traffic noise assessment is provided by SCP Transport, the traffic and transportation consultant for the proposed development as 18 hour AAWT flows and HGV percentages.

2.3.33 In summary, CRTN has been used to determine the noise levels at each existing sensitive receptor, for a total of 3 scenarios:

- Scenario 1: 2014 Base, Without the Development in Place;
- Scenario 2: 2024 Future Assessment Year, Without the Development in Place; and
- Scenario 3: 2024 Future Assessment Year, With the Development in Place.

2.3.34 Details of the existing sensitive receptor locations are given in Table 4 and shown on Drawing LE12277-003.

**Table 4: Existing Noise Sensitive Receptor Locations (Operational)**

| Receptor | Address | Receptor Type | Grid Ref | | Bearing from Site | Approximate Distance to Site Boundary |
|---|---|---|---|---|---|---|
| | | | Easting | Northing | | |
| ESR1 | 11 Clayton Court, Woodbridge | Residential | 625589 | 248228 | North | 220m |
| ESR2 | 12 Crane Close, Woodbridge | Residential | 625734 | 248089 | North east | 20m |
| ESR3 | Telegraph Cottage, Sandy Lane, Martlesham | Residential | 625988 | 247808 | East | 5m |
| ESR4 | 1 Top Street, Martlesham | Residential | 625356 | 247749 | West | 40m |

2.3.35 Impacts will also be felt at receptors adjacent to and beyond those listed above. However, impacts at these receptors will be no greater than the listed receptors.

2.3.36 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.

2.3.37 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.

2.3.38 Noise from existing and development led traffic has been predicted using the methodology described with CRTN, for the proposed sensitive receptors described in Table 5 below, and shown on Drawing LE12277-003.

**Table 5: Proposed Sensitive Receptor Locations (Road Noise)**

| 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 |

**Design Manual for Roads and Bridges, Volume 11, Section 3, Part 7, 2011 (DMRB)**

2.3.39 The changes in road traffic noise levels have been assessed against a set of significance criteria. The criteria shown in Table 6 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 long term changes in road traffic noise. The criteria do not relate to the actual existing noise levels (i.e. traffic noise due to the current development) but only the predicted changes.

**Table 6: Road Traffic Noise Assessment Significance Criteria**

| Magnitude of Impact | Criteria for Assessing Road Traffic Noise |
|---|---|
| Major | > 10.0 dB increase in traffic noise (equating to a doubling in the loudness of noise). |
| Moderate | 5.0 – 9.9 dB increase in traffic noise (equating to a clearly perceptible increase in the loudness of noise). |
| Minor | 3.0 – 4.9 dB increase in traffic noise increase in traffic noise (equating to an increase in the loudness of the noise which is at or about the threshold of perception). |
| Negligible | 0.1 – 2.9 dB increase in traffic noise. No perceptible increase in traffic noise. |

### *Noise from Rail Movements*

2.3.40 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 for the proposed sensitive receptors described in Table 7 below, and shown on Drawing LE12277-003.

**Table 7: Proposed Sensitive Receptor Locations (Rail Noise)**

| Receptor | Receptor Type | Location | Grid Ref | |
|---|---|---|---|---|
| | | | Easting | Northing |
| PSR4 | Residential | Southern part of the site adjacent to the railway line | 625689 | 247652 |

2.3.41 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.

### *Vibration from Rail Movements*

2.3.42 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.

2.3.43 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.

2.3.44 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.

2.3.45 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.

2.3.46 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.

2.3.47 BS6472-1 (2008) provides guidance regarding the significance of Vibration Dose Value (VDV) within buildings in terms of human response, as detailed in Table 8.

**Table 8: 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

# 3 NOISE AND VIBRATION SURVEY

3.1.1 On Thursday the 24th and Friday the 25th April 2014 Wardell Armstrong LLP carried out a noise and vibration survey across the development site.

## 3.2 Noise

3.2.1 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 LE12277-002:

- 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 Sandy Lane.
- Monitoring Location 3: In the south of the site, adjacent to the boundary with the Ipswich to Lowestoft railway line.
- Monitoring Location 4: In the west of the site, adjacent to Top Street.

3.2.2 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 peak 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 peak hour period (0700-0900).

3.2.3 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).

3.2.4 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.

3.2.5 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.

3.2.6 A-weighted[1] $L_{eq}$[2] noise levels were measured to comply with the requirements of WHO. A-weighted $L_{90}$[3] and $L_{10}$[4] 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 A.

3.2.7 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[5]) of a typical train using the line, to calculate daytime and night time ambient noise levels with all train movements included.

3.2.8 The Electronic National Rail Timetable (ENRT) valid 11th May 2015 indicates that there are 31 movements of passenger trains along the Ipswich to Lowestoft railway line during the day and 2 movements during the night.

3.2.9 The Rail Working Time Table (WTT), valid May 2015, does not indicate any timetabled movements of freight trains on the line, however during the noise survey, 1 freight train was witnessed along the Ipswich to Lowestoft rail line. Therefore, to be robust, an estimation of freight train movements has been included.

3.2.10 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 A. Details of train movements observed during the survey are included as Appendix B.

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| | |
|---|---|
| [1] A' Weighting | An electronic filter in a sound level meter which mimics the human ear's response to sounds at different frequencies under defined conditions |
| [2] $L_{eq}$ | Equivalent continuous noise level; the steady sound pressure which contains an equivalent quantity of sound energy as the time-varying sound pressure levels. |
| [3] $L_{90}$ | The noise level which is exceeded for 90% of the measurement period. |
| [4] $L_{10}$ | The noise level which is exceeded for 10% of the measurement period. |
| [5] SEL: | The A-weighted sound pressure level which, if occurring over a period of one second, would contain the same amount of A-weighted energy as the event. |

3.2.11 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 Ipswich to Lowestoft 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.

3.2.12 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.

## 3.3 Vibration

3.3.1 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 LE12277-002. This location is considered representative of the proposed residential dwellings closest to the railway line.

3.3.2 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.

3.3.3 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.

3.3.4 Vibration measurements have been carried out between 05:22 and 09:48 on the 25$^{th}$ April 2014.

# 4 NOISE IMPACT ASSESSMENT

## 4.1 Existing Noise Levels

4.1.1 The measured noise levels for each monitoring location have been divided into daytime (0700-2300 hours) and night-time (2300-0700 hours) categories. The individual levels have been arithmetically averaged to give a single daytime and night-time level for each location within the site boundary.

4.1.2 The results for each of the monitoring locations are presented in Table 9.

**Table 9: Average Daytime and Night-time Noise Levels**

| Time | Monitoring Location | Average Measured Noise Level (Figures in dB $L_{Aeq}$) |
|---|---|---|
| 0700-2300 | 1 | 57 |
| 2300-0700 | | 52 |
| 0700-2300 | 2 | 46 |
| 2300-0700 | | 48 |
| 0700-2300 | 3 | 56 |
| 2300-0700 | | 56 |
| 0700-2300 | 4 | 57 |
| 2300-0700 | | 50 |

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

4.1.4 The maximum noise levels measured during each night-time period of the survey, at each of the monitoring locations, are summarised in Table 10.

**Table 10: Summary of the Maximum Night-time Noise Levels (Figures in dB $L_{Amax}$)**

| Monitoring Location | Maximum Measured Noise Level |
|---|---|
| 1 | 66 |
| 2 | 61 |
| 3 | 83 |
| 4 | 67 |

## 4.2 Noise from Earthworks and Construction

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

4.2.2 The daytime measured noise levels, from the baseline noise survey representative of the existing sensitive receptors in the vicinity of the site, have been provided below in Table 11. ESR locations are shown on drawing LE12277-003.

**Table 11: Construction Noise Assessment Criteria**

| Receptor | Measured and Adjusted Noise Levels – *in accordance with CRTN* (dB $L_{Aeq,\ 16hour}$) | Ambient Noise Level Rounded to the nearest 5dB(A) (dB $L_{Aeq}$) | 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 |

4.2.3 At the time the noise survey was carried out, 24th and 25th 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 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 11 above.

4.2.4 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.

4.2.5 At this stage, detailed information regarding the nature and timescales of activities likely to take place during the earthworks and construction phase is 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.

4.2.6 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.

4.2.7 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 road links surrounding the site. 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 proposed development and this impact has not therefore been considered further.

4.2.8 The contractor undertaking the enabling and construction works has not yet been appointed. However, construction works are likely to be restricted to daytime hours between 08:00 and 18:00 hours Monday to Friday and 08:00 to 13:00 hours on a Saturday, with no work on Sunday and Bank Holidays. The appropriate category value has been determined for the sensitive receptors in the immediate vicinity of the site, based on the average daytime measured $L_{Aeq}$ noise level in the vicinity of existing residential receptors.

4.2.9 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.

4.2.10 The distance between nearest noise sensitive receptors and noise sources associated with construction works, will vary depending on the phase of the proposed development under construction. Given the potentially small distances between the construction activities and receptor, noise levels may occur above those detailed in Table 6. Proposed dwellings which become occupied before the completion of the construction phase of the proposed development would experience a similar noise impact. The noise generated by the earthworks and construction phases of the proposed development may therefore exceed Category B in BS5228 at the existing and proposed sensitive receptors located in the immediate vicinity of the construction phases of the proposed development.

4.2.11 It is therefore recommended that mitigation measures be put in place that will reduce the scale of the potential effect. Details are set out in section 5 of this report.

## 4.3 Road Traffic Noise Assessment

***Existing Sensitive Receptors***

4.3.1 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. Existing sensitive receptor (ESR) locations are detailed in Drawing LE12277-003.

4.3.2 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 with committed developments; and,
- Scenario 3: 2025 Future year with committed developments and the proposed development.

4.3.3 The predicted noise levels are detailed in Table 12.

| Table 12: 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 Scenario 2 and Scenario 3 (Figures in dB(A)) |
| | Scenario 1: 2015 Base year | Scenario 2: 2025 Future year with committed developments | Scenario 3: 2025 Future year with committed developments and The Project | |
| ESR1 | 73 | 74 | 73 | -1 |
| ESR2 | 68 | 69 | 69 | 0 |
| ESR3 | 56 | 59 | 59 | 0 |
| ESR4 | 74 | 76 | 76 | 0 |

4.3.4 The changes in noise levels have been assessed against the significance criteria contained in Table 6. The results show that there will be no increases in noise level between 2025 without the development and 2025 with the development, at existing sensitive receptors. The greatest change in noise level 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. Therefore the noise impact due to development led traffic is considered to be negligible.

4.3.5 The prediction calculations in CRTN can be found in Appendix D.

***Proposed Sensitive Receptors***

4.3.6 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 in the vicinity of the local road network.

4.3.7 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.

4.3.8 The noise level predictions 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.

4.3.9 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.

4.3.10 The results of the prediction calculations for 2025 (with proposed development traffic in place, i.e. Scenario 3) is shown in Table 13.

**Table 13: 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 |

4.3.11 Night time maximum, $L_{AF,\ max,}$ noise levels are taken from measured noise data presented in Table 10.

## 4.4 Rail Noise Assessment

4.4.1 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).

4.4.2 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 Ipswich to Lowestoft 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.

4.4.3 The results of the prediction calculations are shown in Table 14.

**Table 14: 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 |

4.4.4 Night time maximum, LAF, max, noise levels are taken from measured noise data presented in Table 10.

### 4.5 Assessment of Daytime Noise Levels in Outdoor Living Areas

4.5.1 The calculated daytime noise levels for the proposed sensitive receptors (PSRs), presented in Tables 13 and 14 have been used to calculate the sound attenuation required to achieve external daytime guideline noise levels.

4.5.2 Although the daytime noise level measured during the noise survey in the vicinity of PSR4 (ML3) was, higher than the predicted daytime, $L_{Aeq,\ 16hour,}$ noise level, the predicted noise level is considered to be more representative of ambient noise levels throughout the daytime period at PSR4. Noise measurements in this location were carried out over a total period of 49 minutes during the evening peak transportation times, i.e. between 1600 and 1800, in which time 4 train movements occurred. The volume of train movements over the measurement period is not considered to be representative of noise levels over a typical daytime period (0700-2300). Therefore the calculated noise levels for the daytime period have been used.

4.5.3 Tables 13 and 14 show that during the daytime, noise levels affecting the development site would be between 67 and 53dB $L_{Aeq}$. The guideline noise level of 55dB $L_{Aeq,\ 16hour}$ outlined by BS8233 and WHO will be exceeded in outdoor living areas at PSRs 1, 2 and 3. Therefore mitigation measures will be required for proposed outdoor living areas located nearest to the B1438, Top Street and Sandy Lane.

4.5.4 Noise levels at proposed sensitive receptors in the southern part of the site, closest to the rail line will be below the guideline value of 55dB $L_{Aeq,\ 16hour}$ and therefore no mitigation will be required for proposed gardens in this area.

### 4.6 WHO Assessment of Daytime Noise Levels in Living Rooms and Bedrooms

4.6.1 The daytime predicted noise levels, as detailed in Tables 13 and 14 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.

4.6.2 Before internal noise levels can be calculated, 3dB 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.

4.6.3 The calculated noise levels at the façades of the properties, together with the level of attenuation required to achieve 35dB $L_{Aeq}$ in the living room areas, are summarised in Table 15.

| Table 15: Façade Noise Level at Properties in the Vicinity of the Monitoring Locations and Level of Attenuation Required to Achieve the Internal Daytime Noise Limit (Figures in dB(A)) | | |
|---|---|---|
| **Residential Properties** | **Noise Level at the Façade of the Property** | **Level of Attenuation Needed To Achieve Noise Limit in Living Room Areas** |
| 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 |

4.6.4 The facades of the properties further into the site will 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 15.

## 4.7 Assessment of Night-time Noise Levels in Bedrooms

4.7.1 The night time predicted noise levels, as detailed in Tables 13 and 14 have been used in conjunction with the measured night time maximum noise levels presented in Table 10, 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.

4.7.2 Before internal noise levels can be calculated, 3dB 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.

4.7.3 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 16.

| Table 16: 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 (Figures in dB(A)) | | | |
|---|---|---|---|
| **Residential Properties** | **Noise Level at the Façade of the Property ($L_{Aeq}$)** | **Maximum Noise Level at the Façade of the Property ($L_{Amax}$)** | **Level of Attenuation Needed To Achieve the Noise Limits in Bedrooms** |
| 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 |

4.7.4 The facades of the properties further into the site will 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 $L_{Amax,f}$ in the bedrooms, will be less than those detailed in Table 16.

# 5 VIBRATION IMPACT ASSESSMENT

## 5.1 Vibration from Earthworks and Construction

5.1.1 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 17.

**Table 17: 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 | 1.000 | 0.150 | Background |
| Empty | 0.225 | 0.050 | Background |
| Dozer | 1.050 | 0.400 | Background |
| Vibrating roller Drum | | | |
| Vibrator on | 4.470 | 3.270 | 2.350 |
| Vibrator off | 0.500 | 0.150 | 0.050 |
| Loading shovel | 1.025 | 0.150 | Background |

5.1.2 The distance between nearest noise sensitive receptors and vibration sources associated with construction works, will vary depending on the phase of the proposed development under construction. As a worst case scenario, earthworks and construction works may potentially take place at a distance of approximately 10 metres from existing residential properties.

5.1.3 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 proposed development boundaries.

5.1.4 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.

5.1.5 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.

5.1.6 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.

5.1.7 The receptors likely to be affected by piling will vary depending of the phase of the proposed development 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 section 5 of this report.

## 5.2 Existing Vibration Levels from Train Movements

5.2.1 The measured vibration levels associated with train movements are summarised in Table 18 below, and shown in Appendix C.

**Table 18: 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** |

5.2.2 BS6472-1 (2008) provides guidance regarding the significance of VDV values in terms of human response. The 8 hour VDV measured at the site was 0.031m/s and the 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 1. 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 Ipswich to Lowestoft line are not anticipated.

# 6 NOISE AND VIBRATION ATTENUATION SCHEME

## 6.1 Introduction

6.1.1 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, internal living rooms and bedrooms.

6.1.2 The results of the vibration assessment, for the proposed residential areas of the development, indicate that vibration mitigation measures do not need to be incorporated into the proposed site design.

## 6.2 Noise from Earthworks and Construction

6.2.1 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.

6.2.2 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.

6.2.3 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.

### 6.3 Daytime Noise Levels in Outdoor Living Areas

6.3.1 The daytime noise levels, as detailed in Tables 13 and 14 indicate that mitigation is required to achieve the guideline noise level of 55dB $L_{Aeq}$ in outdoor living areas, outlined within BS8233 and WHO 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.

6.3.2 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.

6.3.3 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.

6.3.4 Noise levels can be mitigated within external living areas in the north western part of the site, closest to Top Street by constructing a 3m 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

6.3.5 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.

6.3.6 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.

6.3.7 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.

## 6.4 Glazing Requirements for Living Room and Bedroom Areas During the Daytime

6.4.1 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.

6.4.2 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.

6.4.3 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).

6.4.4 The noise attenuation requirements for living rooms in properties in different areas of the site are summarised in Table 15. 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.

6.4.5 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 the eastern section of Humber Lane to be exceeded.

6.4.6 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.

6.4.7 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 LAeq in living rooms which can be provided by standard thermal double glazing, even with windows open.

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

### 6.5 Glazing Requirements for Bedroom Areas During the Night Time

6.5.1 The noise attenuation requirements for bedrooms across the site areas are summarised in Table 16. 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.

6.5.2 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.

6.5.3 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.

6.5.4 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.

6.5.5 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, the eastern section of Humber Lane, and Donnington Drive. These façades are likely to achieve 30dB LAeq in bedrooms which can be provided by standard thermal double glazing, even with windows open.

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

## 6.6 Acoustic Ventilation Requirements

6.6.1 It is recommended that the acoustic ventilation proposed at the site should, as a minimum, comply with Building Regulations 2000 Approved Document F1 Means of Ventilation and British Standard BS5925 1991: "Code of Practice for Ventilation Principles and Designing for Natural Ventilation". Acoustic ventilation is only recommended for noise sensitive rooms, which are bedrooms and living rooms.

6.6.2 The implementation of the recommended glazing together with appropriate acoustic ventilation should ensure that the required internal daytime and night-time noise limits are achieved.

6.6.3 The façades of some of the properties further into the site will be protected by the buildings themselves and/or screened by other buildings. Therefore, acoustic ventilation may not be required for these plots. The requirement for acoustic ventilation will be confirmed on a plot by plot basis at the detailed design stage.

## 6.7 Vibration from Earthworks and Construction

6.7.1 It is considered that mitigation will not be required to control vibration from construction work. However if piling is required, mitigation may need to be considered.

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

6.7.3 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.

6.7.4 The receptors likely to be affected by piling will vary depending of the phase of the proposed development 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.

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

6.7.6 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

6.7.7 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.

6.7.8 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.

6.7.9 As the construction programme and methodologies become more defined it is suggested that any possible piling vibration be reconsidered and that a detailed strategy for control be implemented

# 7 CONCLUSIONS

7.1.1 Wardell Armstrong has carried out a noise and vibration assessment for the proposed residential development located at land off Duke's park, Woodbridge, Suffolk.

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

7.1.3 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.

7.1.4 With the implementation of best working practice and restriction on working hours, the noise and vibration impacts of earthworks and construction phases, are expected to be negligible, with the possibility of brief periods of slight to moderate impacts in the short term at local level.

7.1.5 The dominant noise source, which will potentially affect the residents of the proposed residential development, is road traffic on Ipswich Road, Top Street, Sandy Lane and rail noise on the Ipswich to Lowestoft line.

7.1.6 The results of the noise survey and assessment indicate that to achieve the limit of 55dB$L_{Aeq\ (16\ Hour)}$ in outdoor living areas, mitigation would be required for those areas located nearest to, and with a direct line of sight to Ipswich Road, Top Street and Sandy Lane.

7.1.7 It is recommended that gardens are located on the screened sides of the affected dwellings, in which case it is unlikely that any further noise mitigation would be required.

7.1.8 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.

7.1.9 Noise levels can be mitigated within external living areas in the north western part of the site, closest to Top Street by constructing a 3m 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

7.1.10 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.

7.1.11 To meet guidance noise levels for internal 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, with a direct line of sight to the rail line, which will require enhanced acoustic glazing as specified in Section 6.5.

7.1.12 The implementation of the recommended glazing should ensure that internal noise levels are met in living rooms and bedroom areas across the development with the windows closed.

7.1.13 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.

7.1.14 The facades of the properties further into the site will be protected by the buildings themselves and/or screened by other buildings. Acoustic ventilation would not necessarily need to be installed in the living rooms and/or bedrooms of these properties. However, the requirement for glazing and acoustic ventilation will be confirmed, on a plot by plot basis, at the detailed application/reserved matters stage.

7.1.15 Vibration levels measured near to the railway line are below the threshold for a low probability of adverse comment for both daytime and night time.

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# Appendix A
# Noise Monitoring Results

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**Appendix A**

Noise Monitoring Results

| Monitoring Location 1 - North western boundary adjacent to Ipswich Road | | | | | | |
|---|---|---|---|---|---|---|
| **Time** | **$L_{Aeq}$ (dB)** | **$L_{A\,min}$ (dB)** | **$L_{A\,max}$ (dB)** | **$L_{A90}$ (dB)** | **$L_{A10}$ (dB)** | **Comments** |
| **25/04/2014 - Night Time** | | | | | | |
| 0509-0524 | 50.8 | 34.0 | 66.2 | 38.1 | 56.1 | Birdsong. Distant road traffic on the A12. Occasional road traffic on Ipswich Road. |
| 0650-0705 | 52.6 | 41.8 | 64.9 | 46.7 | 55.6 | Frequent road traffic on Ipswich Road. Distant road traffic on the A12. Birdsong. |
| **25/04/2014 - Daytime** | | | | | | |
| 0729-0744 | 56.4 | 52.7 | 69.2 | 54.4 | 57.6 | Frequent road traffic on Ipswich Road. Distant road traffic on the A12. Birdsong. |
| 0811-0826 | 56.7 | 51.0 | 64.5 | 54.3 | 58.4 | Frequent road traffic on Ipswich Road. Distant road traffic on the A12. Birdsong. |
| 0859-0914 | 56.4 | 51.1 | 64.7 | 53.7 | 58.1 | Frequent road traffic on Ipswich Road. Distant road traffic on the A12. Birdsong. |

| Monitoring Location 2 - Eastern boundary adjacent to Sandy lane | | | | | | |
|---|---|---|---|---|---|---|
| **Time** | **$L_{Aeq}$ (dB)** | **$L_{A\,min}$ (dB)** | **$L_{A\,max}$ (dB)** | **$L_{A90}$ (dB)** | **$L_{A10}$ (dB)** | **Comments** |
| **25/04/2014 - Night Time** | | | | | | |
| 0600-0615 | 47.7 | 37.6 | 60.7 | 39.8 | 52.6 | Birdsong. Distant road traffic on the A12. 1 car on Sandy Lane. Distant bird scarer. |
| **24/04/2014 - Daytime** | | | | | | |
| 1637-1723 | 46.9 | 29.9 | 63.5 | 33.7 | 51.4 | Occasional road traffic on Sandy Lane. Birdsong. |
| 1751-1806 | 44.3 | 31.8 | 58.8 | 33.9 | 48.9 | Occasional road traffic on Sandy Lane. Birdsong. High level aircraft. |

| Monitoring Location 3 - Southern boundary adjacent to the railway line | | | | | | |
|---|---|---|---|---|---|---|
| **Time** | **$L_{Aeq}$ (dB)** | **$L_{A\,min}$ (dB)** | **$L_{A\,max}$ (dB)** | **$L_{A90}$ (dB)** | **$L_{A10}$ (dB)** | **Comments** |
| **25/04/2014 - Night Time** | | | | | | |
| 0620-0641 | 55.5 | 39.7 | 83.1 | 42.1 | 46.7 | Noise from the passage of 2 passenger trains. Distant road traffic on the A12. Birdsong. High level aircraft. |
| **24/04/2014 - Daytime** | | | | | | |
| 1601-1628 | 53.5 | 31.0 | 80.7 | 32.4 | 39.3 | Noise from the passage of 2 passenger trains. Birdsong. |
| 1726-1748 | 56.2 | 33.4 | 81.1 | 35.1 | 45.9 | Noise from the passage of 2 passenger trains. Birdsong. High level aircraft. |

| Monitoring Location 3 - Southern boundary adjacent to the railway line (Continued) | | | | | | |
|---|---|---|---|---|---|---|
| Time | $L_{Aeq}$ (dB) | $L_{A\,min}$ (dB) | $L_{A\,max}$ (dB) | $L_{A90}$ (dB) | $L_{A10}$ (dB) | Comments |
| **25/04/2014 - Daytime** | | | | | | |
| 0747-0804 | 61.7 | 46.1 | 84.2 | 47.0 | 50.8 | Noise from the passage of 2 passenger trains and 1 freight train. Birdsong. Distant road traffic on the A12. |
| 0920-0937 | 54.1 | 43.0 | 79.0 | 45.0 | 50.0 | Noise from the passage of 1 passenger train. Birdsong. Distant road traffic on the A12. |

| Monitoring Location 4 - Western boundary adjacent to Top Street | | | | | | |
|---|---|---|---|---|---|---|
| Time | $L_{Aeq}$ (dB) | $L_{A\,min}$ (dB) | $L_{A\,max}$ (dB) | $L_{A90}$ (dB) | $L_{A10}$ (dB) | Comments |
| **25/04/2014 - Night Time** | | | | | | |
| 0530-0545 | 49.5 | 37.8 | 66.8 | 44.6 | 52.1 | Distant road traffic on the A12. Birdsong. Occasional road traffic on Top Street and Ipswich Road. |
| **25/04/2014 - Daytime** | | | | | | |
| 0712-0727 | 55.2 | 49.8 | 66.5 | 52.5 | 56.9 | Noise from road traffic on Ipswich Road and the A12. Occasional road traffic on Top Street. Birdsong. |
| 0829-0849 | 58.3 | 52.2 | 69.7 | 55.8 | 59.7 | Near constant road traffic on Top Street. Noise from road traffic on Ipswich Road and the A12. Birdsong. |

**Daytime and Night-time Noise Levels Across the Development Site**

During the noise survey, rail movements were audible at monitoring location ML3. However, the frequency of train movements varies throughout the day and night, and therefore short period measured levels are not necessarily representative of the entire day or night time periods.

To adjust the measured levels and properly account for train movements throughout the 24 hour period, the following steps are taken: Firstly, remove railway noise from the measured levels (by omitting it from the time history output of the sound level meter) to obtain the ‘residual’ noise levels. These are set out in Table 1.

| Table 1: Summary of Residual Noise Levels Across the Site | | |
|---|---|---|
| **Monitoring Location** | **Time, h** | **Residual $L_{Aeq}$ dB** |
| **Night Time Measurements** | | |
| **3** | 0620-0641 | 47.3 |
| | **Night-time Average** | **47.3** |
| **Daytime Measurements** | | |
| **3** | 1601-1629 | 36.8 |
| | 1726-1748 | 40.3 |
| | 0747-0804 | 48.7 |
| | 0920-0937 | 47.7 |
| | **Daytime Average** | **43.4** |

Secondly, the average noise level of all trains using the line must be determined from the measurement data. During the noise survey, train movements at measurement location 3, located 20m from the train line, and the Sound Exposure Levels (SEL) of all trains passing the site were measured, and is summarised in Appendix B.

The third step is to determine the total number of train movements during the daytime and night time. The passenger train movements were counted using the Electronic National Rail Timetable (eNRT), valid from 11th May 2015. To be robust, the highest number of timetabled daytime and night time movements throughout the week has been used in this assessment.

The Network Rail Working Time Table (WTT), valid May 2015, has been reviewed, but it did not indicate any timetabled movements of freight train on the line. However, during the time of the survey a freight train consisting of 4 carriages did was witnessed on the line. Therefore, to be robust an estimation of freight train movements has been included.

The total number of train movements passing the site is shown in Table 2:

| Table 2: Train Movements Adjacent to the Site | |
|---|---|
| **Time** | **Number of Train Movements During the Week (Monday-Friday)** |
| 0700-2300 | Weekday = 31 passenger train movements<br>5 freight train movements |
| 2300-0700 | Weekday = 2 passenger train movements<br>1 freight train movement |

For the purpose of this assessment, the average SEL measured at monitoring location 2, during the daytime and night time has been used in the predictions, at a distance of 20m from the train line (the approximate location of the nearest dwelling), to give the worst case scenario. The residual noise levels from measurement location have also been used in the assessment as it is assumed to be representative of levels in the south of the site.

The final step is to combine the results of the previous three steps to obtain noise levels which are inclusive of all train movements. Following the prediction methodology set out in CORN (Calculation of Railway Noise, 1995), the daytime and night time noise levels have been determined (including all train movements in Table 2) as shown in Table 3.

**Table 3: Calculation of Daytime 16 hour $L_{Aeq}$ and Night-time 8 hour $L_{Aeq}$ at Monitoring Locations Across the Site**

| | | Passenger/Freight Train noise only (calculated) | Residual noise Taken from Table 1. | Ambient noise including all train movements (calculated) |
|---|---|---|---|---|
| **Monitoring Location 3** | | | | |
| **Daytime** | | 50.5 | 43.4 | 53.1 |
| $L_{Aeq}$ = SEL +10log(N) – 10log(T) | | | | |
| Passenger train SEL = | 83.2 | | | |
| No of Passenger Trains N = | 31 | | | |
| Time period T = 16 hours = | 57600 | | | |
| $L_{Aeq}$ = SEL +10log(N) – 10log(T) | | 48.4 | | |
| Freight train SEL = | 89.0 | | | |
| No of Frieght Trains N = | 5 | | | |
| Time period T = 16 hours = | 57600 | | | |
| **Night-time** | | 42 | 47.3 | 49.9 |
| LAeq = SEL +10log(N) – 10log(T) | | | | |
| Passenger train SEL = | 83.6 | | | |
| No of Passenger Trains N = | 2 | | | |
| Time period T = 16 hours = | 28800 | | | |
| LAeq = SEL +10log(N) – 10log(T) | | 44.4 | | |
| Freight train SEL = | 89.0 | | | |
| No of Frieght Trains N = | 1 | | | |
| Time period T = 16 hours = | 28800 | | | |

## Appendix B
## Summary of Train Movements

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**Appendix B**

Summary of Train Movements Observed during the Noise Survey

| Time | No of Carriages | Type | Direction Travelling | Approx Speed (mph) | Measured $L_{max,f}$ dB | Measured SEL |
|---|---|---|---|---|---|---|
| **Monitoring Location 3 - 20m From Railway Line** | | | | | | |
| **24/04/2014** | | | | | | |
| 1608 | 1 | Passenger | East | 40 | 80.7 | 82.5 |
| 1622 | 3 | Passenger | West | 40 | 79.6 | 82.5 |
| 1729 | 3 | Passenger | East | 40 | 81.1 | 84.3 |
| 1731 | 2 | Passenger | West | 40 | 80.7 | 83.4 |
| **25/04/2014** | | | | | | |
| 0633 | 1 | Passenger | East | 40 | 83.1 | 84.4 |
| 0636 | 2 | Passenger | West | 40 | 81.0 | 82.8 |
| 0748 | 2 | Passenger | East | 40 | 81.7 | 85.2 |
| 0754 | 2 | Passenger | West | 40 | 79.7 | 81.8 |
| 0802 | 4 | Freight | East | 30 | 84.2 | 89.0 |
| 0929 | 2 | Passenger | West | 40 | 79.0 | 82.5 |

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# Appendix C
# Vibration Assessment Data

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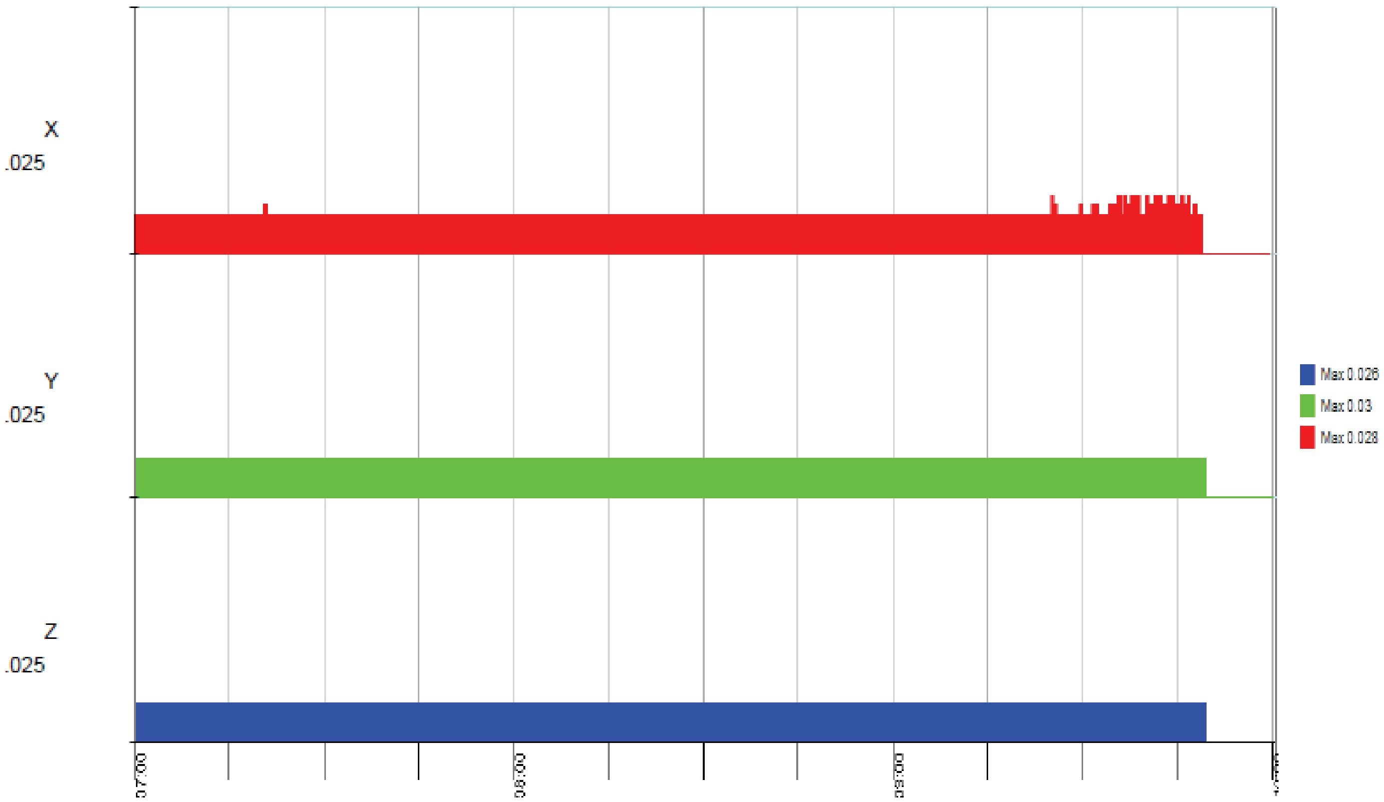
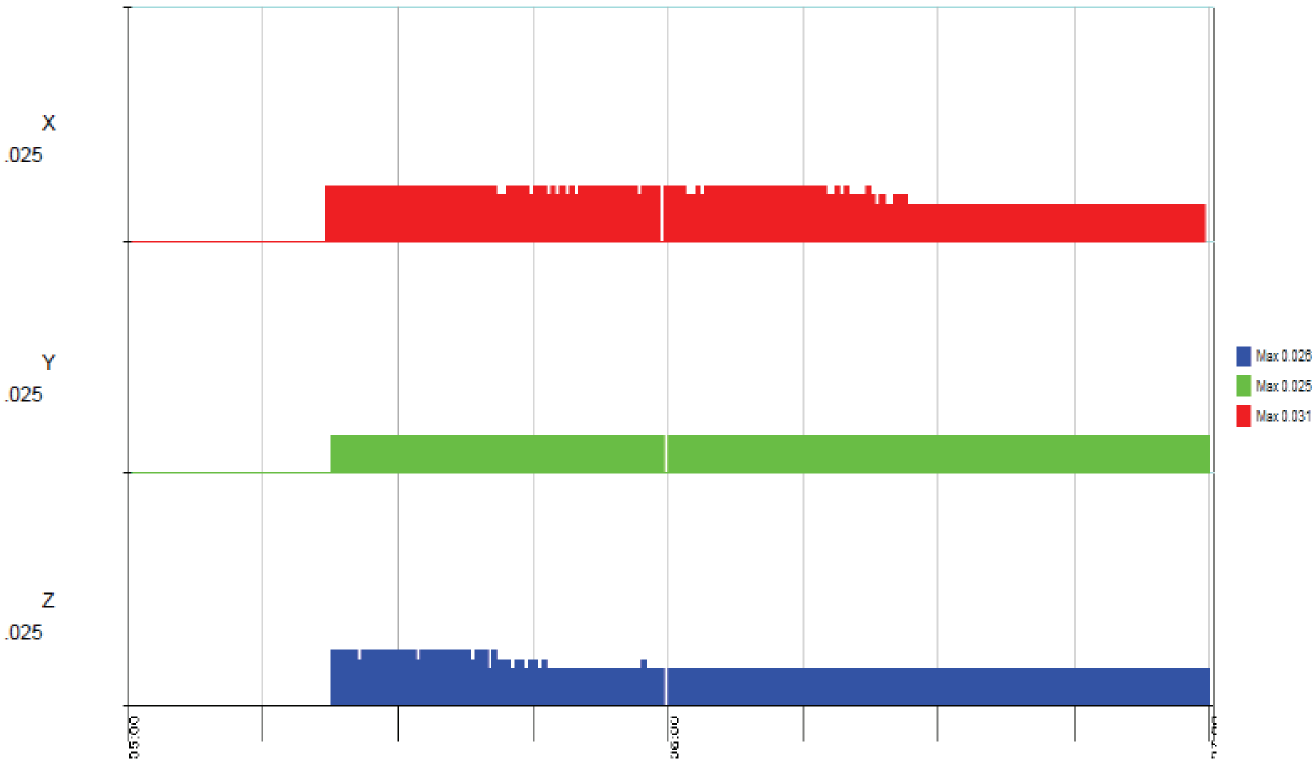
**Appendix C**

Vibration Monitoring Results




| Event 016 | X | Y | Z | X | Y | Z |
|---|---|---|---|---|---|---|
| | | 16 Hour | | | | |
| | .028 | .030 | .026 | | | |
| | | 1 Hour | | | Total | |
| Hour 1 | .013 | .015 | .013 | .013 | .015 | .013 |
| Hour 2 | .013 | .015 | .013 | .016 | .018 | .015 |
| Hour 3 | .016 | .015 | .013 | .018 | .019 | .017 |




| Event 015 | X | Y | Z | X | Y | Z |
|---|---|---|---|---|---|---|
| | | 8 Hour | | | | |
| | .031 | .025 | .026 | | | |
| | | 1 Hour | | | Total | |
| Hour 1 | .020 | .014 | .018 | .017 | .013 | .016 |
| Hour 2 | .017 | .015 | .013 | .020 | .017 | .017 |

**Appendix D**
**CRTN Calculations**

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**Appendix D - CRTN Calculation - Existing Receptors 2025 Base**

* Valid for d ≥ 4 metres

** Values from Traffic Data provided by Hydrock

| Stage 1 | Stage 2 | | | | | | Stage 2 | Stage 2 | | Stage 2 | Stage 3 | | | | | | | | | Stage 4 | | | | Stage 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Without Development 2025** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link | Receptor | Traffic Flow, Q veh/18-hour day** | $L_{10\ (18\text{-hour})}$ dB(A) (CRTN Chart 3) | Traffic Speed: Mean Speed, V mph** | Traffic Speed: Mean Speed, V km/h | HGV, p %** | Correction for Mean Traffic Speed, V, and Percentage Heavy Vehicles, p (CRTN Chart 4) | Road surface | Road Surface Correction (CRTN Para. 16) | Basic Noise Level dB(A) | Shortest horizontal distance, d (m) | Height of reception point relative to effective source position, h (m) | Shortest slant distance from the effective source position, d' (m) (CRTN Chart 7) | Distance Correction dB(A) (CRTN Chart 7)* | Average Height of Propagation, H (m) (Para 20.2 CRTN) | Absorbent Ground Cover % (Para 20.4 CRTN) | Absorbent Ground Cover, I | Absorbent Ground Cover Correction dB(A) (CRTN Chart 8) | Propagation Correction dB(A) | Façade Correction dB(A) (CRTN Para. 26.1) | Angle of view segment, θ (deg) | Angle of View Correction dB(A) (CRTN Chart 10) | Site Layout Correction dB(A) | Combined Noise Level dB(A) | Combined Façade Noise Level dB(A) |
| A12 NE | ESR1 | 45,452 | 75.7 | 70 | 112.6 | 5.4 | 4.6 | Impervious (SMA) | -1 | 79.3 | 30.0 | 1.2 | 33.5 | -3.9 | 1.1 | ≥90 | 1.0 | -4.3 | -8.2 | 2.5 | 170.0 | -0.2 | 2.3 | 73.3 | **73.3** |
| | | | | | | | | | | | | | | | | | | | | | | | | **73.3** | |
| **With Development 2025** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link | Receptor | Traffic Flow, Q veh/18-hour day** | $L_{10\ (18\text{-hour})}$ dB(A) (CRTN Chart 3) | Traffic Speed: Mean Speed, V mph** | Traffic Speed: Mean Speed, V km/h | HGV, p %** | Correction for Mean Traffic Speed, V, and Percentage Heavy Vehicles, p (CRTN Chart 4) | Road surface | Road Surface Correction (CRTN Para. 16) | Basic Noise Level dB(A) | Shortest horizontal distance, d (m) | Height of reception point relative to effective source position, h (m) | Shortest slant distance from the effective source position, d' (m) (CRTN Chart 7) | Distance Correction dB(A) (CRTN Chart 7)* | Average Height of Propagation, H (m) (Para 20.2 CRTN) | Absorbent Ground Cover % (Para 20.4 CRTN) | Absorbent Ground Cover, I | Absorbent Ground Cover Correction dB(A) (CRTN Chart 8) | Propagation Correction dB(A) | Façade Correction dB(A) (CRTN Para. 26.1) | Angle of view segment, θ (deg) | Angle of View Correction dB(A) (CRTN Chart 10) | Site Layout Correction dB(A) | Combined Noise Level dB(A) | Combined Façade Noise Level dB(A) |
| B1438 East of site access | ESR2 | 16,632 | 71.3 | 30 | 48.3 | 3.6 | -1.6 | Impervious (SMA) | -1 | 68.7 | 10.0 | 1.2 | 13.6 | 0.0 | 1.1 | ≥90 | 1.0 | -2.2 | -2.2 | 2.5 | 170.0 | -0.2 | 2.3 | 68.7 | **68.7** |
| | | | | | | | | | | | | | | | | | | | | | | | | **68.7** | |
| **Without Development 2025** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link | Receptor | Traffic Flow, Q veh/18-hour day** | $L_{10\ (18\text{-hour})}$ dB(A) (CRTN Chart 3) | Traffic Speed: Mean Speed, V mph** | Traffic Speed: Mean Speed, V km/h | HGV, p %** | Correction for Mean Traffic Speed, V, and Percentage Heavy Vehicles, p (CRTN Chart 4) | Road surface | Road Surface Correction (CRTN Para. 16) | Basic Noise Level dB(A) | Shortest horizontal distance, d (m) | Height of reception point relative to effective source position, h (m) | Shortest slant distance from the effective source position, d' (m) (CRTN Chart 7) | Distance Correction dB(A) (CRTN Chart 7)* | Average Height of Propagation, H (m) (Para 20.2 CRTN) | Absorbent Ground Cover % (Para 20.4 CRTN) | Absorbent Ground Cover, I | Absorbent Ground Cover Correction dB(A) (CRTN Chart 8) | Propagation Correction dB(A) | Façade Correction dB(A) (CRTN Para. 26.1) | Angle of view segment, θ (deg) | Angle of View Correction dB(A) (CRTN Chart 10) | Site Layout Correction dB(A) | Combined Noise Level dB(A) | Combined Façade Noise Level dB(A) |
| Sandy Lane | ESR3 | 1,716 | 61.4 | 30 | 48.3 | 1.8 | -2.3 | Impervious (SMA) | -1 | 58.2 | 10.0 | 1.2 | 13.6 | 0.0 | 1.1 | ≥90 | 1.0 | -2.2 | -2.2 | 2.5 | 130.0 | -1.4 | 1.1 | 57.1 | **57.1** |
| | | | | | | | | | | | | | | | | | | | | | | | | **57.1** | |
| **With Development 2025** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link | Receptor | Traffic Flow, Q veh/18-hour day** | $L_{10\ (18\text{-hour})}$ dB(A) (CRTN Chart 3) | Traffic Speed: Mean Speed, V mph** | Traffic Speed: Mean Speed, V km/h | HGV, p %** | Correction for Mean Traffic Speed, V, and Percentage Heavy Vehicles, p (CRTN Chart 4) | Road surface | Road Surface Correction (CRTN Para. 16) | Basic Noise Level dB(A) | Shortest horizontal distance, d (m) | Height of reception point relative to effective source position, h (m) | Shortest slant distance from the effective source position, d' (m) (CRTN Chart 7) | Distance Correction dB(A) (CRTN Chart 7)* | Average Height of Propagation, H (m) (Para 20.2 CRTN) | Absorbent Ground Cover % (Para 20.4 CRTN) | Absorbent Ground Cover, I | Absorbent Ground Cover Correction dB(A) (CRTN Chart 8) | Propagation Correction dB(A) | Façade Correction dB(A) (CRTN Para. 26.1) | Angle of view segment, θ (deg) | Angle of View Correction dB(A) (CRTN Chart 10) | Site Layout Correction dB(A) | Combined Noise Level dB(A) | Combined Façade Noise Level dB(A) |
| Top Street North | ESR4 | 12,105 | 69.9 | 60 | 96.5 | 2.0 | 2.6 | Impervious (SMA) | -1 | 71.6 | 5.0 | 1.2 | 8.6 | 2.0 | 1.1 | ≥90 | 1.0 | -1.2 | 0.8 | 2.5 | 180.0 | 0.0 | 2.5 | 74.9 | **74.9** |
| | | | | | | | | | | | | | | | | | | | | | | | | **74.9** | |

**Appendix D - CRTN Calculation - Existing Receptors Commited and Proposed Developments**

* Valid for d ≥ 4 metres

** Values from Traffic Data provided by Hydrock

| Stage 1 | Stage 2 | | | | | | Stage 2 | Stage 2 | | Stage 2 | Stage 3 | | | | | | | | | Stage 4 | | | | Stage 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Without Development 2025** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link | Receptor | Traffic Flow, Q veh/18-hour day** | $L_{10\ (18\text{-}hour)}$ dB(A) (CRTN Chart 3) | Traffic Speed: Mean Speed, V mph** | Traffic Speed: Mean Speed, V km/h | HGV, p %** | Correction for Mean Traffic Speed, V, and Percentage Heavy Vehicles, p (CRTN Chart 4) | Road surface | Road Surface Correction (CRTN Para. 16) | Basic Noise Level dB(A) | Shortest horizontal distance, d (m) | Height of reception point relative to effective source position, h (m) | Shortest slant distance from the effective source position, d' (m) (CRTN Chart 7) | Distance Correction dB(A) (CRTN Chart 7)* | Average Height of Propagation, H (m) (Para 20.2 CRTN) | Absorbent Ground Cover % (Para 20.4 CRTN) | Absorbent Ground Cover, I | Absorbent Ground Cover Correction dB(A) (CRTN Chart 8) | Propagation Correction dB(A) | Façade Correction dB(A) (CRTN Para. 26.1) | Angle of view segment, θ (deg) | Angle of View Correction dB(A) (CRTN Chart 10) | Site Layout Correction dB(A) | Combined Noise Level dB(A) | Combined Façade Noise Level dB(A) |
| A12 NE | ESR1 | 53,084 | 76.3 | 70 | 112.6 | 2.8 | 4.2 | Impervious (SMA) | -1 | 79.5 | 30.0 | 1.2 | 33.5 | -3.9 | 1.1 | ≥90 | 1.0 | -4.3 | -8.2 | 2.5 | 170.0 | -0.2 | 2.3 | 73.6 | **73.6** |
| | | | | | | | | | | | | | | | | | | | | | | | | **73.6** | |
| **With Development 2025** | | | | | | | | | | | | | | | | | | | | | | | | | |
| A12 NE | ESR1 | 49,840 | 76.1 | 70 | 112.6 | 2.8 | 4.2 | Impervious (SMA) | -1 | 79.3 | 30.0 | 1.2 | 33.5 | -3.9 | 1.1 | ≥90 | 1.0 | -4.3 | -8.2 | 2.5 | 170.0 | -0.2 | 2.3 | 73.3 | **73.3** |
| | | | | | | | | | | | | | | | | | | | | | | | | **73.3** | |
| **Without Development 2025** | | | | | | | | | | | | | | | | | | | | | | | | | |
| B1438 East of site access | ESR2 | 19,547 | 72.0 | 30 | 48.3 | 1.3 | -2.4 | Impervious (SMA) | -1 | 68.6 | 10.0 | 1.2 | 13.6 | 0.0 | 1.1 | ≥90 | 1.0 | -2.2 | -2.2 | 2.5 | 170.0 | -0.2 | 2.3 | 68.6 | **68.6** |
| | | | | | | | | | | | | | | | | | | | | | | | | **68.6** | |
| **With Development 2025** | | | | | | | | | | | | | | | | | | | | | | | | | |
| B1438 East of site access | ESR2 | 19,651 | 72.0 | 30 | 48.3 | 1.3 | -2.4 | Impervious (SMA) | -1 | 68.6 | 10.0 | 1.2 | 13.6 | 0.0 | 1.1 | ≥90 | 1.0 | -2.2 | -2.2 | 2.5 | 170.0 | -0.2 | 2.3 | 68.6 | **68.6** |
| | | | | | | | | | | | | | | | | | | | | | | | | **68.6** | |
| **Without Development 2025** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sandy Lane | ESR3 | 1,840 | 61.7 | 30 | 48.3 | 6.1 | -0.9 | Impervious (SMA) | -1 | 59.9 | 10.0 | 1.2 | 13.6 | 0.0 | 1.1 | ≥90 | 1.0 | -2.2 | -2.2 | 2.5 | 130.0 | -1.4 | 1.1 | 58.7 | **58.7** |
| | | | | | | | | | | | | | | | | | | | | | | | | **58.7** | |
| **With Development 2025** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sandy Lane | ESR3 | 1,729 | 61.5 | 30 | 48.3 | 6.1 | -0.9 | Impervious (SMA) | -1 | 59.6 | 10.0 | 1.2 | 13.6 | 0.0 | 1.1 | ≥90 | 1.0 | -2.2 | -2.2 | 2.5 | 130.0 | -1.4 | 1.1 | 58.5 | **58.5** |
| | | | | | | | | | | | | | | | | | | | | | | | | **58.5** | |
| **Without Devlopment 2025** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Top Street North | ESR4 | 14,969 | 70.9 | 60 | 96.5 | 1.6 | 2.5 | Impervious (SMA) | -1 | 72.4 | 5.0 | 1.2 | 8.6 | 2.0 | 1.1 | ≥90 | 1.0 | -1.2 | 0.8 | 2.5 | 180.0 | 0.0 | 2.5 | 75.7 | **75.7** |
| | | | | | | | | | | | | | | | | | | | | | | | | **75.7** | |
| **With Devlopment 2025** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Top Street North | ESR4 | 14,969 | 70.9 | 60 | 96.5 | 1.6 | 2.5 | Impervious (SMA) | -1 | 72.4 | 5.0 | 1.2 | 8.6 | 2.0 | 1.1 | 0.0 | 1.0 | -1.2 | 0.8 | 2.5 | 180.0 | 0.0 | 2.5 | 75.7 | **75.7** |
| | | | | | | | | | | | | | | | | | | | | | | | | **75.7** | |

**Appendix D - CRTN Calculation - Proposed Receptors**

* Valid for d ≥ 4 metres

** Values from Traffic Data provided by TTHC

| Stage 1 | Stage 2 | Stage 2 | Stage 2 | Stage 2 | Stage 3 | Stage 4 | Stage 5 |
|---|---|---|---|---|---|---|---|

**Without Development 2025**

| Link | Receptor | Traffic Flow, Q veh/18-hour day** | $L_{10\ (18\text{-hour})}$ dB(A) (CRTN Chart 3) | Traffic Speed: Mean Speed, V mph** | Traffic Speed: Mean Speed, V km/h | HGV, p %** | Correction for Mean Traffic Speed, V, and Percentage Heavy Vehicles, p (CRTN Chart 4) | Road surface | Road Surface Correction (CRTN Para. 16) | Basic Noise Level dB(A) | Shortest horizontal distance, d (m) | Height of reception point relative to effective source position, h (m) | Shortest slant distance from the effective source position, d' (m) (CRTN Chart 7) | Distance Correction dB(A) (CRTN Chart 7)* | Average Height of Propagation, H (m) (Para 20.2 CRTN) | Absorbent Ground Cover % (Para 20.4 CRTN) | Absorbent Ground Cover, I | Absorbent Ground Cover Correction dB(A) (CRTN Chart 8) | Propagation Correction dB(A) | Façade Correction dB(A) (CRTN Para. 26.1) | Angle of view segment, θ (deg) | Angle of View Correction dB(A) (CRTN Chart 10) | Site Layout Correction dB(A) | Combined Noise Level dB(A) | Combined Façade Noise Level dB(A) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B1438 East of site access | PSR1 | 19,547 | 72.0 | 30 | 48.3 | 1.3 | -2.4 | Impervious (SMA) | -1 | 68.6 | 15.0 | 1.2 | 18.5 | -1.4 | 1.1 | ≥90 | 1.0 | -2.9 | -4.3 | 2.5 | 150.0 | -0.8 | 1.7 | 66.0 | **66.0** |
| | | | | | | | | | | | | | | | | | | | | | | | | **66.0** | |

**With Development 2025**

| Link | Receptor | Traffic Flow, Q veh/18-hour day** | $L_{10\ (18\text{-hour})}$ dB(A) (CRTN Chart 3) | Traffic Speed: Mean Speed, V mph** | Traffic Speed: Mean Speed, V km/h | HGV, p %** | Correction for Mean Traffic Speed, V, and Percentage Heavy Vehicles, p (CRTN Chart 4) | Road surface | Road Surface Correction (CRTN Para. 16) | Basic Noise Level dB(A) | Shortest horizontal distance, d (m) | Height of reception point relative to effective source position, h (m) | Shortest slant distance from the effective source position, d' (m) (CRTN Chart 7) | Distance Correction dB(A) (CRTN Chart 7)* | Average Height of Propagation, H (m) (Para 20.2 CRTN) | Absorbent Ground Cover % (Para 20.4 CRTN) | Absorbent Ground Cover, I | Absorbent Ground Cover Correction dB(A) (CRTN Chart 8) | Propagation Correction dB(A) | Façade Correction dB(A) (CRTN Para. 26.1) | Angle of view segment, θ (deg) | Angle of View Correction dB(A) (CRTN Chart 10) | Site Layout Correction dB(A) | Combined Noise Level dB(A) | Combined Façade Noise Level dB(A) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B1438 East of site access | PSR1 | 19,651 | 72.0 | 30 | 48.3 | 1.3 | -2.4 | Impervious (SMA) | -1 | 68.6 | 15.0 | 1.2 | 18.5 | -1.4 | 1.1 | ≥90 | 1.0 | -2.9 | -4.3 | 2.5 | 150.0 | -0.8 | 1.7 | 66.0 | **66.0** |
| | | | | | | | | | | | | | | | | | | | | | | | | **66.0** | |

**Without Development 2025**

| Link | Receptor | Traffic Flow, Q veh/18-hour day** | $L_{10\ (18\text{-hour})}$ dB(A) (CRTN Chart 3) | Traffic Speed: Mean Speed, V mph** | Traffic Speed: Mean Speed, V km/h | HGV, p %** | Correction for Mean Traffic Speed, V, and Percentage Heavy Vehicles, p (CRTN Chart 4) | Road surface | Road Surface Correction (CRTN Para. 16) | Basic Noise Level dB(A) | Shortest horizontal distance, d (m) | Height of reception point relative to effective source position, h (m) | Shortest slant distance from the effective source position, d' (m) (CRTN Chart 7) | Distance Correction dB(A) (CRTN Chart 7)* | Average Height of Propagation, H (m) (Para 20.2 CRTN) | Absorbent Ground Cover % (Para 20.4 CRTN) | Absorbent Ground Cover, I | Absorbent Ground Cover Correction dB(A) (CRTN Chart 8) | Propagation Correction dB(A) | Façade Correction dB(A) (CRTN Para. 26.1) | Angle of view segment, θ (deg) | Angle of View Correction dB(A) (CRTN Chart 10) | Site Layout Correction dB(A) | Combined Noise Level dB(A) | Combined Façade Noise Level dB(A) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B1438 West of site access | PSR2 | 19,023 | 71.9 | 30 | 48.3 | 1.8 | -2.3 | Impervious (SMA) | -1 | 68.6 | 70.0 | 1.2 | 73.5 | -7.4 | 1.1 | ≥90 | 1.0 | -6.0 | -13.4 | 2.5 | 10.0 | -12.6 | -10.1 | 45.2 | **68.8** |
| Top Street North | | 14,969 | 70.9 | 60 | 96.5 | 1.6 | 2.5 | Impervious (SMA) | -1 | 72.4 | 20.0 | 1.2 | 23.5 | -2.4 | 1.1 | ≥90 | 1.0 | -3.5 | -5.9 | 2.5 | 170.0 | -0.2 | 2.3 | 68.8 | |
| | | | | | | | | | | | | | | | | | | | | | | | | **68.8** | |

**With Development 2025**

| Link | Receptor | Traffic Flow, Q veh/18-hour day** | $L_{10\ (18\text{-hour})}$ dB(A) (CRTN Chart 3) | Traffic Speed: Mean Speed, V mph** | Traffic Speed: Mean Speed, V km/h | HGV, p %** | Correction for Mean Traffic Speed, V, and Percentage Heavy Vehicles, p (CRTN Chart 4) | Road surface | Road Surface Correction (CRTN Para. 16) | Basic Noise Level dB(A) | Shortest horizontal distance, d (m) | Height of reception point relative to effective source position, h (m) | Shortest slant distance from the effective source position, d' (m) (CRTN Chart 7) | Distance Correction dB(A) (CRTN Chart 7)* | Average Height of Propagation, H (m) (Para 20.2 CRTN) | Absorbent Ground Cover % (Para 20.4 CRTN) | Absorbent Ground Cover, I | Absorbent Ground Cover Correction dB(A) (CRTN Chart 8) | Propagation Correction dB(A) | Façade Correction dB(A) (CRTN Para. 26.1) | Angle of view segment, θ (deg) | Angle of View Correction dB(A) (CRTN Chart 10) | Site Layout Correction dB(A) | Combined Noise Level dB(A) | Combined Façade Noise Level dB(A) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B1438 West of site access | PSR2 | 20,070 | 72.1 | 30 | 48.3 | 1.8 | -2.3 | Impervious (SMA) | -1 | 68.9 | 70.0 | 1.2 | 73.5 | -7.4 | 1.1 | ≥90 | 1.0 | -6.0 | -13.4 | 2.5 | 10.0 | -12.6 | -10.1 | 45.4 | **68.8** |
| Top Street North | | 14,969 | 70.9 | 60 | 96.5 | 1.6 | 2.5 | Impervious (SMA) | -1 | 72.4 | 20.0 | 1.2 | 23.5 | -2.4 | 1.1 | ≥90 | 1.0 | -3.5 | -5.9 | 2.5 | 170.0 | -0.2 | 2.3 | 68.8 | |
| | | | | | | | | | | | | | | | | | | | | | | | | **68.8** | |

**Without Development 2025**

| Link | Receptor | Traffic Flow, Q veh/18-hour day** | $L_{10\ (18\text{-hour})}$ dB(A) (CRTN Chart 3) | Traffic Speed: Mean Speed, V mph** | Traffic Speed: Mean Speed, V km/h | HGV, p %** | Correction for Mean Traffic Speed, V, and Percentage Heavy Vehicles, p (CRTN Chart 4) | Road surface | Road Surface Correction (CRTN Para. 16) | Basic Noise Level dB(A) | Shortest horizontal distance, d (m) | Height of reception point relative to effective source position, h (m) | Shortest slant distance from the effective source position, d' (m) (CRTN Chart 7) | Distance Correction dB(A) (CRTN Chart 7)* | Average Height of Propagation, H (m) (Para 20.2 CRTN) | Absorbent Ground Cover % (Para 20.4 CRTN) | Absorbent Ground Cover, I | Absorbent Ground Cover Correction dB(A) (CRTN Chart 8) | Propagation Correction dB(A) | Façade Correction dB(A) (CRTN Para. 26.1) | Angle of view segment, θ (deg) | Angle of View Correction dB(A) (CRTN Chart 10) | Site Layout Correction dB(A) | Combined Noise Level dB(A) | Combined Façade Noise Level dB(A) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sandy Lane | PSR3 | 1,840 | 61.7 | 30 | 48.3 | 6.1 | -0.9 | Impervious (SMA) | -1 | 59.9 | 10.0 | 1.2 | 13.6 | 0.0 | 1.1 | ≥90 | 1.0 | -2.2 | -2.2 | 2.5 | 180.0 | 0.0 | 2.5 | 60.2 | **60.2** |
| | | | | | | | | | | | | | | | | | | | | | | | | **60.2** | |

**With Development 2025**

| Link | Receptor | Traffic Flow, Q veh/18-hour day** | $L_{10\ (18\text{-hour})}$ dB(A) (CRTN Chart 3) | Traffic Speed: Mean Speed, V mph** | Traffic Speed: Mean Speed, V km/h | HGV, p %** | Correction for Mean Traffic Speed, V, and Percentage Heavy Vehicles, p (CRTN Chart 4) | Road surface | Road Surface Correction (CRTN Para. 16) | Basic Noise Level dB(A) | Shortest horizontal distance, d (m) | Height of reception point relative to effective source position, h (m) | Shortest slant distance from the effective source position, d' (m) (CRTN Chart 7) | Distance Correction dB(A) (CRTN Chart 7)* | Average Height of Propagation, H (m) (Para 20.2 CRTN) | Absorbent Ground Cover % (Para 20.4 CRTN) | Absorbent Ground Cover, I | Absorbent Ground Cover Correction dB(A) (CRTN Chart 8) | Propagation Correction dB(A) | Façade Correction dB(A) (CRTN Para. 26.1) | Angle of view segment, θ (deg) | Angle of View Correction dB(A) (CRTN Chart 10) | Site Layout Correction dB(A) | Combined Noise Level dB(A) | Combined Façade Noise Level dB(A) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sandy Lane | PSR3 | 1,729 | 61.5 | 30 | 48.3 | 6.1 | -0.9 | Impervious (SMA) | -1 | 59.6 | 10.0 | 1.2 | 13.6 | 0.0 | 1.1 | ≥90 | 1.0 | -2.2 | -2.2 | 2.5 | 180.0 | 0.0 | 2.5 | 59.9 | **59.9** |
| | | | | | | | | | | | | | | | | | | | | | | | | **59.9** | |

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**Drawing LE12277-002**
**Noise Monitoring Locations**

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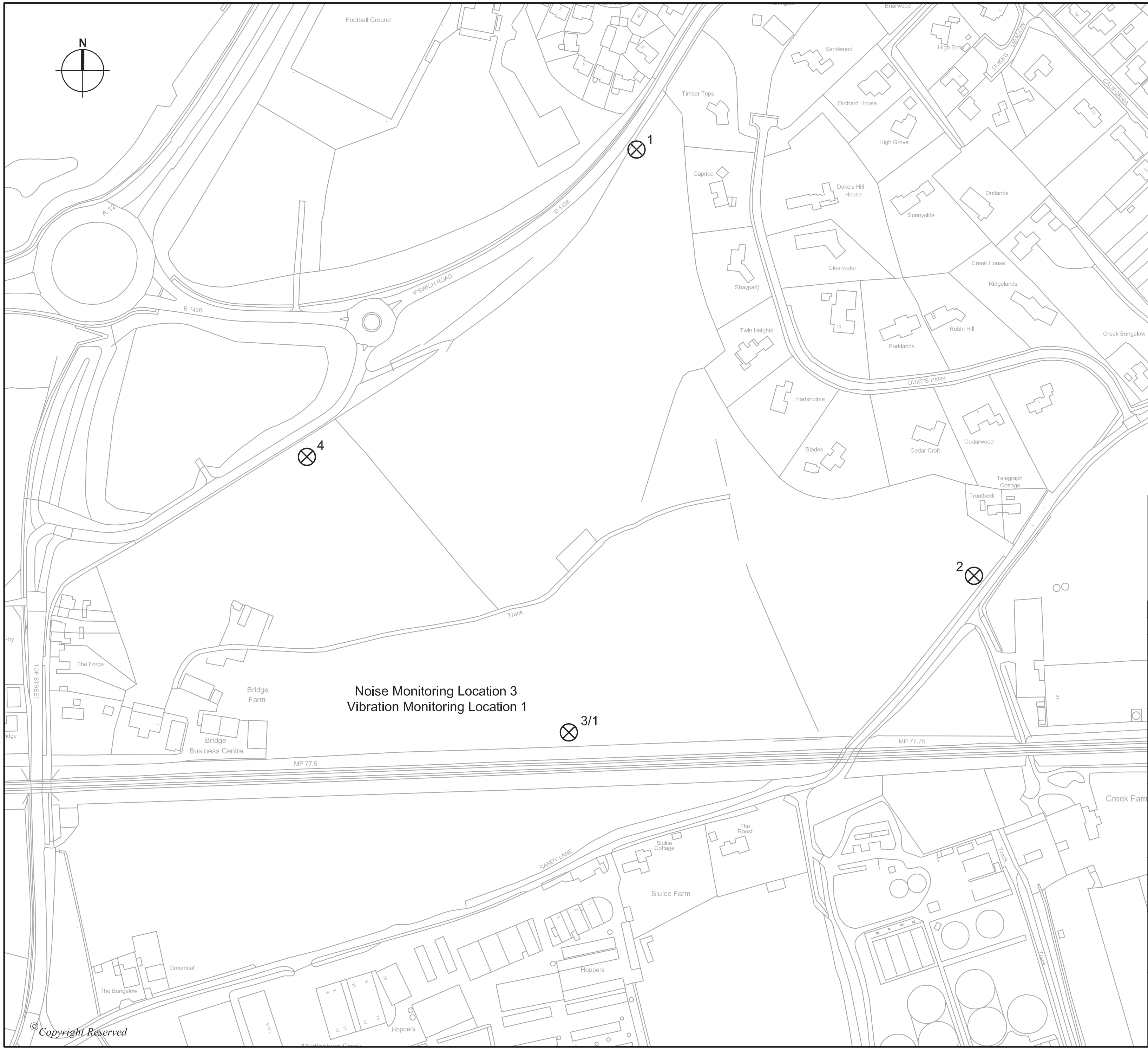


LEGEND:

Noise Monitoring Location ⊗ X

| REVISION | DETAILS | DATE | DRAWN | CHK'D | APP'D |
|---|---|---|---|---|---|
| | | | | | |
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| | | | | | |

CLIENT
GLADMAN DEVELOPMENTS

PROJECT
DUKES PARK
WOODBRIDGE

DRAWING TITLE
MONITORING LOCATIONS

| DRG No. | SCALE | DATE |
|---|---|---|
| LE12277-002 | 1:2500@A3 | 03/11/2015 |
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**Drawing LE12277-003**
**Receptor Locations**

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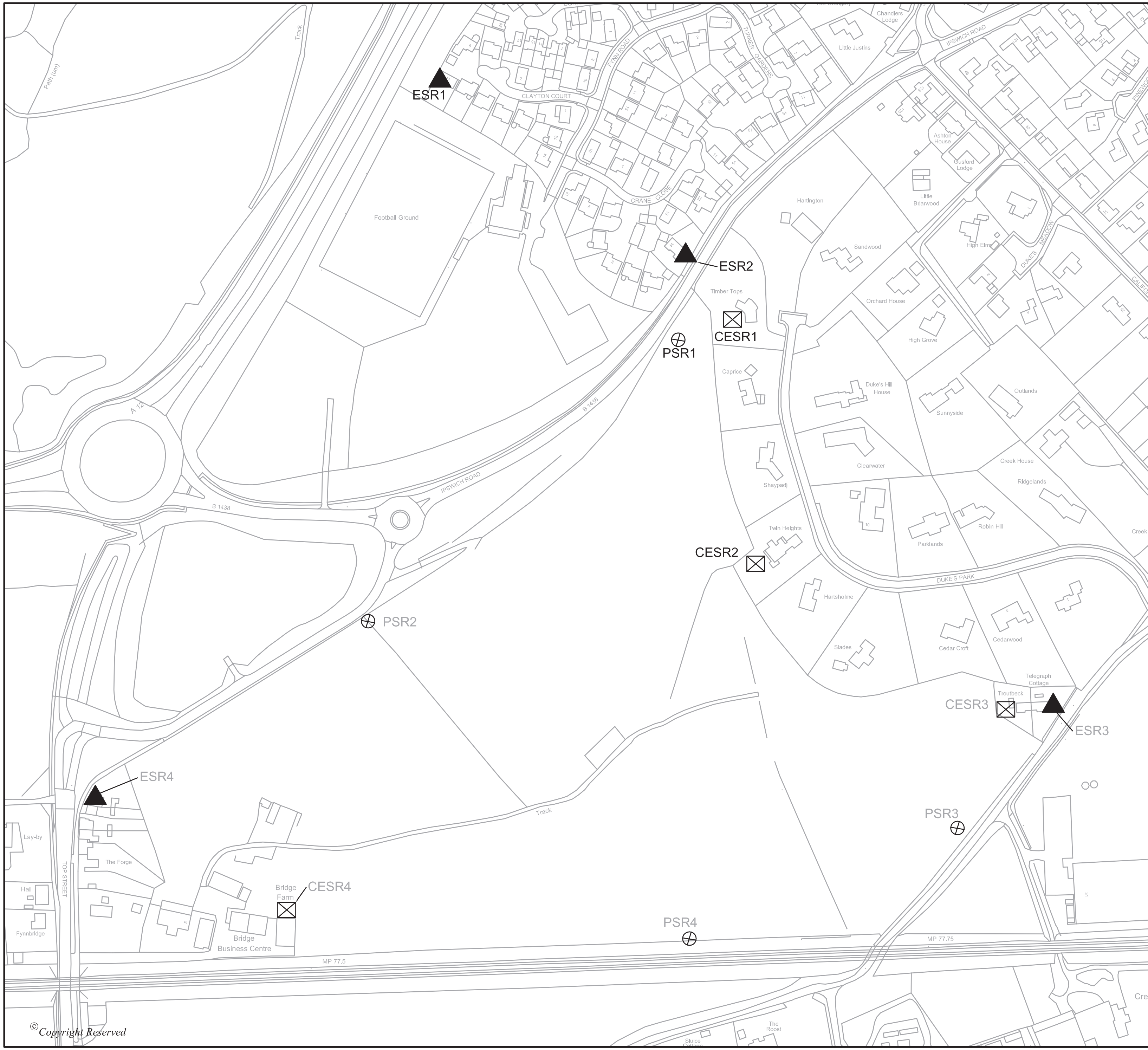


LEGEND

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| ▲ | ESR |
| ⊕ | PSR |
| ☒ | CESR |

| REVISION | DETAILS | DATE | DRAWN | CHK'D | APP'D |
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CLIENT
GLADMAN DEVELOPMENTS

PROJECT
DUKES PARK
WOODBRIDGE

DRAWING TITLE
EXISTING & PROPOSED
SENSITIVE RECEPTORS

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|---|---|---|
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