



UNIVERSAL DESTINATIONS & EXPERIENCES UK PROJECT

Former Kempston Hardwick Brickworks
and adjoining land, Bedford

Environmental Statement Volume 3

Appendix 9.2 - Construction Noise and Vibration Assessment

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1. INTRODUCTION

1.1. APPOINTMENT AND BRIEF

- 1.1.1. This Construction Noise and Vibration Assessment has been prepared in support of the planning proposal for the Proposed Development as described in **Chapter 2: Description of the Proposed Development (Volume 1)** of the Environmental Statement (ES).

1.2. EXTENT OF THE STUDY AREA

- 1.2.1. The proposed Study Area has been defined based on our experience of similar sites and relevant guidance documents. The proposed Study Area and identified receptors are shown in **Figure 9.1: Construction Noise and Vibration Study Area and Sensitive Receptors (Volume 2)**.
- 1.2.2. The Study Area for construction noise encompasses the existing sensitive receptors around the Site up to a distance of 300m from the Site boundary. Construction vibration has been assessed up to a distance of 100m from the Site boundary. The construction noise and vibration Study Areas are in line with the guidance in Design Manual for Roads and Bridges LA111 *Noise and vibration*, BS 5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites, Part 1: Noise (BS 5228-1), 2014, with reference to the validity of the prediction methodologies, and in terms of professional judgement. Any receptors located at distances greater than 300m from the nearest construction activity have also been excluded from the assessment due to the validity of the prediction methodology.
- 1.2.3. It should be noted that noise and vibration associated with construction of the potential East West Rail (EWR) Station for which land is proposed to be safeguarded in the West Gateway Zone has not been assessed because it is not part of the Proposed Development for which planning permission is sought and in any event there are no sensitive receptors within 300m of the land proposed to be safeguarded for station. Therefore, the information provided in the following sections specifically excludes work or plant associated with the potential construction of the EWR Station.
- 1.2.4. A 132kV line will be laid in ducts under the Marston Vale Railway Line in the south of the Core Zone using the Horizontal Directional Drilling (HDD) method. The nearest noise sensitive receptor (NSR) to the HDD works (NSR06) is over 300m away. Therefore, the information provided in the following sections specifically excludes work or plant associated with the HDD construction site.
- 1.2.5. Receptor NSR13 shown in **Figure 9.1: Construction Noise and Vibration Study Area and Sensitive Receptors (Volume 2)** is over 300m from any construction activity and has not been included in the assessment as they are outside of the Study Area.

1.3. CONSTRUCTION PHASES

- 1.3.1. The various construction activities have been assessed according to five Construction Phases as summarised in **Table 1-1**, which are aligned with those within **Annex 3: Construction Access and Phasing of Appendix 2.3: Outline Construction Environmental Management Plan (OCEMP) (Volume 3)**.
- 1.3.2. The locations of each of the four main development zones, i.e. Core Zone, Lake Zone, East Gateway Zone and West Gateway Zone, are identified in the **Zonal Plan (Document Reference 1.8.0)**.

Table 1-1 - Summary of Construction Phases

Construction phase	Works	Applicable zones ⁽¹⁾	Approximate overall duration of phase ⁽²⁾
1a) to 1c) – Enabling Works	Initial works, enabling works, grading and infrastructure	CZ, LZ, EG, WG	Q1 2025 – Q2 2027 Two years and three months
1d) Utility Works	Primary utility connections; primary Utility Compound	CZ, LZ	Q3 2026 – Q2 2029 Two years and nine months
1e) Roadway Works	Manor Road realignment, elevated roundabout and bridges; Public Road A; West Gateway Zone roads and bridges; A421 slip roads	CZ, LZ, EG, WG	Q1 2027 – Q2 2029 Two years and three months
1f) Railway Works	Work associated with expanded Wixams Station	EG	Q1 2027 – Q4 2028 One year and nine months
1g) Theme Park Construction	Vertical construction, fit-out and installation, ride installation and show installation	CZ, LZ	Q2 2027 – Q4 2029 Two years and six months
<p>(1) CZ: Core Zone LZ: Lake Zone EZ: East Gateway Zone WZ: West Gateway Zone</p> <p>(2) The potential for phases to overlap may result in construction activities in different locations within the Site affecting the same receptor resulting in a combined effect. A detailed programme that sets out how and when this might occur is not available. In the absence of that information, the approach taken which assumes that all the plant relevant to that phase are operated at the same location at the closest proximate point to the receptor provides a robust cautious worst-case outcome (where the phrase “cautious worst case” is used it means “a cautious worst case that provides a robust assessment of likely significant effects”).</p>			

- 1.3.3. The approximate distances between construction activity noise sources and receptors during each Construction Phase are shown in **Table 1-2** below. These distances have been used in the determination of the peak construction noise and vibration levels, when plant are located close to the boundary nearest to the relevant NSR. Calculations assume that all plant will be stationary and concentrated at a single location, which provides a cautious worst case prediction of noise and subsequent assessment (this provides a robust assessment of likely significant effects).

Table 1-2 – Closest Distance Between Construction Activities and Receptors

Phase	Distance between construction activity and receptor (m)												
	NSR 01	NSR 02	NSR 03	NSR 04	NSR 05	NSR 06	NSR 07	NSR 08	NSR 09	NSR 10	NSR 11	NSR 12	NSR 13
1a to 1c					220	20	190	60	60	20	290		
1d						20	190	60	60	20	290		
1e	240	260	210	220	20	120		20	40	20		140	
1f								20	210		60		
1g						20	190		170	20	290		

Note – Table cells are empty where the distance from construction activity to receptor is greater than 300m such that the calculation methodology becomes unreliable.

- 1.3.4. Whilst the distances stated in **Table 1-2** facilitate the prediction of the peak noise level, when plant are likely to be at their closest location to the NSR, this situation would only be expected to occur for a limited time within the overall duration of a particular construction phase. It is therefore appropriate to also assess the more typical situation where construction activity and the plant associated with that activity are located towards the centre of the construction site, rather than close to the boundary.
- 1.3.5. The construction activity distances assumed for this ‘typical’ noise impact assessment are provided in **Table 1-3**, below:

Table 1-3 - Typical Distance Between Construction Activities and Receptors

Phase	Distance between construction activity and receptor (m)												
	NSR 01	NSR 02	NSR 03	NSR 04	NSR 05	NSR 06	NSR 07	NSR 08	NSR 09	NSR 10	NSR 11	NSR 12	NSR 13
1a to 1c						120	300	200	200	100			
1d						120	300	200	200	100			
1e					220	250		80	50	50		220	
1f								50	300		70		
1g						120	300		300	100			

Note – Table cells are empty where the distance from construction activity to receptor is greater than 300m such that the calculation methodology becomes unreliable.

2. CONSTRUCTION ACTIVITY NOISE

2.1. CONSTRUCTION ACTIVITY NOISE ASSESSMENT METHOD

- 2.1.1. An assessment of temporary construction noise impacts has been undertaken in line with the guidance contained in BS 5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites, Part 1: Noise (BS 5228-1), 2014.
- 2.1.2. The magnitude and significance of effects for construction noise have been determined by comparing predicted construction noise levels with the defined Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL).
- 2.1.3. The LOAEL for each time period (day, evening/weekends, and night) has been set as the baseline noise level for each receptor or group of receptors. The SOAEL is the threshold level determined using section E.3.2 and Table E.1 of BS 5228-1 (the ABC method), which is replicated in **Table 2-1**.

Table 2-1 - Threshold of Potential Significant Adverse Construction Noise Effects used to Determine the SOAEL

Assessment category and threshold value period	Threshold value, in decibels (dB, $L_{Aeq,T}$)		
	Cat. A ^{A)}	Cat. B ^{B)}	Cat. C ^{C)}
Night-time (23:00 - 07:00)	45	50	55
Evenings and weekends ^{D)}	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75

NOTE 1 - A potential significant adverse effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.

NOTE 2 - If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant adverse effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to site noise.

NOTE 3 - Applied to residential receptors only.

A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.

B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A values.

C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values.

D) 19:00–23:00 weekdays, 13:00–23:00 Saturdays and 07:00–23:00 Sundays.

- 2.1.4. The magnitude of impact of construction noise has been determined using the LOAEL and SOAEL values defined in Paragraph 2.1.3 in accordance with the thresholds defined in **Table 2-2**.

Table 2-2 - Magnitude of Impact - Construction Noise

Magnitude of impact	Construction noise level
High	Above or equal to SOAEL +5 dB
Medium	Above or equal to SOAEL and below SOAEL +5 dB
Low	Above or equal to LOAEL and below SOAEL
Very Low	Below LOAEL

- 2.1.5. The core construction hours and any proposed out of hours construction works are set out in **Appendix 2.1: Environmental Statement Basis of Assessment (Volume 3)**.
- 2.1.6. The magnitude of impact of construction noise has been determined in accordance with the thresholds presented in **Table 4-2 of Appendix 3.2: Significance Criteria for all ES Technical Topics (Volume 3)**. The thresholds are reproduced in this appendix in **Table 2-3**.
- 2.1.7. The baseline noise environment for the construction activity noise assessment has been quantified using data from the noise survey described in **Appendix 9.1: Baseline Noise Survey Details (Volume 3)**.
- 2.1.8. Free-field construction noise levels have been calculated at each of the nearest sensitive receptors to each area of works based on the likely plant items (type, quantity and location), construction activities and proposed construction programme. A degree of professional judgement was used to pragmatically group anticipated plant/activities and sensitive receptors where appropriate.
- 2.1.9. Construction noise levels have been predicted using the methodology outlined in Annex F of BS 5228-1 for both the cautious worst-case and the average case scenarios described above.
- 2.1.10. Sound pressure levels have been calculated based on the stated sound power levels for each construction activity and assume 50% 'soft' and 'hard' ground between the source and receptor.
- 2.1.11. Source noise levels from Annex C and Annex D of BS 5228-1 have been applied to the proposed plant associated with the various Construction Phases, details of which are provided in the following sections.

2.2. CONSTRUCTION ACTIVITY NOISE ASSESSMENT THRESHOLDS

- 2.2.1. Construction noise impact assessment thresholds have been determined for each sensitive receptor and are presented in **Table 2-3**. The thresholds have been determined based on the baseline noise levels presented in **Appendix 9.1: Baseline Noise Survey Details (Volume 3)**.

Table 2-3 - Construction Noise Assessment Thresholds

Receptor ⁽¹⁾	Day-time baseline ambient noise level, dB L _{Aeq} (LOAEL)	Day-time BS5228-1 ABC category	Day-time ABC assessment criterion, dB L _{Aeq,T} (SOAEL)
NSR01 – 04	63	B	70
NSR05	63	B	70

Receptor ⁽¹⁾	Day-time baseline ambient noise level, dB L _{Aeq} (LOAEL)	Day-time BS5228-1 ABC category	Day-time ABC assessment criterion, dB L _{Aeq,T} (SOAEL)
NSR06	51	A	65
NSR07	51	A	65
NSR08	62	A	65
NSR09	62	A	65
NSR10	51	A	65
NSR11	53	A	65
NSR12	59	A	65

(1) NSR13 not considered further due to being beyond 300m from any proposed construction activity

2.2.2. The magnitude of impact of construction noise has been determined using the LOAEL and SOAEL values defined in **Table 2-3** above and in accordance with the thresholds defined in **Table 2-2**.

2.3. CONSTRUCTION ACTIVITY NOISE SOURCES

2.3.1. Noise levels from Annex C and Annex D of BS 5228-1 have been applied to indicative plant selections for each of the construction phases. The plant selections and associated sound levels are provided in **Table 2-4** below.

Table 2-4 - Construction Activity Noise Sources

Construction phase	BS 5228-1 activity	BS 5228-1 plant type	BS 5228-1 reference	L _{Aeq} at 10m (dB)	On-time (%)	No. of items
1a) to 1c) - Enabling Works	General Site Activities	Lifting: Mobile telescopic crane	Table C.04 #41	71	50	1
	Site Preparation	Ground excavation/earthworks: Tracked excavator	Table C.02 #16	75	50	1
	Site Preparation	Ground excavation/earthworks: Dozer	Table C.02 #10	80	50	2
	Site Preparation	Distribution of material: Dump truck (tipping fill)	Table C.02 #30	79	25	2
	N/A	Concrete batching plant	Table D.06 #10	80	25	1

Construction phase	BS 5228-1 activity	BS 5228-1 plant type	BS 5228-1 reference	L _{Aeq} at 10m (dB)	On-time (%)	No. of items
	Site Preparation	Loading lorries: Wheeled loader	Table C.02 #26	79	25	1
	Site Preparation	Clearing site: Wheeled backhoe loader	Table C.02 #8	68	50	1
	Site Preparation	Ground excavation/earthworks: Tracked excavator	Table C.02 #15	76	50	1
	Site preparation	Diesel generator	Table C.04 #78	66	100	1
	Crushing concrete/rubble	Tracked crusher	Table C.01 #14	82	50	1
1d) – Utility Works	General Site Activities	Lifting: Mobile telescopic crane	Table C.04 #41	71	50	1
	Site Preparation	Ground excavation/earthworks: Tracked excavator	Table C.02 #16	75	50	1
	Site Preparation	Ground excavation/earthworks: Dozer	Table C.02 #10	80	50	2
	Site Preparation	Distribution of material: Articulated dump truck (tipping fill)	Table C.02 #32	74	50	1
	Site Preparation	Distribution of material: Dump truck (tipping fill)	Table C.02 #30	79	50	1
	N/A	Concrete batching plant	Table D.06 #10	80	25	1
	Site Preparation	Loading lorries: Wheeled loader	Table C.02 #26	79	25	1
	Site Preparation	Clearing site: Wheeled backhoe loader	Table C.02 #8	68	50	1
	Site Preparation	Ground excavation/earthworks: Tracked excavator	Table C.02 #15	76	50	1
	Site preparation	Diesel generator	Table C.04 #78	66	100	1
	Grading	Paving: Asphalt paver (+ tipper lorry)	Table C.05 #30	75	25	1

Construction phase	BS 5228-1 activity	BS 5228-1 plant type	BS 5228-1 reference	L _{Aeq} at 10m (dB)	On-time (%)	No. of items
1e) – Roadway Works	Road Construction Works	Road planing: Road planer	Table C.05 #7	82	50	1
	Road Construction Works	Spreading chipping/fill: Dozer	Table C.05 #12	77	50	1
	Road Construction Works	Earthworks: Tracked excavator	Table C.05 #18	80	50	1
	Road Construction Works	Rolling and compaction: Vibratory roller	Table C.05 #20	75	50	1
	Road Construction Works	Paving : Asphalt paver (+ tipper lorry)	Table C.05 #30	75	50	1
	General	Lorry movements on access road: Lorry ж	Table C.11 #5	80 ж	100	5
	General Site Activities	Distribution of materials: Articulated dump truck ж	Table C.04 #2	78 ж	100	5
	General Site Activities	Distribution of materials: Dumper ж	Table C.04 #4	76 ж	100	5
	Site preparation	Diesel generator	Table C.04 #78	66	100	1
	N/A	Concrete batching plant	Table D.06 #10	80	25	1
1f) Railway Works	Site Preparation	Clearing site: Tracked excavator	Table C.02 #5	76	50	1
	General Site Activities	Pumping concrete: Concrete pump + concrete mixer truck (idling)	Table C.04 #26	75	25	1
	General Site Activities	Lifting: Lifting platform (idling)	Table C.04 #58	63	25	1
	Waste Disposal Sites	Waste delivery vehicles: Skip wagon ж	Table C.08 #21	78 ж	100	2

Construction phase	BS 5228-1 activity	BS 5228-1 plant type	BS 5228-1 reference	L _{Aeq} at 10m (dB)	On-time (%)	No. of items
	Site Preparation	Distribution of material: Dump truck (tipping fill)	Table C.02 #30	79	50	1
	Demolition	Breaking up concrete: Hand-held pneumatic breaker	Table C.01 #6	83	25	1
	Piling and Ancillary Operations	Tubular steel piling – hydraulic hammer: Hydraulic hammer rig	Table C.03 #3	88	25	1
	Piling and Ancillary Operations	Craneage for piling (lifting piles, casings, etc): Tracked mobile crane	Table C.03 #29	70	25	1
	Piling and Ancillary Operations	Continuous flight auger piling – cast in situ: Concrete pump	Table C.03 #26	75	25	1
	Site preparation	Diesel generator	Table C.04 #78	66	100	1
	General Site Activities	Sweeping and dust suppression: Road sweeper	Table C.04 #90	76	25	1
1g) Theme Park Construction	General Site Activities	Lifting: Mobile telescopic crane	Table C.04 #41	71	50	1
	General Site Activities	Distribution of materials: Wheeled excavator	Table C.04 #10	66	50	1
	Road Construction Works	Spreading chipping/fill: Dozer	Table C.05 #12	77	25	1
	Road Construction Works	Paving: Asphalt paver (+ tipper lorry)	Table C.05 #30	75	25	1
	Site Preparation	Distribution of material: Articulated dump truck (tipping fill)	Table C.02 #32	74	50	1
	Site Preparation	Distribution of material: Dump truck (tipping fill)	Table C.02 #30	79	50	1
	N/A	Concrete batching plant	Table D.06 #10	80	75	1

Construction phase	BS 5228-1 activity	BS 5228-1 plant type	BS 5228-1 reference	L _{Aeq} at 10m (dB)	On-time (%)	No. of items
	Site Preparation	Loading lorries: Wheeled loader	Table C.02 #26	79	50	1
	Site Preparation	Clearing site: Wheeled backhoe loader	Table C.02 #8	68	50	1
	Site Preparation	Ground excavation/earthworks: Tracked excavator	Table C.02 #15	76	50	1
	General Site Activities	Mixing concrete: Cement mixer truck (discharging)	Table C.04 #18	75	25	1
	General Site Activities	Pumping concrete: Concrete pump + cement mixer truck (discharging)	Table C.04 #24	67	25	1
	General Site Activities	Sweeping and dust suppression: Road sweeper	Table C.04 #90	76	25	1
	Site preparation	Diesel generator	Table C.04 #78	66	100	1
	Piling and Ancillary Operations	Rotary bored piling – cast in situ: Tracked drilling rig with hydraulic drifter	Table C.03 #15	82	25	1

✕ For these plant items the drive-by maximum sound pressure level in (L_{Amax}) values provided by BS5228-1 are shown. The equivalent continuous sound levels at the receptors for these sources were calculated using the 'haul road' method from section F.2.5.2 of BS 5228-1. 10 km/h vehicle speed was assumed for the vehicles and the number of 'items' stated relates to the number of vehicles per hour. If higher haul road speeds are utilised, the noise level would reduce due to shorter residence times at the receptor.

2.4. CONSTRUCTION NOISE IMPACT – WITHOUT MITIGATION

- 2.4.1. **Table 2-5** sets out the cautious worst case construction noise level calculated at each receptor location. This is based on the highest predicted construction noise level (peak construction noise) with all plant associated with a particular activity located at the closest location to the receptor being assessed, which would be anticipated to occur for only a limited period of time, relative to the overall construction phase period.
- 2.4.2. **Table 2-6** presents a summary of the predicted unmitigated peak construction noise impacts at each of the previously identified noise-sensitive receptors.
- 2.4.3. Construction noise levels associated with the more typical situation where plant are located towards the centre of the construction site are presented in **Table 2-7**. The predicted unmitigated typical construction noise impacts at each receptor are presented in **Table 2-8**.

2.4.4. The blank cells in the table below indicate a distance of over 300m between the construction activity and receptors i.e. the receptor was outside of the Study Area.

Table 2-5 - Predicted Construction Peak Noise Level – $L_{Aeq,T}$ (dB) - Unmitigated

Receptor	1a) to 1)c Enabling works	1d) Utility works	1e) Roadway works	1f) Railway works	1g) Theme park construction
NSR01-04			54		
NSR05	56		77		
NSR06	79	78	60		78
NSR07	57	56			57
NSR08	68	67	77	79	
NSR09	68	67	71	57	58
NSR10	79	78	77		78
NSR11	53	52		65	53
NSR12	-	-	58	-	-

Table 2-6 - Predicted Construction Peak Noise Impact - Unmitigated

Receptor	1a) to 1)c Enabling works	1d) Utility works	1e) Roadway works	1f) railway Works	1g) Theme park construction
NSR01-04	Very Low	Very Low	Very Low	Very Low	Very Low
NSR05	Very Low	Very Low	High	Very Low	Very Low
NSR06	High	High	Low	Very Low	High
NSR07	Low	Low	Very Low	Very Low	Low
NSR08	Medium	Medium	High	High	Very Low
NSR09	Medium	Medium	High	Very Low	Very Low
NSR10	High	High	High	Very Low	High
NSR11	Very Low	Very Low	Very Low	Medium	Very Low
NSR12	Very Low	Very Low	Very Low	Very Low	Very Low

Table 2-7 - Predicted Construction Typical Noise Level – $L_{Aeq,T}$ (dB) - Unmitigated

Receptor	1a) to 1)c Enabling works	1d) Utility Works	1e) Roadway Works	1f) Railway Works	1g) Theme Park Construction
NSR01-04	-	-	-	-	-
NSR05	-	-	54	-	-
NSR06	62	61	53	-	61
NSR07	53	52	-	-	52
NSR08	57	56	64	71	-
NSR09	57	56	69	53	52
NSR10	63	62	69	-	63
NSR11	-	-	-	64	-
NSR12	-	-	54	-	-

Table 2-8 - Predicted Construction Typical Noise Impact - Unmitigated

Receptor	1a) to 1)c Enabling works	1d) Utility works	1e) Roadway works	1f) Railway works	1g) Theme park construction
NSR01-04	Very Low	Very Low	Very Low	Very Low	Very Low
NSR05	Very Low	Very Low	Very Low	Very Low	Very Low
NSR06	Low	Low	Low	Very Low	Low
NSR07	Low	Low	Very Low	Very Low	Low
NSR08	Very Low	Very Low	Low	High	Very Low
NSR09	Very Low	Very Low	Medium	Very Low	Very Low
NSR10	Low	Low	Medium	Very Low	Low
NSR11	Very Low	Very Low	Very Low	Low	Very Low
NSR12	Very Low	Very Low	Very Low	Very Low	Very Low

- 2.4.5. When considering the cautious worst-case scenario where plant are located close to the Site boundary, medium and high construction noise impacts are predicted when receptors are located both close to the Site boundary and close to the particular phases of construction. This occurs at NSR05 (property to west of Site, near to proposed road works adjacent to A421) NSR06 (property at Broadmead Farm), NSR08 (properties on Ampthill Road), NSR09 (property on Manor Road), NSR10 (properties on Manor Road) and NSR11 (property located to north, off B540).

- 2.4.6. During the more typical scenario where active plant is located away from the Site boundary, the number and magnitude of construction impacts reduces with properties at NSR08 experiencing a high impact during railway works, and properties at NSR09 and NSR10 experiencing medium impacts during roadway works.
- 2.4.7. With respect to the *Noise Policy Statement for England*, effects above the SOAEL have been identified for noise impacts generated by the Proposed Development during the Construction Phase. Noise levels above the SOAEL should be avoided. However, the calculations above do not take account of mitigation when determining noise impact levels. Revised construction noise levels taking account of the attenuation provided by site hoardings are presented in the section below. Examples of Best Practicable Means (BPM, as defined in **Appendix 0.1: Acronyms and Glossary (Volume 3)**) that could be employed to limit construction noise impact at nearby noise sensitive receptors are presented in the Section 4 of this appendix.
- 2.4.8. The following section presents results with the effects of mitigation taken into account.

2.5. CONSTRUCTION NOISE IMPACT – WITH MITIGATION

- 2.5.1. The construction noise levels have been re-calculated to incorporate mitigation in the form of noise barriers (which could be earth bunds or localised Site hoarding etc.). An approximate attenuation of 5 dB is assumed to be provided by the noise barriers where “*the top of the plant is just visible to the receiver over the noise barrier*”, as per the guidance in Section F.2.2.2.1 of BS 5228-1.
- 2.5.2. **Table 2-9** sets out the cautious worst case construction noise level (peak construction noise) calculated at each receptor location with the mitigation set out in **Chapter 4** of this report. **Table 2-10** presents a summary of the predicted mitigated peak construction noise impacts at each of the previously identified noise-sensitive receptors.
- 2.5.3. The typical construction noise levels and typical construction noise impacts at each receptor location, with mitigation, are presented in **Table 2-11** and **Table 2-12** respectively.

Table 2-9 - Predicted Construction Peak Noise Level – $L_{Aeq,T}$ (dB) - Mitigated

Receptor	1a) to 1)c Enabling works	1d) Utility works	1e) Roadway works	1f) Railway works	1g) Theme park construction
NSR01-04	-	-	49	-	-
NSR05	51	-	72	-	-
NSR06	74	73	55	-	73
NSR07	52	51	-	-	52
NSR08	63	62	72	74	-
NSR09	63	62	66	52	53
NSR10	74	73	72	-	73
NSR11	48	47	-	60	48
NSR12	-	-	53	-	-

Table 2-10 - Predicted Construction Peak Noise Impact - Mitigated

Receptor	1a) to 1)c Enabling works	1d) Utility works	1e) Roadway works	1f) Railway works	1g) Theme park construction
NSR01-04	Very Low	Very Low	Very Low	Very Low	Very Low
NSR05	Very Low	Very Low	Medium	Very Low	Very Low
NSR06	High	High	Low	Very Low	High
NSR07	Low	Low	Very Low	Very Low	Low
NSR08	Low	Low	High	High	Very Low
NSR09	Low	Low	Medium	Very Low	Very Low
NSR10	High	High	High	Very Low	High
NSR11	Very Low	Very Low	Very Low	Low	Very Low
NSR12	Very Low	Very Low	Very Low	Very Low	Very Low

Table 2-11 - Predicted Construction Typical Noise Level – $L_{Aeq,T}$ (dB) - Mitigated

Receptor	1a) to 1)c Enabling works	1d) Utility works	1e) Roadway works	1f) Railway works	1g) Theme park construction
NSR01-04	-	-	-	-	-
NSR05	-	-	49	-	-
NSR06	57	56	48	-	56
NSR07	48	47	-	-	47
NSR08	52	51	59	66	
NSR09	52	51	64	48	47
NSR10	58	57	64	-	58
NSR11	-	-	-	59	-
NSR12	-	-	49	-	

Table 2-12 - Predicted Construction Typical Noise Impact - Mitigated

Receptor	1a) to 1)c Enabling works	1d) Utility works	1e) Roadway works	1f) Railway works	1g) Theme park construction
NSR01-04	Very Low	Very Low	Very Low	Very Low	Very Low
NSR05	Very Low	Very Low	Very Low	Very Low	Very Low
NSR06	Low	Low	Very Low	Very Low	Low
NSR07	Very Low	Very Low	Very Low	Very Low	Very Low
NSR08	Very Low	Very Low	Very Low	Medium	Very Low

Receptor	1a) to 1)c Enabling works	1d) Utility works	1e) Roadway works	1f) Railway works	1g) Theme park construction
NSR09	Very Low	Very Low	Low	Very Low	Very Low
NSR10	Low	Low	Low	Very Low	Low
NSR11	Very Low	Very Low	Very Low	Low	Very Low
NSR12	Very Low	Very Low	Very Low	Very Low	Very Low

- 2.5.4. For the cautious worst case peak construction noise, the mitigated noise levels result in medium and high impacts during some construction phases at NSR05, NSR06, NSR08, NSR09 and NSR10.
- 2.5.5. However, under typical construction scenarios, the mitigated noise impacts were considerably lower than for the unmitigated scenario, with just NSR08 predicted to experience a medium impact during railway works. These works are necessary to widen the bridge over a pedestrian underpass adjacent to the travellers' site on Amphill Road. The anticipated activities include the provision of a site compound and non-percussive piling. Due to the close proximity of the travellers' site (and to a lesser extent, several properties along the northern end of Angelica Grove on the east side of the railway) to these works, medium construction noise impacts are anticipated for the duration of the works.

2.6. CONSTRUCTION ACTIVITY NOISE – RESIDUAL EFFECTS

- 2.6.1. The predicted noise impacts are based upon fixed plant locations. In practice, much of the plant will be mobile, so the magnitude of construction noise impacts at different receptors will change throughout the various phases of construction. Assessments have, therefore, been based on both an assumed 'cautious worst case' scenario for the closest receptors to the various construction activities and the 'typical' scenario where the plant are located towards the centre of the site, typically around 100m from the Site boundary.
- 2.6.2. Whilst the cautious worst-case scenario identified several NSRs which are predicted to experience medium and high construction noise impacts, only NSR08 is predicted to experience a 'medium' impact under the typical scenario, once mitigation is taken into account. This receptor is located close to both Amphill Road and the railway and as such, existing daytime ambient noise levels, as identified in **Appendix 9.1 Baseline Noise Survey Details (Volume 3)**, are relatively high at around 65 dB $L_{Aeq,T}$ and will, therefore, provide a degree of masking of construction noise.
- 2.6.3. Nevertheless, it will be the responsibility of the Principal Contractor(s) on Site to ensure compliance with the OCEMP (as set out in **Table 2-1 of Appendix 2.3: OCEMP (Volume 3)**). Examples of typical BPM that could potentially be employed to reduce impacts, including the good practice guidance contained within BS 5228-1, are presented in Section 4 of this appendix. Section 3.7 of the OCEMP (**Appendix 2.3: OCEMP (Volume 3)**) secures delivery of these measures.
- 2.6.4. Noise effects associated with the Construction Phase will also be temporary and will be mostly restricted to day-time hours only, thus avoiding the more sensitive evening and night-time periods.
- 2.6.5. Where certain construction activities require extended working hours, the procedure highlighted in **Appendix 2.1: Environmental Statement Basis of Assessment (Volume 3)** will be followed.

- 2.6.6. Through the application of BPM to control and minimise construction noise impacts at receptors, it is expected that **significant adverse** noise effects will be avoided at the majority of nearby receptors during the majority of the Construction Phase of the Proposed Development.

3. CONSTRUCTION ACTIVITY VIBRATION

3.1. CONSTRUCTION ACTIVITY VIBRATION ASSESSMENT METHOD

- 3.1.1. An assessment of temporary construction vibration impacts has been undertaken in line with the guidance contained in BS 5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites, Part 2: Vibration (BS 5228-2), as well as with reference to LA111. LA111 defines the LOAEL and SOAEL for construction vibration as follows:
- LOAEL – 0.3mm/s peak particle velocity; and
 - SOAEL – 1mm/s peak particle velocity.
- 3.1.2. The above values of LOAEL and SOAEL have been established with reference to human perception and disturbance resulting construction activities in a residential environment.
- 3.1.3. The magnitude of impact of construction vibration has been determined using the LOAEL and SOAEL values defined above, as set out in **Table 3-1** below.

Table 3-1 - Magnitude of Impact – Construction Vibration

Magnitude of impact	Construction vibration level Peak Particle Velocity (PPV) mm/s
High	Above or equal to 10 mm/s PPV
Medium	Above or equal to 1 mm/s and below 10 mm/s PPV
Low	Above or equal to 0.3 mm/s and below 1 mm/s
Very Low	Below 0.3 mm/s

3.2. CONSTRUCTION VIBRATION – WITHOUT MITIGATION

- 3.2.1. The following activities have the potential to generate relatively high levels of construction vibration and have been considered within the assessment:
- A vibratory roller used either for compaction on the Site or for rolling a new road surface. A twin-drum roller with a drum width of 1.7m and a vibration amplitude of 0.9mm has been assumed (a typical twin-drum JCB sized roller). The predictions have been made on the assumption that there is a 33% probability of the predicted peak particle velocity vibration level being exceeded (and a 67% probability that it is not). The figures relate to the 'steady state' condition; this means that levels may be a little higher than predicted during start-up and run-down; however this latter condition would be of very short duration.
 - Impact piling. An impact piling rig with a hammer energy of 30,000 Joules has been assumed with the pile toe being driven through very stiff cohesive soils/dense granular soils; and

- Continuous flight auger (CFA) piling. As stated in BS 5228-2, the levels of vibration associated with continuous flight auger injected piling and pressed-in piling are minimal, as the processes do not involve rapid acceleration or deceleration of tools in contact with the ground but rely to a large extent on steady motions. Consequently, it is assumed that the levels of vibration at 20m would be no greater than 1mm/s.

3.2.2. The predicted vibration levels at the receptors within 100m of the above vibration generating activities are provided in **Table 3-2** below:

Table 3-2 - Predicted Construction Vibration Levels – mm/s PPV

Receptor	Vibratory roller	Impact piling	CFA piling
NSR05, NSR06, NSR08, NSR10 (20m from source)	1.7mm/s	9.2mm/s	<1mm/s
NSR09 (40m from source)	0.7mm/s	4.1mm/s	<1mm/s
NSR11 (60m from source)	0.4mm/s	2.5mm/s	<1mm/s

3.2.3. When compared against the magnitude of impact scale presented in **Table 3-1** the resultant impacts for each of the three scenarios at each receptor in the absence of mitigation is provided in **Table 3-3** below:

Table 3-3 - Predicted Construction Vibration Magnitude of Impact

Receptor	Vibratory roller	Impact piling	CFA piling
NSR05, NSR06, NSR08, NSR10 (20m from source)	Medium adverse impact; significant effect	Medium adverse impact; significant effect	Low adverse impact; not significant effect
NSR09 (40m from source)	Low adverse impact; not significant effect	Medium adverse impact; significant effect	Low adverse impact; not significant effect
NSR11 (60m from source)	Low adverse impact; not significant effect	Medium adverse impact; significant effect	Low adverse impact; not significant effect

KEMPSTON HARDWICK MOATED SITE HERITAGE ASSET

3.2.4. It is understood that Kempston Hardwick moated site, located to the north of Manor Road, is a scheduled monument of archaeological significance. Whilst buried, concerns have been raised about the potential for damage to the asset as a result of groundborne vibration from construction activities. The asset is located approximately 30m from the nearest likely construction location. The approximate location is shown in **Figure 2c: Historic environment features map showing designated heritage sites** of **Appendix 10.1: Historic Environment Desk-Based Assessment (Volume 3)** and identified as a Scheduled Monument, asset number 2.

- 3.2.5. BS 5228-2 makes reference to guidance within BS 7385-2:1993 *Evaluation and measurement for vibration in buildings - Guide to damage levels from groundborne vibration* which provides limits for transient vibration above which cosmetic damage could occur in buildings. The Standard notes that the probability of damage tends towards zero at values at 12.5 mm/s PPV and suggests that buildings of historical value should not, unless structurally unsound, be assumed to be more sensitive than any other building. No guidance is provided on the sensitivity of below ground constructions.
- 3.2.6. In *Piling and Archaeology: An English Heritage Guidance Note (2007)*, guideline maximum permissible PPV values are provided for piling activities close to sensitive heritage assets. These are provided in **Table 3-4** below:

Table 3-4 - Guideline Maximum Permissible Vibration Levels at Heritage Sites from Piling – mm/s PPV

Category	Description	Permissible PPV (mm/s)
I	Ruins and damaged buildings, protected as monuments	2
II	Buildings with visible defects, cracks in masonry	4
III	Undamaged buildings in technically good condition	8
IV	Well-stiffened buildings (i.e. industrial)	10-40

- 3.2.7. Based on the above guidance, it is proposed that the guideline value for Category 1 ruins (2 mm/s PPV) is adopted in this case.
- 3.2.8. The magnitude of impact criteria adopted for human receptors would not be applicable to heritage sites. Based on the assertion that 2 mm/s PPV would be the equivalent of SOAEL for Category I heritage assets, the following magnitude of impact criteria are proposed:
- >4 mm/s PPV equates to high impact
 - Between 2 and 4 mm/s PPV equates to medium impact
 - Between 1 and 2 mm/s PPV equates to low impact
 - <1 mm/s PPV equates to very low impact
- 3.2.9. The predicted vibration levels at this heritage receptor, assuming the same calculation inputs detailed above, are provided in **Table 3-5** below:

Table 3-5 - Predicted Construction Vibration Levels at Heritage Receptor – mm/s PPV

Receptor	Vibratory roller	Impact piling	CFA piling
Kempston Hardwick moated site	2.4mm/s	5.8mm/s	<1mm/s

- 3.2.10. When compared to the threshold for damage noted above, the resultant impacts for each of the three scenarios in the absence of mitigation is as follows:

Vibratory roller – **medium adverse** impact, resulting in a **moderate** effect;

Impact piling – **high adverse** impact, resulting in a **major** effect; and

CFA piling – **very low adverse** impact, resulting in a **negligible** effect.

- 3.2.11. As identified in **Appendix 2.3: OCEMP (Volume 3)**, a Piling Risk Assessment will be produced and this should take into account the potential risks of vibration impacts at Kempston Hardwick moated site and ensure that any piling proposed within 30m of the monument does not exceed the 2mm/s PPV limit described above.

3.3. CONSTRUCTION VIBRATION – WITH MITIGATION

- 3.3.1. The vibration predictions set out above did not take account of mitigation measures, which are presented in Section 4 of this appendix. However, given that a detailed construction programme is not yet known and the piling type cannot yet be confirmed, the proposed mitigation measures have not been assumed to reduce the potential impacts and the residual effects are, therefore, the same as those presented above.

4. CONSTRUCTION NOISE AND VIBRATION MITIGATION

4.1.1. It will be the responsibility of UDX to ensure appropriate measures to control noise and vibration during the construction phase are implemented by the Principal Contractor(s) and their appointed Sub-contractor(s). The following noise and vibration mitigation measures will be applied by the appointed contractors where necessary and are referred to in Section 3.7 of **Appendix 2.3: OCEMP (Volume 3)**:

- The Principal Contractor(s) and their Sub-contractor(s) will at all times apply the principles of BPM as defined in **Appendix 0.1: Acronyms and Glossary (Volume 3)** and carry out all work in such a manner as to avoid or reduce disturbance from noise (and vibration) as far as is practicable;
- Guidance given in BS 5228-1 (Section 8: Control of noise and Annex B: Noise sources, remedies and their effectiveness) will be followed as far as is practicable and advice and training on noise minimisation given to staff during Site induction procedures;
- All plant brought on to Site will comply with the relevant EC/UK noise limits applicable to that equipment or shall be no noisier than would be expected based on the noise levels quoted in BS 5228-1. Each plant item will be well maintained and operated in accordance with manufacturers' recommendations and in such a manner as to minimise noise emissions;
- Electrically powered plant will be preferred, where practicable, to mechanically powered alternatives;
- The use of sound reduced plant fitted with suitable silencers or operated within enclosures will be preferred;
- Pneumatic tools will be fitted with silencers or mufflers;
- Deliveries to Site will be programmed and routed to minimise disturbance to local residents;
- Items of plant operating intermittently will be shut down in the periods between use;
- Where feasible, all stationary plant will be located so that the noise effect at receptors is minimised and, if practicable, every item of static plant, when in operation, will be noise attenuated using methods based on the guidance and advice given in BS 5228-1;
- Careful selection of construction methods and plant will be implemented and utilised, for example, breaking-out of concrete structures using, where possible, low noise methods such as munching or similar, rather than percussion breaking;
- Temporary acoustic barriers and other noise containment measures such as screens, sheeting, and localised acoustic hoarding at the Site boundary close to existing sensitive receptors will be erected where appropriate to minimise noise breakout and reduce noise levels at potentially affected receptors;
- In general, plant and material storage areas will be located away from the Site boundary, to limit impact on nearby sensitive receptors. However, temporary soil mounds shall be located as close as practicable to the Site boundary in areas, to help screen noise from neighbouring residents;

- Impact piling should be avoided in close proximity (within 100m) of any sensitive receptor to avoid significant adverse impacts, and CFA or press-in piling should be adopted instead subject to acceptable conditions;
- Where reasonably practicable, plant and/or methods of work causing significant levels of vibration at sensitive premises should be replaced by other less intrusive plant and/or methods of working;
- To minimise any potential adverse impacts as a result of vibration from stationary plant, equipment immediately adjacent to sensitive receptors could be relocated or isolated using resilient mountings;
- The characteristics of vibration emissions from each item of plant, and their collective effect, should be assessed during the selection process for the acquisition of plant. Where practicable, plant should be selected which will have the least impact in terms of vibration;
- Large concrete pours (for which an extension of working hours may be necessary) will commence as early as possible within normal working hours so that activities can be completed within normal working hours as far as possible;
- There will be a considerate and neighbourly approach to relations with local residents; and
- The Site manager or other appointed Site representative, will be responsible for logging all received environmental construction noise and vibration comments/complaints, as well as the action that is taken in response to each point raised, and whether that action was successful in remedying the issue. Where not successful, supplementary actions will be carried out and resulting effects logged. The contact details for the Site representative will be openly advertised so that local residents have a point of contact in case of any issues arising. The Site representative will be responsible for keeping an open line of contact with local residents and providing advice with respect to the timing and programming of potentially noisy works.

- 4.1.2. Due to unknowns regarding the structural integrity of the Kempston Hardwick moated site, a Piling Risk Assessment should be undertaken and this should consider potential vibration impacts at the monument. Further details are set out in **Appendix 2.3: OCEMP (Volume 3)**.
- 4.1.3. Where certain construction activities require extended working hours, the procedure highlighted in **Appendix 2.1: Environmental Statement Basis of Assessment (Volume 3)** will be followed.



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