XLINKS MOROCCO-UK POWER PROJECT

Preliminary Environmental Information Report

Volume 2, Appendix 6.2: Construction Noise and Vibration

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Contents

Tables

Figures

Glossary

Term	Meaning
Ambient sound level, $L_{Aeq,T}$	The steady sound level which, over a period of time T, contains the same amount of A-weighted sound energy as the time varying sound over the same period. Also known as the equivalent continuous sound pressure level.
Attenuation	The reduction in magnitude of sound energy.
Basic Noise Level	A measure of traffic source noise prior to development. It is calculated from traffic flows, road speed, and HGV percentage.
Converter station	Part of an electrical transmission and distribution system. Converter stations convert electricity from Direct Current (DC) to Alternating Current (AC), or vice versa.
Decibel	A unit used to measure or compare the intensity of a sound by comparing it with a given reference level on a logarithmic scale.
Environmental Impact Assessment	The process of identifying and assessing the significant effects likely to arise from a project. This requires consideration of the likely changes to the environment, where these arise as a consequence of a project, through comparison with the existing and projected future baseline conditions.
Extrapolation	The extension of a graph, curve, or range of values by inferring unknown values from trends in the known data.
Fast Fourier Transform	A computational algorithm which allows for the conversion of a time signal to a representation in the frequency domain.
Free-field	A situation in which the radiation from a sound source is entirely unaffected by the presence of any reflective boundaries.
Landfall	The proposed area in which the offshore cables make landfall in the United Kingdom (come on shore) and the transitional area between the offshore cabling and the onshore cabling. This term applies to the entire landfall area at Cornborough Range, Devon, between Mean Low Water Springs and the Transition Joint Bay inclusive of all construction works, including the offshore and onshore cable routes, and landfall compound(s).
Noise	An unwanted or unexpected sound.
Peak Particle Velocity	An indicator of the magnitude of ground vibration which refers to the movement of molecular particles within the ground.
Propagation	The transmission of acoustic energy through a medium via a sound wave.
Proposed Development	The element of the Xlinks Morocco-UK Power Project within the UK, which includes the offshore cables (from the UK Exclusive Economic Zone to landfall), landfall site, onshore Direct Current and Alternating Current cables, converter stations, road upgrade works and, based on current assumptions, the Alverdiscott Substation Connection Development.
Sound	Fluctuations of pressure within a medium (gas, solid or fluid) within the audible range of loudness and frequencies which excite the sensation of hearing.
Sound Power Level, L_w	The total sound energy emitted by a source per unit time.
Sound Pressure Level, L_p	The amount of force a sound wave exerts on a surface area perpendicular to the direction of travel. A measure of the variation of sound level over a distance.
Spectrum	The presentation of sound in terms of the amount of energy at different frequencies.
Study area	This is an area which is defined for each environmental topic which includes the Proposed Development Draft Order Limits as well as potential spatial and temporal considerations of the impacts on relevant receptors. The study area for each topic is intended to cover the area within which an impact can be reasonably expected.
Surface Impedance	A measure of how resistant a surface or material is to allowing sound to pass through. A high surface impedance results in less sound being allowed to transmit through that material and the larger amount of sound energy reflected.

Term	Meaning
Transmission Loss	A measure of the reduction in sound level of a sound source as it propagates through a medium.
Wavenumber	The number of sound waves in a unit distance.
Xlinks Morocco UK Power Project	The overall scheme from Morocco to the national grid, including all onshore and offshore elements of the transmission network and the generation site in Morocco (referred to as the 'Project').

Acronyms

Term	Meaning
BNL	Basic Noise Level
BS	British Standard
CoPA	Control of Pollution Act
CRTN	Calculation of Road Traffic Noise
DMRB	Design Manual for Roads and Bridges
EIA	Environmental Impact Assessment
EPA	Environmental Protection Act
GIS	Geographic Information System
HDD	Horizontal Directional Drilling
HGV	Heavy Goods Vehicles
ISO	International Organisation for Standardisation
LOAEL	Lowest Observed Adverse Effect Level
OS	Ordnance Survey
PEIR	Preliminary Environmental Impact Assessment
PPV	Peak Particle Velocity
SOAEL	Significant Observed Adverse Effect Level
UK	United Kingdom

Units

Term	Meaning
dB	Decibel
m	Metres
mm	Millimetre
mm/s	Millimetres per second

1 CONSTRUCTION NOISE AND VIBRATION

1.1 Introduction

1.1.1 This document forms Volume 2, Appendix 6.2: Construction Noise and Vibration of the Preliminary Environmental Information Report (PEIR) prepared for the UK elements of the Xlinks Morocco-UK Power Project (referred to hereafter as 'the Proposed Development'). The PEIR presents the preliminary findings of the Environmental Impact Assessment (EIA) process for the Proposed Development.

1.1.2 This document provides full details of the methodology and results of the construction noise and vibration impact assessment for the Proposed Development. Construction noise and vibration impact criteria have been derived from the baseline sound survey data obtained at the nearest noise-sensitive receptors within the construction noise and vibration study area.

1.1.3 No baseline vibration surveys were undertaken since vibration impacts are assessed against absolute criteria as opposed to criteria derived based on the existing environment which is the case for noise impacts.

1.2 Study Area

1.2.1 The noise and vibration study area focuses on noise and vibration sensitive receptors landward of Mean High Water Springs where potential impacts are more likely to occur. A brief description of each study area is provided below with graphical representations provided in **Figure 1** to **Figure 2**.

1.2.2 The noise and vibration study area has been defined in line with best practice guidance and consider the regions in which potential impacts are most likely to occur at receptors sensitive to noise and vibration.

1.2.3 The construction and decommissioning noise and vibration study area has been defined with reference to the guidance in DMRB LA111 – Noise and Vibration. Note 1 of paragraph 3.5 of DMRB LA111 states the following regarding noise sensitive receptors:

'A study area of 300 m from the closest construction activity is normally sufficient to encompass noise sensitive receptors.'

1.2.4 Similarly, Note 1 of paragraph 3.29 of DMRB LA111 states the following regarding vibration sensitive receptors:

'A study area of 100 m from the closest construction activity with the potential to generate vibration is normally sufficient to encompass vibration sensitive receptors.'

1.2.5 The assessment of operation and maintenance noise impacts has been undertaken at the noise sensitive receptors most likely to affected by noise during the operation and maintenance phase of the Proposed Development. These have been identified as being situated within a study area of 500 m from the location of the operational noise sources associated with the Proposed Development.

1.2.6 In summary, the noise and vibration study areas to be used in the assessment will be defined as:

- the area of land temporarily or permanently occupied during the construction, operation and maintenance, and decommissioning of the Proposed Development;
- noise sensitive receptors located within 300 m of construction activities;
- vibration sensitive receptors located within 100 m of construction activities with the potential to generate vibration; and
- noise sensitive receptors located within 500 m of the operational noise sources.

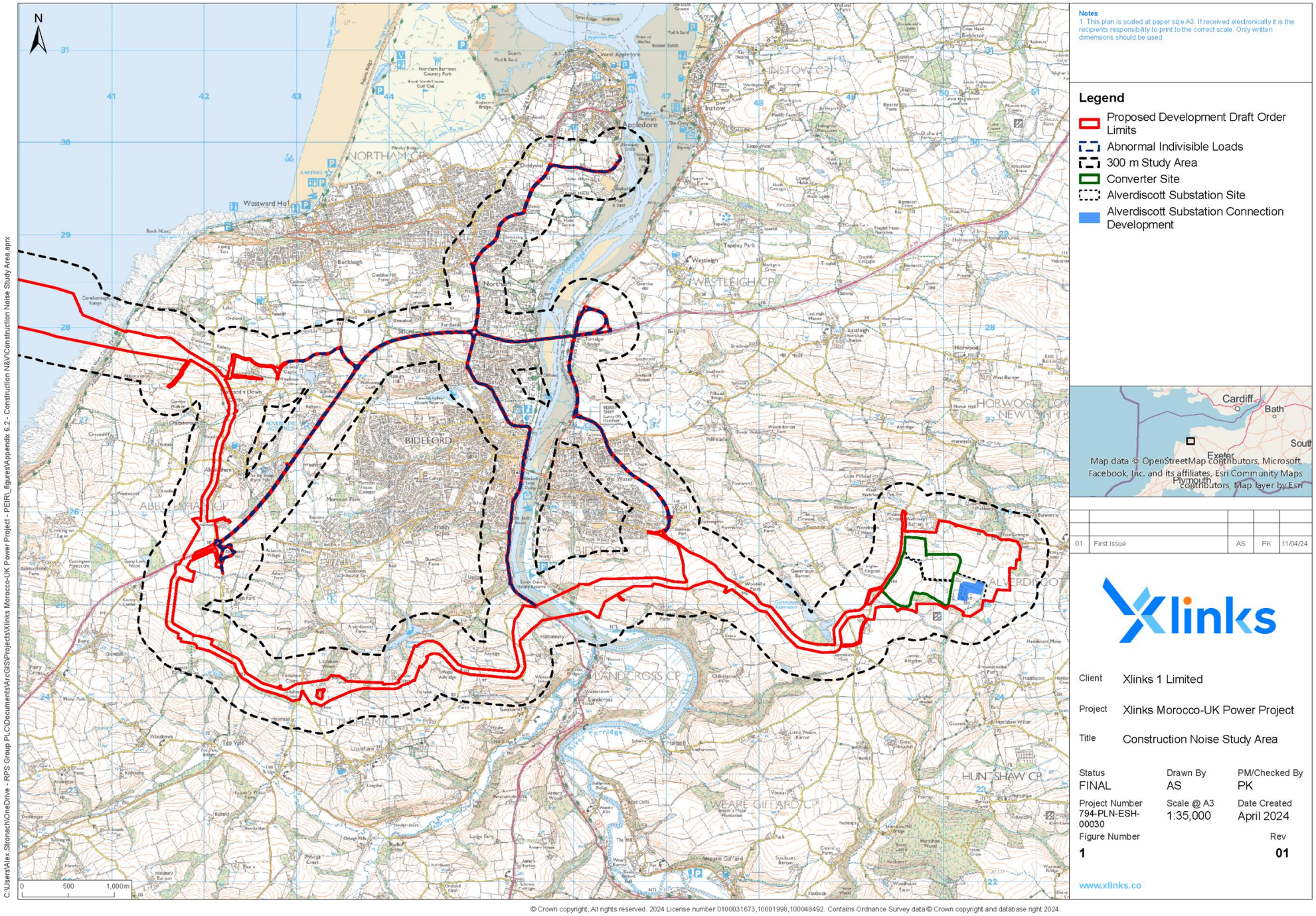

Figure 1: Construction noise study area

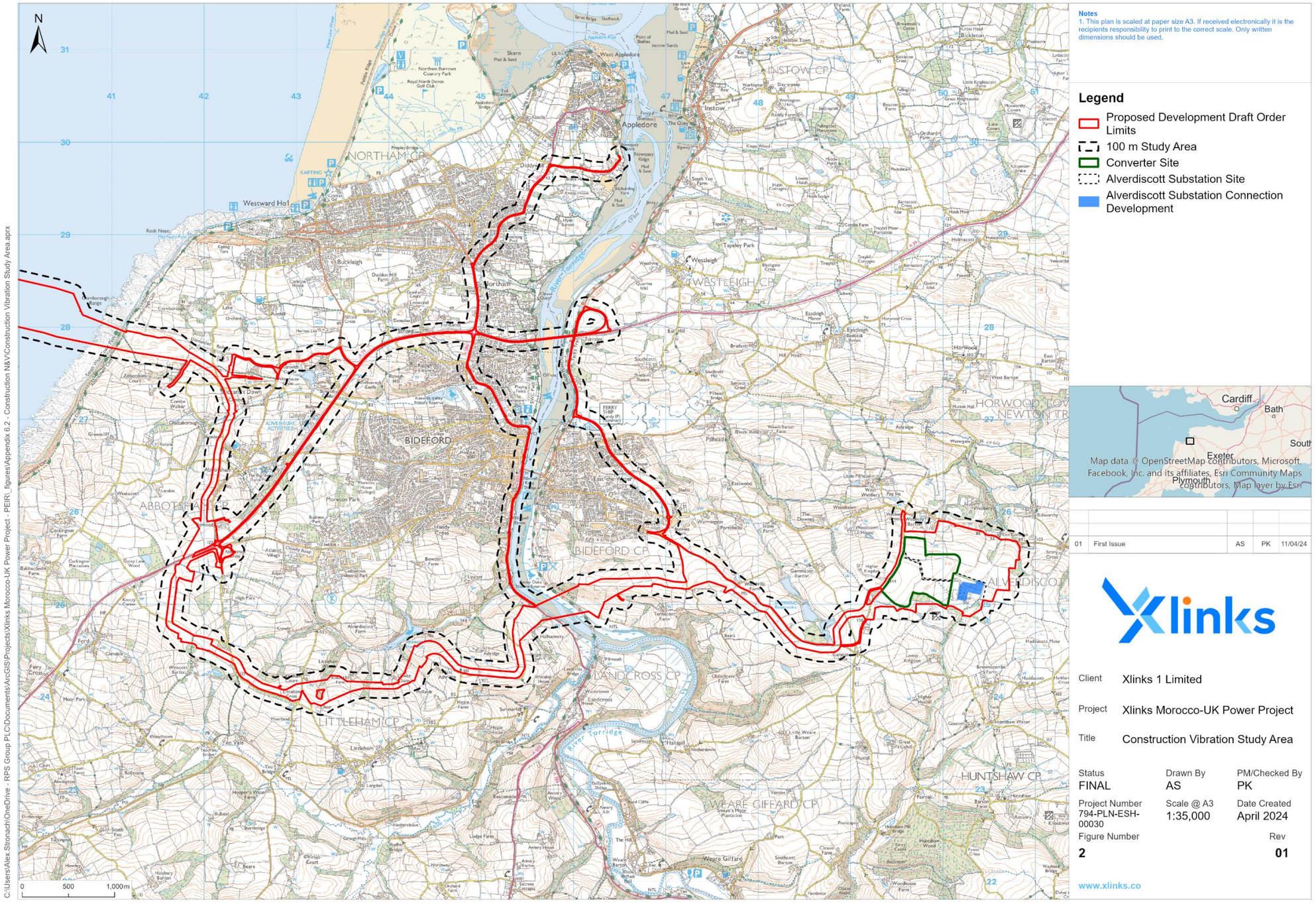

Figure 2: Construction vibration study area

1.3 Legislation and Guidance

1.3.1 This section contains a summary of the relevant guidance and legislation for construction noise and vibration control.

Control of Pollution Act 1974

1.3.2 Section 60 of the Control of Pollution Act 1974 (CoPA) refers to the control of noise on construction sites. It outlines legislation by which Local Authorities can control noise from construction sites and prevent noise disturbance.

1.3.3 British Standards (BS) 5228-1:2009+A1:2014 and BS 5228 2:2009+A1:2014 were approved within The Control of Noise (Code of Practice for Construction and Open Sites) Order 2015 as suitable guidance on appropriate methods for the control of noise from construction and open sites in exercise of the powers conferred on the Secretary of State by sections 71(1)(b), (2) and (3) of the CoPA.

1.3.4 The CoPA provides a Local Authority the power to serve a notice imposing requirements for the way in which construction works are to be carried out in their jurisdiction. This notice can specify the following:

- The plant or machinery permitted for use.
- The hours during which construction work may be undertaken.
- Limits for the emission levels of noise and vibration due to the works at any time or spatial position on site.
- Any other change in circumstance.

1.3.5 Section 61 of the CoPA refers to prior consent for work on construction sites. It provides a method by which a contractor can apply for consent to undertake construction works in advance. Providing consent is granted, and compliance is maintained with the stated method and hours of work, no action may be taken by the Local Authority under Section 60.

1.3.6 Section 71 of the CoPA refers to the preparation and approval of codes of practice for minimising noise.

1.3.7 Section 72 of the CoPA refers to BPM, which is defined as:

'In that expression, 'practicable' means reasonably practicable, having regards among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications'. Whilst 'Means' includes the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and acoustic structures.'

Environmental Protection Act 1990

1.3.8 Section 79, Part of the Environmental Protection Act (EPA) contains a list of matters that amount to statutory nuisances and places a duty on Local Authorities to regularly inspect areas in their jurisdiction to determine where statutory nuisances may exist.

1.3.9 The Local Authority must serve an abatement notice where it is satisfied that a statutory nuisance does not exist, or likely to occur/recur. Section 80 of the EPA provides Local Authorities with the power to serve an abatement to prohibit or restrict its occurrence or recurrence; and to carry out works or other action necessary to abate the nuisance.

1.3.10 Section 82 of the EPA allows a Magistrates' court to act on a complaint made by any person on the grounds that they are aggrieved by a statutory nuisance, such as noise.

1.3.11 The procedures for appeals against abatement notices are detailed in the Statutory Nuisance (Appeals) Regulations 1995.

British Standard 5228

1.3.12 British Standard (BS) comprises two parts:

- BS 5228-1:2009+A1:2014 – *'Code of practice for noise and vibration control on construction and open sites'* – Part 1: Noise
- BS 5228-2:2009+A1:2014 – *'Code of practice for noise and vibration control on construction and open sites'* – Part 2: Vibration.

1.3.13 The Standard provides guidance, information, and procedures for the control of noise and vibration from demolition and construction sites. BS 5228-1:2009+A1:2014 and BS 5228-2:2009+A1:2014 gained approval as guidance on appropriate methods for minimising noise from construction and open sites under the relevant sections of the CoPA.

1.3.14 There are no set standards for the definition of the significance of construction noise effects. However, noise example criteria are provided in BS 5228-1:2009+A1:2014 Annex E and vibration example criteria are provided in BS 5228-2:2009+A1:2014 Annex B.

1.3.15 BS 5228-1:2009+A1:2014 provides basic information and recommendations for methods of noise control relating to construction and open sites where work activities/operations generate significant noise levels. It includes sections on:

- community relations;
- noise and persons on site;
- neighbourhood nuisance;
- project supervision; and
- the control of noise.

1.3.16 The annexes include information on legislative background, noise sources, remedies, and their effectiveness (mitigation options); current and historic sound level data for on-site equipment and site activities; significance of noise effects; calculation procedures estimating sound emissions from sites and sound level monitoring; types of piling; and air overpressure.

1.3.17 BS 5228-2:2009+A1:2014 contains information and recommendations for basic methods of vibration control arising from construction and open sites where work activities/operations generate significant levels of vibration. It includes sections on community relations; vibration and persons on site; neighbourhood nuisance; project supervision; control of vibration and measurement. BS 5228-2:2009+A1:2014 refers to BS International Organisation for Standardisation (ISO)

4866:2010; BS 7385-2:1993; BS 6472-1:2008, and BS 6472-2:2008 for further advice on the significance of vibration.

Design Manual for Roads and Bridges – LA111 – Noise and Vibration

1.3.18 The Design Manual for Roads and Bridges (DMRB) LA111 (Highways England, Transport Scotland, Llwyodraeth Cymru, Department for Infrastructure, 2020), provides guidance on methods for assessing noise and vibration from construction traffic.

1.3.19 The magnitude of noise impacts is assessed using the predicted change in the Basic Noise Level (BNL) on the closest public roads to a receptor following the introduction of construction traffic.

1.3.20 The noise change is calculated using the methods outlined in the Calculation of Road Traffic Noise (CRTN) (Department for Transport, 1988) which considers the following:

- The change in traffic flow due to construction traffic.
- Vehicle speed.
- The percentage of Heavy Goods Vehicles (HGVs).

1.3.21 Paragraph 3.19 of DMRB LA111 states the following:

'Construction noise and construction traffic noise shall constitute a significant effect where it is determined that a major or moderate magnitude of impact will occur for a duration exceeding:

- *10 or more days or nights in any 15 consecutive days or nights*
- *A total number of days exceeding 40 in any 6 consecutive months.*'

1.3.22 Additional guidance is provided for the determination of construction noise impact criteria in terms of the Lowest Observed Adverse Effect Level (LOAEL) and the Significant Observed Adverse Effect Level (SOAEL). This is summarised in Table 6.2 of Volume 2, Chapter 6: Noise and Vibration, of the PEIR, and is reproduced in **Table 1** below for brevity and ease of reference.

Table 1: Summary of noise exposure hierarchy from NPSE and PPG

Response	Examples of Outcomes	Increasing Effect Level	Action
No Observed Effect Level (NOEL)			
Not present	No effect.	No Observed Effect.	No specific measures required.
No Observed Adverse Effect Level (NOAEL)			
Present and not intrusive	Noise can be heard but does not cause any change in behaviour, attitude, or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect.	No specific measures required.

Response	Examples of Outcomes	Increasing Effect Level	Action
Lowest Observed Adverse Effect Level (LOAEL)			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g., turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect.	Mitigate and reduce to a minimum.
Significant Observed Adverse Effect Level (SOAEL)			
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g., avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening, and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect.	Avoid.
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g., regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g., auditory and non-auditory.	Unacceptable Adverse Effect.	Prevent.

1.4 Assessment Criteria

1.4.1 Based on the guidance above, the following impact criteria have been adopted for the assessment of construction noise and vibration impacts.

Construction Noise

1.4.2 Impact criteria for construction noise have been determined in accordance with the guidance in DMRB LA111 and Annex E of BS 5228-1:2009+A1:2014. DMRB LA 111 provides the following guidance in **Table 2** for determining the LOAEL and SOAEL for construction noise and in **Table 3** for determining the magnitude of impact.

Table 2: Construction time period – LOAEL and SOAEL

Time Period	LOAEL	SOAEL
Weekdays (7am-7pm) and Saturdays (7am-1pm)	Baseline noise levels, $L_{Aeq,T}$	Threshold level determined as per BS 5228-1:2009+A1:2014.
Evening (7pm-11pm) and Weekends (1pm-11pm on Saturdays and 7am-11pm on Sundays)		
Night (11pm-7am)		

Table 3: Construction noise impact magnitude criteria

Magnitude of Impact	Construction Noise Level
High	$L_{Aeq,T} \geq$ SOAEL + 5 dB
Medium	SOAEL $\leq L_{Aeq,T} <$ SOAEL +5 dB
Low	LOAEL $L_{Aeq,T} <$ SOAEL
Negligible	$L_{Aeq,T} <$ LOAEL

1.4.3 The threshold levels which quantify the LOAEL and SOAEL have been derived from Example Method 2 in Annex E 3.3 of BS 5228-1:2009+A1:2014 which states the following:

'Noise levels generated by site activities are deemed to be potentially significant if the total noise (pre-construction ambient plus site noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65 dB, 55 dB and 45 dB L_{Aeq}, from site noise alone, for the daytime, evening and night-time periods, respectively; and a duration of one month or more, unless works of a shorter duration are likely to result in significant effect.'

1.4.4 Section 3 of DMRB LA 111 states provides alternative durations when considering the significance of effect of transient construction works. Since many of the construction works undertaken are indeed likely to be transient in nature, the following durations are considered in the assessment of significant effects:

'Construction noise and construction traffic noise shall constitute a significant effect where it is determined that a major or moderate magnitude of impact will occur for a duration exceeding:

1) 10 or more days in any 15 consecutive days or nights;

2) a total number of days exceeding 40 in any 6 consecutive months'

1.4.5 Given the low ambient sound climate in the area surrounding the Proposed Development, the lower cut-off values above provide the SOAEL against which construction noise impacts will be assessed.

1.4.6 The core construction working hours proposed are 7am-7pm on weekdays and 7pm-1pm on Saturdays. However, some construction activities may require works outside of these times and thus criteria have been derived for all possible construction periods outlined in BS 5228:2009+A1:2014.

Construction Traffic

1.4.7 There may be a change in local noise levels due to contributions from construction traffic on local road networks and temporary diversion networks during the construction of the Proposed Development.

1.4.8 The impact assessment will take account of the absolute level of the road traffic noise and the existing sound levels at the nearest receptors.

1.4.9 Impact criteria for these changes have been obtained from the guidance in DMRB LA 111 and are presented in **Table 4** below.

Table 4: Construction traffic noise criteria

Magnitude of Impact	Increase in Basic Noise Level (BNL) of closest public road used for construction traffic (dB)
High	BNL ≥ 5
Medium	3 ≤ BNL < 5
Low	1 ≤ BNL < 3
Negligible	BNL < 1

Construction Vibration

1.4.10 Impact criteria for vibration from construction have been identified based on guidance provided in BS 5228-2:2009+A1:2014. The following outline criteria in defined in Table 5 in terms of peak particle velocity (PPV) can be used to identify potential significant impacts on nearby receptors.

Table 5: Construction vibration criteria

Magnitude of Impact	Vibration Level, Peak Particle Velocity (PPV), mm/s
High	1 ≤ PPV < 10
Medium	0.3 ≤ PPV < 1
Low	PPV < 0.3
Negligible	1 ≤ PPV < 10

1.4.11 As with construction noise, the durations outlined in **paragraph 1.4.4** above are considered in the assessment of significant effects as per in Section 3 of DMRB LA 111.

1.5 Construction Noise Assessment

Methodology

1.5.1 The construction noise impacts have been predicted based upon a construction plant list for each of the various activities required within the Onshore Infrastructure Area. The full list of plant for each scenario is presented in Annex A. The source data presented in Annex A has been corrected for the ‘on-time’ which has been defined as the proportion of the day, evening, or night-time period for which the plant is likely to be in operation.

1.5.2 The construction working hours proposed are 7am to 7pm from Monday to Friday and 7am to 1pm on Saturday. Construction noise impacts due to trenchless techniques have been assessed against the night-time criteria due to the potential for night-time working.

1.5.3 As a guiding practice, noise emissions will be minimised as far as is reasonably practicable in accordance with the approved code of practice BS 5228:2009+A1:2014. Table B.1 in Annex B of BS 5228-1:2009+A1:2014 outlines typical losses associated with construction noise mitigation measures. A summary is provided in **Table 6** below.

Table 6: Noise reduction levels for typical construction plant mitigation

Mitigation Measure	Indicative Reduction in Noise Level (dB)	Justification/Source
Localised acoustic screening.	Up to 10 dB	The effectiveness of an acoustic barrier is dependent upon the difference in path length between the sound travelling the shortest path between source and receiver and the increased path over the top of a barrier. Section F.2.2.2 of BS 5228:2009+A1:2014 states: *'if there is a barrier or other topographic feature between the source and the receiving position, assume an approximate attenuation of 5 dB when the top of the plant is just visible to the receiver over the noise barrier and of 10 dB when the noise screen completely hides the sources from the receiver.'*
Enhanced sound reduction equipment on diesel or petrol engines.	Between 5 and 10 dB	Table B.1, Annex B, BS 5228 - 1:2009+A1:2014
Ventilated enclosures around breakers and rock drills.	Up to 20 dB	Table B.1, Annex B, BS 5228 - 1:2009+A1:2014
Ventilated acoustic shed for the use of rotary drills and boring plant.	Up to 15 dB	Table B.1, Annex B, BS 5228 - 1:2009+A1:2014
Electric or hybrid construction plant.	Variable.	The use of electrically powered construction equipment would reduce the noise emitted from engines and exhausts. However, the actual noise reduction is dependent upon the equipment used.

1.5.4 Other effective mitigation measures which may be used as alternative measures or in conjunction with the measures outlined in **Table 6** include the following:

- Limiting the use of loud equipment during the night-time.
- Increasing the distance between concurrent construction works.
- Positioning plant items away from noise-sensitive receptors.
- Avoiding the simultaneous operation of loud plant items, where possible.

1.5.5 A prediction of noise impacts from all construction activities except trenchless techniques have been undertaken by calculating the distance at which the magnitude of the construction noise impacts changes. Subsequent analysis of the number of residential receptors where a significant impact is predicted has been undertaken using Ordnance Survey (OS) Address Base Plus data and Geographic Information System (GIS) software. The impact magnitude bands are

inserted as spatial buffers around the Onshore Infrastructure Area at the distance at which the impact magnitude changes. The number of receptors within each band is then calculated to determine where effects may occur.

1.5.6 The activities assessed using this method include:

- utility diversions;
- site set-up;
- earthworks;
- road formation;
- signs and lighting; and
- rock cutting.

1.5.7 The same method has been adopted for the following activities with the impacts predicted from the Converter Station Site:

- substructure;
- super structure;
- culvert; and
- demolition.

1.5.8 Noise impacts due to HDD have been modelled using SoundPLAN v8.2 with the equipment required modelled as sources close to the boundary of the construction compound nearest to noise-sensitive receptors.

1.5.9 Details of all modelling inputs for the equipment required are presented in Annex A.

Results

1.5.10 The results of the construction noise assessment for works spread along the Onshore HVDC Cable Corridor are presented in **Table 7** below. The impacts have been predicted based upon the LOAEL at receptors where baseline sound levels were lowest to inform a robust assessment.

1.5.11 The results of the 3D acoustic modelling undertaken for the HDD works are tabulated in Annex B.

Table 7: Number of receptors per construction noise impact band

Activity	Impact Magnitude Band Distance (m)			Number of Receptors per Impact Magnitude Band		
	High	Medium	Low	High	Medium	Low
Onshore HVDC Cable Corridor						
Utility diversions	34	60	860	28	29	1,666
Site Set-up	38	67	960	34	31	1,961
Earthworks	40	72	1,021	34	35	2,284
Road formation	22	40	569	13	21	974
Rock cutting	33	60	834	27	30	1,618
Converter Station Site						
Substructure	95	170	2,400	0	0	230

Activity	Impact Magnitude Band Distance (m)			Number of Receptors per Impact Magnitude Band		
	High	Medium	Low	High	Medium	Low
Super Structure	100	176	2,489	0	0	244
Culvert	25	45	620	0	0	37
Demolition	21	39	539	0	0	27

1.6 Construction Vibration Assessment

Methodology

1.6.1 The use of vibratory rollers for the dynamic compaction during the construction of the haul road, construction compounds, and Converter Site platform has been assessed to determine the likelihood of adverse impacts on nearby receptors.

1.6.2 The assessment has been undertaken with reference to the guidance in Table E.1 of BS 5228-2:2009+A1:2014. This guidance provides empirically derived formula for the prediction of vibration impacts arising from mechanised construction works. During start up and run down, the resultant PPV v_{res} may be calculated using the following equation:

$$v_{res} = k_t\sqrt{n_d}\left[\frac{A}{x + L_d}\right]^{1.5} \quad (1)$$

1.6.3 The impacts with distance during steady state vibratory compaction works may be predicted using the following:

$$v_{res} = k_s\sqrt{n_d}\left[\frac{A^{1.5}}{(x + L_d)^{1.3}}\right] \quad (2)$$

- v_{res}: PPV (mm/s)
- k_t and k_s: scaling factors associated with the probability of exceedance
- n_d: number of vibrating drums
- A: maximum amplitude of drum vibration (mm)
- x: source-receiver separation distance along the ground surface (m)
- L_d: vibrating roller drum width (m).

1.6.4 It is understood that vibratory piling may be required for the installation of the HDD entry and exit pits, as well as for the construction of the Converter Site platform. The potential vibration impacts have been predicted based on the guidance in Table E.1 of BS 5228-2:2009+A1:2014 which provides the following equation for the prediction of vibration impacts with distance due to vibratory piling:

$$v_{res} = \frac{k_v}{x^{\delta}} \quad (3)$$

- v_{res}: PPV (mm/s)

- k_v: scaling factor associated with the probability of exceedance
- x: source-receiver separation distance along the ground surface (m)
- δ: dimensionless empirical constant
  - Start up and run-down: δ = 1.2
  - All operations: δ = 1.3
  - Steady state operations: δ = 1.4

Results

1.6.5 Impact magnitude bands have been generated to count how many receptors will be impacted during the dynamic compaction of the haul road, construction of the temporary construction compounds, and the construction of the Converter Site platform. Consideration has also been given to the potential vibration impacts arising due to piling activities for the installation of the HDD entry/exit pits. The results are presented in **Table 8** below.

Table 8: Number of receptors per construction vibration impact band

Activity	Impact Magnitude Band Distance (m)			Number of Receptors per Impact Magnitude Band		
	High	Medium	Low	High	Medium	Low
Dynamic compaction	10	26	60	2	16	39
Vibratory piling	10	23	58	2	12	38

1.6.6 It should be noted that the assessment has not accounted for any vibration control measures to be included as part of the Outline Onshore Construction Environmental Management Plan (On-CEMP) and that the results of the assessment present the highest possible vibration levels within the parameters of the empirical formulae used for predictions.

1.7 Construction Traffic

1.7.1 The noise impacts due to the introduction of additional construction vehicles on the local highway network around the Proposed Development may increase noise levels at nearby receptors.

1.7.2 The assessment has been informed by predicted construction traffic flows from the transport and traffic assessments. The data provided has been analysed along with the predicted construction period for each of the Zone 1-7 of the Onshore HVDC Cable Corridor to yield predicted daily traffic flows in each zone of the Onshore Infrastructure Area. The results are presented in **Table 9** below.

Table 9: Predicted daily traffic movements.

Zone	Construction Duration (Days)	Construction Traffic Flows		Number of Vehicles per Day
		Vehicle 1 (12 m^3 Lorry)	Vehicle 2 (8 m^3 Lorry)	
1 – Alverdiscott Substation and Converter Site to Gammaton Road	60	2,140	3,222	89
2 – Gammaton Moor to the River Torridge	55	1,906	2,862	87
3 – River Torridge to West Ashridge	80	4,064	6,104	127
4 – West Ashridge to Littleham	50	1,574	2,364	79
5 – Littleham Cross to A39	70	2,902	4,366	104
6 – A39 to Kenwith Stream	115	7,088	10,638	154
7 – Kenwith Stream to Landfall	60	2,140	3,222	89

1.7.3 Baseline traffic flows on the local highway networks are too low to accurately predict the existing traffic noise levels using the calculation procedure outlined in CRTN. As such, an assessment of the change in BNL, as outlined in DMRB, has not been possible.

1.7.4 The construction traffic noise assessment has thus been based on the calculation of absolute noise levels due to construction traffic on the haul road for the Proposed Development with runs the length of the onshore cable corridor from the landfall site to the converter stations.

1.7.5 A 3D noise model has been constructed of each zone using SoundPLAN v8.2. Construction traffic noise has been modelled assuming a moving point source along each zone of the haul road. A typical speed of 30 mph (48 km/h) has been assumed to obtain the effective sound power level as construction vehicles travel along the haul road. This level has been corrected for the number of vehicles per day as presented in **Table 9**.

1.7.6 The results have been generated as noise contour plots to determine how the noise from construction traffic along the haul road propagates and the resultant levels at the nearest receptors. These contours are shown in **Figure 3**.

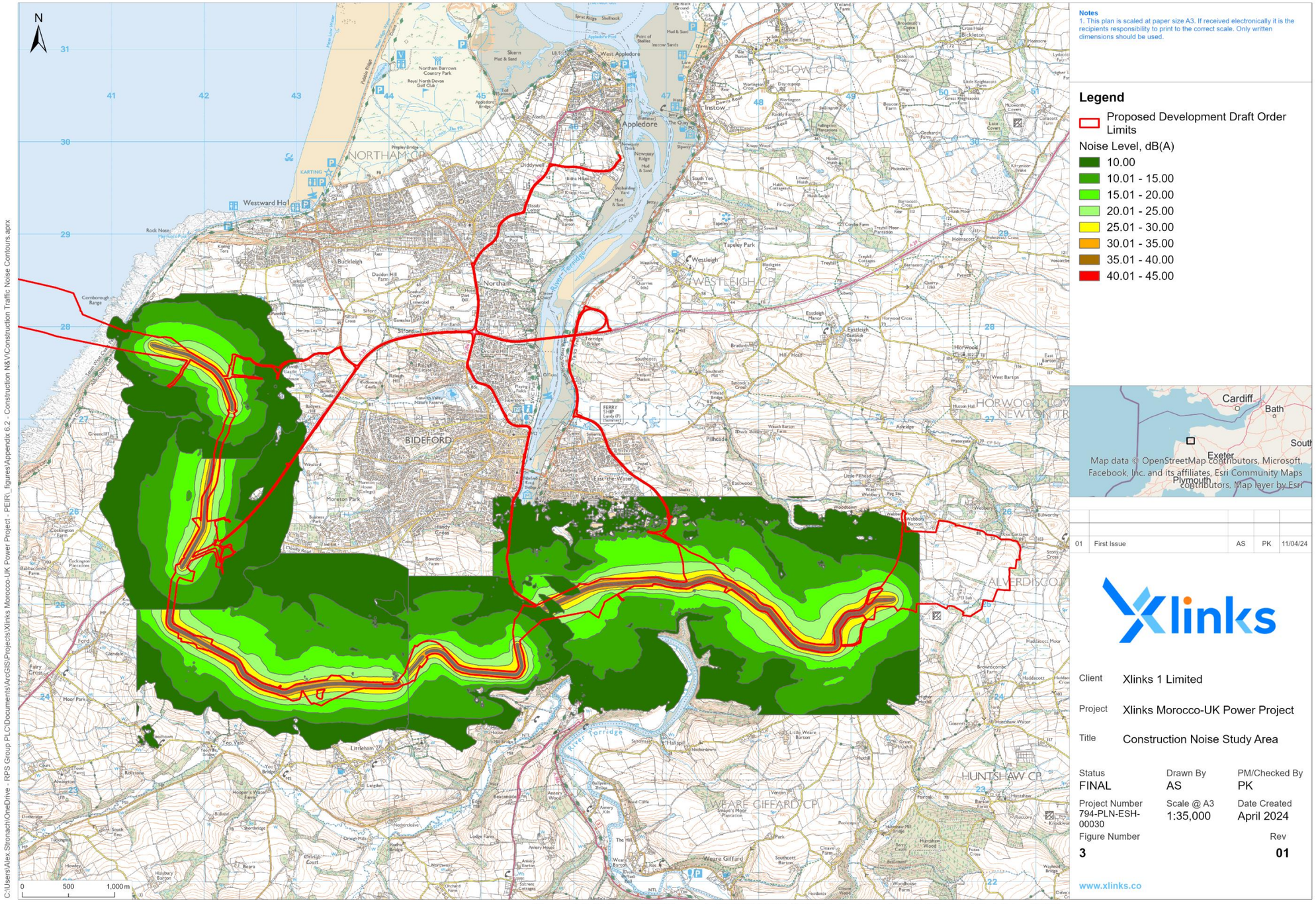

Figure 3: Construction traffic noise contours

Abnormal Indivisible Loads

1.7.7 Abnormal Indivisible Loads (AILs) may be required to transport components to the site during the construction phase of the Proposed Development.

1.7.8 The proposed route for AILs on the local highway network is shown on **Figure 1**. The number of AILs required during the construction phase is not yet known. As such, no assessment has been undertaken as part of the PEIR.

1.7.9 The AILs will travel from the main highways and use the haul road to access the various areas of the Proposed Development. The influence on AILs whilst travelling on the haul road will be considered as part of the Environmental Statement.

1.7.10 The AIL routes in **Figure 1** above can be seen to be limited to well-trafficked roads such as the A39 and the A386. It is unlikely that the introduction of AILs as additional vehicles on the local highway network will increase the existing traffic noise levels sufficiently to result in significance adverse effects due to noise. As such, it is proposed that the impact of noise due to AILs on the local highway network be scoped out of the assessment for the Environmental Statement.

1.7.11 The highway improvements required to allow access for the AILs may result in changes to the traffic flows on the local highway networks. This is addressed in Volume 2, Appendix 6.3: Operational Noise of the PEIR, with a full assessment proposed as part of the Environmental Statement once further details of the highways improvements are available.

1.8 References

British Standards Institution (2014a) *'British Standard 5228-1:2009+A1:2014 (2014) Code of practice for noise and vibration control on construction and open sites - Part 1: Noise'*

British Standards Institution (2014b) *'British Standard 5228-2:2009+A1:2014 (2014) Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration'*

Control of Pollution Act 1974, Chapter 40, Part III

Department of Transport Welsh Office (1988), *Calculation of Road Traffic Noise*

Environmental Protection Act 1990, Chapter 43, Part III

Highways England, Transport Scotland, Llwyodraeth Cymry, Department for Infrastructure (2020), *'Design Manual for Roads and Bridges – LA111: Noise and vibration'*

International Organisation for Standards (1996) *ISO 9613-2:1996 – Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation.*

ANNEX A

Construction Plant Data

Plant Item	% On-Time	Quantity	Sound Power Level (dB) at 1/1-Octave Band Centre Frequency (Hz)								dB(A)
			63	125	250	500	1k	2k	4k	8k	
Utility Diversions											
15T Excavator	100	1	93	91	90	91	92	92	87	80	97
Hiab	100	1	114	108	100	100	100	99	96	93	105
2T Dumper	100	2	110	110	106	105	97	95	89	81	105
Pick-Up	100	1	109	109	98	100	96	94	93	85	102
Site Set-Up											
Hiab	100	1	114	108	100	100	100	99	96	93	105
Vibrating Roller (Small)	10	1	108	106	102	99	96	96	89	85	102
360 Excavator, 15T	100	1	93	91	90	91	92	92	87	80	97
Dumper, 2T	100	2	110	110	106	105	97	95	89	81	105
Delivery Lorry	50	1	108	106	104	101	102	104	101	95	109
Front-End Loader	100	1	121	110	108	107	103	102	95	87	109
Fork Lift	50	2	107	101	97	95	95	91	87	83	99

Plant Item	% On-Time	Quantity	Sound Power Level (dB) at 1/1-Octave Band Centre Frequency (Hz)								dB(A)
			63	125	250	500	1k	2k	4k	8k	
Earthworks											
360 Excavator, 30T	100	1	100	99	102	101	97	94	91	86	103
40T Dumper Truck	100	2	106	99	99	99	99	104	89	80	107
Bomag 120	100	1	113	113	107	99	99	99	96	90	106
Road Formation											
Dozer	100	1	111	100	102	99	98	104	88	82	107
Road Delivery Lorries	50	2	109	107	105	102	103	105	102	96	110
Tracked Excavator, 22T	100	1	108	111	104	101	100	98	97	94	106
Twin Drum Vibrating Roller (2m Wide)	10	1	123	115	106	105	103	98	92	87	108
Articulated Dump Truck, 25T	100	1	114	111	115	106	101	97	90	86	109
Road Paver (Blaw Knox Type)	100	1	106	103	100	99	98	95	93	84	103
Three Point Drum Roller	100	1	110	102	93	92	90	85	79	74	95
Wheeled Backhoe	50	1	102	94	92	92	91	88	87	78	96

Plant Item	% On-Time	Quantity	Sound Power Level (dB) at 1/1-Octave Band Centre Frequency (Hz)								dB(A)
			63	125	250	500	1k	2k	4k	8k	
Loader (JCB Type)											
Signs & Lighting											
Specific Use Road Truck with Hiab	75	1	114	108	100	100	100	99	96	93	105
Access Platform	25	1	106	104	90	91	88	87	86	77	95
Specific Use Road Truck with Hiab (Signage)	75	1	114	108	100	100	100	99	96	93	105
Tracked Excavator, 5T	100	1	90	89	92	91	87	84	81	76	93
Specific Use Road truck (Road Markings)	75	1	114	108	100	100	100	99	96	93	105
Site Dumper, 5T	100	1	111	111	107	106	98	96	90	82	106
Specific Use Road Truck with Hiab (Road Restraint)	75	1	114	108	100	100	100	99	96	93	105
Safety Barrier Piling Rig	50	1	99	98	95	98	100	98	93	83	104

Plant Item	% On-Time	Quantity	Sound Power Level (dB) at 1/1-Octave Band Centre Frequency (Hz)								dB(A)
			63	125	250	500	1k	2k	4k	8k	
Safety Barrier Piling Rig Compressor	25	2	103	99	93	98	99	97	90	85	103
Rock Cutting											
Petrol Hand-Held Saw	10	1	100	117	109	108	108	110	114	113	119
Rock Saw	10	1	94	111	103	102	102	104	108	107	113
Rock Hammer	10	1	114	114	114	121	115	110	107	102	121
Excavator (JCB)	100	1	93	91	90	91	92	92	87	80	97
Tracked Loader (CAT)	100	1	124	113	111	110	106	105	98	90	112
Excavated Material Lorries (8-Wheeled)	50	1	114	111	115	106	101	97	90	86	109
Compressor	50	1	102	98	92	97	98	96	89	84	102
Substructure											
360 Excavator, 20T	100	1	95	93	92	93	94	94	89	82	99
Delivery Lorry	50	2	108	106	104	101	102	104	101	95	109
Bomag 120	100	1	113	113	107	99	99	99	96	90	106

Plant Item	% On-Time	Quantity	Sound Power Level (dB) at 1/1-Octave Band Centre Frequency (Hz)								dB(A)
			63	125	250	500	1k	2k	4k	8k	
25T Dumper Truck	100	2	114	111	115	106	101	97	90	86	109
CFA Piling Rig (Soilmec CM45)	50	1	103	102	99	102	104	102	97	87	108
Hiab	100	1	114	108	100	100	100	99	96	93	105
Concrete Mixer Truck	50	1	111	102	94	97	98	106	88	83	108
Mobile Crane, 55T	25	1	109	105	97	95	90	88	89	79	98
Concrete Pump	50	1	109	101	95	96	98	98	91	83	103
Pick-Up	100	1	109	109	98	100	96	94	93	85	102
Hand Held Air Tools	20	8	124	126	116	108	106	106	105	105	115
Compressor	50	1	102	98	92	97	98	96	89	84	102
Superstructure											
Hiab	100	1	114	108	100	100	100	99	96	93	105
Pick-Up	100	1	109	109	98	100	96	94	93	85	102
Mobile Crane, 55T	25	1	109	105	97	95	90	88	89	79	98
Mobile Crane, 600T	25	1	98	101	98	92	36	96	85	76	99
Concrete Pump	25	1	109	101	95	96	98	98	91	83	103

Plant Item	% On-Time	Quantity	Sound Power Level (dB) at 1/1-Octave Band Centre Frequency (Hz)								dB(A)
			63	125	250	500	1k	2k	4k	8k	
Compressor	50	1	102	98	92	97	98	96	89	84	102
Concrete Mixer Truck	100	1	111	102	94	97	98	106	88	83	108
Circular Saw/Disc Cutter	10	1	115	104	102	100	102	106	112	107	115
Compressor, Small Petrol Driven Poker Vibrators	10	1	105	101	95	100	101	99	92	87	105
Delivery Lorry	50	1	108	106	104	101	102	104	101	95	109
Culvert											
360 Excavator, 20T	100	1	95	93	92	93	94	94	89	82	99
25T Dumper Truck	100	2	114	111	115	106	101	97	90	86	109
Vibrating Roller (Medium Bomag 120)	50	1	121	113	104	103	101	96	90	85	106
Hiab	100	1	114	108	100	100	100	99	96	93	105
Concrete Mixer Truck	100	1	111	102	94	97	98	106	88	83	108
Mobile Crane, 55T	25	1	109	105	97	95	90	88	89	79	98

Plant Item	% On-Time	Quantity	Sound Power Level (dB) at 1/1-Octave Band Centre Frequency (Hz)								dB(A)
			63	125	250	500	1k	2k	4k	8k	
Vibratory Plate (Petrol)	10	1	98	102	99	106	102	103	91	86	108
Pick-Up	100	1	109	109	98	100	96	94	93	85	102
Compressor	50	1	102	98	92	97	98	96	89	84	102
Demolition											
Tracked Crane (70T Crawler)	25	1	96	94	29	90	97	89	81	72	98
Dumper, 2T	100	1	110	110	106	105	97	95	89	81	105
Excavator (JCB)	100	1	93	91	90	91	92	92	87	80	97
Tracked Loader (CAT)	100	1	124	113	111	110	106	105	98	90	112
Excavated Material Lorries (8-Wheeled)	50	1	114	111	115	106	101	97	90	86	109
Hand Held Air Tools (Pneumatic Breakers)	10	2	100	99	105	105	106	104	101	105	111
Compressor	50	1	102	98	92	97	98	96	89	84	102
Excavated Mounted Breaker	10	1	118	118	116	119	113	113	110	106	120

ANNEX B

HDD Construction Noise Assessment

Location	Receptor	LOAEL (dB)			SOAEL (dB)			Construction Noise Level, $L_{Aeq,T}$ (dB)			Magnitude of Impact		
		Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
A39	Beech Cottage	65	58	51	75	65	55	33	33	34	**Negligible**	**Negligible**	**Negligible**
	Bowood Farm	65	58	51	75	65	55	30	30	31	**Negligible**	**Negligible**	**Negligible**
	Hill House	65	58	51	75	65	55	25	25	28	**Negligible**	**Negligible**	**Negligible**
	Lower Bowood	65	58	51	75	65	55	22	22	27	**Negligible**	**Negligible**	**Negligible**
	The Warren	47	39	37	65	55	45	35	35	36	**Negligible**	**Negligible**	**Negligible**
	Venlea	65	58	51	75	65	55	25	25	26	**Negligible**	**Negligible**	**Negligible**
	Winscott Barn	47	39	37	65	55	45	25	25	29	**Negligible**	**Negligible**	**Negligible**
	Winscott Barton	47	39	37	65	55	45	28	28	33	**Negligible**	**Negligible**	**Negligible**
Jennet's Reservoir	Damn View	43	40	35	65	55	45	16	16	20	**Negligible**	**Negligible**	**Negligible**
	Dunn Farm	43	40	35	65	55	45	36	36	40	**Negligible**	**Negligible**	**Low**
	Otter Cottage	43	40	35	65	55	45	30	30	34	**Negligible**	**Negligible**	**Negligible**
	Swallow Cottage	43	40	35	65	55	45	39	39	40	**Negligible**	**Negligible**	**Low**

Location	Receptor	LOAEL (dB)			SOAEL (dB)			Construction Noise Level, $L_{Aeq,T}$ (dB)			Magnitude of Impact		
		Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
	West Ashridge	43	40	35	65	55	45	31	31	34	**Negligible**	**Negligible**	**Negligible**
Kenwith Stream	Chaltaborough	65	58	51	75	65	55	30	30	32	**Negligible**	**Negligible**	**Negligible**
	Chapter House	65	58	51	75	65	55	26	26	29	**Negligible**	**Negligible**	**Negligible**
	Coombe	65	58	51	75	65	55	38	38	42	**Negligible**	**Negligible**	**Negligible**
	Coombe Barn	65	58	51	75	65	55	37	37	39	**Negligible**	**Negligible**	**Negligible**
	Fig Cottage	65	58	51	75	65	55	39	39	43	**Negligible**	**Negligible**	**Negligible**
	Forge Cottage	65	58	51	75	65	55	25	25	31	**Negligible**	**Negligible**	**Negligible**
	Oakleigh	65	58	51	75	65	55	25	25	30	**Negligible**	**Negligible**	**Negligible**
	Shamland	65	58	51	75	65	55	22	22	26	**Negligible**	**Negligible**	**Negligible**
	Shamland Barn	65	58	51	75	65	55	31	31	35	**Negligible**	**Negligible**	**Negligible**
	Silver Mist	65	58	51	75	65	55	28	28	32	**Negligible**	**Negligible**	**Negligible**
	Spry Cottage	65	58	51	75	65	55	25	25	30	**Negligible**	**Negligible**	**Negligible**
	The Flat	65	58	51	75	65	55	34	34	37	**Negligible**	**Negligible**	**Negligible**
	The Old Smithy	65	58	51	75	65	55	30	30	33	**Negligible**	**Negligible**	**Negligible**

Location	Receptor	LOAEL (dB)			SOAEL (dB)			Construction Noise Level, $L_{Aeq,T}$ (dB)			Magnitude of Impact		
		Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
	Thistles	65	58	51	75	65	55	28	28	31	**Negligible**	**Negligible**	**Negligible**
Landfall	Old Stables	43	38	32	65	55	45	25	25	30	**Negligible**	**Negligible**	**Negligible**
	The Coach House	43	38	32	65	55	45	19	19	23	**Negligible**	**Negligible**	**Negligible**
Torridge River	April Cottage	46	43	41	65	55	45	16	16	21	**Negligible**	**Negligible**	**Negligible**
	Halsannery Farm House	46	43	41	65	55	45	29	29	32	**Negligible**	**Negligible**	**Negligible**
	Littlecroft	46	43	41	65	55	45	45	45	45	**Negligible**	**Low**	**Negligible**
	Riverside Cottage	46	43	41	65	55	45	30	30	33	**Negligible**	**Negligible**	**Negligible**
	Tennacott Lodge	46	43	41	65	55	45	21	21	23	**Negligible**	**Negligible**	**Negligible**
	Treetops	46	43	41	65	55	45	51	51	52	**Low**	**Low**	**High**
Winscott Barton	Hullacott	56	46	41	65	55	45	39	39	43	**Negligible**	**Negligible**	**Low**
	Littleham Court	56	46	41	65	55	45	38	38	40	**Negligible**	**Negligible**	**Negligible**
	Littleham Court Manor	56	46	41	65	55	45	38	38	42	**Negligible**	**Negligible**	**Low**
	Littlemoor	56	46	41	65	55	45	22	22	24	**Negligible**	**Negligible**	**Negligible**
	Long Linney	56	46	41	65	55	45	35	35	38	**Negligible**	**Negligible**	**Negligible**

Location	Receptor	LOAEL (dB)			SOAEL (dB)			Construction Noise Level, $L_{Aeq,T}$ (dB)			Magnitude of Impact		
		Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
	Moor Park	56	46	41	65	55	45	23	23	25	**Negligible**	**Negligible**	**Negligible**
	Moorhead Cottage	56	46	41	65	55	45	31	31	37	**Negligible**	**Negligible**	**Negligible**
	Newridge	56	46	41	65	55	45	25	25	28	**Negligible**	**Negligible**	**Negligible**
	Robbin Hill Farm	56	46	41	65	55	45	19	19	28	**Negligible**	**Negligible**	**Negligible**