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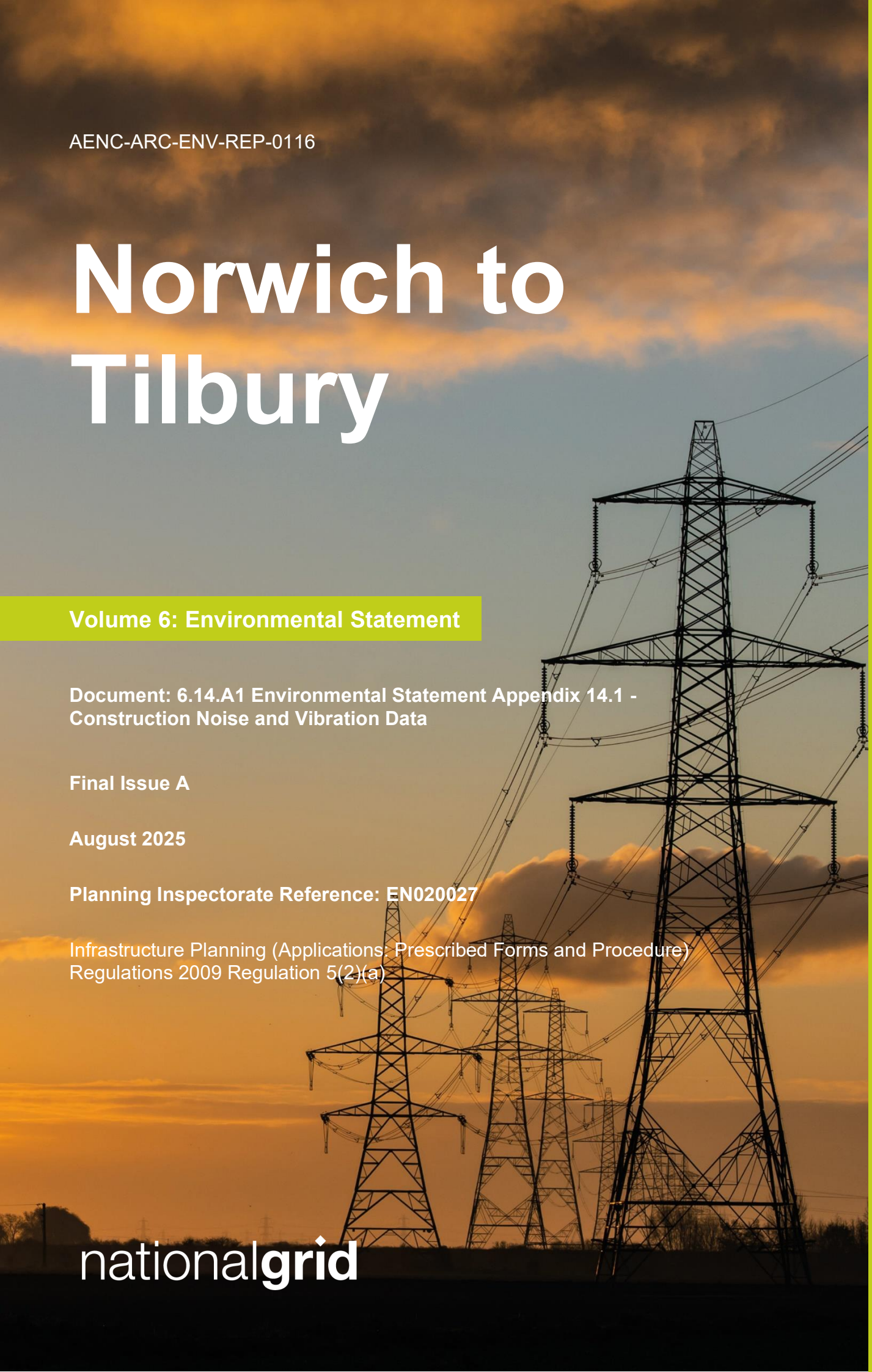

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14. Construction Noise and Vibration Data

14.1 Introduction

14.1.1 This appendix has been produced to support Chapter 14: Noise and Vibration (document reference 6.14) of the Environmental Statement (ES) (Volume 6 of the Development Consent Order (DCO) for Norwich to Tilbury (the 'Project'). It sets out the information and data used within the assessment of noise and vibration effects from construction activities at noise and vibration sensitive receptors (NSR). This appendix includes:

- Construction noise data
- Construction vibration data.

14.2 Construction Noise

Construction Noise Introduction

14.2.1 The construction noise assessment has been undertaken with reference to the methods and empirical data outlined in British Standard (BS) 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise (British Standards Institution (BSI), 2014) (BS 5228-1).

Construction Plant Data

14.2.2 Indicative construction plant and data associated with each proposed construction activity is provided in Table A14.1. The table provides the average expected sound power level for each activity. For the purposes of the assessment, attenuation from mitigation measures is not included such that noise 'hot spots' can be identified, and specific mitigation measures can be identified. The exception are static items such as generators and water pumps, where screening would be considered standard practice where located close to NSR.

Table A14.1.1 Construction Activity Plant and Noise Data

Activity	Plant Item	Number of Plant Items	BS 5228-1 Ref	% On-time	A-weighted Sound Pressure Level at 10m, dBA	Assumed Attenuation due to Embedded BPM, dB	Average Activity Sound Power Level, dBA
General Works							
Site preparation	Tracked excavator	2	C2.7	70	70	0	107
	Dozer	3	C2.1	70	75	0	
Top soil strip	Tracked excavator	2	C2.7	70	70	0	107
	Dozer	3	C2.1	70	75	0	
Temporary access routes/haul roads construction	Wheeled backhoe loader	1	C2.8	70	68	0	107
	Dumper	2	C4.4	70	76	0	
	Articulated dump truck (tipping fill)	1	C.2.32	5	74	0	
	Vibratory roller	1	C2.40	70	73	0	
Temporary Construction Compounds							
Site preparation	Tracked excavator	2	C2.7	70	70	0	107
	Dozer	3	C2.1	70	75	0	
Road construction	Dumper	3	C4.4	70	76	0	110
	Road Roller	1	C5.19	70	80	0	
Compound buildings	Telehandler	2	C4.55	50	70	0	98
	Generator	2	C3.33	100	57	10	

Activity	Plant Item	Number of Plant Items	BS 5228-1 Ref	% On-time	A-weighted Sound Pressure Level at 10m, dBA	Assumed Attenuation due to Embedded BPM, dB	Average Activity Sound Power Level, dBA
Compound operation	Lorry	1	C2.34	25	80	0	104
	Telehandler	2	C4.55	50	70	0	
	Generator	2	C3.33	100	57	10	
Overhead Line Removal							
Site preparation	Tracked excavator	1	C2.7	90	70	0	98
Breaking up concrete	Excavator mounted pulveriser	2	C1.5	50	72	0	100
Dumping brick rubble	Tracked excavator	1	C1.10	10	85	0	103
Breaking up/ cutting steel	tracked excavator	1	C1.16	25	82	0	104
Overhead Line Construction							
Pylon construction	Tracked excavator	1	C2.7	70	70	0	111
	Steel tube piling rig	1	C3.8	25	88	0	
	Concrete pump	1	C3.26	50	75	0	
Pylon Assembly	Telehandler	1	C4.55	50	70	0	95
Pylon installation	Crane lifting pylon	1	C4.46	10	67	0	85
Cable tensioning	Winder	1	Suppliers' data	60	77	0	106
	Rear Winder	1	Suppliers' data	60	77	0	

Activity	Plant Item	Number of Plant Items	BS 5228-1 Ref	% On-time	A-weighted Sound Pressure Level at 10m, dBA	Assumed Attenuation due to Embedded BPM, dB	Average Activity Sound Power Level, dBA
Underground Cable Construction							
Trenching	Tracked excavator	1	C2.7	70	70	0	97
	Tracked mobile crane	1	C3.28	25	67	0	
	Sheet piling (hydraulic jacking)	1	C3.11	25	59	0	
	Power pack	1	C3.12	100	63	10	
Lower and lay	Side boom	3	C3.28	25	67	0	95
	Water pump	1	C2.46	100	62	10	
	Wheeled backhoe loader	1	C2.8	25	68	0	
Backfill trench	Wheeled backhoe loader	1	C2.8	70	68	0	104
	Tracked excavator	1	C2.7	70	70	0	
	Dumper	2	C4.4	25	76	0	
	Vibratory roller	2	C2.40	10	73	0	
Reinstatement	Wheeled backhoe loader	1	C2.8	70	68	0	100
	Dumper	1	C4.4	25	76	0	
Transition joint pit	Generator	3	C3.33	100	57	10	104
	Welder	3	C3.31	25	73	0	
	Grinder	2	C4.93	10	80	0	

Activity	Plant Item	Number of Plant Items	BS 5228-1 Ref	% On-time	A-weighted Sound Pressure Level at 10m, dBA	Assumed Attenuation due to Embedded BPM, dB	Average Activity Sound Power Level, dBA
	Side boom	1	C3.28	25	67	0	
Cable pulling	Conveyor drive unit	1	C10.21	50	76	0	101
	Field Conveyor	2	C10.23	50	53	0	
Horizontal directional drilling	Directional drilling	1	C2.44	70	77	0	104
	Tracked excavator	1	C2.7	50	70	0	
	Water pump	2	C2.46	100	62	10	
Cable Sealing End (CSE) Compound Construction							
Site preparation	Tracked excavator	2	C2.7	70	70	0	107
	Dozer	3	C2.1	70	75	0	
CSE assembly	Telehandler	2	C4.55	70	70	0	100
	Generator	2	C3.33	100	57	10	
Substation Construction							
Site preparation	Tracked excavator	2	C2.7	70	70	0	107
	Dozer	3	C2.1	70	75	0	
Substation assembly	Telehandler	2	C4.55	50	70	0	110
	Generator	2	C3.33	100	57	10	
	Vibratory piling rig	1	C3.8	25	88	0	

14.3 Construction Noise Levels Over Distance

14.3.1 Table A14.1.2 provides indicative construction noise levels over a range of distances and shows how noise levels reduce with distance.

Table A14.1.2 Construction Activity Noise Levels Over Distance

Activity	Average Activity Sound Power Level, dBA	Sound Pressure Level, dBA, at Distance, m					
		10	25	50	100	200	300
General Works							
Site preparation	107	82	74	68	62	56	53
Top soil strip	107	82	74	68	62	56	53
Temporary access routes	107	82	74	68	62	56	52
Temporary Construction Compounds							
Site preparation	107	82	74	68	62	56	53
Road construction	110	85	77	71	65	59	55
Compound buildings	98	73	65	59	53	47	43
Compound operation	103	78	70	64	58	52	49
Overhead Line Removal							
Site preparation	98	73	65	59	53	47	43
Breaking up concrete	100	75	67	61	55	49	45
Dumping brick rubble	103	78	70	64	58	52	48
Breaking up/cutting steel	104	79	71	65	59	53	49
Overhead Line Construction							
Pylon construction	111	86	78	72	66	60	56
Pylon assembly	95	70	62	56	50	44	40

Activity	Average Activity Sound Power Level, dBA	Sound Pressure Level, dBA, at Distance, m					
		10	25	50	100	200	300
Pylon installation	85	60	52	46	40	34	30
Cable tensioning	106	81	73	67	61	55	51
Underground Cable Construction							
Trenching	97	72	64	58	52	46	43
Lower and lay	95	70	62	56	50	44	41
Backfill trench	103	78	71	64	58	52	49
Reinstatement	100	75	67	61	55	49	45
Transition joint pit	104	79	71	65	59	53	49
Cable pulling	101	76	68	62	56	50	46
Horizontal directional drilling	104	79	71	65	59	53	50
CSE Compound Construction							
Site preparation	107	82	74	68	62	56	53
CSE assembly	99	74	67	61	54	48	45
Substation Construction							
Site preparation	107	82	74	68	62	56	53
Substation assembly	110	85	77	71	65	59	56

14.4 Construction Noise Effect Levels

14.4.1 Indicative distances within which Significant Observed Adverse Effect Levels (SOAEL) may be exceeded during daytime, evenings and weekends, and night-time periods are provided Table A14.1.3.

Table A14.1.3 Construction Activity Noise SOAEL Distances

Activity	Average Activity Sound Power Level, dBA	Distance Within Which SOAEL May Be Exceeded, m		
		Daytime[1] (65dBA)	Evenings and Weekends[2] (55dBA)	Night-time[3] (45 dBA)
General Works				
Site preparation	107	71	225	712
Top soil strip	107	71	225	712
Temporary access routes	107	68	216	684
Temporary Construction Compounds				
Site preparation	107	71	225	712
Road construction	110	98	311	984
Compound buildings	98	25	80	252
Compound operation	103	47	149	471
Overhead Line Removal				
Site preparation	98	24	75	238
Breaking up concrete	100	32	100	316
Dumping brick rubble	103	45	141	447
Breaking up/cutting steel	104	50	158	500

[1] 07:00 to 19:00 on weekdays, and 07:00 to 13:00 on Saturdays

[2] 19:00 to 23:00 on weekdays, 13:00 to 23:00 on Saturdays, and 07:00 to 23:00 on Sundays

[3] 23:00 to 07:00

Activity	Average Activity Sound Power Level, dBA	Distance Within Which SOAEL May Be Exceeded, m		
		Daytime[1] (65dBA)	Evenings and Weekends[2] (55dBA)	Night-time[3] (45 dBA)
Overhead Line Construction				
Pylon construction	111	107	338	1067
Pylon assembly	95	18	56	178
Pylon installation	85	6	18	56
Cable tensioning	106	62	195	616
Underground Cable Construction				
Trenching	97	23	73	232
Lower and lay	95	19	59	186
Backfill trench	103	47	149	472
Reinstatement	100	30	95	301
Transition joint pit	104	48	151	479
Cable pulling	101	36	113	356
Horizontal directional drilling	104	50	160	505
CSE Compound Construction				
Site preparation	107	71	225	712
CSE assembly	99	30	94	298
Substation Construction				
Site preparation	107	71	225	712
Substation assembly	110	103	325	1029

14.5 Construction Vibration

Construction Vibration Introduction

14.5.1 The construction vibration assessment has been undertaken with reference to the methods and empirical data outlined in BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration (BSI, 2014) (BS 5228-2).

14.5.2 The main significant sources of vibration during construction activities are expected to be ground compaction, and percussive or vibratory piling. These processes may be required during the following activities:

- Ground compaction with vibratory roller:
  - Setup of temporary construction compounds
  - Site preparation
  - Temporary access route construction
  - Cable laying
- Piling:
  - Pylon foundations
  - Cable Sealing End (CSE) compounds
  - Substation construction.

Prediction of Construction Vibration

14.5.3 Peak particle velocity (PPV) vibration levels in mm/s generated by ground compaction and piling activities can be predicted using the guidance and empirical formulae in Table E1 of BS 5228-2. The formulae are shown below.

Vibratory Roller Calculation Formula

$$v_{res} = k_s\sqrt{n_d}\left[\frac{A}{x+L_d}\right]^{1.5} \qquad \text{(Equation 1)}$$

Where:

- V_{res} = Resultant PPV, in millimetres per second (mm/s)
- k_s = Scaling factor (and probability of predicted value being exceeded)
- n_d = Number of vibrating drums
- A = Maximum amplitude of drum vibration, in millimetres (mm)
- x = Distance measured along the ground surface, in metres (m)
- L_d = vibrating roller drum width, in metres (m)

Percussive Piling Calculation Formula

$$v_{res} \leq k_p \left[\frac{\sqrt{W}}{r^{1.3}}\right] \quad \text{(Equation 2)}$$

Where:

- V_{res} = Resultant PPV, in millimetres per second (mm/s)
- K_p = Scaling factor (depending on soil conditions)
- W = Nominal hammer energy, in joules (J)
- r = Slope distance from the pile toe, in metres (m).

Assumptions

14.5.4 The following conservative assumptions have been made to predict vibration levels to assess a reasonable worst-case:

- Vibratory Roller assumptions:
  - Scaling factor of 75, representative of average conditions
  - Vibratory roller data based on worst case Bomag BW 213, 1 drum of 2.13 m width and maximum amplitude of 1.1 mm
- Percussive piling assumptions:
  - Typical value of nominal hammer energy of 25 kJ
  - Scaling factor of 1.5 representative of typical soil conditions.

Vibration Prediction Results

14.5.5 Equations 1 and 2 have been used to predict the minimum distances within which the vibration threshold values human comfort impacts from vibration in terms of SOAEL and potential cosmetic building damage may be exceeded (1.0mm/s, and 12.5mm/s PPV respectively). The calculated distances in Table A14.1 are used in the preliminary assessment to identify areas where NSR are potentially affected by construction vibration.

Table A14.1.4 Indicative Construction Vibration Threshold Distances

Activity	Distance Within Which SOAEL May Be Exceeded (m)	Distance Within Which Cosmetic Building Damage May Occur (m)
Ground compaction	18	<2
Percussive piling	70	<10

Abbreviations

Abbreviation	Full Reference
BS	British Standard
BSI	British Standards Institution
dB	Decibels
DCO	Development Consent Order
ES	Environmental Statement
Leq	Equivalent Continuous Sound Level
LOAEL	Lowest Observed Adverse Effect Level
mm/s	Millimetres per second (A metric of vibration level from construction activities)
NSR	Noise Sensitive Receptors
PPV	Peak Particle Velocity (a metric of vibration from construction activities)
SOAEL	Significant Observed Adverse Effect Levels

Glossary

Term	Definition
A-Weighted	The A Weighting corrects the variation in the ear's ability to hear different frequencies and provides a good representation of how sound is perceived by the human ear.
Cable	An insulated conductor designed for underground installation.
Cable Sealing End	Structures used to transfer transmission circuits between underground cables and overhead lines.
Cable Sealing End Compound	Electrical infrastructure used as the transition point between overhead lines and underground cables. A compound on the ground acts as the principal transition point.
Code of Construction Practice	A Code of Construction Practice (CoCP) sets out the standards and procedures to which a developer (and its contractors) must adhere in order to manage the potential impacts of construction works.
Conductor	The overhead wire that carries electricity from one place to another. For example, the line between two pylons.
Construction Compounds	Temporary compounds installed during the construction phase of the Project. Each compound may contain storage areas including laydown areas, soils storage and areas for equipment and fuel, drainage, generators, car parking and offices and welfare areas (portacabins).
Construction Environmental Management Plan	A Construction Environmental Management Plan (CEMP) is a document which provides a consistent approach to the control of construction activities for the Project. It would allocate responsible persons, indicators for completion and site-specific control measures for where and when the measures would apply for environmental actions and commitments.
Construction routes	These are the roads on the local road network that would be used by construction vehicles between the strategic road network and the access points within the Order Limits.
Construction Traffic Management Plan	Plan detailing the procedures, requirements and standards necessary for managing the traffic effects during construction of the Project so that safe, adequate and convenient facilities for local movements by all transport modes are maintained throughout the construction process.
Corona Discharge	An electrical discharge caused by the ionisation of fluid such as air surrounding a conductor carrying a high voltage. It represents a local region where the air (or other fluid) has undergone electrical breakdown and become conductive. A corona occurs at locations where the strength of the electric field (potential gradient) around a conductor exceeds the dielectric strength of the air.
Decibel (dB)	Unit for measuring sound levels.

Term	Definition
Equivalent Continuous Sound Level (Leq)	Equivalent continuous sound level is a notional steady sound level that causes the same A-weighted sound energy to be received as that due to the actual and possibly fluctuating sound over a period of time T. It can also be used to relate periods of exposure and noise level. For example, halving or doubling the period of exposure is equivalent in sound energy to a decrease or increase of 3dB(A) in the sound level for the original period.
Frequency Weighting Networks	Frequency weighting networks, which are generally built into sound level meters, attenuate the signal at some frequencies and amplify it at others. The A-weighting network approximately corresponds to human frequency response to sound. Sound levels measured with the A-weighting network are expressed in dB(A). Other weighting networks also exist, such as C-weighting which is nearly linear (i.e. unweighted) and other more specialised weighting networks. Variables such as Lp and Leq that can be measured using such weightings are expressed as LpA / LpC, LAeq / LCeq etc.
Haul Roads	Another term used for the temporary access route, which is a temporary route built to carry construction vehicles within the Order Limits.
Impact Magnitude	This is the scale of change which a given impact may cause. This is compared to the baseline state and consideration is given to how the change relates to accepted thresholds and standards.
Impact Significance	The level of significance is defined by the magnitude of impact in relation to the sensitivity/value of the environmental receptor.
$L_{Aeq,T}$	The A-weighted L_{eq} sound level measured over a specified period of time, T.
Lowest Observed Adverse Effect Level	This is the level of noise above which adverse effects on health and quality of life can be detected.
L_W (Sound power levels)	These are used to describe the noise output of a noise source.
Noise	Unwanted sound.
Noise and vibration sensitive receptor (NSR)	A location that is sensitive to noise and/or vibration. The sensitivity of a receptor to Noise and Vibration varies depending on the receptor type.
Overhead Line	Conductor (wire) carrying electric current, strung from pylon to pylon.
Peak Particle Velocity	A measurement of vibration level, being the maximum rate of displacement of the vibration propagation medium (such as the ground) for a given event, such as the impact of a piling hammer, at specific locations.
Piling	The installation of bored and driven piles and the effecting of ground treatments by vibratory dynamic and other methods of ground stabilisation.

Term	Definition
Pylons	Structures that support the overhead line (conductors). There are two types of pylons; suspension (line), where the conductors are simply suspended from the tower and tension (angle).
Receptor	The physical resource or user group that would respond to an effect e.g. somebody or something adversely affected by a pollutant.
Significance	A measure of the importance or gravity of the environmental effect, defined by significance criteria specific to the environmental topic.
Significant observed adverse effect level (SOAEL)	This is the level of noise above which significant adverse effects on health and quality of life occur.
Sound	Sound is vibrations travelling through a medium (usually air) that can be perceived by the hearing organs.
Substation	Substations are used to control the flow of power through the electricity system. They are also used to change (or transform) the voltage from a higher to lower voltage to allow it to be transmitted to local homes and businesses.
Time Weighting	Sound level meters use various averaging times for the measurement of Route Mean Square sound pressure level. The most commonly used are fast (0.125 s averaging time), slow (1s averaging time) and impulse (0.035 s averaging time). Variables that are measures with time weightings are expressed as L_{AFmax} etc.
Trenchless crossing	A crossing installation method that has limited above ground disturbance which is used to avoid a sensitive feature such as an environmental feature.
Underground cabling	An insulated conductor carrying electric current designed for underground installation. Underground cables link together two cable sealing end compounds.

Bibliography

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

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

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