Haweswater Aqueduct Resilience Programme – Proposed Bowland Section

Environmental Statement

Volume 4

Appendix 17.2: Construction Assessment Approach & Scenarios

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Haweswater Aqueduct Resilience Programme - Proposed Bowland Section

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Contents

1. Construction Assessment Approach and Scenarios

1) This appendix presents (for all sections of the Proposed Programme of Works):

- Details regarding the airborne noise modelling prediction approach
- A description of the construction activities that have been assessed
- A list of plant and equipment that are assumed to be operating during the construction phase of the project (including heavy vehicle movements on haul roads)
- Details regarding the phasing of construction activities and how these have been considered.

2) The appendix presents available information regarding the aspects listed above, based on technical knowledge and reasonable assumptions regarding likely activities, typical plant and equipment, and anticipated timing and durations. This provides a robust basis for construction noise and vibration assessment, which considers the worst-case construction phases in terms of potential for effects to occur.

3) During construction of the project, temporary noise and vibration impacts may occur at nearby sensitive receptors. This would be dependent upon the type of works undertaken, the proximity to nearby receptors, the duration of the works and their timing.

4) Impacts along the tunnel route may result during the tunnelling activity and during the open-cut trenching / connections work at the temporary construction compounds. These construction works are likely to be of limited duration for individual receptors as construction works progress along the tunnel route. Consideration has been given to short-term noise and vibration impacts at nearby sensitive properties and community assets as the various elements of construction (namely tunnelling via TBM, pipeline connections, open-cut trenching and piling) are undertaken.

5) Construction works are likely to be of longer duration at the temporary construction compounds. Therefore, consideration has been given to temporary noise and vibration impacts at sensitive receptors in close proximity to each of these sites.

6) Reference has been made to the preliminary construction programme available at the time of the assessment and the assumed plant and equipment to be used.

7) Consideration has been given to noise increases on the local road network as a result of changes to road traffic volumes and changes in vehicle composition during construction. Calculations have been carried out following the procedures outlined in the Calculation of Road Traffic Nosie (CRTN)[1]. Additional guidance has also been sought from the Design Manual for Roads and Bridges (DMRB) Sustainability & Environment Appraisal LA 111 Noise and vibration, 2020 (Rev. 2)[2] to determine appropriate noise change criteria.

8) There is the potential for blasting to be undertaken to remove high strength rock. The level of information on blast design and ground conditions available at this time prevents detailed predictions of impacts during blasting. The approach to blasting, along with locations where blasting is likely to be undertaken and the measures that shall be adopted to mitigate impacts are detailed within Appendix 17.4.

9) Appendix 17.4 also contains the predicted construction vibration levels, using the empirical predictors presented in Table E.1 of BS 5228-2[3], resulting from piling and vibratory compaction.

[1] Department for Transport and the Welsh Office. 1988. Calculation of Road Traffic Noise. Cardiff: National Assembly for Wales.
[2] Highways England, Transport Scotland, Welsh Government, Department for Infrastructure. 2020. Sustainability & Environment Appraisal LA 111 Noise and vibration. Revision 2.
[3] BSI (2014). British Standard 5228 part 2 (BS 5228-1:2009+A1:2014), *Code of practice for noise and vibration control on construction and open sites, Part 2: Vibration*. London, the British Standards Institution.

1.1 Construction Road Traffic

10) An assessment has been undertaken of the likely change in road traffic noise as a result of construction traffic using the local road network. The assessment has been made using the traffic movements estimated from a spreadsheet traffic model exercise, as reported in Chapter 16: Transport Planning.

11) The criteria used in assessing construction road traffic are presented in Appendix 17.1.

1.1.1 Prediction Method

12) For roads with an Annual Average Weekday Traffic (AAWT) 18-hour flow of 1000 vehicles or more, predictions of airborne noise from construction road traffic have been made in accordance with the method set out in the Calculation of Road Traffic Noise (CRTN)[4] and with the updates detailed in the DMRB LA111 Rev2[5]. The predicted $L_{A10,18h}$ noise levels have been converted to Lday levels using Method 3 contained in TRL report 'Converting the UK traffic noise index $L_{A10,18h}$ to EU noise indices for noise mapping'[6].

13) For roads with an AAWT 18-hour flow of less than 1000 vehicles, $L_{Aeq,T}$ predictions of airborne noise from construction road traffic have been made in accordance with the method set out in the Noise Advisory Council measurement and prediction guide[7].

14) For both prediction methods the traffic noise level shall be expressed as a free-field $L_{Aeq,12h}$ at a reference distance of 10 m from the kerb. Further consideration has been given to construction noise levels at properties in the vicinity of traffic links that are predicted to result in potential significant effects, as per Appendix 17.1.

1.2 Noise Modelling Approach

15) The plant and equipment list was first screened to identify the activities to be taken forward to detailed noise modelling. This involved calculating broadband sound pressure levels for each activity, including corrections for operating on-times, mitigation included in the plant and equipment list, and considered operating periods (day, evening and night). The activities that were predicted to result in the highest noise emissions and/or impacts were included in the noise modelling exercise.

16) Construction noise levels have been predicted using Datakustik CadnaA® noise prediction software. All predictions have been made in accordance with BS 5228-1[8]. The noise model includes a number of model variants, each representing a discrete construction activity. The noise model variants have been combined to create composite construction activities that have been used in assessing potential construction noise impacts. For example, the general surface works activity (Gen) is created by combining the general works (model variants A), Water Treatment Plant (J) and generator (L).

17) The noise model variants are described below in Section 1.3. Section 1.4 presents two tables that illustrate how the noise model variants are combined to create the construction activities assessed, along with a table that presents which of the activities are anticipated to occur at each of the construction compounds.

18) Table 1 presents the noise model settings and conditions.

[4] HMSO. 1988. Department of Transport and Welsh Office. CRTN, 'Calculation of Road Traffic Noise'
[5] Highways England, Transport Scotland, Welsh Government, Department for Infrastructure. 2020. Sustainability & Environment Appraisal LA 111 Noise and vibration. Revision 2
[6] Transport Research Laboratory. Abbott, P.G. and Nelson, P.M. TRL PR/SE/451/102, 'Converting the UK traffic noise index LA10,18h to EU noise indices for noise mapping'
[7] HMSO. 1978. The Noise Advisory Council, 'A guide to measurement and prediction of the equivalent continuous sound level Leq'
[8] British Standards Institution (BSI). 2014. BS5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Noise. London, BSI

Table 1: CadnaA noise model settings and conditions

Model element	Condition or setting
3D contours	1 m ground contour data was included in the model, extending beyond the nearest noise sensitive receiver points in the model. Proposed 3D topography lines at the compounds were included and used to represent all of the modelling scenarios, with the exception of the early enabling works activity.
Receiver points	All receiver points are positioned in either free-field (away from any reflective surfaces) or façade (1 m from building façade and include a +3 dB correction to account for reflections from the facade) positions.
	Receivers have been identified and located within the noise model using the available Ordinance Survey (OS) Address Base Plus product.
	Receiver points are positioned 1.5 m above ground to represent ground floor noise levels. First floor predictions are made at 4.0 m above ground, with higher floors represented at 2.5 m increments as required.
Operating on-times	Operating on-times have been set for all noise sources and for all assessment periods, i.e. weekday and weekend day, evening and night.
	Generators have a 100 % on-time, with no breaks in operation. This is a worst-case assessment assumption, as demand for power from the generators will fluctuate during construction, which may result in periods of lower noise emission.
	Many pumps and compressors have an operating on-time of 80 %, to allow for near continual operation throughout the assessment period, with the exception of break periods.
	Some sources, such as hand tools, air valves, excavators, compressors, have lower operating on-times, to represent their infrequent use.
Ground conditions	Soft ground (α=1) has been assumed throughout the noise model, with the exception of roads, rivers and the proposed compound areas (assumed hard ground, α=0).

19) Site hoarding is proposed to be installed around the boundary of the drive and reception compounds. The hoarding is anticipated to be solid chipboard and 2.4 m in height, with a surface density in excess of 7 kg/m^2, in accordance with BS 7228-1. The site hoarding is represented within the noise model at site boundaries at an assumed height of 2.4 m.

1.3 Construction Noise Model Variants

20) The following construction scenarios have been created within the noise model (construction durations are indicative and will vary between shaft locations):

- General works at the site compounds (noise model variant A): This scenario represents general activity at the drive and reception shaft compounds, and would take place from the end of the enabling works (after the site compounds are established) until the end of the construction phase and the compounds are reinstated
- Portal; construction (noise model variant B): This scenario represents the adit construction and spray concrete lining (SCL) at the drive compounds to prepare for the Tunnel Boring Machine (TBM) launch (with plant positioned in the shaft and at surface level), and would take place early in the construction programme for approximately three months
- Tunnelling (noise model variant C): This scenario represents the tunnelling activity (TBM), without a Slurry Treatment Plant (STP) at surface level at drive shafts, and would take place throughout much of the construction programme after adit construction is complete. The duration would vary depending on the length of tunnel

- Multi Line Syphon (MLS) construction – connections (noise model variant D): This scenario would include capping beam, excavation and propping activities and would take place following the main tunnelling phase. Most of the works would take place towards the end of the construction works. The duration of works is likely to be in the order of one to two months
- Open cut trenching works (noise model variant H): This scenario represents the trenching activity at surface level that is required to excavate a path between the new tunnel and the existing MLS pipeline. The activity is likely to take place once tunnelling works are complete for a duration of approximately 3 months
- Piling (noise model variant I): The assessment assumes piling would be required at structures such as at the proposed new valve houses and at connection points. As a precautionary approach, vibratory sheet piling has been assumed, however lower impact piling methods (such as Continuous Flight Auger, CFA) would be adopted where practicable. The activity could take place sporadically during the construction phase and is unlikely to be undertaken for an extended period. Where practicable, the construction approach at connections will be designed in a way that reduces the requirement for piling. The assessment of noise and vibration during piling in these locations is precautionary and represents a reasonable approach
- Water Treatment Plant (WTP) (noise model variant J): The WTP at each of the compounds is identified on the compound site layout drawings. This activity represents the plant that shall be operating at the WTP and would be in operation after the site compounds are established until the end of the construction phase and the compounds are reinstated
- Generators for main site power (noise model variant L): This scenario includes the generators that shall be required to power plant and equipment at the drive and receptions shafts, including the TBM. It is assumed that the generators would be in operation throughout the construction phase of the project (following initial site establishments). It is assumed that generators will be on continuously at drive compounds, and during the daytime only (weekday and Saturday until 13:00) at reception compounds

21) The site enabling construction scenarios created within the noise model are described below:

- Enabling works (noise model variant M): This scenario represents the earthworks enabling activity that would take place at all of the drive and reception shaft compounds. The activity would take place at the start of the construction phase and would last for several months (approximately three to five months, with duration dependent upon the size of the compound and amount of earthworks anticipated to be required). The assessment has predicted both average noise levels, where equipment is spread evenly throughout the compound, and reasonable worst-case noise levels, when works are positioned closer to the property or environmental asset under consideration.
- Surplus materials earthworks (noise model variant K): This scenario represents the additional surface works that shall be undertaken at Lower Houses Compound (Proposed Bowland Section) to transport and handle material in the vicinity of the compound. The activity would be anticipated to take place after main enabling works are completed and before the start of the tunnelling phase
- Extensive earthworks are anticipated to be required at the launch compound at the Proposed Bowland Section. As such, the number of plant and equipment is assumed to be double that operating at the other compounds. More intensive works have also been assumed in the vicinity of the River Hodder bridge at the Newton-in-Bowland Compound during construction
- Elevated noise levels may occur during the enabling phase of works where vegetation removal is required. Vegetation removal would likely require the use of hand tools such as chainsaws. The noise emission from such equipment can be in excess of 85 dBA at 10 m, but can be reduced through effective temporary screening. The duration of the vegetation removal phase of enabling works would vary depending on the extent of the vegetation removal required, but would be anticipated to be of relatively short duration of less than a month at most locations

22) It is anticipated that the site reinstatement works (during the decommissioning phase of construction) at the site compounds would be broadly comparable to the works undertaken during the early

earthworks enabling phase. As such, the noise model prediction for the earthworks phase are considered to represent noise emissions during both the early enabling works and the site reinstatement works.

1.4 Construction Activities and Indicative Phasing

23) The list of composite construction activities and indicative phasing of works presented below in Table 2 was discussed and confirmed by the Early Contractor Involvement (ECI) contractor in June 2020, with the indicative phasing of construction activities based on the details within the plant list created by the ECI contractor and modified using the phasing presented within the Theoretical Vehicle Movements (v6) spreadsheet.

Table 2: Construction activities using construction modelling variants

Activity	2023			2024			2025			2026			2027			2028			2029			Sporadic during construction
	E	M	L	E	M	L	E	M	L	E	M	L	E	M	L	E	M	L	E	M	L	
Enabling works*		M	M																	M	M**	
General above ground activity (*Gen*)				A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)	A & J & (L)			
Adit construction				Gen + B																		
Tunnelling (+surplus mat.)					Gen + C + K	Gen + C + K	Gen + C + K	Gen + C + K	Gen + C + K	Gen + C + K	Gen + C + K	Gen + C + K	Gen + C + K	Gen + C + K	Gen + C + K	Gen + C + K						
Connections																		Gen + D	Gen + D			
Piling																						Gen+ I
Open cut																		Gen + H	Gen + H			

NOTES:

It is important to note that construction programme dates are indicative and vary between compounds. The dates presented in this table are only intended to highlight relatively long and short duration activities and indicative phasing of works.

E – Early (January to April), M – Mid (May to August), L – Late (September to December)

* Including site reinstatement works.

** Site reinstatement works are anticipated to be completed by mid-2030.

1.5 Construction Activities at Compounds

24) Table 3 presents which of the construction activities are expected to occur at each compound and the operating periods (e.g. day vs. night, weekday vs. weekend) during construction.

25) The rows beneath the 'Locations' heading denote which activities expected to take place at each compound.

26) The rows beneath the 'Period' heading show when the activities are predicted to take place.

Table 3: Construction activities and operating times at construction compounds

Compound	Enabling works	General above ground activity	Portal construction	Tunnelling	Connection works	Piling	Open cut	Surplus Materials
Locations								
Proposed Bowland Section – Reception Shaft	Y	Y			Y	Y	Y	Y
Proposed Bowland Section – Launch Portal	Y	Y	Y	Y	Y	Y	Y	
Periods								
WD - day	Y	Y	Y	Y	Y	Y	Y	Y
WD – eve		Y	Y	Y	Y			
WD – night		Y	Y	Y	Y			
Sat – day	Y	Y	Y	Y	Y	Y	Y	Y
Sat – eve		Y	Y	Y	Y			
Sat - night		Y	Y	Y	Y			
Sun – day		Y	Y	Y	Y			
Sun - night		Y	Y	Y	Y			
NOTES WD - Weekday (Monday to Friday), Sat – Saturday, Sun - Sunday								

1.6 Plant List

27) The plant list presented below in Table 4 is based on that produced by the ECI in March 2020, including later amendments to number of items, mitigation and on-times agreed with the ECI contractor. The table presents an indicative list of plant and equipment for the anticipated construction activities that will be undertaken during the Programme of Works. Table 5 presents the construction haul road average hourly vehicle movements and is based on the Theoretical Vehicle Movements (v6) spreadsheet.

Table 4: Plant and equipment list

Plant	No.	Sound Power Level (L_{WA})	BS 5228-1 noise source 1)	Operating on-time (%)								Mit. (dB)	Note
				Weekday			Sat			Sun			
				D	E	N	D	E	N	D	N		
General plant activity at compound (Noise model variant A)													
Generator	1	88	C4.77	100	100	100	100	100	100	100	100		
13t Excavator	1	98	C2.7	40	-	-	40	20	-	40	-		
5t Excavator	1	93	C4.68	8	-	-	8	-	-	8	-		
6t Dumper	1	102	c2.32	16	-	-	16	-	-	16	-		
Telehandler	1	99	C4.55	40	-	-	40	20	-	20	-		
Compressor, 250cfm	1	94	C5.5	16	-	-	16	-	-	16	-		
Lighting Towers	4	92	c4.79	50	-	-	50	-	-	50	-		Hybrid unit
Misc. hand tools	2	98	M	48	32	32	32	32	32	32	32	5	Low noise tools with efficient silencer
Road sweeper	1	104	C4.90	16	4	-	16	-	-	16	-		
Wheel wash	1	98	TA	32	-	-	32	-	-	32	-		
Crane	1	106	C4.38	8	-	-	8	-	-	8	-		
Jet Wash	1	91	C3.13	8	-	-	8	4	-	8	-		
Waste water pump surface	1	97	C4.88	40	40	40	40	40	40	40	40	10	Full or partial enclosure
Forklift	1	99	C2.35	20	20	-	20	20	-	20	-		
MEWP	1	95	C4.57	24	24	-	24	24	-	24	-		
Telehandler	1	99	C4.55	20	20	-	20	20	-	20	-		
Misc. Hand Tools	2	98	M	8	8	8	8	8	8	8	8	5	Low noise tools with efficient silencer
350t Crawler crane	1	99	C4.50	80	64	64	80	64	64	80	64	5	Efficient exhaust sound reduction equipment
Ventilation fan	1	80	TA	80	80	80	80	80	80	80	80		
Smaller crawler crane + man-riding cage	1	98	C3.30	32	32	-	32	32	-	32	-		
Alimac access lift	1	95	C4.57	40	40	-	40	40	-	40	-		
Slurry pumps	2	97	C4.88	72	72	72	72	72	72	72	72	10	Partial (or full) enclosure
Waste water pump	1	97	C4.88	80	80	80	80	80	80	80	80	10	Full or partial enclosure
Portal construction (Noise model variant B)													
Concrete Pump	1	108	c4.29	40	40	40	40	40	40	40	40	20	Source in shaft (below ground). Unlikely to be audible

Plant	No.	Sound Power Level (L_{WA})	BS 5228-1 noise source 1)	Operating on-time (%)								Mit. (dB)	Note
				Weekday			Sat			Sun			
				D	E	N	D	E	N	D	N		
													above ground during typical construction activities.
Remixer	1	104	c4.22	40	40	40	40	40	40	40	40		
Excavator with road header attachments	1	106	c2.3	24	24	24	24	24	24	24	24	20	*As above*
8t excavator	1	106	c4.63	40	40	40	40	40	40	40	40	20	*As above*
1.5t breaker	1	111	c5.2	16	16	16	16	16	16	16	16	20	*As above*
Spraying Robot	1	106	TA	40	40	40	40	40	40	40	40	20	*As above*
Compressor, 600cfm	1	100	M	40	40	40	40	40	40	40	40		
Muck unloading with excavator	1	109	c6.6	24	-	-	24	-	-	24	-		
Muck skips unloading	1	102	c2.32	40	40	40	40	40	40	40	40		
25t excavator in muckbin	1	103	c2.16	80	40	8	80	40	40	40	40		
Screw conveyors	1	88	M	40	40	40	40	40	40	40	40		
Tunnelling (Noise model variant C)													
Water pumping room	1	115	TA	80	80	80	80	80	80	80	80	20	In container
Chiller	1	96	TA	80	80	80	80	80	80	80	80		
Pneumatic valves (Air exhaust)	1	95	TA	4	4	4	4	4	4	4	4		In 'shed' - ground level, (noise reduction included in source level)
Misc. hand tools	2	98	M	8	-	-	8	8	-	8	-		In container (noise reduction included in source level)
Compressor, 250cfm	1	94	c5.5	80	80	80	80	80	80	80	80	20	In 'shed' - ground level
Compressor, 400cfm	1	103	c3.19	80	80	80	80	80	80	80	80	20	In 'shed' - ground level
Grout plant : Silos' screws motor/gear unit	1	88	M	6	6	6	6	6	6	6	6		
Grout plant Mixer	1	83	TA	6	6	6	6	6	6	6	6		In container (noise reduction included in source level)

Plant	No.	Sound Power Level (L_{WA})	BS 5228-1 noise source 1)	Operating on-time (%)								Mit. (dB)	Note
				Weekday			Sat			Sun			
				D	E	N	D	E	N	D	N		
Grout plant silos dust filters air blast	1	95	TA	6	3	3	6	3	3	3	3		
Grout transfer pump	1	76	M	6	6	6	6	6	6	6	6		
Grout plant pneumatic valves/ flushers	1	95	TA	16	16	16	16	16	16	16	16		
Grout plant Water pump	1	76	M	80	80	80	80	80	80	80	80		In container (noise reduction included in source level)
MLS construction – connections (Noise model variant D)													
Hand held breaker	1	96	M	16	16	-	16	16	-	16	-		
Concrete muncher	1	108	C1.3	16	16	-	16	16	-	16	-		
40t mobile service crane	1	98	c3.30	24	24	24	24	24	24	24	24		
5t excavator	1	93	c4.68	48	48	48	48	48	48	48	48		
Floor scabbler	1	95	c5.27	24	24	-	24	24	-	24	-		
Concrete pump	1	108	c4.29	50	50	-	50	50	-	25	-	10	full or partial enclosure
Vibrating Poker	1	97	c4.34	32	32	-	32	32	-	16	-		
Compressor, 250cfm	1	94	c5.5	40	40	-	40	40	-	40	-		
100kVA Generator	1	89	c4.76	100	100	-	100	100	-	100	-		
Pump - overpumping	1	93	c2.45	24	24	24	24	24	24	24	24		
Piling (Noise model variant I)													
13t Excavator	1	98	c2.7	32	-	-	32	-	-	-	-		
Pump concrete	1	100	M	40	-	-	40	-	-	-	-	5	Screen or partial enclosure
Mobile crane	1	98	c3.30	36	-	-	36	-	-	-	-		
Welding set	1	102	c3.32	8	-	-	8	-	-	-	-		
Compressor, 400cfm	1	103	c3.19	8	-	-	8	-	-	-	-		
Mobile elevated working platform	1	95	c4.57	4	-	-	4	-	-	-	-		
Pressure Washer	1	109	c6.37	20	-	-	20	-	-	-	-		
Piling rig	1	116	c3.8	68	-	-	68	-	-	-	-		
Cage Vibrator for CFA	1	95	Man	8	-	-	8	-	-	-	-		
Bentonite Mixer	1	96	Man	40	-	-	40	-	-	-	-		

Plant	No.	Sound Power Level (L_{WA})	BS 5228-1 noise source 1)	Operating on-time (%)								Mit. (dB)	Note
				Weekday			Sat			Sun			
				D	E	N	D	E	N	D	N		
Mud Plant - Compact Desander	1	96	Man	32	-	-	32	-	-	-	-		
Electric Pump	1	87	Man	52	-	-	52	-	-	-	-	5	Screen or partial enclosure
Diesel Pump	1	90	c2.46	40	-	-	40	-	-	-	-	5	Screen or partial enclosure
Concrete pokers	3	97	c4.34	8	-	-	8	-	-	-	-		
Water Treatment Plant (WTP) (Noise model variant J)													
Transfer pump from clarifier	1	74	TA	24	24	-	24	24	-	24	-		
Transfer pump from clarifier - pipes	1	78	TA	24	24	-	24	24	-	24	-		
De-sanding pump	1	82	TA	24	24	-	24	24	-	24	-	20	Container / enclosure
De-sanding screen	1	79	TA	24	24	-	24	24	-	24	-	20	Container / enclosure
Transfer pump: T4 to T5, T7, CF	1	94	TA	24	24	-	24	24	-	24	-	5	Screen or partial enclosure
Transfer pump: T4 to T3	1	94	TA	24	24	-	24	24	-	24	-	5	Screen or partial enclosure
Centrifugal Pump (A)	1	84	M	80	80	-	80	80	-	80	-	20	Container / enclosure
Centrifugal Pump (B)	1	101	M	80	80	-	80	80	-	80	-	20	Container / enclosure
Water Fall 1	1	98	M	80	80	-	80	80	-	80	-	20	Container / enclosure
Water Fall 2	1	98	M	80	80	-	80	80	-	80	-	20	Container / enclosure
Screw Pump (C)	1	90	C2.46	24	24	-	24	24	-	24	-		Outside
De- sanding Screen (D)	1	91	M	80	80	-	80	80	-	80	-	20	Container / enclosure
Hydro cyclone (E)	1	97	M	80	80	-	80	80	-	80	-	20	Container / enclosure
Centrifugal Pump (F)	1	93	C2.45	80	80	-	80	80	-	80	-	20	Container / enclosure
Scraper (Gear mortar)	1	87	M	80	80	-	80	80	-	80	-	20	Container / enclosure
Mixing Tank	1	94	M	80	80	-	80	80	-	80	-		outside
Roomed Equipment inside the container all 3 pumps running	1	87	M	80	80	-	80	80	-	80	-	20	Container / enclosure

Plant	No.	Sound Power Level (L_{WA})	BS 5228-1 noise source [1]	Operating on-time (%)								Mit. (dB)	Note
				Weekday			Sat			Sun			
				D	E	N	D	E	N	D	N		
Transfer pump from clarifier	1	74	TA	80	80	80	80	80	80	80	80	20	thickener tank - inside
Transfer pump from clarifier - pipes	1	78	TA	80	80	80	80	80	80	80	80		
De-sanding pump	1	82	TA	80	80	80	80	80	80	80	80	40	Inside container – de-sanding WTP unit
De-sanding screen	1	79	TA	80	80	80	80	80	80	80	80	40	Inside container – de-sanding WTP unit
Transfer pump: T4 to T3	1	94	TA	80	80	80	80	80	80	80	80	20	Water pump container - inside
Water Fall 1(a)	1	98	TA	80	80	80	80	80	80	40	40	40	Inside container – de-sanding WTP unit
Screw Pump (C)	1	90	c2.46	24	24	24	24	24	24	24	24	20	Container / enclosure
Roomed Equipment inside the container all 3 pumps running	1	87	TA	80	80	80	80	80	80	80	80	20	Container / enclosure
Open-cut trenching works (Noise model variant H)													
13t Excavator	1	98	c2.7	40	-	-	40	-	-	-	-		
5t Excavator	1	93	c4.68	80	-	-	80	-	-	-	-		
Dumper (idling) 9t	2	91	c4.5	40	-	-	40	-	-	-	-		
Dump truck (tipping fill) 29t	2	107	c2.30	40	-	-	40	-	-	-	-		
Roller (rolling fill) 18t	1	108	c2.37	40	-	-	40	-	-	-	-		
Vibratory roller; 3t	1	101	c2.40	40	-	-	40	-	-	-	-		
Excavator mounted rock breaker, 29t	1	121	C9.11	20	-	-	20	-	-	-	-	5	Barrier at the point of breaking out
Excavator mounted rock breaker, 23t	1	113	C9.12	20	-	-	20	-	-	-	-	5	Barrier at the point of breaking out
Tracked excavator, 22t	1	106	c2.3	80	-	-	80	-	-	-	-		
Dozer, 28t	1	107	c2.11	80	-	-	80	-	-	-	-		
100t crawler crane	1	106	C4.38	80	-	-	80	-	-	-	-	5	Efficient exhaust sound

Plant	No.	Sound Power Level (L_{WA})	BS 5228-1 noise source 1)	Operating on-time (%)								Mit. (dB)	Note
				Weekday			Sat			Sun			
				D	E	N	D	E	N	D	N		
													reduction equipment
Surplus materials earthworks (Noise model variant K)													
30t Excavator	1	106	c2.3	40	-	-	40	-	-	-	-		
5t Excavator	1	93	c4.68	80	-	-	80	-	-	-	-		
Dumper (idling); 9t	2	91	c4.5	40	-	-	40	-	-	-	-		
Dump truck (tipping fill); 29t	2	107	c2.30	40	-	-	40	-	-	-	-		
Roller (rolling fill), 18t	1	108	c2.37	40	-	-	40	-	-	-	-		
Vibratory roller; 8.9t	1	103	c5.20	40	-	-	40	-	-	-	-		
Tracked excavator, 22t	1	106	c2.3	80	-	-	80	-	-	-	-		
Dozer, 28t	1	107	c2.11	80	-	-	80	-	-	-	-		
Enabling works (earthworks) (Noise model variant M) *Plant list doubled at Proposed Bowland Section launch shafts due to anticipated extensive earthworks.*													
Supersilent Generator	1	88	C4.77	80	-	-	80	-	-	-	-		
30t Excavator	3	106	C2.3	80	-	-	80	-	-	-	-		
5t Excavator	3	93	C4.68	80	-	-	80	-	-	-	-		
6t Dumper	1	102	c2.32	40	-	-	40	-	-	-	-		
Telehandler	1	99	C4.55	40	-	-	40	-	-	-	-		
Compressor, 250cfm	1	94	C5.5	20	-	-	20	-	-	-	-		
Lighting Towers	5	92	c4.79	20	-	-	20	-	-	-	-		
Road sweeper	1	104	C4.90	40	-	-	40	-	-	-	-		
Concrete Wagon	1	101	M	20	-	-	20	-	-	-	-		
Wheel wash	1	98	TA	20	-	-	20	-	-	-	-		
Jet Wash	1	91	C3.13	40	-	-	40	-	-	-	-		
Waste water pump surface	1	97	C4.88	20	-	-	20	-	-	-	-		
Forklift	1	99	C2.35	40	-	-	40	-	-	-	-		
Telehandler	1	99	C4.55	40	-	-	40	-	-	-	-		
Roller (rolling fill) 18t	2	108	C2.37	40	-	-	40	-	-	-	-		
Misc. Hand Tools	1	98	M	40	-	-	40	-	-	-	-		
Crane	1	106	C4.38	30	-	-	30	-	-	-	-		Source at Hodder crossing only
Haul Road Surfacing Work, installation / removal (included within noise model variant M) *Plant list has been used for all access roads, including the stone access roads (where it would represent a worst-case approach)*													
Road Paver	1	105	C5.31	40	-	-	40	-	-	-	-		
Tandem Vibratory Roller	1	103	C5.20	40	-	-	40	-	-	-	-		
Compressor	1	103	C3.19	80	-	-	80	-	-	-	-		

Plant	No.	Sound Power Level (L_{WA})	BS 5228-1 noise source [1]	Operating on-time (%)								Mit. (dB)	Note
				Weekday			Sat			Sun			
				D	E	N	D	E	N	D	N		
Road planer	1	110	C5.7	40	-	-	40	-	-	-	-		
Excavator	2	103	C4.64	80	-	-	80	-	-	-	-		
Dump truck tipping fill	1	107	C2.30	40	-	-	40	-	-	-	-		
Mini excavator with hydraulic breaker	1	111	C5.2	40	-	-	40	-	-	-	-		
Generators and transformers for main site power (Noise model variant L)													
250kVA generator	*	90	Man	*	*	*	*	*	*	*	*		Bruno Fusteq model FQ331C (240 kW, assumed ~300kVA)
1250kVA generator	*	95	Man	*	*	*	*	*	*	*	*		Bruno Fusteq model FQ1400C (1000 kW, assumed ~1250kVA)
500 kVA Transformer (Super quiet core) at Reception shaft	1	79	TA	100	-	-	100	-	-	100	-		Calculated using NEMA method presented in Bies & Hansen 2009[9].
2750 to 4000 kVA Transformer (Super quiet core) at Drive portal	1	91	TA	100	100	100	100	100	100	100	100		

NOTES

Note 1 - BS 5228-1 noise source terms have been used (namely, tables C.1 to C.12) where manufacturer or measurement data is unavailable. The ECI contractor has made technical assumptions, based on previous project experience, for sources not available within BS 5228-1. 'M' denotes measured data, 'Man' denotes manufacturer's data and 'TA' denotes technical assumption.

Weekday Day (D) 07:00 to 19:00, Evening (E) 19:00 to 22:00, Night (N) 22:00 to 0700.

Saturday Day (D) 07:00 to 13:00, Evening (E) 13:00 to 22:00, Night (N) 22:00 to 0700.

Sunday Day/Evening (DE) 07:00 to 22:00, Night (N) 22:00 to 0700.

Generators are generally assessed with an assumed on-time of 100%. This is considered a reasonable worst-case approach as power demand will fluctuate throughout the working day.

* The number, composition and operating on-times of generators differs between compounds. Generator requirements were reviewed by ECI contractor and presented in *App 2 - HARP Proposed Site Generator Requirements.xlsx*. The general requirements can be summarised as:

1. Reception compound includes two 250kVA generators operating during the daytime period only.

[9] Bies & Hansen (2009), Engineering Noise Control – Theory and Practice, 4th ed., Spon Press, London

Plant	No.	Sound Power Level (L_{WA})	BS 5228-1 noise source 1)	Operating on-time (%)								Mit. (dB)	Note
				Weekday			Sat			Sun			
				D	E	N	D	E	N	D	N		
2. Drive compound include a combination of 250kVA and 1250kVA generators, operating throughout the day, evening and night-time periods.													

28) The movement of vehicles on designated haul roads has been considered. Predictions are made using the approach presented in BS 5228-1, Annex F.2.5. Vehicles were assigned a speed of 20 km/h and a source height of 1 m above ground. A lorry, with a noise emission of 79 dBA @10 m, was used as a proxy source for all haul road vehicle movements.

29) Movements per hour were determined using the data provided by the ECI contractor, which assumes a 50-hour working week covering weekday daytime and Saturday daytime (morning) movements. The hourly flows are presented in Table 5.

Table 5: Construction haul road average hourly vehicle movements

Period		Enabling works	Portal constructionn	Tunnelling	Connection works	Open cut and piling	General surface work
Weekday	Day	7	5	13	3	9	4
	Evening	-	-	-	-	-	-
	Night	-	-	-	-	-	-
Saturday	Day	7	5	13	3	9	4
	Evening	-	-	-	-	-	-
	Night	-	-	-	-	-	-
Sunday	Day	-	-	-	-	-	-
	Night	-	-	-	-	-	-

NOTES

Weekday (Mon to Fri) Day = 07:00 to 19:00; Eve (evening) = 19:00 to 23:00; Night = 23:00 to 07:00

Saturday Day = 07:00 to 13:00; Eve (evening) = 13:00 to 23:00

Sunday Day = 07:00 to 23:00

Weekend (Sat and Sun) Night = 23:00 to 07:00