

## 12 Noise and Vibration

This chapter presents an assessment of the potential noise and vibration impacts on noise sensitive receptors (NSRs) as a result of the construction and operation of the A985 Kincardine Bridge Refurbishment: Piled Viaduct Replacement (hereafter referred to as the proposed scheme).

There were two NSRs identified within the construction noise and vibration study areas: the two dwellings at Higgins Neuk. As part of the assessment, a baseline noise survey was undertaken at Higgins Neuk to gain an understanding of the existing noise climate in the vicinity of the proposed scheme and to establish threshold noise levels at Higgins Neuk. Potential construction noise levels at Higgins Neuk were calculated based on the indicative construction methodology.

The calculated construction noise levels were below the daytime threshold noise levels at Higgins Neuk. Accordingly, it is considered that, without mitigation, construction activities during typical construction hours would not result in significant adverse effects at Higgins Neuk.

It is anticipated that limited short-term night-time closures would be required to alter the carriageway alignment where the temporary bridge structure ties-in to the existing Kincardine Bridge and A985. Due to the lower threshold levels during the night-time, these works have the potential to temporarily exceed the threshold levels, potentially resulting in significant adverse effects at Higgins Neuk.

Mitigation measures for the proposed scheme in relation to noise and vibration are detailed in this chapter and take into account best practice, legislation, guidance and professional experience. With the appropriate noise mitigation measures employed, it is considered that any adverse noise effects associated with construction of the proposed scheme are unlikely to be significant.

Given the distance between the construction works for the proposed scheme and the nearest NSR, vibration effects for activities such as piling and breaking concrete are not predicted to be significant at any NSRs.

Changes in road traffic noise level effects due to the realignment of traffic caused by the use of the temporary bridge structure are not predicted to be significant at any NSRs.

A just perceptible increase in road traffic noise levels is predicted on Toll Road due to traffic management measures during construction. This perceptible effect is not considered to be significant because the traffic management measures will be temporary. No other perceptible increases in road traffic noise are predicted on the road network in the vicinity of the proposed scheme during construction.

It is anticipated that the proposed scheme will not change the traffic flow, speed or composition on the local road network during the operational phase. Therefore, a material change in operational noise and vibration at NSRs is considered to be unlikely.

### 12.1 Introduction

- 12.1.1 This chapter of the Environmental Impact Assessment (EIA) Report presents the assessment of potential noise and vibration impacts as a result of the construction and operation of the A985 Kincardine Bridge Refurbishment: Piled Viaduct Replacement scheme (hereafter referred to as the proposed scheme).
- 12.1.2 A glossary of acoustical terminology is included as Appendix A12.1 (Glossary of Acoustical Terminology). Calibration certificates for the sound level meter and calibrator used in the noise survey are included as Appendix A12.2 (Calibration Certificates).

## 12.2 Legislation, Policies and Guidance

- 12.2.1 The assessment of potential noise and vibration impacts has been carried out with reference to the following documents:
- Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 7 – Noise and Vibration HD 213/11 Rev 1 (Highways Agency, Transport Scotland, Welsh Government and the Department for Regional Development in Northern Ireland 2011), hereafter referred to as DMRB HD 213/11;
  - Calculation of Road Traffic Noise (CRTN) (The Department of Transport 1988);
  - Planning Advice Note (PAN) 1/2011 - Planning and Noise (The Scottish Government 2011a);
  - Technical Advice Note (TAN) – Assessment of Noise (The Scottish Government 2011b);
  - BS 5228-1: 2009 + A1: 2014 – Code of practice for noise and vibration on construction and open sites, Part 1 – Noise (British Standards Institution 2014a), hereafter referred to as BS 5228-1; and
  - BS 5228-2: 2009 + A1: 2014 – Code of practice for noise and vibration on construction and open sites, Part 2 – Vibration (British Standards Institution 2014b), hereafter referred to as BS 5228-2.
- 12.2.2 DMRB HD 213/11 was updated and superseded by DMRB LA 111 in November 2019. As described in Chapter 4 (Overview of Assessment Process), in line with DMRB GG 101 guidance on implementation of the new DMRB standards, implementation of LA 111 was considered. However, due to the majority of the assessment having been completed, the implementation of LA 111 would have incurred significant additional expense and delay and therefore was not taken forward for the proposed scheme, in agreement with Transport Scotland.
- 12.2.3 In addition, a review of relevant national, regional and local planning policies and guidance relevant to noise and vibration are identified in Appendix A4.1 (Assessment of Policy Compliance).

## 12.3 Approach and Methods

### Sources of Information

- 12.3.1 In addition to the documents identified in Section 12.2 (Legislation, Policies and Guidance), the following sources of information were used:
- Ordnance Survey (OS) MasterMap Topography Layer® and AddressBase® Plus data – used to identify noise sensitive receptors in the vicinity of the proposed scheme;
  - Transportation Noise Action Plan (TNAP) (Transport Scotland 2018) – used to identify Candidate Noise Management Areas in the vicinity of the proposed scheme; and
  - Traffic data for the roads in the vicinity of the proposed scheme – used in the assessment of construction road traffic noise.
- 12.3.2 Identification of Candidate Noise Management Areas is based on the noise maps published by the Scottish Government and the TNAP (Transport Scotland 2018). No Candidate Noise Management Areas have been identified within the construction noise and vibration assessment study areas.

### Construction

- 12.3.3 Temporary impacts for road and bridge schemes normally occur between the start of advance works and the end of the construction period. Although temporary, construction-related noise and vibration effects can be significant.
- 12.3.4 Construction work of any type that involves heavy plant activities will generate noise, which may result in complaints if sensitive scheduling and control of works is not exercised. The noise levels generated by

construction activities and experienced by nearby NSRs such as residential properties depends upon a number of variables, the most notable of which are:

- the noise generated by plant or equipment used on site, generally expressed as sound power levels;
- the periods of operation of the plant on the site, known as its 'on-time';
- the distance between the noise source and the NSRs; and
- the attenuation due to ground absorption, air absorption and barrier effects.

12.3.5 With regards to the assessment of construction noise and vibration, DMRB HD 213/11, paragraph 2.20 states: *'For the control of noise and vibration at construction sites, BS 5228 [reference is made to 2009 version, which has since been updated] provides guidance for predicting construction noise and also provides advice on noise and vibration control techniques.'*

12.3.6 DMRB HD 213/11, paragraph 3.39 states: *'Methods are available for evaluating the significance of construction noise and vibration. These methods are described in Annex E of BS 5228 (Ref 9) and should be used unless an alternative method is agreed with the Overseeing Organisation.'*

12.3.7 The TAN which accompanies PAN 1/2011 includes BS 5228-1 and BS 5228-2 in its summary of relevant and current (at the time of publication) codes of practices that may be useful in supporting decision making involving noise issues. It should be noted that previous versions of BS 5228 (Part 1:1997 and Part 4:1992) are still officially approved under Section 71 of the Control of Pollution Act 1974 via The Control of Noise (Codes of Practice for Construction and Open Sites) (Scotland) Order 2002, but the TAN advises that the updated versions of the codes of practice are applicable for EIA and planning purposes. The TAN, paragraph 1.4 also states that *'Where a technical standard referred to in the index has been superseded by a more recent version or alternative, then that document should be used.'*

12.3.8 Accordingly, the 2014 versions BS 5228-1 and BS 5228-2 have been used as the primary sources of guidance for the assessment of potential construction noise and vibration impacts.

#### Construction Noise

12.3.9 To determine the potential construction noise impact, an assessment based on the guidance within BS 5228-1 has been undertaken. The study area for construction noise has been defined as 300m from all construction activities.

12.3.10 BS 5228-1 provides methods for the calculation of noise from construction activities, including information regarding noise levels from a range of construction equipment. The indicative construction methodology (refer to Chapter 3 (The Proposed Scheme) and Appendix A3.1 (Construction Information)) has been used to calculate indicative construction noise levels.

12.3.11 The 'ABC Method' detailed within BS 5228-1 has been adopted to determine whether significant effects as a result of construction noise are likely. The threshold values defined within the 'ABC Method' are shown in Table 12.1.

12.3.12 The threshold values defined in Table 12.1 are for residential noise sensitive receptors (NSRs) only, alternative threshold values are required for marine life associated with the Firth of Forth Site of Special Scientific Interest (SSSI), Special Protection Area (SPA) and Ramsar site. Noise impacts on these habitat areas and the bird species that utilise them are assessed in Chapter 8 (Marine Ecology) and Chapter 9 (Terrestrial Ecology).

**Table 12.1: Example Threshold of Potential Significant Effect at Dwellings (Reproduced from Table E.1 in BS 5228-1)**

Assessment Category and Threshold Value Period	Threshold Value, in Decibels (dB) ( $L_{Aeq,T}$ )		
	Category A <sup>(A)</sup>	Category B <sup>(B)</sup>	Category C <sup>(C)</sup>
Night-time (23:00 – 07:00)	45	50	55
Evenings and weekends <sup>(D)</sup>	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
<p><b>Note 1</b> A potential significant effect is indicated if the <math>L_{Aeq,T}</math> noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.</p> <p><b>Note 2</b> If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total <math>L_{Aeq,T}</math> noise level for the period increases by more than 3dB due to site noise.</p> <p><b>Note 3</b> Applied to residential receptors only.</p> <p><sup>A</sup> Category A: threshold values to use when ambient noise levels (rounded to the nearest 5dB) are less than these values.  <sup>B</sup> Category B: threshold values to use when ambient noise levels (rounded to the nearest 5dB) are the same as Category A values.  <sup>C</sup> Category C: threshold values to use when ambient noise levels (rounded to the nearest 5 dB) are higher than Category A values.  <sup>D</sup> 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.</p>			

Construction Vibration

- 12.3.13 Consideration has been given to the guidance in BS 5228-2 for the construction vibration assessment. The study area for construction vibration has been defined as 100m from all construction activities with the potential to generate vibration.
- 12.3.14 BS 5228-2 contains guidance on vibration levels in structures from construction works. It provides a prediction methodology for certain mechanised construction works, such as compaction and percussive or vibratory piling works. The standard also presents guidance for the control of vibration from construction works. The vibration guidance provided is for human receptors and buildings only. Vibration impacts on these habitat areas and the bird species that utilise them are assessed in Chapter 8 (Marine Ecology) and Chapter 9 (Terrestrial Ecology).
- 12.3.15 BS 5228-2 (Table B.1) provides guidance on the human response to vibration in terms of peak particle velocity (PPV) and is reproduced in Table 12.2.

**Table 12.2: Guidance on the Human Response to Vibration Levels (Reproduced from Table B.1 in BS 5228-2)**

Vibration Level ( $\text{mms}^{-1}$ ) <sup>(A) (B) (C)</sup>	Effect (BS 5228-2)
0.14	Vibration might just be perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3	Vibration might just be perceptible in residential environments.
1.0	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10.0	Vibration is likely to be intolerable for any more than very brief exposure to this level in most building environments.
<p><sup>A)</sup> The magnitudes of the values presented apply to a measurement position that is representative of the point of entry into the recipient.</p> <p><sup>B)</sup> A transfer function (which relates an external level to an internal level) needs to be applied if only external</p>	

Vibration Level ( $\text{mms}^{-1}$ ) <sup>A) B) C)</sup>	Effect (BS 5228-2)
measurements are available.	
<p><sup>C)</sup> Single or infrequent occurrences of these levels do not necessarily correspond to the stated effect in every case.</p> <p>The values are provided to give an initial indication of potential effects, and where these values are routinely measured or expected then an assessment in accordance with BS 6472: 2008 – Guide to evaluation of human exposure to vibration in buildings, Part 1: Vibration sources other than blasting or Part 2: Blast-induced vibration (British Standards Institution 2008), and/or other available guidance, might be appropriate to determine whether the time varying exposure is likely to give rise to any degree of adverse comment.</p>	

12.3.16 For building structure response, BS 5228-2 (Table B.2) reproduces the advice presented in BS 7385-2: 1993 - Evaluation and measurement for vibration in buildings: guide to damage levels from ground borne vibration (British Standards Institution 1993) (hereafter referred to as BS 7385-2). The response of a building to ground borne vibration is affected by the type of foundation, underlying ground conditions, the building construction and the state of repair of the building. Table 12.3 reproduces the guidance detailed on building classification and guide values for cosmetic building damage.

**Table 12.3: Transient Vibration Guide Values for Cosmetic Damage on Building Structures (Reproduced from Table B.2 in BS 5228-2)**

Type of Building	PPV in Frequency Range of Predominant Pulse	
	4Hz to 15Hz	15Hz and Above
Reinforced or framed structures	50mm/s at 4Hz and above	50mm/s at 4Hz and above
Industrial and heavy commercial buildings		
Un-reinforced or light framed structures	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15 Hz increasing to 50mm/s at 40Hz and above
Residential or light commercial buildings		
<p><b>Note 1</b> Values referred to are at the base of the building.</p> <p><b>Note 2</b> For line 2, at frequencies below 4Hz, a maximum displacement of 0.6mm (zero to peak) is not to be exceeded.</p>		

12.3.17 Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 12.3, with major damage at values greater than four times the values in the table. BS 7385-2 also notes that the probability of cosmetic damage tends towards zero at 12.5mm/s PPV.

Road Traffic Noise During Construction

12.3.18 During the construction of the proposed scheme, it is proposed to construct a temporary bridge structure on the north side of the existing piled viaduct.

12.3.19 There may be temporary road restriction or closures during construction of the proposed scheme, which has the potential to result in temporary changes in roads traffic noise levels on the local road network.

12.3.20 With reference to guidance in DMRB HD 213/11, the change in noise levels at NSRs should be calculated to determine the temporary magnitude of effect associated with the scheme, as part of the 'Scoping Assessment'. DMRB HD 213/11 states that 'A change in road traffic noise of 1dB  $L_{A10,18h}$  in the short term...is the smallest that is considered perceptible.' DMRB HD 213/11 states that for the prediction of road traffic noise the methodology given in CRTN should be used.

12.3.21 High level analysis has been undertaken to determine whether road traffic noise levels at NSRs are likely to change by 1dB  $L_{A10,18h}$  or greater as result of the temporary bridge structure or the temporary road restriction or closures.

**Operation**

12.3.22 It is anticipated that the proposed scheme will not change the traffic flow, speed or composition on the local road network during the operational phase. Therefore, a material change in operational noise and

vibration at NSRs is considered to be unlikely and the assessment of operational noise and vibration has been scoped out of this assessment.

### **Consultation**

- 12.3.23 Details of the full consultation process for the proposed scheme are provided in Chapter 5 (Consultation and Scoping) and Appendix A5.1 (Summary of Consultation Responses).
- 12.3.24 The construction noise assessment methodology was discussed and agreed with Falkirk Council's Environmental Health Department, who also advised that standard construction hours for works within the Falkirk Council boundary are as follows:
- Monday to Friday: 08:00-19:00;
  - Saturday: 08:00-13:00; and
  - Sunday: No works to be audible at the site boundary.
- 12.3.25 It was also advised that extension to these hours can be granted in exceptional circumstances, but a case would have to be made to justify working out of the standard construction hours.
- 12.3.26 Fife Council Environmental Health Department were also consulted and provided the following comment:

*'There is likely to be noise disturbance throughout the duration of the project that has the potential to affect local residents within Falkirk and Fife local authority areas. Section 13 of the accompanying Scoping Report makes reference to the guidance contained within British Standard 5228 during construction operations. Although Fife Council, are not the Planning Authority for the development, it is expected that the Best Practicable Means to protect existing noise sensitive receptors from throughout the duration of the project will be detailed and submitted as part of the Construction and Environmental Management Plan (CEMP).'*

### **Limitations to Assessment**

- 12.3.27 There are limited construction details available at this stage. Therefore, the construction noise calculations have used the measured noise levels of typical construction plant and activities reported in BS 5228-1, Annexes C and D. Assumptions have been made regarding the possible phases of construction, construction plant and methods and also times and durations of activities, based on the indicative construction methodology, detailed in Chapter 3 (The Proposed Scheme ) and Appendix A3.1 (Construction Information), and previous experience of on-line road and bridge construction schemes. These would be finally determined by the Contractor. However, it is considered that the assumptions outlined provide a reasonable representation for the purposes of this assessment. This is usual for the assessment of construction noise at this stage, and construction methodologies would be expected to become more defined at later stages in the project. The construction noise assessment reported in Section 12.5 (Potential Impacts) provides details of the assumptions made for the calculation of the construction noise.
- 12.3.28 Traffic data is fundamental to predicting road traffic noise levels, thus facilitating the assessment of the impact on road traffic noise during construction of the proposed scheme. Traffic flow (numbers of vehicles), composition (percentage of heavy vehicles) and speed data contribute in calculating noise levels. Traffic data has been provided for general traffic management during the works and the temporary overnight road closures that may be required to undertake certain construction activities.
- 12.3.29 It is considered that all information and data inputs for this assessment are of an adequate level of detail to support the noise and vibration assessment.



## 12.4 Baseline Conditions

- 12.4.1 Permission was sought to undertake baseline noise monitoring within the grounds of Higgins Neuk (where the two nearest dwellings to the proposed works are located). However, no response from the resident was received, so monitoring was undertaken adjacent to the property (approximate grid reference: 291955, 686989) in January 2019. The noise levels at this position are considered to be representative of those that are experienced within the grounds of the two dwellings.
- 12.4.2 The measurement location is shown in Diagram 12.1 and Photograph 12.1. An Optimus Green Class 1 sound level meter (serial number G061732). The calibration certificate for the sound level meter and calibrator is provided in Appendix A12.2 (Calibration Certificates). The microphone was positioned at a height of approximately 1.5m in free-field conditions. The equipment was approximately 4.5m from the hedge marking the north-eastern boundary of the property and approximately 10m from the noise barrier which partially surrounds the property.

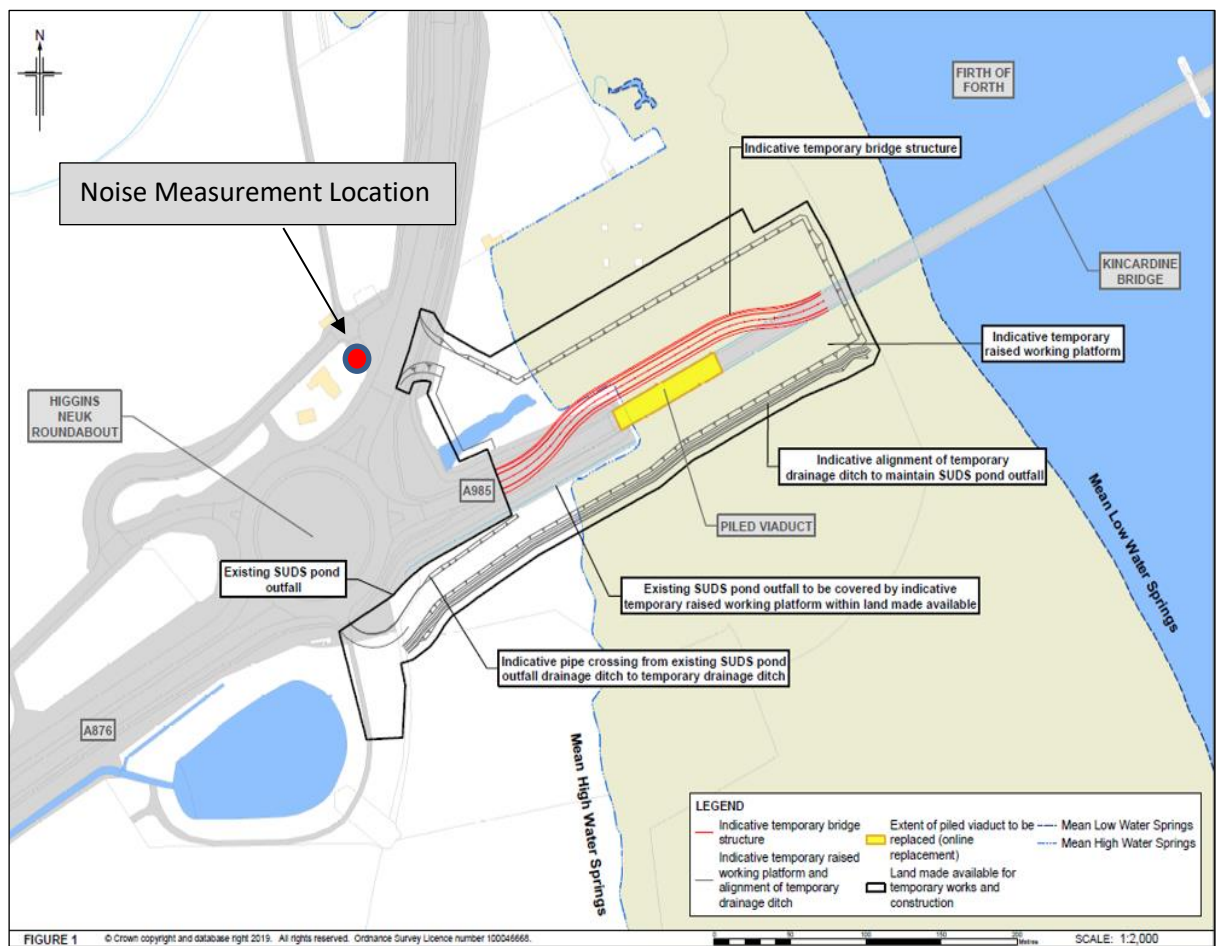


Diagram 12.1: Map showing baseline noise measurement location (red dot) (based on extract from Figure 3.1)



**Photograph 12.1: Photograph showing baseline noise measurement location and noise barrier at Higgins Neuk**

- 12.4.3 The monitoring equipment was calibrated both before and after the measurement period using a Optimus Green acoustic calibrator (serial number 60601), which has itself been calibrated against a reference set traceable to National and International Standards. The greatest drift in calibration observed between the start and end of a measurement was 0.21dB, which is not considered significant.
- 12.4.4 The noise climate was dominated by traffic on the A876 between Higgins Neuk Roundabout and Clackmannanshire bridge. During lulls in traffic during the night, industrial noise to the south-east and north-west was audible. Other noise sources audible during lulls in the traffic include birds, aeroplane or helicopter fly overs and bird scaring guns.
- 12.4.5 Throughout the attended measurements little to no wind and no rainfall was recorded and weather conditions remained conducive for noise monitoring throughout the monitoring period.
- 12.4.6 Table 12.4 provides the measured noise levels at this location.

**Table 12.4: Summary of Attended Noise Level Measurements**

Date	Start Time	Duration	Noise Levels (dB)				Comments
			$L_{A90,T}$	$L_{Aeq,T}$	$L_{A10,T}$	$L_{AFmax,T}$	
09/01/2019	15:45	15 mins	54	59	62	66	Dy. No wind. 80% cloud cover. Noise climate dominated by road traffic noise. Road was subjectively noted to be very busy but occasional gaps in traffic occurred. Loud exhaust on road at 15:46. Helicopter audible at 15:58.
	16:00	15 mins	55	59	62	71	
	19:33	12 mins	48	55	58	66	Dry. No wind. 90% cloud cover. Road traffic remains the dominant noise source but subjectively noted to be quieter than previously noted in afternoon. Not as
	19:45	15 mins	49	56	59	73	



Date	Start Time	Duration	Noise Levels (dB)				Comments
			$L_{A90,T}$	$L_{Aeq,T}$	$L_{A10,T}$	$L_{AFmax,T}$	
							constant, as distant traffic was audible (i.e. as vehicles crossed the bridge). Aeroplane audible at 19:54.
10/01/2019	00:00	15 mins	37	49	53	63	Dry. No wind. 90% cloud cover. Road traffic remained the dominant noise source, although road much quieter. Clear lulls in traffic. During these lulls, birds were audible and industrial noise towards the north-west and south-east was audible.
	00:15	15 mins	36	49	53	64	
	10:15	15 mins	56	60	62	68	Dry. No wind. 100% cloud cover. Noise climate dominated by road traffic noise. Subjectively noted to be very busy and constant. Congestion noted at roundabout so frequent stop/start movements audible.
	10:30	15 mins	55	61	64	71	Car pass by noise equipment at a slow pace at 10:22. Bird scaring guns audible in the distance at 10:25. Plane audible at 10:35. Birds audible at 10:35.

12.4.7 A summary of the ambient noise levels for each time period defined in Table 12.1 are provided in Table 12.5. The reported  $L_{Aeq,T}$  level, in Table 12.5, is the logarithmically averaged noise level. It is assumed that these ambient noise levels are representative of their associated time period.

12.4.8 To establish which threshold category applies for each time period, the ambient noise levels are rounded to the nearest 5dB. The average ambient noise levels rounded to the nearest 5dB, the associated threshold category and level are also presented in Table 12.5.

**Table 12.5: Average Ambient Noise Levels ( $L_{Aeq,T}$ ) and Associated Threshold Categories at Higgins Neuk**

Description	Threshold Value Period		
	Night-time (23:00-07:00)	Evenings and weekends*	Daytime (07:00-19:00) and Saturdays (07:00-13:00)
Average Ambient Noise Levels ( $L_{Aeq,T}$ dB)	49	55	60
Average Ambient Noise Levels ( $L_{Aeq,T}$ dB) Rounded to the Nearest 5dB	50	55	60
BS 5228-1 Threshold Category	Category C	Category B	Category A
BS 5228-1 Threshold Level ( $L_{Aeq,T}$ dB)	55	60	65

\*19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

## 12.5 Potential Impacts

### Introduction

12.5.1 Potential noise and vibration impacts during construction and operation of the proposed scheme are described in this section. No specific embedded mitigation measures have been included for noise and vibration as part of the proposed scheme. Specific mitigation is detailed in Section 12.6 (Mitigation).

### Construction Noise

#### Construction Working Hours and Schedule/Phasing

12.5.2 Falkirk Council Environmental Health Department has advised (refer to paragraphs 12.3.23 to 12.3.26) that standard construction hours for works within the Falkirk Council boundary are between 08:00 and

19:00 Monday to Friday, and between 08:00 and 13:00 on Saturdays, with no works to be audible at the site boundary on Sundays.

12.5.3 It is anticipated that some work would be required outside the normal working hours for exceptional activities (such as those that can only take place when traffic flows are low). Falkirk Council Environmental Health Department also advised that extension to the standard construction hours can be granted in exceptional circumstances, but a case would have to be made to justify working out of the standard construction hours.

12.5.4 The overall construction period is expected to be between 18 and 24 months.

Construction Noise Impact

12.5.5 Based on the indicative construction methodology, detailed in Chapter 3 (The Proposed Scheme) and Appendix A3.1 (Construction Information), and previous experience of construction projects, the following construction phases are considered most likely to result in significant noise impacts:

- construction vehicles use of the site access from the north side;
- vibratory or impact sheet piling between the temporary bridge structure and existing viaduct;
- construction of piles and footings for the temporary bridge and replacement piled viaduct;
- breaking concrete pilasters and removing parapet panels from existing viaduct; and
- erection of bridge support structure and deck for the temporary bridge and replacement piled viaduct.

12.5.6 Table 12.6 presents details for typical plant which could reasonably be expected to be used during construction, with corresponding source noise levels taken from tables in BS 5228-1. For the times of operation of the construction works themselves, a typical 11-hour working day is assumed, (between 08:00 and 19:00) during the week. It is assumed that construction activities will take place for 10 hours, allowing for breaks. A similar percentage of activity time has been assumed for Saturday (between 08:00 and 13:00). Because access to the site by HGVs and other construction vehicles occurs much nearer to NSRs than most of the construction activities this has been considered separately, based on vehicles passing at their nearest point to NSRs for 25% of the 11-hour working day, i.e. for 15 minutes in each hour. Acoustic 'on-times' have been derived based upon experience, given the definition of the term contained in BS 5228-1. The acoustic on-time is the period that the equipment is working at full power or within 3dB of its maximum.

**Table 12.6: Indicative Plant and Equipment to be used during Construction**

Phase	Activity	Plant Description	BS 5228-1 Ref.	No. of Plant	Total L <sub>w</sub> dB	% On-time	Shift Duration (hrs)	Duration of Activity (hrs)	% Activity Time
Site Access	Distribution of Materials	Lorry (4-axle wagon)	C.2.34	1	108.0	25%	11	11	100%
Vibratory Sheet Piling	Earthworks	Tracked excavator (35t)	C.5.18	1	108.0	30%	11	10	91%
	Sheet steel piling - vibratory	Vibratory piling rig (52t)	C.3.8	1	116.0	30%	11	10	91%
	Distribution of Materials	Lorry (4-axle wagon)	C.2.34	1	108.0	30%	11	10	91%

Phase	Activity	Plant Description	BS 5228-1 Ref.	No. of Plant	Total L <sub>w</sub> dB	% On-time	Shift Duration (hrs)	Duration of Activity (hrs)	% Activity Time
	Distribution of Materials	Telescopic handler (10t)	C.2.35	1	99.0	30%	11	10	91%
Impact Sheet Piling	Earthworks	Tracked excavator 35t	C.5.18	1	108.0	30%	11	10	91%
	Tubular steel piling - hydraulic hammer	Hydraulic hammer rig (4t hammer)	C.3.2	1	115.0	30%	11	10	91%
	Distribution of Materials	Lorry (4-axle wagon)	C.2.34	1	108.0	30%	11	10	91%
	Lifting	Tracked mobile crane (600t/125m)	C.4.50	1	99.0	30%	11	10	91%
	Tubular steel piling - hydraulic hammer	Drop hammer pile rig power pack 23kW	C.3.5	1	97.0	30%	11	10	91%
Bored Piling	Earthworks	Tracked excavator (35t)	C.5.18	1	108.0	30%	11	10	91%
	Rotary bored piling - cast in situ	Large rotary bored piling rig (110t)	C.3.14	2	114.0	25%	11	10	91%
	Lifting	Wheeled mobile crane (35t)	C.4.43	1	98.0	30%	11	10	91%
	Pumping Concrete	Concrete pump + truck (idling) (6t)	C.4.26	1	103.0	30%	11	10	91%
	Distribution of Materials	Lorry (4-axle wagon)	C.2.34	1	108.0	30%	11	10	91%
Breaking Concrete	Breaking up Concrete	Breaker mounted on wheeled backhoe (7.4t)	C.1.1	1	120.0	10%	11	10	91%
	Distribution of Materials	Wheeled excavator (14t)	C.4.12	2	108.0	30%	11	10	91%
	Distribution of Materials	Lorry (4-axle wagon)	C.2.34	2	111.0	30%	11	10	91%
Structures	Earthworks	Tracked excavator 35t	C.5.18	1	108.0	30%	11	10	91%
	Distribution of Materials	Lorry (4-axle wagon)	C.2.34	1	108.0	20%	11	10	91%
	Rolling and Compaction	Vibratory roller 8.9t	C.5.20	1	103.0	25%	11	10	91%
	Pumping Concrete	Concrete mixer truck	C.4.27	1	107.0	30%	11	10	91%
	Concrete Other	Poker vibrator	C.4.33	1	106.0	15%	11	10	91%
	Concrete Other	Vibratory tamper (15kg)	C.4.35	1	91.0	10%	11	10	91%

Phase	Activity	Plant Description	BS 5228-1 Ref.	No. of Plant	Total L <sub>w</sub> dB	% On-time	Shift Duration (hrs)	Duration of Activity (hrs)	% Activity Time
	Breaking Road Surface	Compressor for hand-held pneumatic breaker (1t)	C.5.5	2	96.0	20%	11	10	91%
	Lifting	Mobile telescopic crane 280 kW (100t)	C.4.41	1	99.0	30%	11	10	91%

- 12.5.7 The only residential NSRs within the construction noise study area are the two dwellings at Higgins Neuk, the nearest of which is approximately 40m from the proposed temporary site access from the north side, 110m away from the proposed temporary bridge structure and 150m away from the existing piled viaduct. The next nearest NSRs are over 400m away and outwith the construction noise study area; at this distance, significant construction noise effects are considered unlikely and are not considered further.
- 12.5.8 Construction noise calculations have been undertaken for the two dwellings at Higgins Neuk based on the nearest of the dwellings to the proposed scheme.
- 12.5.9 The noise barrier which partially surrounds Higgins Neuk would screen the two dwellings there from the construction works such that there was no visibility of the works at ground floor level. In this scenario, BS 5228-1 advises assuming an approximate attenuation of 10dB, which has been incorporated in the calculated construction noise levels. BS 5228-1 also states that it is not usually advisable to combine the effects of screening and soft ground attenuation, and therefore hard ground attenuation has been assumed between the two dwelling at Higgins Neuk and the construction activities.
- 12.5.10 The total construction noise levels for the construction phases presented in Table 12.6 have been calculated and are shown in Table 12.7. These values are free-field and calculated at ground floor level to allow comparison with the measured baseline noise levels and associated threshold criteria.

**Table 12.7: Calculated Construction Noise Levels at Higgins Neuk**

Phase	Distance	Phase Total Construction Noise Level, L <sub>Aeq,T</sub> (dB)
Site Access	40m	51.9
Vibratory Sheet Piling	150m	50.1
Impact Sheet Piling	150m	49.4
Bored Piling	110m	51.1
Breaking Concrete	150m	50.0
Structures	110m	48.6

- 12.5.11 As can be seen in Table 12.7, the calculated construction noise levels at Higgins Neuk are below the 65dB L<sub>Aeq,T</sub> threshold value for daytime. Accordingly, it is considered that, without mitigation, construction activities during typical construction hours would not result in significant adverse effects at Higgins Neuk.
- 12.5.12 It is anticipated that limited short-term night-time closures would be required to alter the carriageway alignment where the temporary bridge structure ties-in to the existing Kincardine Bridge and A985. Due to the lower threshold levels during the night-time, and the reduced level of acoustic screening provided by the noise barrier at Higgins Neuk for any bedrooms which are at first floor level, these works have the potential to temporarily exceed the threshold levels, potentially resulting in significant adverse effects at Higgins Neuk.

### **Construction Vibration**

- 12.5.13 The distance between the site access and the two dwellings at Higgins Neuk is approximately 40m. At this distance, assuming the site access track is a well-maintained level surface, significant vibration effects from HGVs using the site access track are considered unlikely. Given the distance between the other construction works for the proposed scheme and Higgins Neuk is greater than 100m (i.e. beyond the construction vibration study area), vibration effects for activities such as piling and breaking concrete are not considered likely to be significant.

### **Road Traffic Noise During Construction**

#### Road Traffic Noise Impact due to Realignment of Traffic

- 12.5.14 The indicative location of the temporary bridge is shown on Diagram 12.1 and Figure 3.1. The predicted change in noise level at the nearest NSRs due to the realignment of the traffic will depend on the extent which the temporary road is moved in the direction of the NSR. The nearest two NSRs at Higgins Neuk are approximately 110m from the proposed temporary bridge structure, which will bring the road approximately 10m closer than it currently is, resulting in a maximum increase in road traffic noise of 0.4dB and a negligible adverse impact which does not result in a significant effect. In practice, the road traffic noise level increases at Higgins Neuk would be less than calculated, as the road traffic noise levels would be dominated by traffic on A876 between Higgins Neuk Roundabout and Clackmannanshire Bridge, masking the increase in noise contribution from traffic on Kincardine Bridge.

#### Road Traffic Noise Impact due to Traffic Management Measures

- 12.5.15 The road traffic noise impact due to traffic management measures during construction has been assessed by comparing the predicted 'basic noise level' (BNL) of the roads in the vicinity of the proposed scheme, with and without traffic management measures in place. The BNL as defined in CRTN is the road traffic noise level at a reference distance of 10m away from the nearest carriageway edge. To calculate the BNL, traffic data for the roads are required in the form of traffic flow, composition (i.e. percentage of the traffic flow that are heavy goods vehicles (HGVs)) and speed. For road traffic noise calculations, the traffic data needs to be in an 18-hour (06:00 to 00:00) Annual Average Weekday Traffic (AAWT) format.
- 12.5.16 Traffic data for the roads in the vicinity of the proposed scheme, with and without traffic management measures in place, have been provided by the Trunk Road Operating Company for the roads labelled in Diagram 12.2. The roads are identified in Tables 12.8 and 12.9, with the associated traffic data and BNLs without and with traffic management, respectively.



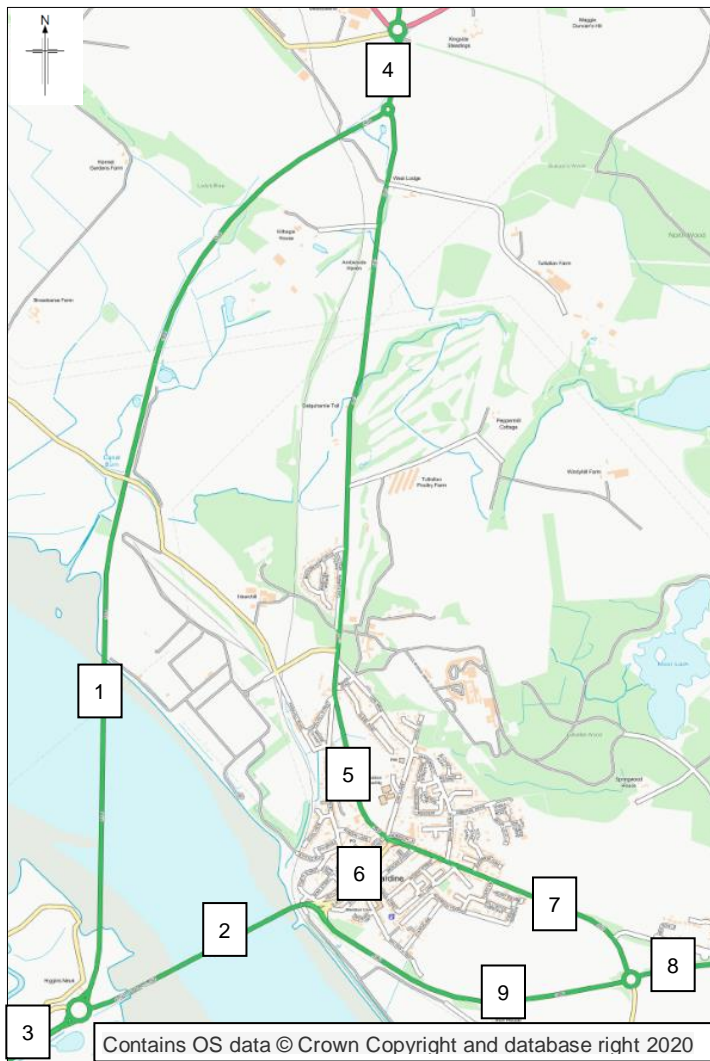


Diagram 12.2: Map illustrating roads included in the road traffic noise assessment

Table 12.8: Traffic Data without Traffic Management Measures

ID	Road Name	18-hour AAWT Traffic Data			BNL (dB L <sub>A10,18h</sub> )
		Flow	% HGV	Speed (kph)	
1	Clackmannanshire Bridge (A876)	21,239	5	87	74.7
2	Kincardine Bridge (A985)	13,765	4	48	69.0
3	South Approach Road (A876)	35,031	4	97	77.6
4	A977	24,875	5	65	73.4
5	A977 (inc. Feregait)	5,001	4	61	65.8
6	North Approach Road	4,049	2	48	63.0
7	Toll Road	2,904	5	67	64.2
8	A985 (East of Lonannet Roundabout)	11,798	4	94	72.6
9	A985 (West of Lonannet Roundabout)	9,981	4	100	72.4

**Table 12.9: Traffic Data with Traffic Management Measures**

ID	Road Name	18-hour AAWT Traffic Data			BNL (dB L <sub>A10,18h</sub> )
		Flow	% HGV	Speed (kph)	
1	Clackmannanshire Bridge (A876)	21,586	5	87	74.8
2	Kincardine Bridge (A985)	13,420	4	49	68.9
3	South Approach Road (A876)	35,036	5	97	77.8
4	A977	24,876	5	65	73.4
5	A977 (inc. Feregait)	4,657	4	61	65.5
6	North Approach Road	2,852	3	48	61.8
7	Toll Road	4,023	4	66	65.3
8	A985 (East of Lonannet Roundabout)	11,798	5	94	72.8
9	A985 (West of Lonannet Roundabout)	11,863	4	100	73.2

12.5.17 A comparison of the BNLs with and without traffic management measures is presented in Table 12.10.

**Table 12.10: Comparison of BNLs with and without Traffic Management Measures**

ID	Road Name	BNL (dB L <sub>A10,18h</sub> )		
		Without Traffic Management	With Traffic Management	Difference
1	Clackmannanshire Bridge (A876)	74.7	74.8	0.1
2	Kincardine Bridge (A985)	69.0	68.9	-0.1
3	South Approach Road (A876)	77.6	77.8	0.2
4	A977	73.4	73.4	0.0
5	A977 (inc. Feregait)	65.8	65.5	-0.3
6	North Approach Road	63.0	61.8	-1.2
7	Toll Road	64.2	65.3	1.1
8	A985 (East of Lonannet Roundabout)	72.6	72.8	0.2
9	A985 (West of Lonannet Roundabout)	72.4	73.2	0.8

12.5.18 With reference to Table 12.10, perceptible changes in road traffic noise with traffic management measures in place are predicted to occur at North Approach Road and Toll Road. A 1.2dB reduction in road traffic noise is predicted at North Approach Road, which is a minor beneficial impact and a 1.1dB increase in road traffic noise is predicted at Toll Road, which is a minor adverse impact. Given that these changes in road traffic noise are just above the 1dB change which DMRB HD 2 13/11 states is the smallest that is considered perceptible, and given that the traffic management measures will be temporary, these perceptible impacts are not considered to result in any significant effects.

12.5.19 The changes in BNLs at all other roads are less than 1dB and are therefore considered to be negligible (imperceptible) impacts and are not considered to result in any significant effects.

Road Traffic Noise Impact due to Temporary Road Closures

12.5.20 It is anticipated that limited short-term night-time closures of Kincardine Bridge would be required to alter the carriageway alignment at the tie-in locations. This is likely to result in temporary increases in traffic flow on diversion routes that would lead to a perceptible increase in road traffic noise levels along these routes. However, as these closures are expected to occur over limited short-term night-time closures, any adverse effects are not considered to be significant.

## 12.6 Mitigation

- 12.6.1 Mitigation measures for the proposed scheme in relation to noise and vibration are detailed below and take into account best practice, legislation, guidance and professional experience.

### **Essential Construction Noise and Vibration Mitigation**

- 12.6.2 A Construction Environmental Management Plan (CEMP) will be prepared by the Contractor. The CEMP will set out how the Contractor intends to operate the construction site, including construction-related mitigation measures. The relevant section(s) of the CEMP will be in place prior to the start of construction work and will cover a range of aspects including noise and vibration (**Mitigation Item NV1**).
- 12.6.3 Noise and vibration limits for residential and ecological NSRs will be agreed with the Falkirk Council Environmental Health Department and SNH, respectively, and these limits will be incorporated into the Contract Documents. The Contractor will be required to develop and implement a Noise and Vibration Management Plan (NVMP) as part of the CEMP to meet these requirements (**Mitigation Item NV2**). The NVMP will include the design of any necessary NSR specific construction mitigation over and above the standard mitigation included within this chapter.
- 12.6.4 The following essential mitigation measures, as recommended in BS 5228-1 and BS 5228-2, would be employed to minimise the noise and vibration impacts during the construction phase:

### Community Relations (**Mitigation Item NV3**)

- 12.6.5 The Contractor will appoint a community liaison officer who will:
- liaise with the relevant local authorities and nearby residents affected by the construction works and provide a feedback mechanism for any concerns to be raised;
  - consult and seek approval from Falkirk Council regarding any proposed working outwith normal working hours;
  - notify occupiers of nearby properties a minimum of two weeks in advance of the nature and anticipated duration of planned construction works that may affect them; and
  - establish a dedicated freephone telephone helpline together with a dedicated email address and postal address for enquiries and complaints during the construction phase. The relevant contact numbers, email and postal addresses will as a minimum be displayed on signs around the construction site and will be published on the project website. Enquiries and complaints will be logged in a register and appropriate action will be taken in response to any complaints.

### Training of Employees (**Mitigation Item NV4**)

- 12.6.6 The Contractor will ensure that all site workers receive adequate environmental training relevant to their role prior to working on the construction site. This will include specific environmental project inductions and 'toolbox talks' on best practice construction methods as appropriate, which would be anticipated to include those relating to noise and vibration control, by employing techniques to keep site noise to a minimum. This would be effectively supervised to ensure that best working practice in respect of noise and vibration reduction is followed.

### Execution of Works (**Mitigation Item NV5**)

- 12.6.7 The Contractor will use best practicable means to limit the level of noise to which operators and others in the vicinity of site operations would be exposed. This includes the following:
- the hours of working will be planned and account will be taken of the effects of noise upon persons in areas surrounding site operations and upon persons working on site, taking into account the nature

of land use in the areas concerned, the duration of work and the likely consequence of any lengthening of work periods;

- where reasonably practicable, quiet working methods will be employed, including use of the most suitable plant, reasonable hours of working for noisy operations, and economy and speed of operations;
- noise will be controlled at source, for example, by modification of existing plant/equipment, its use and location and ensuring maintenance of all noise-generating equipment;
- the spread of noise will be limited, i.e. by distance between source and receiver and/or screening;
- on-site noise levels will be monitored regularly, particularly if changes in machinery or project designs are introduced, by a suitably qualified person appointed specifically for the purpose;
- on those parts of a site where high levels of noise are likely to be a hazard to persons working on the site, prominent warning notices will be displayed and, where necessary, ear protectors will be provided;
- proper use of plant with respect to minimising noise emissions and regular maintenance in line with plant manuals;
- where appropriate, inherently quiet plant will be selected. All major compressors will be 'sound reduced' models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic percussive tools will be fitted with mufflers or silencers of the type recommended by the manufacturers;
- machines in intermittent use will be shut down in the intervening periods between work or throttled down to a minimum;
- all ancillary plant such as generators, compressors and pumps will be positioned so as to cause minimum noise disturbance. If necessary, acoustic barriers or enclosures will be provided; and
- adherence to the codes of practice for construction working and piling given in BS 5228-1 and BS 5228-2 and the guidance given therein regarding minimising noise and vibration emissions from the site.

#### **Schedule of Environmental Commitments**

- 12.6.8 A summary of the essential mitigation measures, to be implemented in constructing and operating the proposed scheme relevant to noise and vibration is provided in Table 12.11. Chapter 17 (Schedule of Environmental Commitments) contains the complete schedule of measures for the proposed scheme.

**Table 12.11: Schedule of Environmental Commitments – Noise and Vibration**

Mitigation Item	Party Responsible for Implementation	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required	Monitoring / Compliance
NV1	Contractor	Pre-construction & Construction	A Construction Environmental Management Plan (CEMP) will be prepared by the Contractor. The CEMP will set out how the Contractor intends to operate the construction site, including construction-related mitigation measures. The relevant section(s) of the CEMP will be in place prior to the start of construction work and will cover a range of aspects including noise and vibration	To set out how the Contractor intends to operate the construction site, including construction related mitigation measures.	Consultation with Falkirk Council	CEMP to be included as Employer's Requirement in the Contract.
NV2	Designer & Contractor	Pre-construction & Construction	Noise and vibration limits for residential and ecological NSRs will be agreed with the Falkirk Council Environmental Health Department and SNH, respectively, and these limits will be incorporated into the Contract Documents. The Contractor will be required to develop and implement a Noise and Vibration Management Plan (NVMP) as part of the CEMP to meet these requirements. The NVMP will include the design of any necessary NSR specific construction mitigation over and above the standard mitigation included within this chapter.	To agree noise and vibration limits and design receptor specific mitigation, over and above the standard mitigation detailed in NV5, where required.	Approval from Falkirk Council and SNH	NVMP to be included as Employer's Requirement in the Contract.
NV3	Contractor	Pre-construction & Construction	The Contractor will appoint a community liaison officer who will: <ul style="list-style-type: none"> <li>liaise with the relevant local authorities and nearby residents affected by the construction works and provide a feedback mechanism for any concerns to be raised;</li> <li>consult and seek approval from Falkirk Council regarding any proposed working outwith normal working hours;</li> <li>notify occupiers of nearby properties a minimum of two weeks in advance of the nature and anticipated duration of planned construction works that may affect them; and</li> <li>establish a dedicated freephone telephone helpline together with a dedicated email address and postal address for enquiries and complaints during the construction phase. The relevant contact numbers, email and postal addresses will as a minimum be displayed on signs around the construction site and will be published on the project website. Enquiries and complaints will be logged in a register and appropriate action will be taken in response to any complaints.</li> </ul>	To inform stakeholders and consultees throughout the construction period.	Consultation with Falkirk Council	n/a



Mitigation Item	Party Responsible for Implementation	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required	Monitoring / Compliance
NV4	Contractor	Pre-construction & Construction	The Contractor will ensure that all site workers receive adequate environmental training relevant to their role prior to working on the construction site. This will include specific environmental project inductions and 'toolbox talks' on best practice construction methods as appropriate, which would be anticipated to include those relating to noise and vibration control, by employing techniques to keep site noise to a minimum. This would be effectively supervised to ensure that best working practice in respect of noise and vibration reduction is followed	To ensure site workers are aware of best practice construction methods, mitigation measures and how they are implemented.	None required	n/a
NV5	Contractor	Pre-construction & Construction	<p>The Contractor will use best practicable means to limit the level of noise to which operators and others in the vicinity of site operations would be exposed. This includes the following:</p> <ul style="list-style-type: none"> <li>the hours of working will be planned and account will be taken of the effects of noise upon persons in areas surrounding site operations and upon persons working on site, taking into account the nature of land use in the areas concerned, the duration of work and the likely consequence of any lengthening of work periods;</li> <li>where reasonably practicable, quiet working methods will be employed, including use of the most suitable plant, reasonable hours of working for noisy operations, and economy and speed of operations;</li> <li>noise will be controlled at source, for example, by modification of existing plant/equipment, its use and location and ensuring maintenance of all noise-generating equipment;</li> <li>the spread of noise will be limited, i.e. by distance between source and receiver and/or screening;</li> <li>on-site noise levels will be monitored regularly, particularly if changes in machinery or project designs are introduced, by a suitably qualified person appointed specifically for the purpose;</li> <li>on those parts of a site where high levels of noise are likely to be a hazard to persons working on the site, prominent warning notices will be displayed and, where necessary, ear protectors will be provided;</li> </ul>	To reduce, as far as practicable, the level of noise to which operators and others in the vicinity of site operations would be exposed.	None required	n/a

Mitigation Item	Party Responsible for Implementation	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required	Monitoring / Compliance
			<ul style="list-style-type: none"> <li>proper use of plant with respect to minimising noise emissions and regular maintenance in line with plant manuals;</li> <li>where appropriate, inherently quiet plant will be selected. All major compressors will be 'sound reduced' models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic percussive tools will be fitted with mufflers or silencers of the type recommended by the manufacturers;</li> <li>machines in intermittent use will be shut down in the intervening periods between work or throttled down to a minimum;</li> <li>all ancillary plant such as generators, compressors and pumps will be positioned so as to cause minimum noise disturbance. If necessary, acoustic barriers or enclosures will be provided; and</li> <li>adherence to the codes of practice for construction working and piling given in BS 5228-1 and BS 5228-2 and the guidance given therein regarding minimising noise and vibration emissions from the site.</li> </ul>			

## 12.7 Residual Effects

- 12.7.1 With the appropriate essential noise mitigation measures outlined in Section 12.6 (Mitigation) employed, it is considered that any adverse noise or vibration effects associated with construction of the proposed scheme are unlikely to be significant.

## 12.8 Assessment of Policy Compliance

- 12.8.1 DMRB LA 104 (Highways England, Transport Scotland, Welsh Government and Department for Infrastructure Northern Ireland 2019) states that environmental assessment, reporting and monitoring shall meet the requirements of the national planning policy for each relevant Overseeing Organisation.
- 12.8.2 Appendix A4.1 (Assessment of Policy Compliance) provides a review of national and local policy documents which are of relevance to the assessment undertaken and reported in this chapter in accordance with DMRB guidance.
- 12.8.3 National planning policy objectives (and accompanying best practice guidance) of relevance to this assessment are included in National Planning Framework 3 (Scottish Government 2014a), Scottish Planning Policy (SPP) (Scottish Government 2014b) themes *Placemaking* and *Valuing the Natural Environment* as well as Scottish National Marine Plan (SNMP) Policy GEN 13 (Noise) (Scottish Government 2015) and PAN 1/2011 (Planning and Noise) (Scottish Government 2011a). In addition, Falkirk Local Development Plan 2 Policy PE01 (Placemaking) (Falkirk Council 2020) and FIFEplan Policy 10 (Amenity) (Fife Council 2017) are of relevance.

### Summary of Policy Compliance

- 12.8.4 Overall, the design and assessment of the proposed scheme has had regard to, and is compliant with policy objectives to minimise noise and vibration effects. A full policy compliance assessment can be found in Table 7 of Appendix A4.1 (Assessment of Policy Compliance).

## 12.9 Statement of Significance

- 12.9.1 Taking into account the essential mitigation measures as described in Section 12.6 (Mitigation), there are no noise or vibration effects considered to be significant in accordance with The Road (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017 ('the Roads EIA Regulations').

## 12.10 References

### EU Directives and National Legislation

Control of Pollution Act 1974. London: HMSO

Control of Noise (Codes of Practice for Construction and Open Sites) (Scotland) Order 2002

The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017

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