15. Noise and Vibration

Summary

This chapter considers the potential noise and vibration impacts and effects of the proposed scheme on noise and vibration sensitive receptors.

The study area for construction noise, construction vibration and operational noise were determined using Design Manual for Roads and Bridges (DMRB) guidance. Construction noise modelling and construction vibration calculations was undertaken at sample locations representative of the nearest noise and vibration sensitive receptors to the proposed scheme. Operational noise modelling was undertaken for all noise sensitive receptors within the operational noise study area.

As part of the assessment, a baseline noise survey was undertaken at nine locations to gain an understanding of the existing noise climate within the vicinity of the proposed scheme, validate baseline noise modelling results and to provide data for public consultation purposes.

The construction noise assessment identified six individual or groups of noise sensitive receptors which had the potential to experience significant construction noise effects. Standard mitigation measures across A9 dualling projects have been proposed for minimising construction noise levels. With the implementation of these measures, it is anticipated that the potential for significant residual adverse construction noise effects will remain at three individual or groups of noise sensitive receptors, but these would be minimised as far as practicable.

The construction vibration assessment identified three individual or groups of vibration sensitive receptors which had the potential to experience significant construction noise effects. Specific mitigation measures have been proposed to reduce vibratory compaction and sheet piling vibration levels. With the implementation of these measures, it is anticipated that no vibration sensitive receptors would experience significant residual construction vibration effects.

It should be noted that the construction assessment is indicative only as it is based upon assumed plant/equipment, construction programme and working methods. Once appointed, the contractor would be required to update the assessment, once working methods, working times, the plant and equipment to be used and the construction programme have been finalised.

The operational noise assessment identified five noise sensitive receptors which had the potential to experience significant adverse operational noise effects. An acoustic barrier has been proposed as a specific mitigation measure to reduce the Do-Something operational noise levels such that significant adverse operational noise effects are not experienced at four of these receptors. It is not considered practicable to reduce Do-Something operational noise

levels at the remaining noise sensitive receptor, and therefore a significant residual adverse operational noise effect is anticipated at one noise sensitive receptor.

The operational noise assessment identified 65 noise sensitive receptors which had the potential to experience significant beneficial operational noise effects.

15.1 Introduction

15.1.1 This chapter presents the DMRB Stage 3 assessment of potential noise and vibration impacts as a result of construction and operation of the proposed scheme. The chapter is supported by the following appendices and figures, which are cross-referenced in the text where relevant:

- Appendix A15.1 Noise and Vibration Terminology;
- Appendix A15.2 Detailed Baseline Noise Survey Results and Notes;
- Appendix A15.3 Noise and Vibration Calculation and Model Inputs and Assumptions;
- Appendix A15.4 Predicted Residual Operational Noise Levels at All Noise Sensitive Receptors;
- Figure 15.1 Construction Noise Assessment Context Plan;
- Figure 15.2 Operational Noise Assessment Context Plan;
- Figure 15.3 Location of Specific Mitigation for Operational Noise;
- Figure 15.4 to Figure 15.9 Operational Noise Change Contour Plots;
- Figure 15.10 Residual Construction Noise Effects; and,
- Figure 15.11 Residual Operational Noise Effects.

15.1.2 The assessment of noise and vibration impacts associated with the proposed scheme has been undertaken in accordance with Design Manual for Roads and Bridges (DMRB) LA 111, Noise and Vibration, Revision 2 (Highways England et al, 2020a), hereafter referred to as DMRB LA 111.

15.1.3 To assist in the understanding of the noise and vibration assessment it is useful to consider the units of noise and vibration and how noise and vibration is described quantitatively.

15.1.4 DMRB LA 111 defines noise as unwanted sound. Sound is measured in terms of decibels (dB). The decibel is not an absolute unit of measurement; it is a ratio between a measured quantity and an agreed reference level. The measured quantity is the variation in atmospheric pressure and the reference level is taken as the lowest pressure to which a healthy ear can hear as sound, i.e. 2×10^{-5} pascals (20µPa). Whilst the audible range of hearing extends from 20 Hertz (Hz) to 20,000Hz, human hearing is not equally sensitive to sound across this range of frequencies, and therefore corrections or 'weightings' are applied to the measured linear levels to simulate the response of the ear. The A-weighting, a standard weighting used to represent the response of the human ear to noise across audible frequencies, is most often used to represent the response of the ear to environmental noise. When considering noise

levels associated with road traffic, it may be helpful to note that doubling or halving of the traffic flow is equivalent to an increase or decrease, respectively, of approximately 3dB(A), and a subjective impression of a doubling or halving of loudness generally corresponds to a 10dB(A) sound level increase or decrease, respectively.

Road Traffic Noise

15.1.5 In terms of road traffic noise, it is useful to understand the causes of noise associated with a flow of road traffic vehicles.

15.1.6 Road traffic noise can be separated into two main components. The first is generated by the engine, exhaust system and transmission, and is the dominant noise source when traffic is not freely flowing. This is particularly apparent from heavy goods vehicles (HGVs), when accelerating, braking or changing gears and this contributes a significant proportion of low frequency noise. The second noise source component is generated from the interaction of tyres with the road surface and is the dominant noise source under free flow traffic conditions at moderate to high road speeds and contributes a significant proportion of higher frequency noise.

15.1.7 The noise from a stream of traffic at a receptor point is an aggregation of noise from each of a number of vehicles at various distances. There are several factors that influence the noise level experienced at a receptor point and these can be separated into two categories. Firstly, there are factors that affect the noise emissions at source, such as traffic volume, speed and composition (i.e. the percentage of HGVs), the gradient of the carriageway and the surface characteristics of the carriageway. Secondly there are those factors affecting the propagation characteristics, such as the distance of the receptor from the source, the topography and characteristics of the ground between the source and receptor, the presence of any screening or barrier effects and the wind strength and direction.

Measurement of Road Traffic Noise

15.1.8 Noise from traffic on a road will change as traffic flows alter during the day and will also fluctuate within shorter time periods as vehicles pass. In order to compare situations with different traffic noise levels it is necessary to use an index to produce single figure estimates of overall noise levels. The metric used for road traffic noise is $L_{A10,18h}$ which is the arithmetic mean value of the A-weighted noise levels, which are exceeded for 10% of the time in each of the 18 one-hour periods between 06:00 and 00:00.

Road Traffic Vibration

15.1.9 Traffic induced vibration is a low frequency disturbance which can be transmitted through the air or ground. Air-borne vibration from traffic is produced by the engine and exhaust of the vehicle, whereas ground-borne vibration is produced by the interaction between rolling wheels and the road surface.

15.1.10 Paragraph 1.4 of DMRB LA 111 states that: '*Operational vibration is scoped out of the assessment methodology as a maintained road surface will be free of irregularities as part of*

project design and under general maintenance, so operational vibration will not have the potential to lead to significant adverse effects.'

15.1.11 Accordingly, operational vibration is not assessed in this chapter.

Legislative and Policy Background

15.1.12 Road traffic noise levels were predicted in accordance with the guidance contained in Calculation of Road Traffic Noise (Department of Transport and Welsh Office, 1988), hereafter referred to as CRTN, supplemented with the additional guidance contained in DMRB LA 111 (refer to Appendix A. Operation noise calculations, A2 – CRTN Modifications).

15.1.13 An assessment of temporary noise and vibration impacts from the construction of the scheme has also been undertaken following the methodology provided by BS 5228:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites' Part 1 – Noise (BSI, 2014a) and Part 2 – Vibration (BSI, 2014b), hereafter referred to as BS 5228-1 and BS 5228-2.

15.1.14 In addition, the assessment of potential noise and vibration impacts has been carried out with reference to the following documents:

- The Noise Insulation (Scotland) Regulations (NISR);
- Memorandum on the Noise Insulation (Scotland) Regulations (NISR Memorandum);
- The Environmental Noise (Scotland) Amendment Regulations 2018;
- Control of Pollution Act 1974;
- Planning Advice Note (PAN) 1/2011 – Planning and Noise (The Scottish Government, 2011a); and
- Technical Advice Note (TAN) – Assessment of Noise (The Scottish Government, 2011b).

15.1.15 It should be noted that DMRB LA 111 introduces the following concepts, which are defined in the Noise Policy Statement for England (Department for Environment, Food and Rural Affairs, 2010) (NPSE):

- Lowest Observed Adverse Effect Level (LOAEL) – this is the level above which adverse effects on health and quality of life can be detected; and,
- Significant Observed Adverse Effect Level (SOAEL) – this is the level above which significant adverse effects on health and quality of life occur.

15.1.16 Whilst the NPSE is only applicable in England, the concept of LOAEL and SOAEL are used in the DMRB LA 111 assessment methodology, which is applicable in Scotland, and, therefore, have been adopted for this assessment.

15.1.17 A review of relevant national, regional and local planning policies and guidance relevant to noise and vibration was undertaken, as described in Section 15.7 (Compliance Against Plans and Policies).

15.2 Approach and Methods

Identification of Noise and Vibration Sensitive Receptors

15.2.1 DMRB LA 111 defines noise sensitive receptors (NSRs) as "*receptors which are potentially sensitive to noise*" and provides examples which include:

- dwellings;
- hospitals;
- healthcare facilities;
- education facilities;
- community facilities;
- Environmental Noise Directive (END) quiet areas or potential END quiet areas;
- international and national or statutorily designated sites;
- public rights of way; and
- cultural heritage assets.

15.2.2 This approach is broadly in line with the examples of receptors with a high sensitivity provided in Table 2.1 in TAN – Assessment of Noise, reproduced in Table 15.1.

Table 15.1: Level of Sensitivity Associated with Various Examples of NSRs (Reproduced from Table 2.1 of TAN)

Sensitivity	Description	Example of Receptor Usage
High	Receptors where people or operations are particularly susceptible to noise.	▪ Residential, including private gardens where appropriate. ▪ Quiet outdoor areas used for recreation. ▪ Conference facilities. ▪ Theatres/auditoria/studios. ▪ Schools during the daytime. ▪ Hospitals/residential care homes. ▪ Places of worship.
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance.	▪ Offices. ▪ Bars/cafes/restaurants where external noise may be intrusive. ▪ Sports grounds when spectator noise is not a normal part of the event and where quiet conditions are necessary (e.g. tennis, golf, bowls).
Low	Receptors where distraction or	▪ Buildings not occupied during working hours. ▪ Factories and working environments with existing high noise levels.

Sensitivity	Description	Example of Receptor Usage
	disturbance from noise is minimal.	▪ Sports grounds when spectator noise is a normal part of the event. ▪ Night clubs.

15.2.3 Identification of NSRs is primarily based on Ordnance Survey (OS) MasterMap Topography Layer® and AddressBase® Plus data.

15.2.4 Identification of END quiet areas and noise management areas is based on the noise maps published by the Scottish Government and the Transportation Noise Action Plan (TNAP) (Transport Scotland, 2018). No END quiet areas or potential quiet areas have been identified within the noise assessment study areas. In addition, no END Noise Management Areas (NMAs) or Candidate Noise Management Areas (CNMAs) have been identified within the noise assessment study areas.

15.2.5 For vibration, DMRB LA 111 defines vibration sensitive receptors (VSRs) as "*receptors which are potentially sensitive to vibration*" and provides examples which include:

- dwellings;
- hospitals;
- healthcare facilities;
- education facilities;
- community facilities;
- buildings containing vibration sensitive equipment; and,
- cultural heritage assets.

15.2.6 Identification of VSRs is primarily based on Ordnance Survey (OS) MasterMap Topography Layer® and AddressBase® Plus data.

15.2.7 Whilst all NSRs and VSRs identified within the study areas were included in the assessment, a number of sample representative NSRs and VSRs were selected for additional discussion, identified as those most likely to experience impacts arising from either the construction or operation of the proposed scheme. In total, 15 sample NSRs/VSRs were selected for the construction assessments and nine sample NSRs, corresponding to the baseline noise survey locations, were selected for the operational noise assessment as shown in Figure 15.1 and Figure 15.2, respectively. The sample NSRs are considered to have acoustic environments representative of those at other nearby NSRs. They are located where people could be particularly sensitive to noise and vibration and include sensitive receptors close to the proposed scheme.

Construction Noise Assessment Approach and Methods

Construction Noise Assessment – Study Areas

15.2.8 The study area for construction noise has been assigned in accordance with DMRB LA 111, which suggests that a study area of 300m from the closest construction activity is normally sufficient to cover potential adverse effects at noise sensitive receptors. The construction noise study area is shown in Figure 15.1. 594 noise sensitive receptors have been identified within the construction noise study area.

15.2.9 Paragraphs 3.6 and 3.7 of DMRB LA 111 also advise that where a project requires full carriageway closures during the night-time period (23:00 – 07:00) to enable construction works to take place, a diversion route study area shall be defined to extend 25m from the kerb line of the diversion route. Full carriageway night-time closures are not expected to be required and therefore a diversion route study area has not been defined.

15.2.10 For construction traffic, paragraph 3.8 of DMRB LA 111 advises that a construction traffic study area should extend 50m from the kerb line of public roads with the potential for an increase in basic noise levels (BNL) of 1dB(A) or more as a result of the addition of construction traffic to existing traffic levels. The BNL is defined in CRTN, and is a reference noise emission from a road link, 10m away from the nearside carriageway edge, calculated using the traffic flow, speed and HGV percentage. During the construction phase of the proposed scheme, access to the construction works is expected to be principally via the A9, other A-roads in the proximity of the proposed scheme and the main roads in Dunkeld and Birnam. To experience an increase in BNL of 1dB(A), the road traffic flow on the A9 and other A-roads would need to increase by approximately 25%. These roads are unlikely to experience such an increase in BNL because of construction traffic due to the relatively high existing traffic levels. Therefore, there are not expected to be any public roads that meet this condition and therefore a construction traffic study area has not been defined.

Construction Noise Assessment – Baseline Conditions

15.2.11 Paragraph 3.9 of DMRB LA 111 states that the construction noise baseline shall be determined via one or more of the following methods:

- noise measurements, based upon actual survey data;
- predicted noise levels (noise model outputs);
- existing noise mapping undertaken by public bodies or as part of other developments.

15.2.12 For the proposed scheme the construction noise baseline has been determined based on predicted noise levels.

Construction Noise Assessment – Assessment Approach

15.2.13 The construction noise assessment has followed the guidance in DMRB LA 111, which also refers to the use of BS 5228-1. 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. However, reference has been made to BS 5228-1 2009 + A1: 2014 for the purpose of this assessment, as this is the standard referenced in DMRB LA 111, and the most recent version.

15.2.14 Noise predictions have been undertaken at NSRs for construction activities anticipated to generate the highest noise levels, using noise level data from the various items of plant that would be used during the construction of the proposed scheme. Factors such as the proximity to noise sensitive receptors, the attenuation due to ground absorption, air absorption and barrier effects and duration that each item of plant is operating over a working day are also considered within the predictions. Until construction physically starts, some of the information required to inform these predictions is based on professional judgement and in collaboration with the design team.

15.2.15 BS 5228-1 describes a calculation methodology to determine the impact from construction noise, including the assignment of significance.

15.2.16 Predicted noise levels during the worst-case construction activities have been calculated using the CadnaA noise modelling package. The predicted construction noise levels have been predicted at the façades of sample NSR representative of receptors nearest to the proposed scheme. Appendix A15.3 presents a list of settings and technical assumptions made within the noise model.

15.2.17 The construction noise predictions have used noise emission data from plant equipment reported in Annexes C and D of BS 5228-1. Appendix A15.3 provides details of the assumed list of construction activities, equipment and other parameters utilised for the construction noise assessment.

15.2.18 It is anticipated that most construction activities will be undertaken during the day on weekdays and on Saturday mornings and therefore only the daytime period has been considered. However, once a contractor is appointed for the proposed scheme and plans the construction works in detail, there may be a requirement for night-time or full weekend working. Activities which may require night-time working include bridge deck installation, demolition on, over or adjacent to the live carriageway, installing cross-carriageway ducts, surfacing (e.g. surface course and specialist coatings) and road-marking activities, work at junctions and accesses that would create unacceptable disruption during day-time periods. This assessment has not assessed these activities as the contractor would be required to undertake an updated assessment as part of the CEMP, as detailed in Section 15.5 (Mitigation), when construction works are planned in detail.

Construction Noise Assessment – Magnitude of Impact and Significance of Effect

15.2.19 To determine significance of effect from construction noise, a comparison is made between the predicted noise level arising from construction operations, and the determined LOAEL/SOAEL values. DMRB LA 111 states that the LOAEL and SOAEL shall be established and reported within the environmental assessment for all NSRs within the construction noise assessment study area. DMRB LA 111 Table 3.12 provides guidance on how the LOAEL and

SOAEL should be determined. The LOAEL is established using baseline ambient $L_{Aeq,T}$ noise levels whilst the SOAEL is set as the threshold level determined in accordance with BS 5228-1 Section E3.2 and BS 5228-1 Table E.1. The threshold levels from Table E.1 of BS 5228-1 are presented in Table 15.4.

Table 15.4: Threshold of Potential Significant Effect at Dwellings (Based on Table E.1 of BS 5228-1)

Assessment Category and Threshold Value Period	Category A Threshold Value ($L_{Aeq,T}$ dB)	Category B Threshold Value ($L_{Aeq,T}$ dB)	Category C Threshold Value ($L_{Aeq,T}$ dB)
Night-time (23:00 – 07:00)	45	50	55
Evenings and weekends (19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays)	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
When Applicable	when ambient noise levels (rounded to the nearest 5dB) are less than these values	when ambient noise levels (rounded to the nearest 5dB) equal the category A values	when ambient noise levels (rounded to the nearest 5dB) are greater than the category A values

15.2.20 A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the sites exceeds the threshold level for the category appropriate to the ambient noise level. 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 $L_{Aeq,T}$ noise level for the period increases by more than 3dB due to site noise.

15.2.21 Although BS 5228-1 notes that the method for determining threshold values presented in Table 15.4 is for residential receptors only, this method has been applied for all NSRs within the construction assessment study area, are required by DMRB LA 111.

15.2.22 In order to assign the LOAEL and SOAEL, information on the existing noise climate is required. The predicted noise level for the Do-Minimum Opening Year scenario has been used to define the baseline in accordance with DMRB LA 111 paragraph 3.9. The noise model predicts noise levels as $L_{A10,18hr}$ whilst the LOAEL values are $L_{Aeq,T}$, therefore it is necessary to convert the predicted Do-Minimum Opening Year traffic noise levels from $L_{A10,18hr}$ to $L_{Aeq,12hr}$ to obtain the daytime LOAEL. This conversion has been undertaken using Method 3 of the Transport Research Laboratory (TRL) report Converting the UK traffic noise index $L_{A10,18h}$ to EU noise indices for noise mapping (Abbott & Nelson, 2002).

15.2.23 DMRB LA 111 provides guidance on determining the magnitude of impact for construction noise. The classification of construction noise magnitude of impacts is detailed in Table 15.5, reproduced from Table 3.16 of DMRB LA 111. As discussed above, the LOAEL is the baseline ambient noise level at the NSR and the SOAEL is the corresponding threshold level determined in accordance with BS 5228-1.

Table 15.5: Construction Noise Magnitude of Impact (Reproduced from Table 3.16 of DMRB LA 111)

Magnitude of Impact	Construction Noise Level
Major	Above or equal to SOAEL +5dB
Moderate	Above or equal to SOAEL and below SOAEL +5dB
Minor	Above or equal to LOAEL and below SOAEL
Negligible	Below LOAEL

15.2.24 In accordance with paragraph 3.19 of DMRB LA 111, construction noise shall constitute a significant effect where it is determined that a major or moderate magnitude of impact will occur for a duration exceeding:

- 10 or more days or nights in any 15 consecutive days or nights; or
- a total number of days or nights exceeding 40 in any 6 consecutive months.

Construction Vibration Assessment Approach and Methods

Construction Vibration Assessment – Study Area

15.2.25 The study area for construction noise has been assigned in accordance with DMRB LA 111, which suggests that a study area of 100m from the closest construction activity with the potential to generate vibration is normally sufficient to cover potential adverse effects at vibration sensitive receptors. The construction vibration study area is shown in Figure 15.1. 337 vibration sensitive receptors have been identified within the construction vibration study area.

Construction Vibration Assessment – Baseline Conditions

15.2.26 In accordance with paragraph 3.30 of DMRB LA 111, the construction vibration baseline has been assumed to be zero due to the absence of construction work prior to project commencement.

Construction Vibration Assessment – Assessment Approach

15.2.27 The construction vibration assessment follows the guidance in DMRB LA 111, which also refers to the use of BS 5228-2 contains guidance on vibration levels in structures from construction works. It provides a prediction methodology for mechanised construction works, such as compaction and piling works, and presents guidance for the control of vibration from construction works.

15.2.28 Construction vibration levels have been considered at VSRs within the construction vibration study area. The prediction methods and historical measured vibration data contained in BS 5228-2 were used. Appendix A15.3 provides details of the assumed list of vibration generating construction activities, equipment and other parameters utilised for the construction vibration calculations.

Construction Vibration Assessment – Magnitude of Impact and Significance of Effect (Human Response)

15.2.29 DMRB LA 111 only considers the potential significant effects from construction vibration on human receptors.

15.2.30 To determine significance of effect from construction vibration, the magnitude of the predicted vibration level is compared against the determined LOAEL and SOAEL values. DMRB LA 111 states that the LOAEL and SOAEL for construction vibration shall be set as detailed in Table 15.6, which is reproduced from Table 3.31 of DMRB LA 111. The vibration level in Table 15.6 is given in terms of the Peak Particle Velocity (PPV).

Table 15.6: Construction Vibration LOAELs and SOAELs (Reproduced from Table 3.31 of DMRB LA 111)

Time Period	LOAEL	SOAEL
All time periods	0.3mm/s PPV	1.0mm/s PPV

15.2.31 DMRB LA 111 then provides guidance on determining the magnitude of impact for construction vibration on human receptors based on the predictions undertaken and the LOAEL and SOAEL values. The classification of construction vibration magnitude of impacts is detailed in Table 15.7, reproduced from Table 3.33 of DMRB LA 111.

Table 15.7: Construction Vibration Magnitude of Impact (Reproduced from Table 3.33 of DMRB LA 111)

Magnitude of Impact	Construction Vibration Level
Major	Above or equal to 10mm/s PPV
Moderate	Above or equal to SOAEL and below 10mm/s PPV
Minor	Above or equal to LOAEL and below SOAEL
Negligible	Below LOAEL

15.2.32 In accordance with paragraph 3.19 of DMRB LA 111, construction vibration shall constitute a significant effect on human receptors where it is determined that a major or moderate magnitude of impact will occur for a duration exceeding:

- 10 or more days or nights in any 15 consecutive days or nights; or
- a total number of days or nights exceeding 40 in any 6 consecutive months.

Construction Vibration Assessment – Magnitude of Impact and Significance of Effect (Building Structure Response)

15.2.33 DMRB LA 111 does not provide a methodology for potential significant effects from construction vibration in terms of building structures. Therefore, for building structure response, the assessment has followed the guidance in BS 5228-2, which reproduces the advice given in BS 7385-2:1993 - Evaluation and measurement for vibration in buildings: guide to damage levels from ground borne vibration (BSI, 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.

15.2.34 Table 15.8 presents guidance on building classification and associated guide values for ground borne vibration with regards to risk of building damage. The values for structurally sound buildings are taken from BS 7385-2, which states that *"the probability of damage tends towards zero at 12.5mm/s peak component particle velocity*". This value has been rounded down to the integer (i.e. 12 mm/s). BS 7385-2 also states that values may need to be reduced by up to 50% for an estimate of damage from continuous vibration. If a building is structurally unsound, then these values may need to be reduced; a reduction of 50% has been assumed and applied in Table 15.8. BS 7385-2 also states that *"a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive".*

Table 15.8: Guidance on the Onset of Damage to Buildings, based on guidance in BS 7385-2

Type of Building	Transient Vibration at Building Foundation (PPV mm/s)	Continuous Vibration at Building Foundation (PPV mm/s)
Structurally sound buildings	12	6
Structurally unsound buildings	6	3

15.2.35 Based on the guidance in BS 7385-2, the vibration level which indicates a risk for damage considered for this assessment has been conservatively set to 12mm/s for transient vibration, and 6mm/s for continuous vibration (e.g. at structure locations) assuming the sensitive buildings are structurally sound. If the buildings were found to be structurally unsound, the risk of damage levels considered for this assessment have been reduced to 6mm/s for transient vibration, and 3mm/s for continuous vibration.

15.2.36 Although not specified in DMRB LA 111, construction vibration has also been considered a significant effect if there is deemed to be a risk of damage at a building due to construction vibration.

Operational Noise Assessment Approach and Methods

Operational Noise Assessment – Study Area

15.2.37 The study area for operational road traffic noise has been assigned in accordance with DMRB LA 111, which suggests that the following is sufficient for most projects, but it can be reduced or extended to ensure it is proportionate to the risk of likely significant effects:

- the area within 600m of new road links or road links physically changed or bypassed by the project;
- the area within 50m of other road links with potential to experience a short-term BNL change of more than 1.0dB(A) as a result of the project.

15.2.38 The forecast traffic data provided for use in this assessment was analysed, and no bypassed routes were identified. Therefore, based on the above, the operational study area of noise model calculations is defined as 600m around the carriageway edges of the proposed scheme.

15.2.39 DMRB LA 111 requires consideration of potential noise impacts on the wider road network beyond the modelled operational noise study area, where changes of 1.0dB(A) or more in noise level are predicted in the short-term. Any expected changes beyond the operational noise study area have not been included in the noise modelling exercise but have been calculated using BNL calculations carried out in accordance with CRTN and have been reported separately to noise model predictions.

15.2.40 The overall operational noise study area, which incorporates the operational 600m noise modelling area and the 50m BNL calculation area, is presented in Figure 15.2.

Operational Noise Assessment – Baseline Conditions

15.2.41 Paragraph 3.45 of DMRB LA 111 states that the operational noise baseline shall be determined from Do-Minimum noise levels in each assessment year and that noise monitoring should be used be used to validate baseline noise modelling results and to provide data for public consultation purposes.

15.2.42 Details of the noise monitoring undertaken are provided in Appendix A15.2 (Detailed Baseline Noise Survey Results and Notes) and a summary is provided in Section 15.3 (Baseline Conditions).

Operational Noise Assessment – Assessment Approach

15.2.43 The assessment of noise from the operation of the proposed scheme has been undertaken quantitatively based on the guidance within DMRB LA 111. The approach within DMRB LA 111 is to compare the predicted noise levels at NSRs, with and without the proposed scheme in place. Noise levels have been predicted using CadnaA noise modelling software, following the methodology contained within CRTN and the guidance given in DMRB LA 111 Appendix A, for the following scenarios:

- Do Minimum scenario in the opening year (DMOY), assuming that the proposed scheme is not constructed.
- Do Minimum scenario in the future assessment year (DMFY), assuming that the proposed scheme is not constructed.
- Do Something scenario in the opening year (DSOY), assuming that the proposed scheme is constructed.

- Do Something scenario in the future assessment year (DSFY), assuming that the proposed scheme is constructed.

15.2.44 All modelled calculations are based on predicted traffic flows and associated variables in the form of 18-hour (06:00 to 00:00) annual average weekday traffic (AAWT) using traffic data modelled for the above scenarios, based on the latest available Transport Model for Scotland 2018 (TMfS 2018).

15.2.45 The proposed scheme is expected to open in 2036, which is the assumed Opening Year. DMRB LA 111 states that the future assessment year should be 15 years after opening, therefore the future assessment year is 2051.

15.2.46 The assessment has considered noise level changes at all NSRs within the study area, with the following scenarios being considered:

- In the short-term:
  - Do-Minimum scenario in the opening year (DMOY 2036) compared against the Do-Something scenario in the opening year (DSOY 2036).
- In the long-term:
  - Do-Minimum scenario in the opening year (DMOY 2036) compared against the Do-Something scenario in the future year (DSFY 2051); and
  - Do-Minimum scenario in the opening year (DMOY 2036) compared against the Do-Minimum scenario in the future year (DMFY 2051).

15.2.47 Daytime noise levels have been predicted at all NSRs, for all scenarios listed above, within the operational noise study area shown in Figure 15.2. Noise levels have been predicted using CadnaA® noise modelling software, which calculates the $L_{A10,18hr}$ road traffic noise levels at NSRs in accordance with CRTN and the supplementary CRTN guidance contained in DMRB LA 111. In addition, noise levels have also been predicted in the base scenario, which includes the traffic flow information for the existing road network for 2025 and is used to compare predicted noise levels with measured noise levels.

15.2.48 The Transport Research Laboratory (TRL) report 'Converting the UK traffic noise index $L_{A10,18h}$ to EU noise indices for noise mapping' (Abbott & Nelson, 2002) has been used to derive the night-time noise levels for each scenario, using Method 3 of the TRL report. Method 3 converts the predicted daytime noise levels ($L_{A10,18hr}$) to an equivalent $L_{night,outside}$ noise level.

15.2.49 For each NSR that is a building, predictions have been undertaken at a series of prediction points at 5m intervals around the building, 1m from the façade, and include a 2.5dB façade correction. Predictions were undertaken at a default height of 1.5m above ground level to represent ground floor level. For NSR buildings with first floor or higher rooms, noise levels were also calculated at 4m above ground to represent first floor level. In accordance with DMRB LA 111, the calculation point used for reporting purposes has been selected as follows:

- the façade with the greatest magnitude of noise change; and

- where the greatest magnitude of noise change is equal on more than one façade, the façade experiencing the greatest magnitude of noise change and highest Do-Something noise level.

15.2.50 No guidance is given as to whether the greatest magnitude of noise change should be based on the short-term or long-term scenario. This has been interpreted as the short-term noise change scenario because this is what the initial assessment of operational noise significance is based on.

15.2.51 For each outdoor noise sensitive receptor (e.g. a designated site, public right of way or cultural heritage asset which are not buildings or indoors) associated with one or more NSRs, predictions have been undertaken at a series of prediction points across a 10m by 10m grid over the outdoor receptor area. As these outdoor receptor areas can be relatively large, the assessment has been based on what percentage of the outdoor receptor area that is in each magnitude of noise change category have been presented.

15.2.52 The input data and assumptions for the operational noise model are presented in Appendix A15.3.

Operational Noise Assessment – Magnitude of Change and Significance of Effect

15.2.53 DMRB LA 111 provides guidance on determining the magnitude of change for operational noise. The classification of operational noise magnitude of change is detailed in Table 15.9 for short-term noise changes and Table 15.10 for long-term noise changes, reproduced from Tables 3.54a and 3.54b of DMRB LA 111.

Table 15.9: Operational Noise Magnitude of Change – Short-term (Reproduced from Table 3.54a of DMRB LA 111)

Short-term Magnitude of Change	Short-term Noise Change (dB $L_{A10,18hr}$ or $L_{night,outside}$)
Major	Above or equal to 5.0
Moderate	3.0 to 4.9
Minor	1.0 to 2.9
Negligible	Less than 1.0

Table 15.10: Operational Noise Magnitude of Change – Long-term (Reproduced from Table 3.54b of DMRB LA 111)

Long-term Magnitude of Change	Long-term Noise Change (dB $L_{A10,18hr}$ or $L_{night,outside}$)
Major	Above or equal to 10.0
Moderate	5.0 to 9.9
Minor	3.0 to 4.9
Negligible	Less than 3.0

15.2.54 DMRB LA 111 states that the LOAEL and SOAEL shall be set for all noise sensitive receptors within the operational noise study area, for time periods when they are in use. The LOAELs and SOAELs considered in this assessment are defined in Table 15.11 below, which are reproduced from Table 3.49.1 of DMRB LA 111. These LOAELs and SOAELs are considered to apply to both dwellings and other noise sensitive receptors for the purpose of this assessment.

Table 15.11: Operational Noise LOAELs and SOAELs for all Receptors (Reproduced from Table 3.49.1 of DMRB LA 111)

Time Period	LOAEL	SOAEL
Day (06:00 – 24:00)	55dB $L_{A10,18hr}$ (façade)	68dB $L_{A10,18hr}$ (façade)
Night (23:00 – 07:00)	40dB $L_{night,outside}$ (free-field)	55dB $L_{night,outside}$ (free-field)

15.2.55 DMRB LA 111 states that the initial assessment of the likely significant effect on noise sensitive buildings shall be determined using the significance criteria in Table 15.12, which is reproduced from Table 3.58 of DMRB LA 111.

Table 15.12: Initial Assessment of Operational Noise Significance (Reproduced from Table 3.58 of DMRB LA 111)

Significance	Short-term Magnitude
Significant	Major
Significant	Moderate
Not significant	Minor
Not significant	Negligible

15.2.56 Following the initial determination of significance based on the short-term magnitude of change, DMRB LA 111 states that where the magnitude of change in the short-term is negligible at noise sensitive buildings, it shall be concluded that the noise change will not cause changes to behaviours or response to noise and, as such, will not give rise to a likely significant effect.

15.2.57 However, for noise sensitive receptors where the magnitude of change in the short-term is minor, moderate or major at noise sensitive receptors then the final significance of impact shall be determined by considering other factors. Guidance on some factors to consider are contained in Table 15.13, reproduced from Table 3.60 of DMRB LA 111.

Table 15.13: Determining Final Operational Significance on Noise Sensitive Buildings (Reproduced from Table 3.60 of DMRB LA 111)

Local Circumstance	Influence on Significance Judgement
Noise level change (is the magnitude of change close to the minor/moderate boundary?)	1) Noise level changes within 1dB of the top of the 'minor' range can indicate that it is more appropriate to determine a likely significant effect. Noise level changes within 1dB of the bottom of a 'moderate; range can indicate that it is more appropriate to consider a change is not a likely significant effect.
Differing magnitude of impact in the long-term and/or future year to magnitude of impact in the short-term	1) Where a greater impact in the long-term and/or future year is predicted, it can be more appropriate to consider that a smaller change is a likely significant effect. A lower impact in the long-term and/or future year over the short-term can indicate that it is more appropriate to consider that a larger change is not significant. 2) A similar change in the long-term and non-project noise change can indicate that the change is not due to the project and not an indication of a likely significant effect.
Absolute noise level with reference to LOAEL and SOAEL (by design this includes sensitivity of receptor)	1) A noise change where all do-something absolute noise levels are below SOAEL requires no modification of the initial assessment. 2) Where any do-something absolute noise levels are above the SOAEL, a noise change in the short-term of 1.0dB or over results in a likely significant effect.

Local Circumstance	Influence on Significance Judgement
Location of noise sensitive parts of a receptor	1) If the sensitive parts of a receptor are protected from the noise source, it can be appropriate to conclude a moderate or major magnitude of change in the short-term and/or long-term is not a likely significant effect. 2) An example of this would be where no windows of sensitive rooms face the road, and outdoor spaces are protected from the road by buildings. 3) Conversely, if the sensitive parts of the receptor are exposed to the noise source, it can be more appropriate to conclude a minor change in the short-term and/or long term is a likely significant effect. 4) An example of this would be when a house has many windows of sensitive rooms and outdoor spaces facing the road. 5) It will only be necessary to look in detail at individual receptors in terms of this circumstance where the decision on whether the noise change gives rise to a significant environmental effect is marginal.
Acoustic context	1) If a project changes the acoustic character of an area, it can be appropriate to conclude a minor magnitude of change in the short-term and/or long-term is a likely significant effect.
Likely perception of change by residents	1) If the project results in obvious changes to the landscape or setting of a receptor, it is likely that noise level changes will be more acutely perceived by the noise sensitive receptors. In these cases it can be appropriate to conclude that a minor change in the short-term and/or long-term is a likely significant effect. 2) Conversely, if the project results in no obvious changes for the landscape, particularly if the road is not visible from the receptor, it can be appropriate to conclude that a moderate change in the short-term and/or long-term is not a likely significant effect.

Operational Noise Assessment – Noise Insulation Regulations

15.2.58 An assessment of potential eligibility for noise insulation under the NISR has been undertaken.

15.2.59 The NISR provide for acoustic insulation to be offered for residential properties. The qualifying criteria are detailed within the NISR and within the NISR Memorandum, Regulations 3 and 6. The qualifying criteria, which all must be met, are as follows:

- the properties are situated within 300m of the new or altered carriageway;
- the properties lie within the triangular area at the terminal point of the new road, the apexes of which are 50m along the centreline of the existing road form the terminal point of the bases of which extend from points 300m on either side of the road to the nearest point on the carriageway, at right angles to the centreline of the carriageway;
- a straight line can be drawn from any point of the property to a point on the carriageway without passing another building;
- the use of the road causes, or is expected to cause, noise at a level not less than 68dB(A); and
- the property will experience noise levels exceeding the 'prevailing noise level' by at least 1.0dB(A).

15.2.60 Since the NISR Memorandum was issued in 1975, the methodology for predicting noise levels from road traffic has been updated via the release of CRTN in 1988 and DMRB LA 111 in 2020; however, in Scotland the statutory methodology for NISR assessment remains as set out in the NISR Memorandum.

15.2.61 The NISR Memorandum is not implemented in any currently available software package for the detailed prediction of noise using three-dimensional modelling. Accordingly, the prediction methodology adopted for the indicative NISR assessment for the proposed scheme makes use of the more detailed and accurate prediction methods set out in CRTN and uses, as a proxy for the specified level, a CRTN predicted noise level of 65 dB $L_{A10,18hr}$ (64.5 dB $L_{A10,18hr}$ when presented to one decimal place). Potentially eligible façades that are predicted to experience noise levels that meet or exceed the proxy specified level and meet the other qualifying criteria would be determined to be potentially eligible for NISR. Any potentially eligible facades should be fully assessed using the NISR Memorandum at a later date, noting that full NISR assessments are required within 12 months of the proposed scheme opening and again in the 5th, 10th and 15th year after the year of opening.

Operational Noise Assessment – Dunkeld & Birnam Station Replacement Car Park Noise

15.2.62 Prediction of the Dunkeld & Birnam Station replacement car park noise levels at the nearest noise sensitive receptors to the car park has followed the methodology outlined in ISO 9613-2 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation (International Organization for Standardization, 1996). Full details of the noise calculation methodology and assumptions are provided in Appendix A15.3.

15.2.63 Predicted operational park and ride noise levels have been compared with World Health Organization (WHO) Guidelines for Community Noise (WHO, 1999) and baseline noise levels (ambient noise levels without noise from the Dunkeld & Birnam Station replacement car park) to determine the likelihood for significant effects to occur. The predicted Do-Something 2036 road traffic noise levels, obtained from the operational road traffic noise model, have been

used to represent baseline noise levels. The predicted $L_{A10,18hr}$ daytime road traffic noise levels have been converted to $L_{Aeq,16hr}$ daytime residual noise levels by subtracting 2dB, in accordance with Transport Analysis Guidance (TAG) Unit A3 – Environmental Impact Appraisal (Department for Transport, 2024).

15.2.64 In Guidelines for Community Noise, WHO advise that few people are moderately annoyed when daytime noise levels are below 50dB $L_{Aeq,16hrs}$. Guidelines for Community Noise has been partially superseded by WHO Environmental Noise Guidelines, which was published in 2018. However, WHO recommends that they remain valid for any guidelines not covered by the current document.

Consultation

15.2.65 The PKC Environmental Health Department and Planning Department was consulted regarding the baseline noise survey. Both the noise monitoring locations and the noise measurement procedure were agreed with an Environmental Health Officer from PKC via email letter on 24 August 2016 and 31 August 2016, prior to the surveys commencing.

15.2.66 Noise surveys were undertaken in September and October 2016 and the results of these informed the noise assessment undertaken at DMRB Stage 2 and were presented in the DMRB Stage 2 Scheme Assessment Report.

15.2.67 To ensure that the measured baseline noise levels included in the noise assessment undertaken at DMRB Stage 3 were up-to-date, the baseline noise surveys were repeated in January and February 2025. One location was adjusted (moved from 9 Telford Gardens to 6 King Duncan's Place) due to access issues and a new location was added (St. Catherine's Cottage) to increase the coverage of the baseline noise measurements.

Cumulative Effects

15.2.68 Potentially significant cumulative effects of the proposed scheme, and those of the proposed scheme in combination with other reasonably foreseeable developments, are assessed in Chapter 21 (Assessment of Cumulative Effects).

Limitations of the Assessment

Construction Noise and Vibration

15.2.69 The construction assessment is indicative and, at the time of undertaking the assessment, the contractor who will build the proposed scheme is yet to be appointed. However, reference to the Constructability & Phasing Report for the proposed scheme and Appendix A6.1 (Construction Information) and previous experience on similar schemes has been used to develop an assumed list of plant and equipment based upon conservative assumptions as to the construction methods.

Operational Road Traffic Noise

15.2.70 The operational assessment of road traffic noise has been undertaken following DMRB LA 111 and CRTN. It is considered that all traffic model data inputs for this assessment are adequate to support the assessment requirements defined in DMRB LA 111. Appendix A15.3 provides details of the operational noise model assumptions and the sources used.

15.2.71 Traffic data is fundamental to predicting operational noise levels. Traffic flow (numbers of vehicles), composition (percentage of heavy vehicles) and speed data all contribute. Traffic data have been provided for the year of opening (2036) and future assessment year (2051) for the Do-Minimum (without the proposed scheme in place) and Do-Something (with the proposed scheme in place) scenarios.

15.2.72 No minimum traffic flow threshold has been imposed for roads with very low traffic flows. Excluding such roads or adjusting the traffic flows so that they are within the range of validity for the CRTN method has the potential to obscure or overestimate adverse noise effects. On this matter CRTN advises the following.

'*…calculations can be extended outside the quoted ranges for the purpose of assessing changes in noise levels, e.g. environmental appraisal of road schemes at distances greater than 300 m from a road, and generally for situations where reduced accuracy in predicting absolute levels can be accepted*.'

15.2.73 It is therefore considered that, while noise levels calculated for roads with very low flows may be subject to increased error, the approach adopted is the most accurate in this situation.

Operational Noise - Dunkeld & Birnam Station Replacement Car Park

15.2.74 The main limitations associated with the assessment of operational noise at Dunkeld & Birnam Station replacement car park are the assumptions made regarding the number of car movements per hour at the car park and source noise data associated with the use of the car park.

15.2.75 For further details on the assumptions relating to the park and ride noise assessment refer to Appendix A15.3.

15.3 Baseline Conditions

15.3.1 The baseline noise monitoring locations (listed in a south to north direction) are presented in Table 15.14 and Figure 15.2.

Table 15.14: Baseline noise monitoring locations

Address	Easting	Northing
Rowan Cottage, Birnam	304500	740236
Hollybank, Perth Road, Birnam	303795	741350
St Catherine's Cottage, Birnam	303297	741606

Address	Easting	Northing
Oakbank, Birnam	303165	741522
The Old Bakehouse, 12 Birnam Terrace, Birnam	303186	741709
6 King Duncan's Place, Birnam	302788	741967
Braeknowe, Birnam	302638	741922
Caileagan, Little Dunkeld	302605	742164
Craigview, Inver	301672	742249

15.3.2 The noise surveys were undertaken between 30 January 2025 and 13 February 2025, with the intention of capturing a minimum of two weekdays of noise data in suitable weather conditions. Paragraph 3.47 of DMRB LA111 states that noise monitoring data shall only be valid when it is undertaken during periods when:

- wind speed is less than 5m/s; and
- there is no precipitation and road surfaces are dry.

15.3.3 The actual period of monitoring varied between each location and can be viewed in Appendix A15.2 (Detailed Baseline Noise Survey Results and Notes).

15.3.4 The appendix provides detailed site notes, photographs and noise levels measured at each of the monitoring locations. However, for ease of reference, the average measured weekday $L_{A10,18hr}$, $L_{Aeq,16hr}$ and $L_{night,outside}$ noise levels during suitable weather conditions over the survey periods are summarised in Table 15.15.

Table 15.15: Summary of Average Measured Noise Levels During Baseline Noise Surveys

Receptor Name	$L_{A10,18hr}$ (dB)	$L_{Aeq,16hr}$ (dB)	$L_{night,outside}$ (dB)
Rowan Cottage	60.0	57.8	49.3
Hollybank	56.2	55.0	46.8
St Catherine's Cottage	65.1	61.9	55.1
Oakbank	56.8	54.7	47.6
The Old Bakehouse, 12 Birnam Terrace	52.6	52.8	44.1
6 King Duncan's Place	63.7	61.6	56.1
Braeknowe	57.9	57.2	54.3
Caileagan	58.3	57.2	49.6
Craigview	64.2	62.1	55.9

Comparison of Measured Noise levels with Modelled Predicted Noise Levels

15.3.5 To assist in the understanding of the existing noise levels and explain the noise climate in areas near the proposed scheme, predicted noise levels from the operational noise modelling were

compared with the measured noise levels at the nine measurement locations. Table 15.16 provides this comparison. The predictions of noise levels of the existing road network were undertaken using the assumptions discussed in Section 15.2 (Approach and Methods) and base model traffic data for 2025.

Table 15.16: Comparison of Calculated and Measured Baseline Road Traffic Noise Levels

Receptor Name	Calculated Noise Level ($L_{A10,18hr}$ dB)	Measured Noise Level ($L_{A10,18hr}$ dB)	Noise Level Difference (dB)
Rowan Cottage	58.8	60.0	-1.2
Hollybank	58.4	56.2	+2.2
St Catherine's Cottage	62.1	65.1	-3.0
Oakbank	57.4	56.8	+0.6
The Old Bakehouse, 12 Birnam Terrace	57.9	52.6	+5.3
6 King Duncan's Place	66.4	63.7	+2.7
Braeknowe	58.5	57.9	+0.6
Caileagan	61.0	58.3	+2.7
Craigview	64.5	64.2	+0.3

15.3.6 It should be noted that there is rarely complete agreement between predicted and measured noise levels. The predicted noise levels use traffic flow data for an 18-hour period averaged over a year, while the measured levels are dependent on the traffic at the time of the measurement. The measured noise levels are also affected by noise sources other than road traffic noise, while the predicted noise levels are based on road traffic noise only. Due to the precautionary approach to the noise assessment, local acoustic barriers such as walls on property or field boundaries are not included in the 3D noise models. In addition, the CRTN prediction method assumes light downwind propagation from every modelled road to every prediction point in the model. This is unlikely to occur in reality. These factors can result in relatively wide variations between measured and calculated baseline road traffic noise levels. Table 15.16 provides a comparison between the calculated and measured noise levels, with the difference calculated by subtracting the measured noise level from the predicted noise level. The average measured $L_{A10,18hr}$ noise levels include only data measured on weekdays to allow comparison with the calculated $L_{A10,18hr}$, which is based on weekday only traffic data.

15.3.7 The results in Table 15.16 show that at eight of the locations there is a reasonably good correlation (a difference of no greater than 3dB) between the modelled predicted noise levels and the measured noise levels. At The Old Bakehouse, 12 Birnam Terrace, the difference between the predicted and measured noise levels is +5.3dB. There is a close boarded timber fence running along the southern boundary of properties at The Old Bakehouse, between the receptor and the existing A9 (as seen in the top left corner of Photograph 5 in Appendix A15.2: Detailed Baseline Noise Survey Results and Notes). The fence would provide additional screening of the road from the sample receptor and explain the differences between the predicted and measured noise levels.

15.3.8 Based on the above, the noise models and calculated noise levels were determined to be suitable for this assessment and, as such, no amendments were made to the noise models.

15.4 Potential Impacts and Effects

Construction

15.4.1 This section describes the potential impacts of the proposed scheme on noise sensitive receptors during construction that could arise in the absence of standard or specific mitigation. It should be noted that the assessment of construction noise and vibration does not include for any benefits associated with the standard good practice mitigation measures discussed Section 15.5 (Mitigation).

Construction Noise

15.4.2 Table 15.17 shows the predicted daytime construction noise levels per activity at the sample NSRs, along with magnitude of impact derived in line with Table 15.5. Where the construction activities take place in a different direction relative to the noise sensitive receptor, the LOAEL and SOAEL have been derived based on the baseline noise level at the façade facing the construction activity being assessed. Predicted construction noise levels in excess of the applicable SOAEL (as defined in Table 15.6) are highlighted in bold text.

15.4.3 It should be noted that the predicted noise levels presented in Table 15.17 are based on the activity occurring at the nearest location possible to each noise sensitive receptor, thereby representing a worst-case scenario. The majority of construction activities are transient in nature (with the exception of specific structures), and therefore, noise levels would be reduced as these activities move further from the receptor. All activities include the presence of generators in each of the site compounds and the haul routes are assumed to be operational.

Table 15.17: Construction Noise Magnitude of Impact

Receptor Name	Activity		Construction Noise Level ($L_{Aeq,T}$)	LOAEL ($L_{Aeq,T}$)	SOAEL ($L_{Aeq,T}$)	Magnitude of Impact
Roman Bridge Cottage	Earthworks	Excavation	62	62	65	Minor
		Backfill & Compaction	62	62	65	Minor
	Surfacing	Surfacing	59	62	65	Negligible
Inkpot Cottage	Earthworks	Excavation	77	61	65	**Major**
		Backfill & Compaction	77	61	65	**Major**
	Surfacing	Surfacing	60	61	65	Negligible
	Structure: Murthly	Sheet Piling	56	61	65	Negligible
		Excavation	55	61	65	Negligible

Receptor Name	Activity		Construction Noise Level ($L_{Aeq,T}$)	LOAEL ($L_{Aeq,T}$)	SOAEL ($L_{Aeq,T}$)	Magnitude of Impact
	Estate Bridge	Piling Platform	57	61	65	Negligible
		Bored Piling	56	61	65	Negligible
		Pile Cap	60	61	65	Negligible
		Installation of Pre-Cast Elements	52	61	65	Negligible
		Backfill & Compaction	56	61	65	Negligible
Ballincrieff	Earthworks	Excavation	78	60	65	**Major**
		Backfill & Compaction	78	60	65	**Major**
	Surfacing	Surfacing	74	58	65	**Major**
	Site Compound	Compound Construction	50	58	65	Negligible
		Compound Operation	51	58	65	Negligible
	Structure: Birnam Junction Bridge	Excavation	42	57	65	Negligible
		Backfill & Compaction	43	57	65	Negligible
		Surfacing	38	57	65	Negligible
		Piling Platform	41	57	65	Negligible
		Bored Piling	43	57	65	Negligible
		Pile Cap	42	57	65	Negligible
		Installation of Pre-Cast Elements	37	57	65	Negligible
		Formwork & Reinforcing	35	57	65	Negligible
		Concrete	33	57	65	Negligible
St Catherine's Cottage	Earthworks	Excavation	81	64	70	**Major**
		Backfill & Compaction	81	64	70	**Major**
	Surfacing	Surfacing	64	64	70	Minor
		Excavation	55	64	70	Negligible
		Bored Piling	43	64	70	Negligible

Receptor Name	Activity		Construction Noise Level ($L_{Aeq,T}$)	LOAEL ($L_{Aeq,T}$)	SOAEL ($L_{Aeq,T}$)	Magnitude of Impact
	Piled Retaining Wall	Capping Beam	41	64	70	Negligible
		Facing	35	64	70	Negligible
	Structure: Birnam Glen and Inchewan Burn Bridge	Excavation (Low Headroom)	41	64	70	Negligible
		Bored Piling (Low Headroom)	38	64	70	Negligible
		Formwork & Reinforcing	41	64	70	Negligible
		Concrete	39	64	70	Negligible
		Backfill & Compaction	47	64	70	Negligible
		Installation of Pre-Cast Elements	42	64	70	Negligible
		Surfacing	43	64	70	Negligible
	Structure: Dunkeld & Birnam Underpass	Sheet Piling	49	64	70	Negligible
		Excavation	50	64	70	Negligible
		Installation of Pre-Cast Elements	47	64	70	Negligible
		Backfill & Compaction	52	64	70	Negligible
		Surfacing	48	64	70	Negligible
Craigmore	Earthworks	Excavation	62	62	65	Minor
		Backfill & Compaction	62	62	65	Minor
	Surfacing	Surfacing	59	62	65	Negligible
	Piled Retaining Wall	Excavation	59	62	65	Negligible
		Bored Piling	49	62	65	Negligible
		Capping Beam	50	62	65	Negligible
		Facing	44	62	65	Negligible

Receptor Name	Activity		Construction Noise Level ($L_{Aeq,T}$)	LOAEL ($L_{Aeq,T}$)	SOAEL ($L_{Aeq,T}$)	Magnitude of Impact
	Structure: Birnam Glen and Inchewan Burn Bridge	Excavation (Low Headroom)	40	62	65	Negligible
		Bored Piling (Low Headroom)	36	62	65	Negligible
		Formwork & Reinforcing	40	62	65	Negligible
		Concrete	38	62	65	Negligible
		Backfill & Compaction	46	62	65	Negligible
		Installation of Pre-Cast Elements	41	62	65	Negligible
		Surfacing	42	62	65	Negligible
	Structure: Dunkeld & Birnam Underpass	Sheet Piling	49	62	65	Negligible
		Excavation	50	62	65	Negligible
		Installation of Pre-Cast Elements	45	62	65	Negligible
		Backfill & Compaction	50	62	65	Negligible
		Surfacing	46	62	65	Negligible
The Old Bakehouse	Excavation	Excavation	84	63	70	**Major**
		Backfill & Compaction	84	63	70	**Major**
	Surfacing	Surfacing	65	63	70	Minor
	Piled Retaining Wall	Excavation	68	63	70	Minor
		Bored Piling	66	63	70	Minor
		Capping Beam	66	63	70	Minor
		Facing	59	63	70	Negligible
	Structure: Birnam Glen and	Excavation (Low Headroom)	56	63	70	Negligible

Receptor Name	Activity		Construction Noise Level ($L_{Aeq,T}$)	LOAEL ($L_{Aeq,T}$)	SOAEL ($L_{Aeq,T}$)	Magnitude of Impact
	Inchewan Burn Bridge	Bored Piling (Low Headroom)	54	63	70	Negligible
		Formwork & Reinforcing	55	63	70	Negligible
		Concrete	51	63	70	Negligible
		Backfill & Compaction	59	63	70	Negligible
		Installation of Pre-Cast Elements	55	63	70	Negligible
		Surfacing	56	63	70	Negligible
	Structure: Dunkeld & Birnam Underpass	Sheet Piling	66	63	70	Minor
		Excavation	66	63	70	Minor
		Installation of Pre-Cast Elements	62	63	70	Negligible
		Backfill & Compaction	65	63	70	Minor
		Surfacing	68	63	70	Minor
Dunkeld and Birnam Railway Station	Earthworks	Excavation	102	71	75	**Major**
		Backfill & Compaction	102	71	75	**Major**
	Surfacing	Surfacing	84	71	75	**Major**
	Piled Retaining Wall	Excavation	76	71	75	**Moderate**
		Bored Piling	77	71	75	**Moderate**
		Capping Beam	81	71	75	**Major**
		Facing	51	71	75	Negligible
	Structure: Birnam Glen and Inchewan Burn Bridge	Excavation (Low Headroom)	63	71	75	Negligible
		Bored Piling (Low Headroom)	60	71	75	Negligible
		Formwork & Reinforcing	68	71	75	Negligible

Receptor Name	Activity		Construction Noise Level ($L_{Aeq,T}$)	LOAEL ($L_{Aeq,T}$)	SOAEL ($L_{Aeq,T}$)	Magnitude of Impact
		Concrete	64	71	75	Negligible
		Backfill & Compaction	71	71	75	Minor
		Installation of Pre-Cast Elements	67	71	75	Minor
		Surfacing	68	71	75	Negligible
	Structure: Dunkeld & Birnam Underpass	Sheet Piling	75	71	75	**Moderate**
		Excavation	74	71	75	Minor
		Installation of Pre-Cast Elements	70	71	75	Negligible
		Backfill & Compaction	74	71	75	Minor
		Surfacing	71	71	75	Minor
55 Stell Park Gardens	Earthworks	Excavation	62	65	70	Negligible
		Backfill & Compaction	62	65	70	Negligible
	Surfacing	Surfacing	57	65	70	Negligible
	Piled Retaining Wall	Excavation	61	65	70	Negligible
		Bored Piling	62	65	70	Negligible
		Capping Beam	60	65	70	Negligible
		Facing	53	65	70	Negligible
	Structure: Birnam Glen and Inchewan Burn Bridge	Excavation (Low Headroom)	59	65	70	Negligible
		Bored Piling (Low Headroom)	56	65	70	Negligible
		Formwork & Reinforcing	56	65	70	Negligible
		Concrete	54	65	70	Negligible
		Backfill & Compaction	62	65	70	Negligible

Receptor Name	Activity		Construction Noise Level ($L_{Aeq,T}$)	LOAEL ($L_{Aeq,T}$)	SOAEL ($L_{Aeq,T}$)	Magnitude of Impact
		Installation of Pre-Cast Elements	57	65	70	Negligible
		Surfacing	58	65	70	Negligible
	Structure: Dunkeld & Birnam Underpass	Sheet Piling	58	65	70	Negligible
		Excavation	58	65	70	Negligible
		Installation of Pre-Cast Elements	54	65	70	Negligible
		Backfill & Compaction	58	65	70	Negligible
		Surfacing	55	65	70	Negligible
6 King Duncan's Place	Earthworks	Excavation	68	62	65	**Moderate**
		Backfill & Compaction	68	62	65	**Moderate**
	Surfacing	Surfacing	66	62	65	**Moderate**
	Site Compound	Compound Construction	50	62	65	Negligible
		Compound Operation	51	62	65	Negligible
	Cantilever Retaining Wall	Excavation	45	62	65	Negligible
		Sheet Piling	42	62	65	Negligible
		Formwork & Reinforcing	37	62	65	Negligible
		Concrete	35	62	65	Negligible
	Piled Retaining Wall	Excavation	55	62	65	Negligible
		Bored Piling	67	62	65	**Moderate**
		Capping Beam	69	62	65	**Moderate**
		Facing	62	62	65	Minor
Braeknowe	Earthworks	Excavation	62	59	65	Minor
		Backfill & Compaction	61	59	65	Minor
	Surfacing	Surfacing	57	59	65	Negligible
	Site Compound	Compound Construction	64	59	65	Minor

Receptor Name	Activity		Construction Noise Level ($L_{Aeq,T}$)	LOAEL ($L_{Aeq,T}$)	SOAEL ($L_{Aeq,T}$)	Magnitude of Impact
		Compound Operation	64	59	65	Minor
	Cantilever Retaining Wall	Excavation	64	59	65	Minor
		Sheet Piling	64	59	65	Minor
		Formwork & Reinforcing	59	59	65	Negligible
		Concrete	56	59	65	Negligible
	Piled Retaining Wall	Excavation	48	59	65	Negligible
		Bored Piling	51	59	65	Negligible
		Capping Beam	49	59	65	Negligible
		Facing	45	59	65	Negligible
Lagmhor	Earthworks	Excavation	85	64	70	**Major**
		Backfill & Compaction	85	64	70	**Major**
	Surfacing	Surfacing	76	64	70	**Major**
	Site Compound	Compound Construction	52	64	70	Negligible
		Compound Operation	53	64	70	Negligible
	Structure: River Brann Bridge	Excavation	42	64	70	Negligible
		Backfill & Compaction	42	64	70	Negligible
		Surfacing	38	64	70	Negligible
		Scaffolding & Crash Deck	37	64	70	Negligible
		Demolition & Lifting Out	36	64	70	Negligible
		Breaking Out Concrete	42	64	70	Negligible
		Sheet Piling	40	64	70	Negligible
		Lifting In Bridge Beams	37	64	70	Negligible
		Formwork & Reinforcing	35	64	70	Negligible
		Concrete	33	64	70	Negligible

Receptor Name	Activity		Construction Noise Level ($L_{Aeq,T}$)	LOAEL ($L_{Aeq,T}$)	SOAEL ($L_{Aeq,T}$)	Magnitude of Impact
	Cantilever Retaining Wall	Excavation	85	64	70	**Major**
		Sheet Piling	85	64	70	**Major**
		Formwork & Reinforcing	82	64	70	**Major**
		Concrete	77	64	70	**Major**
	Piled Retaining Wall	Excavation	37	64	70	Negligible
		Bored Piling	37	64	70	Negligible
		Capping Beam	36	64	70	Negligible
		Facing	29	64	70	Negligible
Dunkeld and Birnam Recreation Club	Earthworks	Excavation	72	66	70	**Moderate**
		Backfill & Compaction	72	66	70	**Moderate**
	Surfacing	Surfacing	69	66	70	Minor
	Site Compound	Compound Construction	53	66	70	Negligible
		Compound Operation	54	66	70	Negligible
	Structure: River Brann Bridge	Excavation	66	66	70	Minor
		Backfill & Compaction	66	66	70	Minor
		Surfacing	62	66	70	Negligible
		Scaffolding & Crash Deck	61	66	70	Negligible
		Demolition & Lifting Out	60	66	70	Negligible
		Breaking Out Concrete	69	66	70	Minor
		Sheet Piling	65	66	70	Negligible
		Lifting In Bridge Beams	60	66	70	Negligible
		Formwork & Reinforcing	62	66	70	Negligible
		Concrete	57	66	70	Negligible
		Excavation	60	66	70	Negligible
		Sheet Piling	54	66	70	Negligible

Receptor Name	Activity		Construction Noise Level ($L_{Aeq,T}$)	LOAEL ($L_{Aeq,T}$)	SOAEL ($L_{Aeq,T}$)	Magnitude of Impact
	Cantilever Retaining Wall	Formwork & Reinforcing	48	66	70	Negligible
		Concrete	46	66	70	Negligible
Rose Cottage	Earthworks	Excavation	77	70	75	**Moderate**
		Backfill & Compaction	77	70	75	**Moderate**
	Surfacing	Surfacing	76	70	75	**Moderate**
	Site Compound	Compound Construction	61	70	75	Negligible
		Compound Operation	62	70	75	Negligible
	Structure: Inver Rail Bridge and Inch Rail Bridge	Excavation	68	66	70	Minor
		Backfill & Compaction	69	66	70	Minor
		Breaking Out Concrete	73	66	70	**Moderate**
		Installation of Pre-Cast Elements	65	66	70	Negligible
		Surfacing	66	66	70	Minor
	Piled Retaining Wall	Excavation	68	70	75	Negligible
		Bored Piling	71	70	75	Minor
		Capping Beam	75	70	75	**Moderate**
		Facing	69	70	75	Negligible
Dunkeld House Hotel	Earthworks	Excavation	58	56	65	Minor
		Backfill & Compaction	45	56	65	Negligible
	Surfacing	Surfacing	41	56	65	Negligible
	Site Compound	Compound Construction	56	56	65	Minor
		Compound Operation	57	56	65	Minor

15.4.4 Table 15.17 indicates that, in a worst-case scenario, Inkpot Cottage, Ballincrieff, St Catherine's Cottage, The Old Bakehouse, Dunkeld and Birnam Railway Station, 6 King Duncan's Place, Lagmhor, Dunkeld and Birnam Recreation Club and Rose Cottage are predicted to experience daytime impacts of moderate and/or major magnitude during construction.

15.4.5 As set out in Section 15.2 (Approach and Methods), an impact of moderate magnitude or above is considered potentially significant, dependent upon further contextual factors such as duration of the activity.

15.4.6 Inkpot Cottage and St Catherine's Cottage are predicted to experience a major impact magnitude for two construction activities related to earthworks (excavation and backfill and compaction) when occurring at the closest point. Ballincrief is predicted to experience a major impact magnitude for two construction activities related to earthworks (excavation and backfill and compaction) and a major impact magnitude for construction activities related to surfacing when occurring at the closest point. Although construction noise levels will decrease as these activities move away from these NSRs, given the relatively large exceedances of the SOAEL it is considered likely that moderate and major impact magnitudes will be sustained for more than 10 days in any 15 consecutive days or exceed 40 days in a six-month period. Therefore, construction noise impacts at Inkpot Cottage, St Catherine's Cottage and Ballincrief are predicted to be significant.

15.4.7 Dunkeld and Birnam Recreation Club is predicted to experience a moderate impact magnitude for two construction activities related to earthworks (excavation and backfill and compaction) when occurring at the closest point. 6 King Duncan's Place is predicted to experience a moderate impact magnitude for two construction activities related to earthworks (excavation and backfill and compaction) and two related to construction of a piled retaining wall (bored piling and capping beam) when occurring at the closest point. Rose Cottage is predicted to experience a moderate impact magnitude for two construction activities related to earthworks (excavation and backfill and compaction), one related to surfacing, one related to construction of Inver Rail Bridge and Inch Rail Bridge (breaking out concrete) and one related to construction of a piled retaining wall (capping beam) when occurring at the closest point. Construction noise levels will decrease as these activities move away from this NSR. Given the relatively low exceedances of the SOAEL it is considered unlikely that impacts of moderate magnitude will be sustained for more than 10 days in any 15 consecutive days or exceed 40 days in a six-month period. Therefore, construction noise impacts at Dunkeld and Birnam Recreation Club, 6 King Duncan's Place and Rose Cottage are not predicted to be significant.

15.4.8 The Old Bakehouse is predicted to experience a major impact magnitude for two construction activities related to earthworks (excavation and backfill and compaction). Lagmhor is predicted to experience a major impact magnitude for two construction activities related to earthworks (excavation and backfill and compaction), one related to surfacing and four activities related to the construction of a cantilever retaining wall (excavation, sheet piling, formwork and reinforcing and concrete) when occurring at the closest point. Given the relatively large exceedances of the SOAEL and the static nature of construction activities at structures, it is considered likely that moderate and major impact magnitudes will be sustained for more than 10 days in any 15 consecutive days or exceed 40 days in a six-month period. Therefore, construction noise impacts at The Old Bakehouse and Lagmhor are predicted to be significant.

15.4.9 Dunkeld and Birnam Station is predicted to experience a major impact magnitude for two construction activities related to earthworks (excavation and backfill and compaction), surfacing and one construction activity related to construction of a piled retaining wall

(capping beam) when occurring at the closest point. Dunkeld and Birnam Station is predicted to experience a moderate impact magnitude for two activities related to construction of a piled retaining wall (excavation and bored piling) and one activity related to construction of Dunkeld and Birnam Underpass (sheet piling). Although construction noise levels resulting in major impact magnitudes will decrease as these activities move away from these NSRs, given the relatively large exceedances of the SOAEL it is considered likely that moderate and major impact magnitudes will be sustained for more than 10 days in any 15 consecutive days or exceed 40 days in a six-month period. Therefore, construction noise impacts at Dunkeld and Birnam Station are predicted to be significant.

15.4.10 For those sample noise sensitive receptors predicted to experience a significant effect from the construction of the proposed scheme, standard mitigation will be necessary and recommendations are provided in Section 15.5 (Mitigation).

Construction Vibration Impacts

15.4.11 Of the construction activities proposed, those associated with vibratory earthworks compaction and piling are expected to give rise to the highest vibration levels at nearby VSRs.

15.4.12 The predicted vibration levels presented in Tables 15.18 to 15.20 are intended to provide an indication of reasonable worst-case groundborne vibration levels during earthworks compaction and sheet piling. Vibration levels experienced during construction would be influenced by factors including the number of surface layers, the thickness, density and stiffness of surface layers, the depth of the water table, the topography of the scheme, and the operating frequency of the plant. For compaction plant, the speeds of the compactor would also influence vibration emissions. For percussive piling, as the pile depths are not known at this stage, the horizontal distance between each VSR and the nearest sheet piling activity has conservatively been assumed for the slope distance. It has been assumed that percussive piles are driven to refusal.

Vibratory Earthwork Compaction – Vibration Impact on Human Receptors

15.4.13 For the purposes of vibratory earthworks compaction calculations, it has been assumed that an 18 tonne Bomag BW 216 PD-5 single drum vibratory compactor would be used. Like most vibratory compactors, the BW 216 has a lower vibration amplitude setting, and vibration levels have been calculated for both higher and lower amplitude settings.

15.4.14 Table 15.18 shows the predicted construction vibration levels when operating with the higher vibration amplitude setting at the construction sample VSRs within 100m of where vibratory earthwork compaction is likely to be undertaken during construction of the proposed scheme, which is all of them except Dunkeld House Hotel. Predicted vibration levels above or equal to the SOAEL (1.0 mm/s PPV), and therefore predicted to experience a moderate or major magnitude of impact, are highlighted in bold text. It should be noted that the predicted vibration levels presented in Table 15.18 assume that the activity is occurring at the nearest point possible to each sample VSR, thereby representing a worst-case scenario. Vibratory earthwork compaction is transient in nature, and therefore, vibration levels would be reduced as this activity moves further from the receptor.

Table 15.18: Predicted PPV Levels due to Vibratory Earthworks Compaction – Higher Vibration Amplitude Setting

Receptor Name	Distance (m)	Steady State Vibration Level (mm/s)	Start-up and Run-down Vibration Level (mm/s)
Roman Bridge Cottage	100	0.2	0.4
Inkpot Cottage	31	0.9	**1.5**
Ballincrieff	26	**1.1**	**1.9**
St Catherine's Cottage	19	**1.7**	**2.7**
Craigmore	67	0.3	0.6
The Old Bakehouse	9	**4.5**	**6.3**
Dunkeld and Birnam Railway Station	2	**19.8**	**22.8**
55 Stell Park Gardens	26	**1.1**	**1.9**
6 King Duncan's Place	35	0.7	**1.3**
Braeknowe	37	0.7	**1.2**
Lagmhor	12	**3.1**	**4.6**
Dunkeld and Birnam Recreation Club	34	0.8	**1.4**
Rose Cottage	13	**2.8**	**4.2**

15.4.15 The predicted vibration levels presented in Table 15.18 indicate that vibration levels have the potential to be above or equal to the SOAEL and below 10mm/s PPV at VSRs within 5m to 45m of the proposed scheme, indicating moderate magnitudes of impact, and the potential for significant vibration effects.

15.4.16 In one case where the sample VSR is within 5m (Dunkeld and Birnam Railway Station), the predicted vibration level is above 10mm/s PPV. Vibration levels of this magnitude indicate a major magnitude of impact and the potential for significant vibration effects.

15.4.17 The predicted vibration levels presented in Table 15.19 reflect the use of the Bomag BW 216 using the lower vibration amplitude setting.

Table 15.19: Predicted PPV Levels due to Vibratory Earthworks Compaction – Lower Vibration Amplitude Setting

Receptor Name	Distance (m)	Steady State Vibration Level (mm/s)	Start-up and Run-down Vibration Level (mm/s)
Roman Bridge Cottage	100	0.1	0.1
Inkpot Cottage	31	0.3	0.6
Ballincrieff	26	0.4	0.7
St Catherine's Cottage	19	0.7	**1.1**
Craigmore	67	0.1	0.2
The Old Bakehouse	9	**1.7**	**2.4**
Dunkeld and Birnam Railway Station	2	**7.6**	**8.8**
55 Stell Park Gardens	26	0.4	0.7
6 King Duncan's Place	35	0.3	0.5
Braeknowe	37	0.3	0.5
Lagmhor	12	**1.2**	**1.8**
Dunkeld and Birnam Recreation Club	34	0.3	0.5
Rose Cottage	13	**1.1**	**1.6**

15.4.18 The predicted vibration levels presented in Table 15.19 show that, with the lower amplitude setting selected, vibration levels at the nearest sensitive receptors are substantially reduced, although moderate magnitudes of impact are still predicted at sample VSRs within 20m of the proposed scheme.

Vibratory Earthwork Compaction – Vibration Impact on Buildings and Structures

15.4.19 In terms of cosmetic damage to buildings and structures (using the criteria presented in Table 15.8) the lowest level where damage may occur to structurally sound buildings is at 6mm/s PPV for continuous vibration source (i.e. vibration compaction). Table 15.18 indicates that at the higher amplitude setting, two sample VSRs (The Old Bakehouse and Dunkeld and Birnam Railway Station) are predicted to experience continuous vibration levels above 6mm/s PPV. Therefore, mitigation measures will be required to avoid the risk of cosmetic building damage as a result of vibratory earthwork compaction activities at these locations.

15.4.20 Table 15.19 indicates that, when considering the lower amplitude setting, one sample VSR (Dunkeld and Birnam Station) is predicted to experience continuous vibration levels above 6mm/s PPV.

Sheet Piling – Vibration Impact on Human Receptors

15.4.21 Table 15.20 shows the predicted construction vibration levels for sheet piling at the five construction sample VSRs within 100m of where sheet piling is likely to be undertaken during construction of the proposed scheme. Both percussive and vibratory sheet piling have been considered in this vibration assessment. Predicted vibration levels above or equal to the SOAEL (1.0 mm/s PPV), and therefore predicted to experience a moderate or major magnitude of impact, are highlighted in bold text. It should be noted that the predicted vibration levels presented in Table 15.20 assume that sheet piling is occurring at the nearest point possible to each sample VSR, thereby representing a worst-case scenario.

Table 15.20: Predicted PPV Levels due to Sheet Piling

Receptor Name	Distance (m)	Vibratory Piling Vibration Level (mm/s PPV)	Percussive Piling Vibration Level (mm/s PPV)
The Old Bakehouse	42	0.5	0.4
Dunkeld and Birnam Railway Station	16	**1.6**	**1.3**
Braeknowe	70	0.2	0.2
Lagmhor	13	**2.1**	**1.6**
Dunkeld and Birnam Recreation Club	75	0.2	0.2

15.4.22 The predicted vibration levels presented in Table 15.20 for vibratory and percussive piling indicate that that vibration levels have the potential to be above or equal to the SOAEL and below 10mm/s PPV at Dunkeld and Birnam Railway Station and Lagmhor, indicating moderate magnitudes of impact, and the potential for significant vibration effects.

Sheet Piling – Vibration Impact on Buildings and Structures

15.4.23 Table 15.20 indicates that no sample VSRs are predicted to experience continuous vibration levels above 6mm/s PPV. The predicted vibration levels for percussive piling indicate that no VSRs are predicted to experience transient vibration levels above 12mm/s PPV. Therefore, cosmetic damage to buildings and structures during vibratory or percussive sheet piling is considered unlikely at all VSRs.

Bored Piling – Vibration Impact on Human Receptors

15.4.24 There are no vibration calculation methodologies to assess the vibration generated by bored piling; however, BS 5228-2 includes historical measured data that can be used to infer potential impacts.

15.4.25 The most relevant historical data, for piling works within sand and gravel overlying rock (within chalk in the measured data in BS 5228-2 (Table D.6, reference number 105)) provides measured vibration levels of 2.4mm/s PPV at a plan distance of 3.5m, reducing to 1.7mm/s PPV at a plan distance of 8m.

15.4.26 The nearest sample VSR to bored piling activities is The Old Bakehouse, which is approximately 10m from the closest line of piles. At this distance, vibration levels are likely to be between 1.0mm/s PPV and 1.7mm/s PPV, indicating a moderate magnitude of impact, and the potential for significant vibration effects.

15.4.27 All other sample VSRs are at least 30m from bored piling activities. At this distance, it is considered that vibration levels from bored piling are likely to be below 1.0mm/s PPV and significant vibration effects are unlikely.

Bored Piling – Vibration Impact on Buildings and Structures

15.4.28 The most relevant historical data for bored piling indicates that no sample VSRs are considered likely to experience continuous vibration levels above 6mm/s PPV. Therefore, cosmetic damage to buildings and structures during bored piling is considered unlikely at all VSRs.

Construction Vibration Effects

Vibratory Compaction

15.4.29 Table 15.18 indicates that the Bomag BW 216 PD-5 with the higher vibration setting is not suitable for use within 45m of vibration sensitive receptors as it results in vibration levels above the SOAEL and when within 10m there is a risk of cosmetic building damage. This significance assessment for construction vibration has therefore focused on the use of the Bomag BW 216 PD-5 using the lower vibration setting.

15.4.30 Table 15.19 indicates the potential for moderate adverse impacts to occur when vibratory compaction plant is within 20m of vibration sensitive receptors. These works are transient in nature and the assessment performed assumes that the vibratory compaction plant is operating at the nearest point of the planning application boundary to the vibration sensitive receptor. As such, the vibration levels presented in Table 15.19 are considered to represent the worst case and, at other times, would be lower than those quoted.

15.4.31 Based on the significance criteria provided in Table 15.7 and paragraph 15.2.32, only those moderate and major impacts for vibratory compaction at The Old Bakehouse and Dunkeld and Birnam Railway Station are considered to be significant adverse effects, as at other locations, the duration of the impact is likely to be less than 10 days in a 15-day period or 40 days in a six-month period.

15.4.32 One sample VSR (Dunkeld and Birnam Station) is considered to have the potential for cosmetic damage during vibratory earthwork compaction, resulting in significant adverse effects.

15.4.33 Therefore, as there is the potential for significant effects to occur, appropriate mitigation measures for vibratory compaction works are discussed in Section 15.5 (Mitigation).

Sheet Piling

15.4.34 Table 15.20 indicates the potential for moderate adverse impacts to occur for vibratory or percussive sheet piling works at Dunkeld and Birnam Railway Station and Lagmhor.

15.4.35 The duration of the sheet piling works at the cantilevered retaining wall in the vicinity of Lagmhor is likely to be less than 10 days in a 15-day period and therefore the moderate adverse impacts predicted here for sheet piling are not considered to be significant. Therefore, based on the significance criteria provided in Table 15.7 and paragraph 15.2.32, only the moderate impacts for sheet piling at Dunkeld and Birnam Railway Station are considered likely experience a significant adverse effect as these works are likely to take longer than 10 days in a 15-day period.

15.4.36 No sample VSRs are predicted to experience continuous vibration levels from vibratory sheet piling above 6mm/s PPV or experience transient vibration levels from percussive sheet piling above 12mm/s PPV. Therefore, significant adverse effects due to cosmetic damage to buildings and structures are considered unlikely.

15.4.37 Therefore, as there is the potential for significant effects to occur, appropriate mitigation measures for sheet piling works are discussed in Section 15.5 (Mitigation).

Bored Piling

15.4.38 The most relevant historical data for bored piling indicates the potential for moderate adverse impacts to occur for bored piling works at The Old Bakehouse. The duration of the bored piling works at the piled retaining wall in the vicinity of The Old Bakehouse is likely to be less than 10 days in a 15-day period and therefore the moderate adverse impacts predicted here for sheet piling are not considered to be significant. Therefore, based on the significance criteria provided in Table 15.7 and paragraph 15.2.32, bored piling is considered unlikely to result in a significant adverse effect.

Operation

Introduction

15.4.39 The predicted operational noise levels and the associated magnitude of change at the sample NSRs are summarised in Table 15.21 and Table 15.22. The predicted operational noise levels for all NSRs in the noise model study area without specific mitigation are not provided; instead, the predicted residual operational noise levels for all NSRs in the noise model study area with specific mitigation are provided in Appendix A15.4.

15.4.40 DMRB LA 111 summary tables for all identified NSRs within the 600m study area are provided within Table 15.23, Table 15.24 and Table 15.25 and provides a broader view of potential noise impacts than the sample NSRs assessment tables.

15.4.41 In the following tables, where reference is made to the predicted daytime and night-time noise levels, the assessment has been undertaken at the receptor point which experiences the greatest noise level difference when comparing the DMOY 2036 scenario against the DSOY 2036 scenario as described in Paragraph 15.2.49.

15.4.42 It should be noted that, in the commentary that follows these tables, emphasis is placed on discussion of noise changes of minor magnitude or more (more than 1 dB change in the short-term and 3 dB in the long-term) as these changes are those which are potentially significant

based upon the criteria in Table 15.12. It should be noted that, whilst Table 15.12 indicates that impacts of moderate or major magnitude are to be initial assessed as potentially significant, Table 15.13 states that minor noise changes (1 dB or more in the short-term) where noise levels are above SOAEL are also potentially significant, subject to consideration of other contextual factors.

15.4.43 The assessment of noise impacts on outdoor NSRs have been considered and reported separately due to the nature of these spaces and impacts.

Sample Noise Sensitive Receptors

15.4.44 Sample NSRs are shown in Figure 15.2. Table 15.21 and Table 15.22 present the predicted daytime and night-time noise levels at sample NSRs in the opening year with and without the proposed scheme, and in the future assessment year with and without the proposed scheme. In addition, the associated short-term and long-term noise level changes and magnitudes of impact are also presented.

Table 15.21: Comparison of Predicted Daytime Noise Impacts at Sample NSRs, with and without the Proposed Scheme in Place

Property Name	DMOY 2036 dB $L_{A10,18hr}$	DMFY 2051 dB $L_{A10,18hr}$	DSOY 2036 dB $L_{A10,18hr}$	DSFY 2051 dB $L_{A10,18hr}$	Short-term Change (dB)	Short-term Magnitude of Impact	Long-term Change with Scheme (dB)	Long-term Magnitude of Impact with Scheme	Long-term Change without Scheme (dB)	Long-term Magnitude of Impact without Scheme
Rowan Cottage	62.0	59.8	65.1	65.8	3.1	Moderate Adverse	3.8	Minor Adverse	-2.2	Negligible Beneficial
Hollybank	59.3	57.1	53.9	54.6	-5.4	Major Beneficial	-4.7	Minor Beneficial	-2.2	Negligible Beneficial
St Catherine's Cottage	65.5	64.1	62.5	63.3	-3.0	Moderate Beneficial	-2.2	Negligible Beneficial	-1.4	Negligible Beneficial
Oakbank	62.7	60.5	61.5	62.3	-1.2	Minor Beneficial	-0.4	Negligible Beneficial	-2.2	Negligible Beneficial
The Old Bakehouse, 12 Birnam Terrace	64.7	62.6	61.4	62.2	-3.3	Moderate Beneficial	-2.5	Negligible Beneficial	-2.1	Negligible Beneficial
6 King Duncan's Place	62.9	60.7	63.2	63.8	0.3	Negligible Adverse	0.9	Negligible Adverse	-2.2	Negligible Beneficial
Braeknowe	60.2	60.3	60.4	61.1	0.2	Negligible Adverse	0.9	Negligible Adverse	0.1	Negligible Adverse
Caileagan	65.3	65.9	64.1	64.7	-1.2	Minor Beneficial	-0.6	Negligible Beneficial	0.6	Negligible Adverse
Craigview	68.4	66.9	68.0	68.8	-0.4	Negligible Beneficial	0.4	Negligible Adverse	-1.5	Negligible Beneficial

15.4.45 Table 15.21 shows that, in terms of sample NSRs, one receptor, Rowan Cottage, is predicted to experience a moderate adverse magnitude of impact in the short-term and a minor adverse magnitude of impact in the long-term with the proposed scheme in place during the daytime. Rowan Cottage is in relatively close proximity to the proposed scheme and the predicted increases in noise are due to changes to topography with the proposed scheme in place, which would impact the existing screening of the A9. The DMOY 2036 and DSOY 2036 noise levels are between the daytime LOAEL and SOAEL at Rowan Cottage.

15.4.46 In terms of beneficial impacts, one sample NSR, Hollybank, is predicted to experience a major beneficial magnitude of impact in the short-term, reducing to a minor beneficial magnitude of impact in the long-term during daytime. Two sample NSRs, St Catherine's Cottage and The Old Bakehouse, 12 Birnam Terrace are predicted to experience a moderate beneficial magnitude of impact in the short-term, reducing to a negligible beneficial magnitude of impact in the long-term during the daytime. The predicted noise decreases at Hollybank are due to the use of low noise road surfacing of the A9 and the 2m high woven wattle fence between the A9 and the NSR included as part of the proposed scheme. The predicted noise decreases at St. Catherine's Cottage are due to the use of low noise road surfacing of the A9 and changes in the screening of the A9 due to the earthworks included as part of the proposed scheme. The predicted noise decreases at The Old Bakehouse, 12 Birnam Terrace are due to the use of low noise road surfacing of the A9 and the 2m high parapet at the top of the retaining wall at the Dunkeld & Birnam Station replacement car park as part of the proposed scheme. The DMOY 2036 and DSOY 2036 noise levels are between the daytime LOAEL and SOAEL at Hollybank, St. Catherine's Cottage and The Old Bakehouse.

15.4.47 Two sample NSRs, Oakbank and Caileagan, are predicted to experience a minor beneficial magnitude of impact in the short-term, reducing to a negligible beneficial magnitude of impact in the long-term during the daytime. The predicted noise decreases at Oakbank are due to the use of low noise road surfacing on the A9 as part of the proposed scheme. The predicted noise decreases at Caileagan are due to the changes in the speed and alignment of traffic on the A9 with the introduction of a roundabout at the Dunkeld Junction and the partial screening of the A923 as part of the proposed scheme. The DMOY 2036 and DSOY 2036 noise levels are between the daytime LOAEL and SOAEL at all three sample NSRs.

15.4.48 The remaining NSRs, 6 King Duncan's Place, Braeknowe and Craigview, are predicted to experience a negligible adverse or beneficial magnitude of impact in the short-term and long-term during the daytime.

15.4.49 In the long-term daytime period, without the proposed scheme in place, no NSR is predicted to experience more than a negligible magnitude of impact, either beneficial or adverse, during the daytime.

Table 15.22: Comparison of Predicted Night-time Noise Impacts at Sample NSRs, with and without the Proposed Scheme in Place

Property Name	DMOY 2036 dB $L_{night, outside}$	DMFY 2051 dB $L_{night, outside}$	DSOY 2036 dB $L_{night, outside}$	DSFY 2051 dB $L_{night, outside}$	Short-term Change (dB)	Short-term Magnitude of Impact	Long-term Change with Scheme (dB)	Long-term Magnitude of Impact with Scheme	Long-term Change without Scheme (dB)	Long-term Magnitude of Impact without Scheme
Rowan Cottage	49.6	47.5	52.4	53.0	2.8	Minor Adverse	3.4	Minor Adverse	-2.1	Negligible Beneficial
Hollybank	47.1	45.1	42.2	42.8	-4.9	Moderate Beneficial	-4.3	Minor Beneficial	-2.2	Negligible Beneficial
St Catherine's Cottage	52.6	51.4	50.0	50.7	-2.6	Minor Beneficial	-1.9	Negligible Beneficial	-1.2	Negligible Beneficial
Oakbank	50.2	48.2	49.1	49.8	-1.1	Minor Beneficial	-0.4	Negligible Beneficial	-2.0	Negligible Beneficial
The Old Bakehouse, 12 Birnam Terrace	51.9	50.1	49.0	49.7	-2.9	Minor Beneficial	-2.2	Negligible Beneficial	-1.8	Negligible Beneficial
6 King Duncan's Place	50.4	48.4	50.6	51.1	0.2	Negligible Adverse	0.7	Negligible Adverse	-2.0	Negligible Beneficial
Braeknowe	47.9	48.0	48.1	48.7	0.2	Negligible Adverse	0.8	Negligible Adverse	0.1	Negligible Adverse
Caileagan	52.5	53.0	51.4	52.0	-1.1	Minor Beneficial	-0.5	Negligible Beneficial	0.5	Negligible Adverse
Craigview	55.3	54.0	54.9	55.6	-0.4	Negligible Beneficial	0.3	Negligible Adverse	-1.3	Negligible Beneficial

15.4.50 Table 15.22 shows that, in terms of sample NSRs, one receptor, Rowan Cottage, is predicted to experience a minor adverse magnitude of impact in the short-term and long-term with the proposed scheme in place during the night-time. Rowan Cottage is in relatively close proximity to the proposed scheme and the predicted increases in noise are due to changes to topography with the proposed scheme in place, which would impact the existing screening of the A9. The DMOY 2036 and DSOY 2036 noise levels are between the night-time LOAEL and SOAEL at Rowan Cottage.

15.4.51 In terms of beneficial impacts, one sample NSR, Hollybank, is predicted to experience a moderate beneficial magnitude of impact in the short-term, reducing to a negligible beneficial magnitude of impact in the long-term during the night-time. The predicted noise decreases at Hollybank are due to the use of low noise road surfacing of the A9 and the 2m high woven wattle fence between the A9 and the NSR included part of the proposed scheme. The DMOY 2036 and DSOY 2036 noise levels are between the night-time LOAEL and SOAEL at The Hollybank.

15.4.52 Four sample NSRs, St Catherine's Cottage, Oakbank, The Old Bakehouse, 12 Birnam Terrace and Caileagan, are predicted to experience a minor beneficial magnitude of impact in the short-term, reducing to a negligible beneficial magnitude of impact in the long-term during the night-time. The predicted noise decreases are due to the use of low noise road surfacing on the A9 as part of the proposed scheme. The DMOY 2036 and DSOY 2036 noise levels are between the night-time LOAEL and SOAEL at all four sample NSRs.

15.4.53 The remaining NSRs, 6 King Duncan's Place, Braeknowe and Craigview, are predicted to experience a negligible adverse or beneficial magnitude of impact in the short-term and long-term during the night-time.

15.4.54 In the long-term night-time period, without the proposed scheme in place, no NSR is predicted to experience more than a negligible magnitude of impact, either beneficial or adverse, during the night-time.

Summary Tables for all NSRs within 600m Study Area

15.4.55 As described in the introduction to this section, Table 15.23, Table 15.24 and Table 15.25 provide the short-term and long-term noise level change comparisons for all NSRs in the study area in accordance with the reporting requirements of DMRB LA 111.

Table 15.23: Summary of Short-term Operational Noise Impacts – DMOY 2036 vs. DSOY 2036

Change in Noise Level (dB(A))		Magnitude of Impact	No. of Dwellings (Daytime)	No. of other NSRs (Daytime)	No. of Dwellings (Night-time)	No. of other NSRs (Night-time)
Increase in noise level dB $L_{A10,18hr}/L_{night,outside}$	<1.0	Negligible	232	33	238	37
	1.0 – 2.9	Minor	91	17	74	12
	3.0 – 4.9	Moderate	2	2	0	0
	>5.0	Major	0	0	0	0
No Change	0.0	No Change	0	0	21	7
Decrease in noise level dB $L_{A10,18hr}/L_{night,outside}$	<1.0	Negligible	196	19	218	20
	1.0 – 2.9	Minor	127	14	119	11
	3.0 – 4.9	Moderate	47	8	27	7
	>5.0	Major	10	1	8	0

15.4.56 Table 15.23 shows that, in the short-term with the proposed scheme in place, two dwellings and two other sensitive receptors are predicted to experience a moderate adverse magnitude of impact and 91 dwellings and 17 other sensitive receptors a minor adverse magnitude of impact during the daytime. 74 dwellings and 12 other sensitive receptors are predicted to experience a minor adverse magnitude of impact during the night-time.

15.4.57 The majority of the NSRs predicted to experience moderate or minor adverse noise impacts are located near Perth Road, the A822, the B867 and Pittensorn Road, where the proposed scheme is predicted to result in increases in traffic flow and therefore road traffic noise on these roads. The remainder moderate or minor adverse noise impacts predicted at NSRs are more directly due to the change in alignment, screening or road traffic of the A9 as a result of the proposed scheme.

15.4.58 In terms of short-term beneficial impacts during the daytime, ten dwellings and one other NSRs are predicted to experience a major beneficial magnitude of impact; 47 dwellings and eight other sensitive receptors a moderate beneficial magnitude of impact; and 127 dwellings and 14 other sensitive receptors a minor beneficial magnitude of impact. During the night-time eight dwellings are predicted to experience a major beneficial magnitude of impact; 27

dwellings and seven other sensitive receptors a moderate beneficial magnitude of impact; and 119 dwellings and 11 other sensitive receptors a minor beneficial magnitude of impact.

15.4.59 The majority of the NSRs predicted to experience moderate or minor beneficial noise impacts are in relatively close proximity to the proposed scheme and are due to the low noise road surfacing included as embedded mitigation. The major and remainder moderate beneficial noise impacts are predicted at NSRs near the parapet on top of the retaining wall at the Dunkeld & Birnam Station replacement car park or the two woven wattle fences alongside the A9, which are included as part of the proposed scheme and would provide acoustic screening.

15.4.60 All other short-term impacts during both the daytime and night-time are predicted to be of negligible magnitude of impact or less.

Table 15.24: Summary of Long-term Operational Noise Impacts (with Proposed Scheme) – DMOY 2036 vs. DSFY 2051

Change in Noise Level (dB(A))		Magnitude of Impact	No. of Dwellings (Daytime)	No. of other NSRs (Daytime)	No. of Dwellings (Night-time)	No. of other NSRs (Night-time)
Increase in noise level dB $L_{A10,18hr}/L_{night,outside}$	<3.0	Negligible	493	68	493	68
	3.0 – 4.9	Minor	2	2	2	2
	5.0 – 9.9	Moderate	0	0	0	0
	>10.0	Major	0	0	0	0
No Change	0.0	No Change	8	0	9	0
Decrease in noise level dB $L_{A10,18hr}/L_{night,outside}$	<3.0	Negligible	170	20	176	21
	3.0 – 4.9	Minor	25	4	21	3
	5.0 – 9.9	Moderate	7	0	4	0
	>10.0	Major	0	0	0	0

15.4.61 Table 15.24 shows that, in the long-term with the proposed scheme in place, two dwellings and two other sensitive receptors are predicted to experience a minor adverse magnitude of impact during the daytime and night-time. The predicted increases in noise are due to changes to topography with the proposed scheme in place, which would impact the existing screening of the A9.

15.4.62 In terms of long-term beneficial impacts, seven dwellings are predicted to experience a moderate beneficial magnitude of impact and 25 dwellings and four other NSR a minor

beneficial magnitude of impact during the daytime. During the night-time, four dwellings are predicted to experience a moderate beneficial magnitude of impact and 21 dwellings and three other NSRs a minor beneficial magnitude of impact.

15.4.63 The NSRs predicted to experience minor beneficial noise impacts are relatively near to the proposed scheme and are due to the low noise road surfacing included as embedded mitigation and/or the additional screening of the A9 with the proposed scheme in place. The moderate beneficial noise impacts are predicted at NSRs near the parapet on top of the retaining wall at the Dunkeld & Birnam Station replacement car park or the two woven wattle fences alongside the A9, which are included as part of the proposed scheme and would provide acoustic screening.

15.4.64 All other long-term impacts during both the daytime and night-time with the proposed scheme are predicted to be of negligible magnitude of impact or less.

Table 15.25: Summary of Long-term Operational Noise Impacts (without Proposed Scheme) – DMOY 2036 vs. DMFY 2051

Change in Noise Level (dB(A))		Magnitude of Impact	No. of Dwellings (Daytime)	No. of other NSRs (Daytime)	No. of Dwellings (Night-time)	No. of other NSRs (Night-time)
Increase in noise level dB $L_{A10,18hr}/L_{night,outside}$	<3.0	Negligible	200	30	198	28
	3.0 – 4.9	Minor	0	0	0	0
	5.0 – 9.9	Moderate	0	0	0	0
	>10.0	Major	0	0	0	0
No Change	0.0	No Change	23	4	24	5
Decrease in noise level dB $L_{A10,18hr}/L_{night,outside}$	<3.0	Negligible	482	60	483	61
	3.0 – 4.9	Minor	0	0	0	0
	5.0 – 9.9	Moderate	0	0	0	0
	>10.0	Major	0	0	0	0

15.4.65 Table 15.25 shows that the predicted long-term impact magnitude at all noise sensitive receptors is either negligible or unchanged if the proposed scheme were not to go ahead.

Noise Change Contour Plots

15.4.66 Noise change contours have not been produced for the scenarios without specific mitigation included. Noise change contours for scenarios with specific mitigation included are discussed further in Section 15.6 (Residual Effects).

Magnitude of Impact – Basic Noise Levels

15.4.67 DMRB LA 111 requires consideration of the impact on the wider road network (outside of the area within 600m of new road links or road links physically changed or bypassed by the proposed scheme) where there are predicted Basic Noise Level (BNL) changes of 1dB(A) or more in the short-term. The affected routes are presented in Figure 15.2. The number of NSRs within 50m of such roads has been counted, and the total number of NSRs predicted to experience each short-term magnitude of impact category has been summarised in Table 15.26. There are no links where there are predicted BNL changes of 3dB(A) or more in the long-term.

Table 15.26: Short-term BNL Magnitude of Impact with the Proposed Scheme

Change in Noise Level (dB(A))		**Number of NSRs 50m from the Links within each Short-term Magnitude of Impact Category**
Increase in noise level, $L_{A10,18hr}$	1.0 – 2.9	6
	3.0 – 4.9	0
	⩾5.0	0
Decrease in noise level, $L_{A10,18hr}$	1.0 – 2.9	0
	3.0 – 4.9	0
	⩾5.0	0

15.4.68 Table 15.26 shows that, outside the operational study area, there are six noise sensitive receptors that lie within 50m of a road (the A822) with a BNL increase of 1dB(A) or more in the short-term (all minor adverse). There are no NSRs that lie within 50m of a road with a BNL decrease of 1dB(A) or more in the short-term.

Magnitude of Impact – Noise Sensitive Outdoor Areas

15.4.69 As well as noise sensitive buildings, DMRB LA 111 also identifies outdoor areas such as public rights of way, designated sites and cultural heritage assets as noise sensitive receptors. Whilst noise levels can be calculated at specific points around a noise sensitive building, public rights of way and other open areas often span a considerable area or length. Therefore, rather than assessing an arbitrary point within these noise sensitive receptors, an assessment of the potential noise impacts has been undertaken across the total length or area noise sensitive outdoor areas within the study area to provide a more balanced approach.

Public Rights of Way

15.4.70 Within the operational noise study area, 102 core paths, 13 rights of way, 19 national routes, two regional routes and 25 local paths have been identified and assessed. The percentage of each public right of way that falls into each magnitude of change category has been calculated. The total percentage of each type of public right of way that falls within each magnitude of change category in both the short-term and long-term are presented in Table 15.27 and Table 15.28, respectively.

Table 15.27: Short-term Noise Impact on Public Rights of Way

Change in Noise Level (dB(A))		Core Paths (%)	Rights of Way (%)	National Routes (%)	Regional Routes (%)	Local Paths (%)
Increase in noise level, $L_{A10,18hr}$	<1.0	27	20	31	0	25
	1.0 – 2.9	16	4	22	0	13
	3.0 – 4.9	0	0	1	0	1
	≥5.0	0	0	1	0	2
No Change	0.0	6	4	9	0	8
Decrease in noise level, $L_{A10,18hr}$	<1.0	31	39	21	6	32
	1.0 – 2.9	13	21	12	78	13
	3.0 – 4.9	4	10	2	16	4
	≥5.0	2	2	0	0	2

Table 15.28: Long-term Noise Impact on Public Rights of Way

Change in Noise Level (dB(A))		Core Paths (%)	Rights of Way (%)	National Routes (%)	Regional Routes (%)	Local Paths (%)
Increase in noise level, $L_{A10,18hr}$	<3.0	60	58	76	2	62
	3.0 – 4.9	1	0	3	0	1
	5.0 – 9.9	0	0	2	0	1
	≥10.0	0	0	0	0	1
No Change	0.0	5	2	2	4	4
Decrease in noise level, $L_{A10,18hr}$	<3.0	31	36	17	94	27
	3.0 – 4.9	2	2	1	0	3
	5.0 – 9.9	1	1	0	0	1
	≥10.0	0	1	0	0	0

15.4.71 Table 15.27 and Table 15.28 show that the majority of the public rights of way within the study area will experience a change of minor magnitude of impact or less. 1% of national routes and local paths are predicted to experience a moderate adverse magnitude of impact and 1% of

national routes and 2% of local paths are predicted to experience a major adverse magnitude of impact in the short-term. In the long-term, 1% of local paths are predicted to experience a major adverse magnitude of impact and 2% of national routes and 1% of local paths are predicted to experience a moderate adverse magnitude of impact.

15.4.72 In terms of beneficial impacts, 4% of core paths, 10% of rights of way, 2% of national routes, 16% of regional routes and 4% of local paths are predicted to experience a moderate beneficial magnitude of impact in the short-term. 2% of core paths, 2% of rights of way and 2% of local paths are predicted to experience a major beneficial magnitude of impact in the short-term. In the long-term, 1% of core paths, rights of way and local paths are predicted to experience a moderate beneficial magnitude of impact. 1% of rights of way are predicted to experience a major beneficial magnitude of impact in the long-term.

15.4.73 Core paths, rights of way and regional routes are not predicted to experience moderate or major adverse magnitudes of impact at any location on these public rights of way. The relatively low percentage (no greater than 3%) of the national routes and local paths within the study area predicted to experience a moderate or major adverse magnitude of impact in the short-term and long-term occur where they cross the proposed scheme.

15.4.74 Overall, there are no individual public rights of way where a moderate or major adverse magnitude of impact is predicted across more than a small segment of the path. Therefore, no significant adverse effects are predicted for public rights of way within the study area.

Designated Sites and Cultural Heritage Assets

15.4.75 Within the operational noise study area, the following designated sites and cultural heritage assets have been identified and assessed:

- four Scheduled Monuments;
- three Gardens and Designed Landscapes (GDL);
- two Conservations Areas;
- one Battlefield Inventory site;
- two Sites of Special Scientific Interest; and
- one Special Area of Conservation.

15.4.76 The percentage of each designated site and cultural heritage asset that falls into each magnitude of change category has been calculated individually. The percentage of each designated site and cultural heritage asset that falls within each magnitude of change category in both the short-term and long-term are presented in Table 15.29 and Table 15.30, respectively. Some of the designated sites and cultural heritage assets extend beyond the operational noise study area, most notably Murthly Castle GDL, Mill Dam SSSI and River Tay SAC, where 34%, 49% and 1% of noise sensitive outdoor area falls within the operational noise study area. In these situations, only the area within the operational noise study area has been considered within the analysis.

Table 15.29: Short-term Noise Impact on Designated Sites and Cultural Heritage Assets

Noise Sensitive Outdoor Area	≥5.0 dB Increase (%)	3.0 – 4.9 dB Increase (%)	1.0 – 2.9 dB Increase (%)	<1.0 dB Increase (%)	No Change (%)	<1.0 dB Decrease (%)	1.0 – 2.9 dB Decrease (%)	3.0 – 4.9 dB Decrease (%)	≥5.0 dB Decrease (%)
Scheduled Monuments									
Dunkeld Cathedral	0	0	0	5	27	33	34	0	0
Dunkeld, two standing stones 450m WNW of Newtyle	0	0	0	0	0	0	100	0	0
King's Seat Fort	0	0	0	0	0	67	26	7	0
Torrvald, Farmstead 700m SW of Dunkeld House	0	0	6	62	5	27	0	0	0
Gardens and Designed Landscapes									
Dunkeld House	0	0	1	37	11	38	12	0	0
Murthly Castle	1	1	60	17	1	7	7	5	1
The Hermitage	0	0	9	62	8	17	3	0	0
Conservation Areas									
Birnam, Conservation Area	0	0	6	9	2	68	11	2	1
Dunkeld Conservation Area	0	0	0	26	21	44	9	0	0
Battlefield Inventory									
Battle of Dunkeld	0	0	0	33	19	41	7	0	0
Sites of Special Scientific Interest									
Craig Tronach	0	0	5	59	5	31	0	0	0
Mill Dam	0	0	34	66	0	0	0	0	0

Noise Sensitive Outdoor Area	≥5.0 dB Increase (%)	3.0 – 4.9 dB Increase (%)	1.0 – 2.9 dB Increase (%)	<1.0 dB Increase (%)	No Change (%)	<1.0 dB Decrease (%)	1.0 – 2.9 dB Decrease (%)	3.0 – 4.9 dB Decrease (%)	≥5.0 dB Decrease (%)
Special Areas of Conservation									
River Tay	0	0	10	18	3	29	34	4	0

Table 15.30: Long-term Noise Impact on Designated Sites and Cultural Heritage Assets

Noise Sensitive Outdoor Area	≥10.0 dB Increase (%)	5.0 – 9.9 dB Increase (%)	3.0 – 4.9 dB Increase (%)	<3.0 dB Increase (%)	No Change (%)	<3.0 dB Decrease (%)	3.0 – 4.9 dB Decrease (%)	5.0 – 9.9 dB Decrease (%)	≥10.0 dB Decrease (%)
Scheduled Monuments									
Dunkeld Cathedral	0	0	0	55	2	43	0	0	0
Dunkeld, two standing stones 450m WNW of Newtyle	0	0	0	0	0	100	0	0	0
King's Seat Fort	0	0	0	48	13	39	0	0	0
Torrvald, Farmstead 700m SW of Dunkeld House	0	0	0	100	0	0	0	0	0
Gardens and Designed Landscapes									
Dunkeld House	0	0	0	79	4	17	0	0	0
Murthly Castle	0	1	1	28	2	66	1	1	0
The Hermitage	0	0	0	95	1	4	0	0	0
Conservation Areas									
Birnam, Conservation Area	0	0	0	73	5	20	2	1	0

Noise Sensitive Outdoor Area	≥10.0 dB Increase (%)	5.0 – 9.9 dB Increase (%)	3.0 – 4.9 dB Increase (%)	<3.0 dB Increase (%)	No Change (%)	<3.0 dB Decrease (%)	3.0 – 4.9 dB Decrease (%)	5.0 – 9.9 dB Decrease (%)	≥10.0 dB Decrease (%)
Dunkeld Conservation Area	0	0	0	81	2	17	0	0	0
Battlefield Inventory									
Battle of Dunkeld	0	0	0	87	3	10	0	0	0
Sites of Special Scientific Interest									
Craig Tronach	0	0	0	49	14	38	0	0	0
Mill Dam	0	0	0	100	0	0	0	0	0
Special Areas of Conservation									
River Tay	0	0	0	34	3	61	2	0	0

15.4.77 Table 15.29 and Table 15.30 show that the majority of the designated sites and cultural heritage assets within the study area will experience a change of minor magnitude of impact or less. 1% of the Murthly Castle GDL is predicted to experience a moderate adverse magnitude of impact in the short-term and long-term and 1% is predicted to experience a major adverse magnitude of impact in the short-term. The relatively low percentage of the GDL within the study area predicted to experience a moderate or major adverse magnitude of impact in the short-term and long-term occurs where it crosses the proposed scheme.

15.4.78 In terms of beneficial impacts, no designated sites or cultural heritage assets are predicted to experience moderate and/or major beneficial magnitudes of impact across more than 7% of their area in the short-term or 1% of their area in the long-term.

15.4.79 Overall, there are no designated sites and cultural heritage assets where a moderate or major adverse magnitude of impact is predicted across more than a small segment of their area. Therefore, no significant adverse effects are predicted for public rights of way within the study area.

Significance of Effect – Operational Road Traffic Noise

15.4.80 An assessment of the significance of effects has been carried out following analysis of the predicted noise levels in all operational assessment scenarios and the resultant change in noise levels, following the methodology for significance assessment described in Section 15.2 (Approach and Methods). Additionally, the contextual elements detailed in Table 15.13 have been considered in determining significance.

15.4.81 Table 15.31 presents a summary of the predicted significant effects and the justification for the significance conclusion for noise sensitive receptors where the initial and/or final assessment of significance is determined to be potentially significant. For clarity, the receptors considered in Table 15.31 are those where the magnitude of impact was minor or above, indicating a possible significant effect.

Table 15.31: Summary of the Assessment of Significant Operational Road Traffic Noise Effects (without Specific Mitigation)

Receptor (or Group of Receptors)	No. of Receptors	Short-term Magnitude of Impact (Daytime)	Final Operational Significance	Justification of Significance Judgement
Dwellings south of A9, near to B867 and Pittensorn Road	7 dwellings	Minor Adverse	Not significant	Noise level increase is 1.0 to 1.4dB(A) for short-term during daytime and 0.8 to 1.2dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are below SOAEL.
Sensitive receptors north of A9, before start of proposed scheme	3 dwellings (Boat of Murthly, Greystones and Roman Bridge Cottage) and 1 other sensitive receptor (Upper Murthly Fishings)	Minor Adverse	Not significant	Noise level increase is 1.1 to 1.4dB(A) for short-term during daytime and 1.0 to 1.2dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are below SOAEL.
Inkpot Cottage	1 dwelling	Minor Averse	Not significant	Noise level increase is 1.0dB(A) for short-term during daytime and 0.9dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are below SOAEL.
Ringwood Cottage, Rowan Cottage, Willow Tree Cottage and Oak Tree Cottage	2 dwellings and 2 other sensitive receptors	Moderate Adverse	Significant adverse	Noise level increase is 3.0 to 3.2dB(A) for short-term during daytime and 2.7 to 2.8dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL. The noise increases are due to changes to topography with the proposed scheme in place, which would impact the existing screening of the A9 and therefore there is likely to be a perception of change by residents.

Receptor (or Group of Receptors)	No. of Receptors	Short-term Magnitude of Impact (Daytime)	Final Operational Significance	Justification of Significance Judgement
Deans Cross, The Old Toll House and 1-5 Deans Park	7 dwellings	Moderate Beneficial (Deans Cross, The Old Toll House and 2 Deans Park) Minor Beneficial (1 & 3-5 Deans Park)	Not significant	At Deans Cross, The Old Toll House and 2 Deans Park, noise level decrease is 3.0 to 3.2dB(A) for short-term during daytime and 2.7 to 2.8dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are below the LOAEL. At 1 and 3-5 Deans Park, noise level decrease is 1.6 to 1.9dB(A) for short-term during daytime and 1.5 to 1.7dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are below or slightly above the LOAEL.
Ballincrieff House, Barbed Wire and Poppies, Oakwood and Tomcroy House	4 dwellings	Major Beneficial	Significant beneficial	Noise level decreases are 5.7 to 8.0dB(A) for short-term during daytime and 5.1 to 7.2dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Craigbeathe	1 dwelling	Minor Adverse	Not significant	Noise level increase is 1.0dB(A) for short-term during daytime and 0.9dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Noise sensitive receptors north of Perth Road between A9 and south end of St. Mary's Road	69 dwellings and 3 other sensitive receptors	Moderate Beneficial (33 dwellings and 3 other sensitive receptors)	Significant beneficial (36 dwellings) Not significant	At 33 dwellings and three other sensitive receptors, noise level decrease is 3.0 to 5.3dB(A) for short-term during daytime and 2.7 to 4.8dB(A) during night-time. Absolute noise levels in Do-Minimum are between the LOAEL and SOAEL.

Receptor (or Group of Receptors)	No. of Receptors	Short-term Magnitude of Impact (Daytime)	Final Operational Significance	Justification of Significance Judgement
		Minor Beneficial (36 dwellings)	(36 dwellings)	At 36 dwellings, noise level decreases are 1.0 to 2.4dB(A) for short-term during daytime and 0.9 to 2.1dB(A) during night-time. Absolute noise levels in Do-Minimum are between the LOAEL and SOAEL.
Hollybank, Carse Na Tay, Shian, Wychwood and Rowanlea	5 dwellings	Major Beneficial	Significant beneficial	Noise level decreases are 5.4 to 6.4dB(A) for short-term during daytime and 4.9 to 5.8dB(A) during night-time. Absolute noise levels in Do-Minimum are between the LOAEL and SOAEL.
Dowiestone and 6 Perth Road	1 dwelling and 1 other sensitive receptor	Moderate Beneficial	Significant beneficial	Noise level decreases are 3.4 and 4.4dB(A) for short-term during daytime and 2.7 and 3.7dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Sensitive receptors near Perth Road, between St. Mary's Road and the A923	75 dwellings and 10 other sensitive receptors	Minor Adverse	Not significant	Noise level increases are 1.0 to 1.5dB(A) for short-term during daytime and 0.8 to 1.3dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Oak Place and View Park	2 dwellings	Minor Beneficial	Not significant	Noise level decreases are 1.0 to 1.1dB(A) for short-term during daytime and 0.8 to 0.9B(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Cranstackie, Old Pines, Torwood House, Birchwood Cottage, Dunaird House,	6 dwellings and 1 other sensitive receptor	Minor Beneficial	Not significant	Noise level decreases are 1.0 to 1.1dB(A) for short-term during daytime and 0.8 to 1.0B(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.

Receptor (or Group of Receptors)	No. of Receptors	Short-term Magnitude of Impact (Daytime)	Final Operational Significance	Justification of Significance Judgement
Dunaird Coach House and Dunaird House Self Catering Units				
Laikin	1 dwelling	Minor Beneficial	Not significant	Noise level decrease is 1.5dB(A) for short-term during daytime and 1.4B(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
St Catherine's Cottage	1 dwelling	Moderate Beneficial	Significant beneficial	Noise level decrease is 3.0dB(A) for short-term during daytime and 2.6B(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Annfield, Kilblaan and Smithy Cottage	3 dwellings	Minor Beneficial	Not significant	Noise level decreases are 2.0 to 2.6dB(A) for short-term during daytime and 1.8 to 2.3B(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
1, 1A, 2, 3, 4, 5, 6, 8, 9, 10 and 10A Gladstone Terrace	11 dwellings	Minor Beneficial	Not significant	Noise level decreases are 1.0 to 1.1dB(A) for short-term during daytime and 0.9 to 1.0B(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Cherrytree, St Abbs and Craigielea	3 dwellings	Minor Beneficial	Not significant	Noise level decreases are 1.1 to 1.4dB(A) for short-term during daytime and 1.0 to 1.2B(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.

Receptor (or Group of Receptors)	No. of Receptors	Short-term Magnitude of Impact (Daytime)	Final Operational Significance	Justification of Significance Judgement
Larachmhor, Oakbank, The Lodge, Heath Park, Craigmore, Birnam Bank Cottage and Tigh-na-beith	6 dwellings and 1 other sensitive receptor	Minor Beneficial	Not significant	Noise level decreases are 1.0 to 1.2dB(A) for short-term during daytime and 0.9 to 1.1dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something below the SOAEL at four dwellings and one other sensitive receptors and below the LOAEL at two dwellings.
Dunkeld and Birnam Railway Station	1 other sensitive receptor	Major Beneficial	Significant beneficial	Noise level decrease is 5.0dB(A) for short-term and 4.5dB(A) for long-term during daytime. Absolute noise levels in Do-Minimum are above the SOAEL and in Do-Something are between the LOAEL and SOAEL.
Sensitive receptors at Birnam Terrace and Station Road	23 dwellings and 3 other sensitive receptors	Minor Beneficial	Not significant	Noise level decreases are 1.0 to 2.4dB(A) for short-term during daytime and 0.9 to 2.1dB(A) during night-time. Absolute noise levels in Do-Minimum are between the LOAEL and SOAEL.
12 & 13 Birnam Terrace	2 dwellings	Moderate Beneficial	Significant beneficial	Noise level decreases are 3.3dB(A) for short-term during daytime and 2.9dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Glenburn and Rosemount	2 dwellings	Minor Beneficial	Not significant	Noise level decreases are 1.1 and 1.3dB(A) for short-term during daytime and 1.0 and 1.2dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Merryburn, Tigh Lois, The Merryburn, 8 Station Road, 2 Station	5 dwellings and 2 other sensitive receptors	Moderate Beneficial	Significant beneficial	Noise level decreases are 3.0 to 3.3dB(A) for short-term during daytime and 2.8 to 3.0dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something

Receptor (or Group of Receptors)	No. of Receptors	Short-term Magnitude of Impact (Daytime)	Final Operational Significance	Justification of Significance Judgement
Cottages, Tirohia and Tigh Dughlas				are between the LOAEL and SOAEL except at 2 Station Cottages, where they are above the SOAEL.
1 Station Cottages	1 dwelling	Minor Beneficial	Significant beneficial	Noise level decreases is 1.8dB(A) for short-term during daytime and 1.6dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are above the SOAEL.
Beltane, Sunny Corner and Dunkeld Fire Station	2 dwellings and 1 other sensitive receptor	Minor Beneficial	Not significant	Noise level decreases are 1.1 to 1.7dB(A) for short-term during daytime and 0.9 to 1.5dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
42, 50 and 55 Stell Park Road	3 dwellings	Minor Beneficial	Not significant	Noise level decreases are 1.2 to 1.3dB(A) for short-term during daytime and 1.0 to 1.2dB(A) during night-time. At 42 Stell Park Road, absolute noise levels in Do-Minimum are between the LOAEL and SOAEL and in Do-Something are below the LOAEL during daytime and between the LOAEL and SOAEL in Do-Minimum and Do-Something during night-time. At 50 and 55 Stell Park Road, absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
10 King Duncan's Place	1 dwelling	Minor Beneficial	Not significant	Noise level decrease is 1.2dB(A) for short-term during daytime and 1.0dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.

Receptor (or Group of Receptors)	No. of Receptors	Short-term Magnitude of Impact (Daytime)	Final Operational Significance	Justification of Significance Judgement
Dwellings north of the A9, west of the A923 and south of River Tay	14 dwellings	Minor Beneficial	Not Significant	Noise level decreases are 1.0 to 1.8dB(A) for short-term during daytime and 0.9 to 1.6dB(A) during night-time. Absolute noise levels are between the LOAEL and SOAEL.
Craigvinean, Craigvinean Surgery and Dunkeld and Birnam Recreation Club	1 dwelling and 2 other sensitive receptors	Moderate Beneficial	Significant beneficial	Noise level decreases are 3.0 to 3.8dB(A) for short-term during daytime and 2.8 to 3.4dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Noise sensitive receptors in Dunkeld	6 dwellings and 1 other sensitive receptor	Minor Beneficial	Not Significant	Noise level decreases are 1.1 to 1.3dB(A) for short-term during daytime and 1.0 to 1.1dB(A) during night-time. Absolute noise levels are below or just above the LOAEL.
Ladywell Cottage, Ladywell Farm and Ladywell Bothy	3 dwellings	Minor Adverse	Not Significant	Noise level increases are 1.0 to 1.2dB(A) for short-term during daytime and 0.9 to 1.0dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Milltimber and 2 Ladeside Cottages	2 dwellings	Minor Beneficial	Not Significant	Noise level decreases are 1.0 to 1.3dB(A) for short-term during daytime and 0.8 to 1.2dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Rose Cottage	1 dwelling	Minor Beneficial	Significant beneficial	Noise level decrease is 2.6dB(A) for short-term during daytime and 2.4dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are above the SOAEL.

Receptor (or Group of Receptors)	No. of Receptors	Short-term Magnitude of Impact (Daytime)	Final Operational Significance	Justification of Significance Judgement
Neil Gow Cottage and Sunnybank Cottage	2 dwellings	Moderate Beneficial	Significant beneficial	Noise level decrease is 3.0dB(A) for short-term during daytime and 2.7dB(A) during night-time. Absolute noise levels in Do-Minimum and Do-Something are between the LOAEL and SOAEL.
Noise sensitive receptors at Hilton Dunkeld House Hotel and Dunkeld House Lodges	1 dwelling and 11 other sensitive receptors	Minor Adverse at 1 dwelling and 6 other sensitive receptors Minor Beneficial at 5 other sensitive receptors	Not significant	Noise level increases are 1.0 to 1.4dB(A) for short-term during daytime and 0.9 to 1.3dB(A) during night-time. Noise level decreases are 1.0 to 1.4dB(A) for short-term during daytime and 0.9 to 1.3dB(A) during night-time. Absolute noise levels are below or just above the LOAEL.
Woodlands and Upper Dunkeld Fishing Hut	1 dwelling and 1 other sensitive receptor	Minor Beneficial	Not significant	Noise level decreases are 1.1 and 2.6dB(A) for short-term during daytime and 1.0 and 2.4dB(A) during night-time. At Woodlands, absolute noise levels are below the LOAEL during daytime and between the LOAEL and SOAEL in during night-time. At Upper Dunkeld Fishing Hut, absolute noise levels are between the LOAEL and SOAEL.
NSRs near the A822, approximately 840m south of ch5800 of the proposed scheme	5 dwellings and 1 other sensitive receptor	Minor Adverse	Significant adverse (1 other sensitive receptor);	An increase in the BNL of the A822 of 1.1 to 1.5dB(A), resulting in a minor adverse magnitude of impact, is predicted in the short-term. At one other sensitive receptor (Dundonachie Coach House), absolute noise levels are likely to be above the SOAEL for daytime and/or

Receptor (or Group of Receptors)	No. of Receptors	Short-term Magnitude of Impact (Daytime)	Final Operational Significance	Justification of Significance Judgement
			not significant (5 dwellings)	night-time periods. At five dwellings, absolute noise levels are likely to be between the LOAEL and SOAEL for daytime and/or night-time periods.

15.4.82 The overall results from Table 15.31 are summarised in Table 15.32.

Table 15.32: Summary of Significant Operational Road Traffic Effects (without Specific Mitigation)

Receptor Type	Significant Adverse	Significant Beneficial
Dwelling	2	56
Other Sensitive Receptor	3	9

15.4.83 Table 15.31 and Table 15.32 demonstrate that there are two dwellings and three other noise sensitive receptors predicted to experience significant adverse effects as a result of the operation of the proposed scheme. These effects are either a direct result of a decrease in screening of the traffic noise due to the proposed scheme or from the redistribution of the traffic flows on existing roads connecting to the proposed scheme.

15.4.84 There are 56 dwellings and nine other sensitive receptors predicted to experience significant beneficial effects as a result of the operation of the proposed scheme. These effects are a direct result of the increase in screening of traffic noise due to the proposed scheme.

Noise Insulation

15.4.85 An indicative NISR assessment has been performed using the methodology set out in Section 15.2 (Approach and Methods).

15.4.86 56 residential properties within 300m of the proposed scheme are predicted to have a relevant noise level of at least 65dB $L_{A10,18hr}$ (façade) (the proxy for the NISR specified level of 68dB $L_{A10,18hr}$ (façade)) and a noise increase between the relevant noise level and the prevailing noise level of at least 1dB(A). A straight line can be drawn from any point of these residential properties to a point on the carriageway of the proposed scheme. Therefore, 56 residential properties would concurrently meet the qualifying criteria detailed in paragraph 15.2.59 of Section 15.2 (Approach and Methods).

15.4.87 52 of these potentially qualifying residential properties are located on Perth Road, and the predicted noise increases are due to the increase of the traffic flows on Perth Road with the proposed scheme in place in combination with the expected traffic growth across the road network over 15 years. At the remaining four potentially qualifying dwellings (Craigbeathe and 5, 7 and 15 Telford Gardens) the predicted noise increases are a direct result of the decrease of screening of traffic noise due to the proposed scheme.

15.4.88 Accordingly, the indicative NISR assessment has identified 56 residential properties that could qualify for noise insulation due to the proposed scheme. However, this would be subject to further assessment once the final design and traffic forecast data is available.

Operational Car Park Noise Impacts

15.4.89 Operational car park noise levels have been predicted at the nearest noise sensitive receptors to the north-west, north and north-east of the Dunkeld & Birnam Station replacement car

park, at Tirohia, The Old Bakehouse and Craigielea, respectively. The predicted baseline noise level and the operational noise level specifically from the car park are presented in Table 15.33.

Table 15.33: Predicted Baseline and Operational Dunkeld & Birnam Station Car Park Noise Levels

Receptor	Predicted Noise Level dB $L_{Aeq,16hr}$	
	Baseline	Operation
Tirohia	61.9	43.0
The Old Bakehouse	60.7	41.0
Craigielea	53.6	29.1

15.4.90 Table 15.33 shows that the predicted operational car park noise levels are at least 10dB below the predicted existing noise levels during daytime at Tirohia, The Old Bakehouse and Craigielea. Accordingly, the addition of operational car park noise to the baseline residual noise would result in a negligible increase in noise of no greater than 0.1dB.

15.4.91 Table 15.33 shows that the predicted operational car park noise levels are below the WHO guideline noise level for outdoor areas in the daytime (50dB $L_{Aeq,16hr}$).

15.4.92 Based on the comparison of predicted operational car park noise levels with baseline existing noise levels and WHO guideline noise levels, it is considered that significant operational car park noise effects are unlikely to occur.

15.5 Mitigation

15.5.1 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. This chapter makes reference to overarching standard measures applicable across A9 dualling projects ('SMC' mitigation item references), and also to noise and vibration specific mitigation ('P02' mitigation item references). Those that specifically relate to noise and vibration are assigned a 'NV' reference. All migration measures are summarised in Chapter 22 (Schedule of Environmental Commitments).

Embedded Mitigation

15.5.2 The proposed scheme requires the construction of cuttings and embankments (collectively referred to as 'earthworks'). Earthworks of the proposed scheme have been included within the 3D noise model. Although no earthworks were included within the design specifically to provide noise mitigation to NSRs, the proposed earthworks in some locations will offer a greater degree of noise attenuation than if they were not included.

15.5.3 Although no acoustic barriers were included in the design specifically to provide noise mitigation to NSRs, the proposed scheme includes walls, parapets and fences as part of landscape and visual impact mitigation measures, which in some locations will offer a greater

degree of noise attenuation than if they were not included. This includes the 2m high woven wattle fence alongside Dunkeld and Birnam Station (Mitigation Item P02-LV17) and the 2m high parapet on top of the retaining wall included as part of the Dunkeld and Birnam Station replacement car park and access design (included as part of Mitigation Item P02-LV25). These barriers have been included within the 3D noise model.

15.5.4 In addition, as part of the proposed scheme, all mainline and slip roads will be surfaced with a low noise road surfacing material. According to DMRB LA 111 this can reduce noise levels by approximately 3.0dB $L_{A10,18hr}$ when compared with conventional hot rolled asphalt, although this is only valid for sections of the proposed scheme with traffic speeds greater than 75km/h. For sections of the proposed scheme with traffic speeds less than or equal to 75km/h, for example some sections of slip roads, the noise level reduction of low noise road surfacing compared with conventional HRA surfacing is negligible.

Standard Mitigation

15.5.5 A Construction Environmental Management Plan (CEMP) will be prepared by the Contractor (**Mitigation Item SMC-S1**). 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.

15.5.6 Prior to construction a suitably qualified Environmental Clerk of Works (EnvCoW) will be appointed by the Contractor (**Mitigation Item SMC-S2**). The EnvCoW(s) will report to the Environmental Coordinator and be present on site, as required, during the construction period to monitor the implementation of the mitigation measures identified and ensure that activities are carried out in such a manner to prevent or reduce impacts on the environment. This would involve the ENVCoW(s) ensuring the contractor is adhering to the mitigation measures set out in **Mitigation Item SMC-NV2**.

15.5.7 As previously stated, at this stage of the proposed scheme, detailed methods and programming of work and type of plant likely to be employed during the construction phase is not fully known. A scheme of noise and vibration monitoring will therefore be agreed with the PKC Environmental Health Department, and noise and vibration limits will be contained within the CEMP (refer to **Mitigation Item SMC-S1**). The contractor will be required to develop and implement a Noise and Vibration Management Plan to meet these requirements. The assessment will include the design of any necessary NSR specific construction mitigation over and above the standard mitigation included within this EIAR chapter (**Mitigation Item SMC-NV1**).

15.5.8 The mitigation measures presented in the following sections (Community Relations, Training of Employees and Execution of Works), as recommended in BS 5228-1 and BS 5228-2, would be employed to minimise the noise impacts during the construction phase.

Community Relations

15.5.9 In accordance with Table 1 of Chapter 22 (Schedule of Environmental Commitments), throughout the construction period the Contractor will contribute towards the overall communications strategy for the A9 Dualling Programme (**Mitigation Item SMC-S3**), which will assist in mitigation of noise and vibration, for example by providing forewarning of impending noisy activities and a feedback mechanism for any concerns to be raised. As part of the communications strategy the Contractor will appoint a community liaison officer supported by a liaison team as necessary who will:

- liaise with the following: relevant local authorities; other statutory bodies and regulatory authorities; community councils and relevant community groups; and businesses and residents in local communities affected by the construction works;
- 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;
- support the production of project communications such as the project website and newsletters; 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

15.5.10 The Contractor will ensure that all site workers receive adequate environmental training relevant to their role prior to working on the construction site, including specific environmental project inductions and 'toolbox talks' on best practice construction methods as appropriate (**Mitigation Item SMC-S4**), which would be anticipated to include those relating to noise and vibration control, by employing techniques to keep site noise to a minimum, and would be effectively supervised to ensure that best working practice in respect of noise reduction is followed.

Execution of Works

15.5.11 Best Practicable Means will be used to limit the level of noise to which operators and others in the vicinity of site operations would be exposed (**Mitigation Item SMC-NV2**). This includes the following:

- 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;
- any work outside of normal working hours will be agreed with the relevant local authority;

- 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;
- permanent noise mitigation measures such as acoustic screens and earthwork bunds are to be constructed as early as practical;
- 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. A method of noise measurement will be agreed prior to the commencement of site works;
- 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 practicable, vehicles and mechanical plant used for the purpose of the works will be fitted with effective exhaust silencers and will be maintained in good, efficient working order;
- 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 British Standard BS 5228-1 and the guidance given therein minimising noise emissions from the site.

15.5.12 In addition, PKC will be consulted regarding any proposed working outwith normal working hours.

15.5.13 Furthermore, where, following application of proposed mitigation and any Section 61 consents under the Control of Pollution Act 1974, noise levels are expected to still exceed the trigger levels defined in Annex E.4 of BS 5228-1 and any Section 61 consents under the Control

of Pollution Act 1974, a scheme for the installation of noise insulation or the reasonable costs thereof, or a scheme to facilitate temporary rehousing of occupants, as appropriate, would need to be implemented.

Specific Mitigation

Specific Construction Mitigation Measures

15.5.14 The potential for significant adverse noise and vibration effects during the construction phase have been identified. Therefore, in addition to the standard good practice noise and vibration mitigation measures identified, specific mitigation measures may also be required.

15.5.15 It should be noted that the construction assessment is indicative only as it is based upon assumed plant/equipment, construction programme and working methods. Once appointed, the contractor would be required to update the assessment, once working methods, working times, the plant and equipment to be used and the construction programme have been finalised.

Specific Vibratory Compaction Mitigation Measures

15.5.16 Potential significant adverse construction vibration effects have been identified as a result of vibratory compaction works.

15.5.17 The assessment has assumed the use of an 18-tonne Bomag BW 216 PD-5 single drum vibratory roller, which has a higher and a lower vibration setting. Predictions assuming use of this roller in proximity to sensitive receptors on the higher vibration setting has highlighted the potential for significant adverse effects and cosmetic building damage. Even with the lowest vibration settings selected, significant adverse effects are predicted for VSRs within approximately 20m of the works, although it should be noted that this is based on a worst-case as the predicted effects would be transient and would only occur when the roller is within this distance.

15.5.18 The following measures (**Mitigation Item P02-NV01**) would be considered at each VSR where a potential for significant vibration effects from vibratory compaction is identified:

- selection of low vibratory or non-vibratory plant;
- starting up and turning off vibratory compaction plant as far away from sensitive receptors as practicable; and,
- engage with the local community to warn them of the potential for construction vibration, provide timings and contact information, and advise what is being done to control vibration;
- where there is considered to be the potential for cosmetic damage on a building or structure due to vibratory compaction:
  - undertake a structural survey of the building or structure prior to and after construction of the proposed scheme begins to ascertain its structural condition before and after the works; and,

- once the structural assessments have been undertaken, consideration of vibration limit values and compliance measurements would be required, with the requirement to undertake vibration measurement whilst the works are within a certain distance.

15.5.19 The above measures would reduce the risk that significant adverse vibration effects would arise from vibratory compaction during construction. Not all measures would be required for each location. The appointed contractor would be required to update the construction assessment, once working methods, the plant and equipment to be used and the construction programme have been sufficiently finalised, to determine the most appropriate form of mitigation to implement for each VSR.

Specific Sheet Piling Vibration Mitigation Measures

15.5.20 Potential significant adverse construction vibration effects have been identified as a result of sheet piling works.

15.5.21 The following measures (**Mitigation Item P02-NV02**) would be considered at each VSR where a potential for significant vibration effects from sheet piling is identified:

- use of 'soft-start' piling techniques to reduce the vibration impacts generated by start-up and ramp down of the piling rig;
- pre-augering or pre-excavation of pile route to remove obstructions and reduce the potential for high vibration events and increase the rate of pile insertion;
- where vibratory piling is proposed, use percussive piling or an alternative method of piling (such as press piling) for piling near to sensitive buildings or structures;
- engage with the local community to warn them of the potential for construction vibration, provide timings and contact information, and advise what is being done to control vibration;
- where there is considered to be the potential for cosmetic damage on a building or structure due to sheet piling:
  - undertake a structural survey of the building or structure prior to and after construction of the proposed scheme begins to ascertain its structural condition before and after the works; and,
  - once the structural assessments have been undertaken, consideration of vibration limit values and compliance measurements would be required, with the requirement to undertake vibration measurement whilst the works are within a certain distance.

15.5.22 The above measures would reduce the risk that significant adverse vibration effects would arise from sheet piling during construction. Not all measures would be required for each location. The appointed contractor would be required to update the construction assessment, once working methods, the plant and equipment to be used and the construction programme have been sufficiently finalised, to determine the most appropriate form of mitigation to implement for each VSR.

Specific Operational Noise Mitigation Measures

15.5.23 Five NSRs are predicted to experience significant adverse operational noise effects. Mitigation has therefore been considered, in the form of noise barriers/bunds, to reduce noise levels for those NSRs.

15.5.24 In proposing any noise barriers/bunds, the suitability of each potential mitigation measure should be determined based on the criteria contained in DMRB LA 111 (paragraph 3.65):

- '*for residential noise receptors only, a comparison of the monetised noise benefit of a mitigation measure against the cost of the measure over the anticipated design life of the project;*
- *the likely perceived benefit of the measure at any noise sensitive receptors;*
- *the benefit of a measure in terms of elimination of likely significant effects;*
- *practicality of the measure, for example, in terms of safety considerations and engineering constraints; and,*
- *the impact of the measure across other environmental factors, for example the visual impact of a noise barrier*'.

15.5.25 Two dwellings and two other sensitive receptors to the south-west of the proposed scheme at approximately ch1300 (Ringwood Cottage, Rowan Cottage, Willow Tree Cottage and Oak Tree Cottage) are predicted to experience significant adverse effects due to an increase in road traffic noise as a result of the proposed scheme.

15.5.26 Mitigation analysis indicates that if a reflective barrier of 100m in length and 2.0m in height was installed along the northbound side of the proposed scheme (ch1240-1340; see Figure 15.3) where it passes the affected NSRs, this would reduce the Do-Something noise levels by approximately 2dB(A) such that significant adverse effects predicted at all four NSRs would be mitigated (**Mitigation Item P02-NV03**).

15.5.27 One other sensitive receptor adjacent to the A822, approximately 840m south of ch5800 of the proposed scheme (Dundonachie Coach House), is predicted to experience significant adverse effects due to the predicted increase in traffic flow on the A822 as a result of the proposed scheme. Noise barriers have not been considered for this noise sensitive receptor for the following reasons:

- Potential visual impact/intrusion that could result for visitors to the other sensitive receptor, as a relatively high acoustic barrier (i.e. up to approximately first floor height) would be required close to the building to provide the required screening.
- It is considered likely to be impracticable to install a relatively high acoustic barrier in very close proximity to the building and the A822 (there is approximately 3m between the building and road).
- These properties are accessed directly from the A822, and therefore any noise barriers installed would contain a large gap, reducing or totally undermining its acoustic performance.

15.5.28 Based on the above, one permanent noise barrier is proposed as a specific noise mitigation measure for operational noise. No other specific noise mitigation measures for operational noise are proposed for the proposed scheme as no others are considered effective or practicable.

15.6 Residual Effects

Residual Construction Noise and Vibration Effects

15.6.1 The assessment has not quantified the residual construction noise and vibration levels because the reduction in construction noise or vibration levels due to mitigation measures are variable and site specific, and, at the time of writing, the construction activities, plant and programme are not finalised and, for vibration, exact ground conditions are not known. However, noise and vibration mitigation will be implemented through a Best Practicable Means approach during the construction period by the contractor.

15.6.2 It is anticipated that, with mitigation, significant construction noise effects will be minimised as far as practicable at all NSRs. It is considered that there is still the potential for residual significant construction noise effects at The Old Bakehouse, Lagmhor and Dunkeld and Birnam Station and other nearby NSRs due to the proximity of the works, the number of construction activities predicted to result in exceedances of the SOAEL and the static nature of some of the construction activities related to structures.

15.6.3 Figure 15.10 shows noise sensitive receptors within the construction noise study area predicted to experience a significant adverse residual effect.

15.6.4 It is anticipated that, with mitigation, construction vibration will not result in significant effects at any VSRs or other buildings or structures.

Residual Operational Noise Effects

Residual Noise Effects at Sample Noise Sensitive Receptors

15.6.5 Table 15.34 and Table 15.35 present the predicted daytime and night-time noise levels at sample NSRs in the short-term with and without the proposed scheme (with specific mitigation) and in the long-term with and without the proposed scheme (with specific mitigation), along with the associated noise changes and magnitudes of impact. Only sample NSR locations where the noise levels are different compared to the without mitigation scenarios presented in Table 15.34 and Table 15.35 have been included (i.e. only Rowan Cottage is included).

Table 15.34: Comparison of Predicted Daytime Noise Impacts at Sample NSRs, with and without the Proposed Scheme in Place (with Specific Mitigation)

Property Name	Do-Minimum dB $L_{A10,18hr}$		Do-Something dB $L_{A10,18hr}$		Short-term		Long-term with Proposed Scheme		Long-term without Proposed Scheme	
	DMOY 2036 dB $L_{A10,18hr}$	DMFY 2051 dB $L_{A10,18hr}$	DSOY 2036 dB $L_{A10,18hr}$	DSFY 2051 dB $L_{A10,18hr}$	Short-term Change (dB)	Short-term Magnitude of Impact	Long-term Change with Scheme (dB)	Long-term Magnitude of Impact with Scheme	Long-term Change without Scheme (dB)	Long-term Magnitude of Impact without Scheme
Rowan Cottage	62.0	59.8	63.0	63.7	1.0	Minor Adverse	1.7	Negligible Adverse	-2.2	Negligible Beneficial

Table 15.35: Comparison of Predicted Night-time Noise Impacts at Sample NSRs, with and without the Proposed Scheme in Place (with Specific Mitigation)

Property Name	Do-Minimum dB $L_{night,outside}$		Do-Something dB $L_{night,outside}$		Short-term		Long-term with Proposed Scheme		Long-term without Proposed Scheme	
	DMOY 2036 dB $L_{night,outside}$	DMFY 2051 dB $L_{night,outside}$	DSOY 2036 dB $L_{night,outside}$	DSFY 2051 dB $L_{night,outside}$	Short-term Change (dB)	Short-term Magnitude of Impact	Long-term Change with Scheme (dB)	Long-term Magnitude of Impact with Scheme	Long-term Change without Scheme (dB)	Long-term Magnitude of Impact without Scheme
Rowan Cottage	49.6	47.5	50.4	51.0	0.8	Negligible Adverse	1.4	Negligible Adverse	-2.1	Negligible Beneficial

15.6.6 Comparing Table 15.34 with Table 15.21 shows that at Rowan Cottage the magnitude of impact during daytime has reduced from moderate adverse to minor adverse in the short-term and from minor adverse to negligible adverse in the long-term. Daytime Do-Something noise levels remain between the LOAEL and SOEAL.

15.6.7 Comparing Table 15.35 with Table 15.22 shows that at Rowan Cottage the magnitude of impact during night-time has reduced from minor adverse to negligible adverse in the short-term and long-term. Night-time Do-Something noise levels remain between the LOAEL and SOEAL.

Summary Tables for all NSRs within 600m Study Area (with Specific Mitigation)

15.6.8 Table 15.36 and Table 15.37 provide the Do-Something noise level change comparisons for all NSRs in the study area with the specific mitigation measures in place. References are made to Table 15.23 and Table 15.24 to compare the change in noise impacts at all NSRs.

Table 15.36: Summary of Short-term Operational Noise Impacts – DMOY 2036 vs. DSOY 2036 (With Specific Mitigation)

Change in Noise Level (dB(A))		Magnitude of Impact	No. of Dwellings (Daytime)	No. of other NSRs (Daytime)	No. of Dwellings (Night-time)	No. of other NSRs (Night-time)
Increase in noise level dB $L_{A10,18hr}/L_{night,outside}$	<1.0	Negligible	232	33	240	38
	1.0 – 2.9	Minor	93	19	72	11
	3.0 – 4.9	Moderate	0	0	0	0
	>5.0	Major	0	0	0	0
No Change	0.0	No Change	0	0	21	7
Decrease in noise level dB $L_{A10,18hr}/L_{night,outside}$	<1.0	Negligible	196	19	218	20
	1.0 – 2.9	Minor	127	14	119	11
	3.0 – 4.9	Moderate	47	8	27	7
	>5.0	Major	10	1	8	0

15.6.9 Table 15.36 shows that, in the short-term with the proposed scheme with specific mitigation in place, no NSRs are predicted to experience a moderate adverse magnitude of impact (two dwellings and two other sensitive receptors were predicted without specific mitigation measures in place) during the daytime period. 93 dwellings and 19 other sensitive receptors are predicted to experience a minor adverse magnitude of impact during the daytime (91

dwellings and 17 other sensitive receptors were predicted without mitigation measures in place). For the night-time period, 72 dwellings and 11 other sensitive receptors are predicted to experience a minor adverse magnitude of impact (74 dwellings and 12 other sensitive receptors were predicted without mitigation measures in place). No moderate or major adverse magnitudes of impact are predicted for the night-time period (the same as without mitigation measures in place).

15.6.10 In terms of beneficial impacts, the results are the same as without mitigation measures in place.

15.6.11 The reduction in the number of NSRs predicted to experience a moderate adverse magnitude of impact is due to the acoustic barrier included as a specific mitigation measure, which screens NSRs in the vicinity of Rowan Cottage from road traffic noise from the A9.

Table 15.37: Summary of Long-term Operational Noise Impacts (with Proposed Scheme) – DMOY 2036 vs. DSFY 2051 (With Specific Mitigation)

Change in Noise Level (dB(A))		Magnitude of Impact	No. of Dwellings (Daytime)	No. of other NSRs (Daytime)	No. of Dwellings (Night-time)	No. of other NSRs (Night-time)
Increase in noise level dB $L_{A10,18hr}/L_{night,outside}$	<3.0	Negligible	495	70	495	70
	3.0 – 4.9	Minor	0	0	0	0
	5.0 – 9.9	Moderate	0	0	0	0
	>10.0	Major	0	0	0	0
No Change	0.0	No Change	8	0	9	0
Decrease in noise level dB $L_{A10,18hr}/L_{night,outside}$	<3.0	Negligible	170	20	176	21
	3.0 – 4.9	Minor	25	4	21	3
	5.0 – 9.9	Moderate	7	0	4	0
	>10.0	Major	0	0	0	0

15.6.12 Table 15.37 shows that, in the long-term with the proposed scheme with specific mitigation in place, no NSRs are predicted to experience a minor adverse magnitude of impact (two dwellings and two other sensitive receptors were predicted without specific mitigation measures in place) during the daytime and night-time periods. No moderate or major adverse magnitudes of impact are predicted for the night-time period (the same as without mitigation measures in place).

15.6.13 In terms of beneficial impacts, the results are the same as without mitigation measures in place.

15.6.14 The reduction in the number of NSRs predicted to experience a minor adverse magnitude of impact is due to the acoustic barrier included as a specific mitigation measure, which screens NSRs in the vicinity of Rowan Cottage from road traffic noise from the A9.

Noise Change Contour Plots

15.6.15 Table 15.36, Table 15.37 and Table 15.25 are supplemented by Figures 15.4 to 15.9, which provide noise change contour plots for the following scenarios:

- Figure 15.4 – Short-term noise change contour plot with the proposed scheme (Do-Minimum 2036 vs Do-Something 2036) Daytime, with specific mitigation;
- Figure 15.5 – Long-term noise change contour plot with the proposed scheme (Do-Minimum 2036 vs Do-Something 2051) Daytime, with specific mitigation;
- Figure 15.6 – Long-term noise change contour plot without the proposed scheme (Do-Minimum 2036 vs Do-Minimum 2051) Daytime;
- Figure 15.7 – Short-term noise change contour plot with the proposed scheme (Do-Minimum 2036 vs Do-Something 2036) Night-time, with specific mitigation;
- Figure 15.8 – Long-term noise change contour plot with the proposed scheme (Do-Minimum 2036 vs Do-Something 2051) Night-time, with specific mitigation; and,
- Figure 15.9 – Long-term noise change contour plot without the Scheme (Do-Minimum 2036 vs Do-Minimum 2051) Night-time.

Residual Magnitude of Impact – Noise Sensitive Outdoor Areas

15.6.16 It is considered that the magnitude of impacts for noise sensitive outdoor areas would not be materially affected by the barrier, and that residual impacts would be very similar to the without mitigation scenario (refer to Table 15.27, Table 15.28, Table 15.29 and Table 15.30).

Residual Significance of Effect – Operational Road Traffic Noise

15.6.17 With the proposed operational noise mitigation measures, the significant effects described in Table 15.32 for Ringwood Cottage, Rowan Cottage, Willow Tree Cottage and Oak Tree Cottage (two dwellings and two other sensitive receptors) are predicted to be mitigated.

15.6.18 Figure 15.11 shows noise sensitive receptors within the operational noise study area predicted to experience either significant adverse or beneficial residual effects, whilst a summary of the residual operational road traffic noise significant effects is presented in Table 15.38.

Table 15.38: Summary of Significant Operational Road Traffic Effects (with Specific Mitigation)

Receptor Type	Significant Adverse	Significant Beneficial
Dwelling	0	56
Other Sensitive Receptor	1	9

15.6.19 A comparison of Table 15.38 with Table 15.32 demonstrates that with the proposed acoustic barrier, the proposed scheme is predicted to result in four fewer significant adverse effects.

15.7 Compliance Against Plans and Policy

15.7.1 DMRB LA 104, Environmental Assessment and Monitoring, Revision 1, states that environmental assessment, reporting and monitoring shall meet the requirements of the national planning policy for each relevant Overseeing Organisation.

15.7.2 Appendix A3.1 (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. The compliance assessment undertaken in Appendix 3.1 focuses principally on the long-term effects of the proposed scheme rather than the short-term, temporary effect from construction.

15.7.3 National policy objectives of relevance to this assessment are provided in the National Planning Framework 4 (2023). The Perth and Kinross Local Development Plan 2 (Perth and Kinross Council 2019), Policy 56 (Noise Pollution) is relevant to this chapter.

Summary of Policy Compliance

15.7.4 Overall, the design and assessment of the proposed scheme has had regard to, and is compliant with, policy objectives to reduce noise and vibration effects. A full policy compliance assessment can be found in Table A3.1-8 of Appendix A3.1 (Assessment of Policy Compliance).

15.8 Statement of Significance

15.8.1 Table 15.39 summarises the significant effects identified in Section 15.4 (Potential Impacts and Effects), the proposed mitigation set out in Section 15.5 (Mitigation) and the residual effects assuming the effect implementation of those measures.

Table 15.39: Summary of Significant Effects

Receptor(s)	Description of Effect	Significance of Effect (Prior to Standard and Specific Mitigation)	Proposed Mitigation	Residual Significance of Effect (With Standard and Specific Mitigation)
Construction Noise				
Inkpot Cottage (and nearby Ringwood Cottage, Rowan Cottage, Willow Tree Cottage and Oak Tree Cottage)	Major adverse noise impact during construction.	Significant adverse	Contractor to conduct updated noise and vibration assessment and create noise and vibration mitigation strategy as part of CEMP (**Mitigation Item SMC-NV1**). Application of Best Practicable Mean (as described in Section 15.5 (Mitigation) including limiting duration of exposure to noise levels above SOAEL (**Mitigation Item SMC-NV2**).	Not significant
Ballincrief (and nearby Barbed Wire and Poppies, Oakwood and Tomcroy House)	Major adverse noise impact during construction.	Significant adverse		Not significant
St Catherine's Cottage (and nearby Annfield, Kilblaan and Smithy Cottage)	Major adverse noise impact during construction.	Significant adverse		Not significant
The Old Bakehouse (and nearby Tirohia, 1 and 2 Station Cottages)	Major adverse noise impact during construction.	Significant adverse		Significant adverse
Lagmhor (and nearby Caileagan, Braan Cottage, Craigvinean Flat and Craigvinean Surgery)	Major adverse noise impact during construction.	Significant adverse		Significant adverse
Dunkeld and Birnam Station	Moderate to major adverse noise	Significant adverse		Significant adverse

Receptor(s)	Description of Effect	Significance of Effect (Prior to Standard and Specific Mitigation)	Proposed Mitigation	Residual Significance of Effect (With Standard and Specific Mitigation)
	impact during construction.			
Construction Vibration (Vibratory Compaction)				
The Old Bakehouse (and nearby Tirohia, 1 and 2 Station Cottages)	Moderate adverse vibration impact during construction.	Significant adverse	Contractor to conduct updated noise and vibration assessment and create noise and vibration mitigation strategy as part of CEMP (**Mitigation Item SMC-NV1**). Application of Best Practicable Mean (as described in Section 15.5 (Mitigation) including limiting duration of exposure to noise levels above SOAEL (**Mitigation Item SMC-NV2**). Employ specific mitigation measures (**Mitigation Item P02-NV01**) to reduce the impacts of vibration upon buildings and structures, such as: ▪ selection of low vibratory or non-vibratory plant; ▪ starting up and turning off vibratory compaction plant as far away from sensitive receptors as practicable; ▪ engage with the local community to warn them of the potential for construction vibration, provide timings and contact	Not significant
Dunkeld and Birnam Station	Moderate to major adverse vibration impact during construction. Potential for cosmetic damage.	Significant adverse		Not significant

Receptor(s)	Description of Effect	Significance of Effect (Prior to Standard and Specific Mitigation)	Proposed Mitigation	Residual Significance of Effect (With Standard and Specific Mitigation)
			information, and advise what is being done to control vibration; ▪ where there is considered to be the potential for cosmetic damage on a building or structure due to vibratory compaction: - undertake a structural survey of the building or structure prior to and after construction of the proposed scheme begins to ascertain its structural condition before and after the works; and, - once the structural assessments have been undertaken, consideration of vibration limit values and compliance measurements would be required, with the requirement to undertake vibration measurement whilst the works are within a certain distance.	
Construction Vibration (Sheet Piling)				
Dunkeld and Birnam Station	Moderate adverse vibration impact during construction.	Significant adverse	Contractor to conduct updated noise and vibration assessment and create noise and vibration mitigation strategy as part of CEMP (**Mitigation Item SMC-NV1**).	Not significant

Receptor(s)	Description of Effect	Significance of Effect (Prior to Standard and Specific Mitigation)	Proposed Mitigation	Residual Significance of Effect (With Standard and Specific Mitigation)
			Application of Best Practicable Mean (as described in Section 15.5 (Mitigation) including limiting duration of exposure to noise levels above SOAEL (**Mitigation Item SMC-NV2**). The following measures (**Mitigation Item P02-NV02**) would be considered at each VSR where a potential for significant vibration effects from sheet piling is identified: ▪ pre-augering or pre-excavation of pile route to remove obstructions and reduce the potential for high vibration events and increase the rate of pile insertion; ▪ where vibratory piling is proposed, use percussive piling or an alternative method of piling (such as press piling) for piling near to sensitive buildings or structures; ▪ engage with the local community to warn them of the potential for construction vibration, provide timings and contact information, and advise what is being done to control vibration;	

Receptor(s)	Description of Effect	Significance of Effect (Prior to Standard and Specific Mitigation)	Proposed Mitigation	Residual Significance of Effect (With Standard and Specific Mitigation)
			▪ where there is considered to be the potential for cosmetic damage on a building or structure due to sheet piling: - undertake a structural survey of the building or structure prior to and after construction of the proposed scheme begins to ascertain its structural condition before and after the works; and, - once the structural assessments have been undertaken, consideration of vibration limit values and compliance measurements would be required, with the requirement to undertake vibration measurement whilst the works are within a certain distance.	
Operational Noise				
Ringwood Cottage, Rowan Cottage, Willow Tree Cottage and Oak Tree Cottage	Moderate adverse noise impact during operation.	Significant adverse	Reflective barrier of 100m length and 2.0m height along the northbound side of the proposed scheme (ch1240-1340) (**Mitigation Item P02-NV03**).	Not significant
Ballincrieff House, Barbed Wire and Poppies, Oakwood and Tomcroy House	Major beneficial noise impact during operation.	Significant beneficial	N/A	Significant beneficial

Receptor(s)	Description of Effect	Significance of Effect (Prior to Standard and Specific Mitigation)	Proposed Mitigation	Residual Significance of Effect (With Standard and Specific Mitigation)
Noise sensitive receptors north of Perth Road between A9 and south end of St. Mary's Road (33 dwellings and 3 other sensitive receptors)	Moderate beneficial noise impact during operation.	Significant beneficial	N/A	Significant beneficial
Hollybank, Carse Na Tay, Shian, Wychwood and Rowanlea	Major beneficial noise impact during operation.	Significant beneficial	N/A	Significant beneficial
Dowiestone and 6 Perth Road	Moderate beneficial noise impact during operation.	Significant beneficial	N/A	Significant beneficial
Dunkeld and Birnam Railway Station	Major beneficial noise impact during operation.	Significant beneficial	N/A	Significant beneficial
12 & 13 Birnam Terrace	Moderate beneficial noise impact during operation.	Significant beneficial	N/A	Significant beneficial
Merryburn, Tigh Lois, The Merryburn, 8 Station Road, 2 Station Cottages and Tigh Dughlas	Moderate beneficial noise impact during operation.	Significant beneficial	N/A	Significant beneficial

Receptor(s)	Description of Effect	Significance of Effect (Prior to Standard and Specific Mitigation)	Proposed Mitigation	Residual Significance of Effect (With Standard and Specific Mitigation)
1 Station Cottages and Tirohia	Minor beneficial noise impact during operation.	Significant beneficial	N/A	Significant beneficial
Craigvinean, Craigvinean Surgery and Dunkeld and Birnam Recreation Club	Moderate beneficial noise impact during operation.	Significant beneficial	N/A	Significant beneficial
Rose Cottage	Minor beneficial noise impact during operation.	Significant beneficial	N/A	Significant beneficial
Neil Gow Cottage and Sunnybank Cottage	Moderate beneficial noise impact during operation.	Significant beneficial	N/A	Significant beneficial
Dundonachie Coach House	Minor adverse noise impact during operation.	Significant adverse	No specific mitigation measures proposed at this location.	Significant adverse

15.9 References

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