15 Noise and Vibration

Potential noise and vibration impacts arising from the construction and operation of the proposed scheme have been assessed for sensitive receptors.

The noise environment for residential properties and other noise sensitive receptors in the study area is largely dominated by road traffic noise on nearby heavily trafficked roads.

Consideration has been given to the potential operational noise and vibration impacts. The proposed scheme includes low noise road surfacing, and a noise barrier is proposed for one property (Broompark Cottage) to mitigate for potential noise increase. With the proposed scheme in place no receptor will experience adverse short-term moderate or major noise increases. A total of 85 dwellings and two other sensitive receptors will experience moderate noise benefits, with 22 dwellings and one other sensitive receptor experiencing major noise benefits in the short-term. Far more dwellings and other sensitive receptors experience decreases in noise level than increases in noise level, with only three properties subject to a perceptible noise increase in the short-term.

In the long-term, with the proposed scheme in place no receptor will experience perceptible noise increases. Whereas 47 dwellings and two other sensitive receptors are predicted to experience long-term perceptible daytime noise benefits with the proposed scheme in place.

For the construction noise assessment, consideration was given to the likely worst-case phases of works, based on a preliminary construction programme and details of plant and equipment typically used for each phase. Construction noise was modelled assuming worst-case conditions. Significant potential noise impacts were identified for a number of the closest properties to the construction work, in particular, the earthworks and carriageway surfacing phases. However, given that much of these works are transient, the duration of impacts for the majority of receptors will be restricted to periods where the works are closest. Through a proactive approach by the contractor to community liaison and by implementing a best practice approach and an appropriate mitigation strategy, the impact would be reduced.

Vibration predictions from the earth compaction works indicate that those closest properties to such works are likely to be exposed to perceptible levels of vibration. The potential for cosmetic damage from compaction activities close to sensitive receptors is highlighted based upon worst-case assumptions. Mitigation measures and monitoring is proposed for periods when compaction activities are undertaken close to sensitive receptors.

15.1 Introduction

15.1.1 This chapter presents an assessment of the predicted construction and operational noise and vibration impacts of the proposed scheme. The chapter is supported by the following appendices, which are cross-referenced in the text where relevant:

- A15.1 (Noise and Vibration – Introduction and Terms);
- A15.2 (Baseline Noise Surveys);
- A15.3 (Operational Noise Predictions and Operational Traffic Data); and
- A15.4 (Construction Noise Predictions and Assumed Construction Plant/Equipment).

15.1.2 The assessment has been carried out according to methodology based on the guidance provided in DMRB Volume 11 Section 3 Part 7 (HD 213/11 – Revision 1) 'Noise and Vibration' for a Detailed Assessment. Any implications of noise or vibration on ecological receptors are separately considered within the assessment presented in Chapter 10 (Ecology and Nature Conservation).

15.2 Approach and Methods

Policy and Guidance

15.2.1 The assessment and mitigation of road traffic noise and vibration was carried out according to established prediction and assessment methodologies that are governed or guided by the following key documents:

- DMRB Volume 11 Section 3 Part 7 (HD 213/11 – Revision 1), Noise and Vibration. This includes guidance on the assessment methods for noise and vibration from new highways. DMRB is adopted by Transport Scotland for new trunk road schemes. The latest revision, issued in November 2011 has been used in this assessment and is referred to as 'HD 213/11';
- DMRB Volume 11 Section 2 Part 5 (HA 205/08), Assessment and Management of Environmental Effects;
- Calculation of Road Traffic Noise (CRTN) (Department of Transport Welsh Office, 1988); and
- 'Guidance for Possible Measures to Manage Noise from Road and Rail' (Scottish Government, undated).

15.2.2 The Environmental Noise Directive 2002/49/EC provides the following objectives:

- to determine the noise exposure of the population by mapping;
- to make the information on environmental noise available to the public; and
- to establish action plans based on the mapping results to prevent and reduce environmental noise where necessary and to preserve environmental noise quality where it is good.

15.2.3 The Environmental Noise (Scotland) Regulations 2006 transpose END in Scotland. The geographical scope for Transportation Noise Action Plans is determined by the location of roads with more than six million vehicle passages a year. The A9 was included in the noise mapping exercise and subsequent Transportation Noise Action Plan. However, there appear to be no areas designated 'Candidate Noise Management Areas' near to the proposed scheme.

Consultation

15.2.4 The Environment Service Department of Perth & Kinross Council was contacted in February 2013, with agreement reached on locations for baseline noise monitoring.

Study Area

Noise

15.2.5 The study area for the noise assessment was defined in accordance with HD 213/11. Firstly, the Calculation Area is defined as all residential dwellings and other noise sensitive receptors within 600m of the proposed scheme and for those roads (within 1km of the proposed scheme) on the existing road network that are predicted to result in noise changes of 1 dB in the year of opening or 3 dB in the design year.

15.2.6 HD 213/11 requires consideration beyond the Calculation Area, to take into account the likely noise impacts on the wider road network (considered in terms of change in basic noise level; BNL). This is required for such roads where there is a 1 dB increase or decrease in noise in the baseline year and/or a 3 dB increase or decrease in the future assessment year compared to the baseline year.

15.2.7 Figure 15.1 presents the Calculation Area and study area as defined by the requirements of HD 213/11. HD 213/11 requires a qualitative assessment to be undertaken for sensitive receptors that are outside the calculation area but within 1km of the proposed scheme.

Vibration

15.2.8 The study area for the vibration assessment was defined as within 40m of all roads where noise level predictions were undertaken.

Traffic Data

15.2.9 Traffic data were provided for the following parameters for each road link for the baseline and future year scenarios (traffic data provided in Appendix A15.3):

- Annual Average Weekday Traffic (AAWT) between 06:00 – 00:00 (18hr):
  (i) Total traffic flow (AAWT 18hr);
  (ii) Percentage Heavy Duty Vehicles (HDV); and
  (iii) Vehicle speed (kph).

15.2.10 The baseline traffic data were prepared using 12 hour count data, with projected traffic growth over time being based on levels within the Transport Model for Scotland (TMfS07), which was the latest model available at the time of this review. Whilst the proposed scheme is not considered likely to notably affect the traffic demand at a local level (Luncarty to Pass of Birnam), it is anticipated that the wider programme of proposed dualling of the A9 from Perth to Inverness may attract additional traffic to this strategic route. The traffic data utilised in this assessment therefore assume that the full programme of works to dual the A9 will be implemented. As the additional traffic is only included in the future scenario, this is considered to represent a worst-case scenario, as impacts are predicted based on relative changes in traffic, and this scenario is expected to represent the greatest difference between the baseline (DM 2019) and future (DS 2034) scenario.

Identification of Noise and Vibration Sensitive Locations

15.2.11 HD 213/11 provides examples of sensitive receptors. These include dwellings, hospitals, schools, community facilities, designated areas (e.g. AONB, National Park, SAC, SPA, SSSI, SAM) and public rights of way such as footpaths.

15.2.12 For the purposes of assessment, noise sensitive receptors (such as residential properties, schools, hospitals, care homes) were identified primarily using Ordnance Survey (OS) mapping.

15.2.13 While all receptors within the study area have been assessed in accordance with HD 213/11 ten sample receptors have been selected for discussion purposes (see Table 15.1 and also Figure 15.2). These sample receptors are considered to have noise environments representative of those at other nearby receptors and they are located where people are particularly sensitive to noise and include dwellings close to the proposed scheme. Furthermore, locations have been selected where it has been anticipated that receptors have the potential to experience perceptible changes in noise level following the introduction of the proposed scheme, including those on 'affected roads' on the local road network.

15.2.14 Designated areas in the study area that may be potentially sensitive to noise level changes are identified in Table 15.2.

Table 15.1: Sample Receptors

Reference No.	Receptor Name
1	6 Kirkhill Drive
2	32 Westfield
3	Kirkhill House
4	Ordie View
5	Newmill
6	1 Lower Gauls
7	57 Innewan Gardens
8	Broompark Cottage
9	Milton Cottage
10	Holm Cottage

Table 15.2: Designated Areas

Reference No.	Type	Receptor Name
11	Cultural heritage	Court Hill Tumulus
12	Cultural heritage	Battleby House Gardens
13	Ecological	Cairnleith Moss SSSI

Assessment Methodology for Operational Noise and Vibration

Road Traffic Noise

15.2.15 Assessment of noise levels at various noise sensitive receivers has followed the Detailed Assessment methodology outlined in HD 213/11. Noise levels have been calculated at all residential dwellings and other sensitive receptors within the study area as defined in paragraph 15.2.6.

15.2.16 This assessment considers noise level changes at dwellings and other sensitive receptors according to their baseline façade noise levels. It should be noted that in this context, the baseline is considered to be the Do-Minimum (DM) scenario in the opening year. The following comparisons are made:

- DM scenario in opening year (2019) against DM in the future assessment year (2034);
- DM scenario in the baseline year (2019) against Do-Something (DS) scenario in the baseline year (2019); and
- DM scenario in baseline year (2019) against DS scenario in the future assessment year (2034).

15.2.17 The future assessment year is that defined as the year within the first 15 years of opening of the proposed scheme where traffic flows are greatest. The future assessment year is therefore usually the design year of the proposed scheme (15 years after opening), which in this assessment is 2034.

15.2.18 Consideration has also been given to night-time noise levels in accordance with HD 213/11. Consideration is given to those receptors that are predicted to experience a $L_{night,outside}$ noise level of 55 dB or greater in any scenario. In the absence of hourly traffic data, Method 3 within the Transport Research Laboratory (TRL) Report *'Converting the UK traffic noise index LA10, 18hr to EU noise indices for noise mapping'* has been used to determine estimated night-time levels from daytime 18-hour AAWT flows. The estimated night-time levels are dependent upon whether the road is classified as a "Motorway" or "Non Motorway". In general, for "Motorways", the estimated night-time noise levels using Method 3 are slightly lower than the daytime levels, to represent the relatively consistent use of the motorway network during all periods (day, evening and night). For "Non Motorways", estimated night-time noise levels are considerably lower than daytime levels, which is generally consistent with traffic usage on these types of road.

15.2.19 The night-time noise predictions presented in this assessment have therefore assumed that the proposed road is classified as a "Non-Motorway". This was based on the apparent noise level reduction at night, compared to the day, as identified in the noise survey work (see Section 15.4: Potential Impacts).

15.2.20 For the night-time assessment, the following comparisons are made:

- DM scenario (baseline) in opening year (2019) against DM in the future assessment year (2034); and
- DM scenario (baseline) in opening year (2019) against DS in the future assessment year (2034).

15.2.21 Noise levels at receptors have been calculated at first floor (4m) height, except for bungalows which have been calculated at ground floor (1.5m) height, using the CadnaA noise modelling package, which incorporates the methodology contained in the Calculation of Road Traffic Noise 1988 (CRTN). CRTN is a technical memorandum produced by the Department for Transport and Welsh Office providing the definitive method of predicting road traffic noise in the United Kingdom.

15.2.22 Noise level predictions take account of typical weekday volumes of traffic during the eighteen hour period from 6am to midnight (18-hour AAWT flows) and the following variables:

- percentage of Heavy Duty Vehicles (HDVs);
- traffic speeds;
- road gradient;
- local topography;
- nature of the ground cover between the road and the receptor;
- shielding effects of any intervening structures, including allowances for limited angles of view from the road and any reflection effects from relevant surfaces; and
- road surfacing type.

15.2.23 The road surface on much of the existing highway network is conventional Hot Rolled Asphalt (HRA), although a Low Noise Road Surface (LNRS) exists on a number of sections of the A9. A LNRS would be used for the entirety of the proposed scheme. HD 213/11 provides specific guidance in relation to the noise level correction that should be applied when using LNRS for new carriageways. It states that:

> *"where new carriageways are to be constructed and a thin surfacing system [low noise surfacing] used, or where an existing surface is to be replaced with a thin surfacing system, a -3.5 dB(A) correction should be assumed for the thin surface system [equivalent to a Road Surface Influence (RSI) of -5 dB(A)] unless any information is available regarding the specific surface to be installed. This advice applies where the mean traffic speed is >= 75 kph. Where the mean speed is < 75 kph, a -1 dB(A) correction should be applied to a new low-noise surface."*

15.2.24 The following road surface types have been derived from a pavement investigation undertaken in February 2013:

- DM 2019: HRA everywhere, except for the following chainages on the mainline, where a -3.5 dB correction was applied (ch0-1300, ch1300-1980, ch2600-2880) to reflect existing LNRS.
- DM 2034: Assumed that the A9 mainline will be resurfaced with TS2010 (Transport Scotland road specification) if the proposed scheme doesn't go ahead. This is a LNRS, therefore a -3.5 dB correction was applied for the entire mainline and standard HRA for the side roads.
- DS 2019: Assumed that the side roads are HRA, but the proposed scheme mainline is LNRS (-3.5 dB as speed >75 kph). The existing sections of A9 to the north and south of the proposed scheme were also assumed to be HRA.
- DS 2034: Assumed that the side roads are HRA, but the proposed scheme mainline is LNRS (-3.5 dB as speed >75 kph). The existing sections of A9 to the north and south of the proposed scheme were also assumed to be LNRS.

15.2.25 In line with HD 213/11, a minimum traffic speed of 20 km/h is used in the noise model where the traffic model predictions provide speeds less than this.

15.2.26 Carriageway associated with the proposed scheme and certain sections of the existing carriageway have been modelled using a LNRS, with an associated surface correction of -3.5 dB in line with the maximum allowable correction contained within HD 213/11. In the situation where existing sections

of carriageway with LNRS performs less well than assumed, e.g. due to wear and tear, this approach provides a conservative approach when determining the proposed scheme effects. That is, the provision of a new LNRS with the proposed scheme would otherwise appear to have greater benefits when compared with the baseline situation.

15.2.27 The majority of the existing carriageway and any slip roads (existing and future) are assumed to be HRA with a texture depth of 2mm. Horizontal and vertical alignment information of the proposed scheme and surrounding area were derived from the three dimensional model of the DMRB Stage 3 design.

15.2.28 Identification of sensitive receptors is based on Ordnance Survey (OS) MasterMap data. The heights of buildings within the noise model have been derived from Google Street View and Microsoft Birdseye View mapping. Two storey high buildings are assumed to be 7m. In general, building height increases by 2.5m per storey.

15.2.29 The noise model receptor heights have been assumed to be 1.5m for bungalows, and where applicable churches, schools, parks, doctor surgeries and other ground floor level receptors. A receptor height of 4m has been assumed for all two-storey or taller properties.

15.2.30 Where applicable, noise levels at sensitive receptors have been predicted at a distance of 1m from the most exposed façade and include a 2.5 dB façade correction. Noise levels for sensitive receptors positioned in open spaces and for the night-time period are free-field.

15.2.31 In accordance with HD 213/11, for open space sensitive receptors, such as parks and other recreational areas, a representative position in close proximity to the nearest main road where the public could potentially be exposed to traffic noise has been selected.

15.2.32 The general approach to EIA as explained in Chapter 4 (Overview of Assessment) provides for the identification of impact significance taking into account the value or sensitivity of a receptors and the magnitude of impact. However, as discussed in paragraph 3.36 of HD 213/11, in terms of road traffic noise, a standard methodology has not yet been developed to assign a significance according to both value/sensitivity and magnitude. This chapter therefore presents the assessment findings for operational noise in terms of impact magnitude only.

15.2.33 Section 3 of HD 213/11 provides guidance on the magnitude of impacts for traffic noise. Magnitude of impact is considered for both the short-term and long-term. A change in road traffic noise of 1 dB(A) in the short-term (for example when a project is opened) is the smallest that is considered perceptible. In the long-term, a 3 dB(A) change is considered perceptible. The classification of noise impact magnitude is as detailed in Tables 15.3 and 15.4.

Table 15.3: Classification of Magnitude of Short-term Noise Impacts

Noise Change (LA10,18hr)	Magnitude of Impact
0	No change
0.1 – 0.9	Negligible
1 – 2.9	Minor
3 – 4.9	Moderate
5+	Major

Table 15.4: Classification of Magnitude of Noise Impacts in the Long-term

Noise Change (LA10,18hr)	Magnitude of Impact
0	No change
0.1 – 2.9	Negligible
3 – 4.9	Minor
5 – 9.9	Moderate
10+	Major

15.2.34 For the assessment of night-time noise impacts, HD 213/11 advises that until further research is available, only noise impacts in the long-term should be considered. Therefore, the classification in Table 15.4 is used in this assessment for determining night-time noise impacts. In addition, HD 213/11 advises only those sensitive receptors predicted to be subject to noise levels exceeding 55 dB $L_{night,outside}$ should be considered.

Ground borne Vibration

15.2.35 HD 213/11 advises that should the level of vibration at a receptor be predicted to rise to above a level of 0.3 mm/s, or an existing level above 0.3 mm/s is predicted to increase, then this should be classed as an adverse impact from vibration.

15.2.36 Within the study area, the closest residential properties to the proposed scheme which would have the potential to be exposed to the highest level of ground borne vibration are as follows:

- 65-69 Innewan Gardens – 29m from existing A9;
- Little Steps Nursery on A9, near Bankfoot – 12m from existing A9;
- Newmill – 26m from the existing A9;
- Hilton Bungalow – 26m from the A9; and
- Bellfield on A9 near Bankfoot – 20m from the existing A9.

15.2.37 Given the distances to the proposed scheme and maintained new road surfaces, plus the fact that the carriageway will not move closer to these properties with the proposed scheme, it is not considered that operational groundborne vibration will be a key issue. It is therefore, not considered further in this chapter. There are no cumulative noise and vibration impacts as a consequence.

Vibration Nuisance

15.2.38 Where properties are within 40m of the carriageway, HD 213/11 recommends that, for a given level of noise exposure, the percentage of those 'bothered' by airborne vibration is 10% lower than the corresponding figure for noise nuisance derived from tables contained within HD 213/11. Where noise levels are below 58 dB $L_{A10,18hr}$, it should be assumed that residents would not be 'bothered' by vibration. Consideration has been given to changes in airborne vibration nuisance at all dwellings within 40m of roads where noise level predictions have been undertaken.

Assessment Methodology for Construction Noise and Vibration

15.2.39 Disruption caused during the construction phase of the proposed scheme has the potential to affect residents and other sensitive receptors adjacent to the works. HD 213/11 advises on the use of BS 5228 to assess and control noise and vibration from construction activities.

15.2.40 BS 5228-1: 2009 contains details of construction noise prediction methods and noise levels from different types and sizes of construction equipment. It contains a database on the noise emission from individual items of equipment and activities and routines to predict noise from demolition and construction methods. The standard also suggests practical ways to mitigate excessive noise.

15.2.41 BS 5228-1: 2009 provides two methodologies for the prediction of noise significance during typical construction works, based upon noise change and existing measured ambient noise levels. As there are both residential properties and other sensitive receptors (such as education facilities) in the vicinity of the proposed scheme, consideration has been given to Method 2, as Method 1 only applies for residential properties.

15.2.42 CadnaA is a software programme for calculating construction site noise using the methodology set out in BS 5228. Construction plant, activities and programme will be used to predict "worst-case" noise levels at nearby sensitive receptors. CadnaA has been used in this assessment to calculate

noise levels from the construction activities associated with each construction phase. The variables considered in the calculations comprise:

- plant type and location;
- operating times;
- local topography;
- nature of the ground cover between the site and the receptor; and
- shielding effects of any intervening structures, including allowances for limited angles of view.

15.2.43 Construction plant information as set out in Appendix A4.1 (Construction Information), together with an indicative construction works programme formed the basis of the assessment. Construction plant noise levels used in this assessment have been taken from the current sound level data presented in Annex C of BS 5228-1: 2009.

15.2.44 Noise levels generated by construction activities are deemed to be significant if the total noise (pre-construction ambient plus construction noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65 dB, 55 dB and 45 dB LAeq,T from construction noise alone, for the daytime, evening and night-time periods respectively. This applies for a duration of one month or more, unless works for a shorter duration are likely to result in a significant effect. The evaluation criteria are generally applicable for residential housing, hotels and hostels, buildings in religious use, schools and health or community facilities.

15.2.45 BS 5228-2: 2009 contains guidance on vibration levels in structures from construction works. It provides a prediction methodology for mechanised construction works, such as compaction and tunnelling works, and piling activities. The standard also presents guidance for the control of vibration from construction works.

15.2.46 BS 5228-2: 2009 provides guidance on the human response to vibration in buildings. For construction works, the guidance contained in Table 15.5 is provided:

Table 15.5: Guidance on the Human Response to Vibration levels from BS5228-2:2009

Vibration Level	Effect
0.14 mm/s	Vibration might just be perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s	Vibration might just be perceptible in residential environments.
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10.0 mm/s	Vibration is likely to be intolerable for any more than very brief exposure to this level.

15.2.47 For building structure response, BS 5228-2: 2009 reproduces the advice given in BS 7385-2: 1993 - Evaluation and measurement for vibration in buildings: guide to damage levels from ground borne vibration. The response of a building to ground borne vibration is affected by the type of foundation, underlying ground conditions, the building construction and the state of repair of the building. Table 15.6 reproduces the guidance detailed on building classification and guide values for cosmetic building damage.

Table 15.6: Guidance on the effects of vibration Levels on Building Structures from BS 5228-2:2009

Type of Building	PPV in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures	50 mm/s	50 mm/s
Industrial and heavy commercial buildings		
Un-reinforced or light framed structures	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Residential or light commercial buildings		

15.2.48 Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 15.6, with major damage at values greater than four times the values in the table. BS 7385-2: 1993 also notes that the probability of cosmetic damage tends towards zero at 12.5 mm/s peak component particle velocity.

Baseline Conditions

15.2.49 Baseline noise levels within the study area were predicted using the noise model for the DM baseline year (2019) traffic scenario as required by HD 213/11, paragraph 3.8. The CRTN prediction method provides noise forecasts across the entire study area under consistent scenarios (i.e. not subject to traffic flow variations, or meteorological variations that would affect propagation scenarios). The CRTN procedure assumes a moderately adverse wind scenario; that is with the wind blowing from the source to the receiver (as described in CRTN paragraph 4).

15.2.50 The noise environment in the whole of the study area is generally dominated by traffic noise and is therefore predictable using the road traffic noise model. In some locations there may be contributions from other noise sources including rail and aircraft noise; although at all of the noise survey positions road traffic formed the dominant source of noise. This method of using the traffic model to quantify baseline noise levels is standard practice for highway noise assessment with the predicted levels for areas further from traffic noise sources or areas close to non-traffic sources being checked against noise survey measurement data.

Noise Measurement Survey

15.2.51 A baseline noise survey was conducted to establish existing noise levels at a sample of sensitive locations within the study area, according to guidance provided in HD 213/11. This included both long-term surveys (noise logging equipment installed at two locations for a number of weeks) and short-term attended surveys (carried out at 5 locations across the noise study area).

15.2.52 The results from the noise surveys have been used to verify the results of the noise modelling exercise. These surveys were also considered important to determine if certain parts of the study area are influenced by noise from sources other than traffic. At all of the noise survey positions, road traffic formed the dominant source of noise.

15.2.53 The survey methodology, results and survey locations are presented in Appendix A15.2 (Baseline Noise Surveys).

Limitations to Assessment

15.2.54 Traffic data are fundamental to predicting noise levels, thus facilitating the noise and vibration assessment of a scheme. Traffic flow, composition and speed data all contribute in calculating noise levels. Traffic data have been provided for the year of opening (2019) and design year (2034) for the DM and DS scenarios, using the DMRB Stage 3 design for the proposed scheme.

15.2.55 It is considered that all data inputs for this assessment are of an adequate level to support a 'Detailed' level of assessment as defined in HD 213/11.

15.3 Baseline Conditions

A9 Dualling: Strategic Environmental Assessment (SEA)

15.3.1 As noted in Chapter 2 (Need for the Scheme), an SEA of the wider programme of proposed dualling of the A9 from Perth to Inverness has been undertaken. The outcomes of the SEA, including responses from consultees and recommendations, were reviewed as part of this assessment. The SEA recommends that projects '*schedule and control the timing of construction activities to minimise noise impacts on sensitive receptors*'. No further requirements or recommendations are made.

Existing Noise Levels

15.3.2 For the purposes of the operational noise assessment, potential impacts are predicted in relation to the DM scenario in 2019, which are the predicted ambient noise levels immediately before the change produced by the proposed scheme, as set out in HD 213/11. For the purposes of construction noise assessment the baseline against which changes are considered is taken as that immediately prior to the start of works.

15.3.3 The baseline noise predictions are supplemented by both long-term noise surveys (noise logging equipment installed at two locations for a number of weeks) and short-term attended noise surveys (carried out at five locations across the noise study area), the results of which were used to verify the results of the noise modelling exercise. It is important to keep in mind that a potentially significant component of any apparent difference between predicted and measured levels may be due to variance in the measured data due to, for example, daily traffic variations, changes in meteorological and other local conditions.

15.3.4 Measured noise levels from the noise surveys were compared to those predicted by the noise model for 2012. The comparison of predicted and measured data is summarised in Table 15.7. The noise levels presented in Table 15.7 are façade and at ground floor level.

Table 15.7: Comparison of Predicted and Measured Noise Levels

Monitoring Location	Predicted Level		Measured dBLA10,18h		Difference	
	Day LA10	Night LAeq	Day LA10	Night LAeq	Day LA10	Night LAeq
Ordie View	62.1	52.1	59.1	-	-3.0	-
Holm Cottage	66.9	56.4	68.3	-	1.4	-
Loakmill	60.1	50.3	57.7	49.3	-2.4	-1.0
Hilton Cottage	67.0	56.5	68.2	-	1.2	
57 Innewan Gardens	64.5	54.3	57.0	50.7	-7.5	-3.6
Broompark Cottage	58.8	49.2	54.6	-	-4.2	-
Gellywood	54.4	45.2	51.8	-	-2.6	-

15.3.5 Table 15.7 demonstrates good correlation between measured and prediction noise levels with the exception of 57 Innewan Gardens and Broompark Cottage, with the predicted noise levels generally higher than those measured. A dense line of trees are situated between these receivers and the A9, and it is considered likely that the tree belts identified above are providing noise attenuation to 57 Innewan Gardens and Broompark Cottage and this would explain the difference in measured and predicted noise levels. HD 213/11 details that the use of shrubs or trees as a noise barrier is effective only if the foliage is at least 10m deep, dense and consistent for the full height of the vegetation. HD 213/11 makes reference to the Department for Transport (TRL) publication *'The use of vegetation for traffic noise screening'*. The TRL publication details that 10m of vegetation can result in a noise reduction of 5 dB greater than grass or 8 dB greater than a hard reflecting surface.

15.3.6 In determining the likely noise impact consideration is given to noise change; the absolute noise levels themselves are not imperative. Provided the vegetation remains the above likely attenuation effect will prevail in both the DM and DS scenarios; thus the subsequent noise change will be unaffected. In addition, the predicted noise levels are higher than measured and hence for the purposes of this assessment can be considered worst-case.

15.3.7 Consideration was given to adjusting predicted noise levels to account for the increased attenuation due to the trees. However, due to possible seasonal variations in foliage and changes to the tree belt with time it was considered that it was better to acknowledge the effect of the trees but to assess with the noise model as set up and focus on potential noise change. In terms of potential eligibility for noise insulation this approach represents a worst-case approach.

15.3.8 Predicted baseline noise levels for the year of opening (2019) are presented in Table 15.8 and Table 15.9 respectively for the sample receptor locations and designated sites.

Table 15.8: Predicted Baseline Noise Levels for Sample Receptors in 2019

Reference No.	Receptor Name	Predicted Baseline Noise Level, dB	
		Day-time (06:00 – 00:00) dB LA10,18hr	Night-time (23:00 – 07:00) dB Lnight, outside
1	6 Kirkhill Drive	53.7	42.3
2	32 Westfield	67.0	54.3
3	Kirkhill House	65.7	53.1
4	Ordie View	66.0	53.4
5	Newmill	66.5	53.8
6	1Lower Gauls	65.4	52.8
7	57 InnewanGardens	69.3	56.4
8	Broompark Cottage	64.0	51.6
9	Milton Cottage	49.0	38.1
10	Holm Cottage	71.7	58.5

Table 15.9: Predicted Baseline Noise Levels for Designated Areas in 2019

Reference No.	Receptor Name	Predicted Baseline Noise Level, dB
11	Court Hill Tumulus	54.2
12	Battleby House Gardens	49.1
13	Cairnleith Moss SSSI	49.9

15.4 Potential Impacts

Operational Impacts

15.4.1 In accordance with the requirements of HD 213/11, predicted noise levels at all noise sensitive receptors within the Calculation Area are detailed in Appendix A15.3 (Construction Noise Predictions and Assumed Construction Plant/Equipment).

Noise Levels at Sample Receptors

15.4.2 Table 15.10 compares day-time noise levels at each sample receptor location in the DM in 2019 against the DS scenario in 2019 (short-term impact). Tables 15.11 and 15.12 compares noise levels at each sample receptor location in the DM in 2019 against the DS scenario in 2034 (long-term impact) for the day and night-time period. Tables 15.10, 15.11 and 15.12 show the magnitude of noise change in accordance with the criteria presented in Tables 15.3 and 15.4.

Table 15.10: Comparison of Predicted Day-time Noise Levels for Do-Minimum and Do-Something Scenarios (2019)

Ref	Receptor Name	DM 2019 LA10,18h (dB)	DS 2019 LA10,18h (dB)	Noise Level Change (dB)	Magnitude of Change
1	6 Kirkhill Drive	53.7	54.4	+0.7	Negligible
2	32 Westfield	67.0	67.1	+0.1	Negligible
3	Kirkhill House	65.7	66.3	+0.6	Negligible
4	Ordie View	66.0	65.7	-0.3	Negligible
5	Newmill	66.5	67.0	+0.5	Negligible
6	1 Lower Gauls	65.4	64.5	-0.9	Negligible
7	57 Innewan Gardens	69.3	63.7	-5.6	Major (beneficial)

Ref	Receptor Name	DM 2019 LA10,18h (dB)	DS 2019 LA10,18h (dB)	Noise Level Change (dB)	Magnitude of Change
8	Broompark Cottage	64.0	66.1 *	+2.1	Minor (adverse) *
9	Milton Cottage	49.0	49.9	+0.9	Negligible
10	Holm Cottage	71.7	69.3	-2.4	Minor (beneficial)

* Note that this includes a correction of +5 dB in the DS scenario to allow for removal of intervening vegetation, as explained in paragraph 15.4.5 below.

15.4.3 Table 15.10 shows that the short-term magnitude of change for most of the sample receptors considered is negligible, e.g. 6 Kirkhill Drive, 32 Westfield and Ordie View. These sample receptors are located adjacent to sections of the A9 where LNRS already exists. Therefore, the future benefit of implementing LNRS as part of the proposed scheme is not realised.

15.4.4 57 Innewan Gardens is predicted to experience a major noise benefit. This receptor benefits from the introduction of LNRS with the proposed scheme. In addition, the proposed dualling of the A9 adjacent to 57 Innewan Gardens results in an increased distance from the road traffic source.

15.4.5 Broompark Cottage is shown to experience a minor adverse noise impact. This takes into account the fact that the proposed scheme will require removal of intervening deciduous woodland currently present between the property and the A9; as per the TRL Report discussed in paragraph 15.3.5, shrubs and trees may provide noise attenuation if greater than 10m depth. At Broompark Cottage, the depth of existing woodland is approximately 25m, for which the TRL Report indicates an additional attenuation (over grass, i.e. soft ground covering as per CRTN methodology) of approximately 5dB. This corresponds with the difference demonstrated between the measured and predicted noise levels at Broompark Cottage (-4.2 dB), as shown in Table 15.7. To ensure that a worst-case scenario was assessed, a 5 dB noise increase was therefore applied to account for the tree removal as part of the works for the proposed scheme. It should be noted that the predicted overall change is less than 5 dB, as the introduction of LNRS and the proposed retaining wall will help to reduce noise. Proposals to reduce this potential impact are explained in Section 15.5 (Mitigation).

Table 15.11: Comparison of Predicted Day-time Noise Levels for Do-Minimum (2019) and Do-Something Scenario (2034)

Ref	Receptor Name	DM 2019 LA10,18h (dB)	DS 2034 LA10,18h (dB)	Noise Level Change (dB)	Magnitude of Change
1	6 Kirkhill Drive	53.7	55.0	+1.3	Negligible
2	32 Westfield	67.0	67.4	+0.4	Negligible
3	Kirkhill House	65.7	65.6	-0.1	Negligible
4	Ordie View	66.0	66.5	+0.5	Negligible
5	Newmill	66.5	67.8	+1.3	Negligible
6	1 Lower Gauls	65.4	64.3	-1.1	Negligible
7	57 Innewan Gardens	69.3	64.6	-4.7	Minor (beneficial)
8	Broompark Cottage	64.0	67.0 *	+3.0	Minor (adverse) *
9	Milton Cottage	49.0	50.7	+1.7	Negligible
10	Holm Cottage	71.7	70.1	-1.6	Negligible

* Note that this includes a correction of +5 dB in the DS scenario to allow for removal of intervening vegetation, as explained in paragraph 15.4.5.

15.4.6 Table 15.11 shows that the long-term magnitude of change for the sample receptors considered varies between negligible and minor.

15.4.7 For Broompark Cottage, as discussed above in paragraph 15.4.5, a +5 dB correction has been applied to allow for the effects of vegetation removal, resulting in a minor adverse noise impact. Proposals to reduce this potential impact are explained in Section 15.5 (Mitigation).

Table 15.12: Comparison of Predicted Night-time Noise Levels for Do-Minimum (2019) and Do-Something Scenario (2034)

Ref	Receptor Name	DM 2019 Lnight,outside (dB)	DS 2034 Lnight,outside (dB)	Noise Level Change (dB)	Magnitude of Change
1	6 Kirkhill Drive	42.3	43.5	+2.2	Negligible
2	32 Westfield	54.3	54.6	+0.3	Negligible
3	Kirkhill House	53.1	53.0	-0.1	Negligible
4	Ordie View	53.4	53.8	+0.4	Negligible
5	Newmill	53.8	55.0	+1.2	Negligible
6	1 Lower Gauls	52.8	51.9	-0.9	Negligible
7	57 Innewan Gardens	56.4	52.1	-4.3	Minor (beneficial)
8	Broompark Cottage	51.6	54.7	+3.1	Minor (adverse)
9	Milton Cottage	38.1	39.6	+1.5	Negligible
10	Holm Cottage	58.5	57.1	-1.4	Negligible

* Note that this includes a correction of +5 dB in the DS scenario to allow for removal of intervening vegetation, as explained in paragraph 15.4.5.

15.4.8 As in the case of the long-term magnitude of change for the daytime, the magnitude of change for the night-time varies between negligible and minor, refer to Table 15.12.

15.4.9 Table 15.13 compares day-time noise levels at each designated area receptor location in the DM in 2019 against the DS scenario in 2019 (short-term impact), whilst Table 15.14 compares noise levels at each designated area receptor location in the DM in 2019 against the DS scenario in 2034 (long-term impact).

Table 15.13: Comparison of Predicted Day-time Noise Levels for Do-Minimum and Do-Something Scenarios (2019) for Designated Areas

Ref	Receptor Name	DM 2019 LA10,18h (dB)	DS 2019 LA10,18h (dB)	Noise Level Change (dB)	Magnitude of Change
11	Court Hill Tumulus	54.2	51.5	-2.7	Minor (beneficial)
12	Battleby House Gardens	49.1	49.3	+0.2	Negligible
13	Cairnleith Moss SSSI	49.9	47.3	-2.6	Minor (beneficial)

15.4.10 Table 15.13 shows that at two of the designated areas there are minor noise benefits with a negligible noise increase at the third.

Table 15.14: Comparison of Predicted Day-time Noise Levels for Do-Minimum (2019) and Do-Something Scenario (2034) for Designated Areas

Ref	Receptor Name	DM 2019, LA10,18h (dB)	DS 2034, LA10,18h (dB)	Noise Level Change (dB)	Magnitude of Change
11	Court Hill Tumulus	54.2	52.4	-1.8	Negligible
12	Battleby House Gardens	49.1	48.0	-0.9	Negligible
13	Cairnleith Moss SSSI	49.9	48.2	-1.7	Negligible

15.4.11 Table 15.14 shows that there are negligible noise benefits for the three designated areas considered.

Summary Tables

15.4.12 Tables 15.15, 15.16 and 15.17 provide the potential noise level change comparisons in accordance with the reporting requirements for a Detailed Assessment within HD 213/11. For these summary tables, changes in daytime noise levels are in terms of $L_{A10,18hr}$, whereas changes in night-time noise levels are in terms of a $L_{night,outside}$.

Table 15.15: Detailed Assessment Summary Table: Short-term Traffic Noise Reporting Table – Do-Minimum (2019) against Do-Something (2019)

Scenario/Comparison: DM 2019 against DS 2019			
Change in Noise Level (dB)		**Daytime**	
		No of dwellings	**No of other sensitive receptors**
Increase in noise level	0.1 – 0.9	523	9
	1.0 – 2.9	4	0
	3.0 – 4.9	0	0
	5+	0	0
No Change	0	66	1
Decrease in noise level	0.1 – 0.9	18	0
	1.0 – 2.9	332	7
	3.0 – 4.9	85	2
	5+	22	1

15.4.13 Table 15.15 shows that no receptor will experience adverse short-term moderate or major noise increases. Three properties are predicted to experience adverse minor noise impacts with 523 dwellings and nine other sensitive receptors experiencing negligible increases in noise levels. It should be noted that of the four properties highlighted as experiencing minor adverse impacts, three are predicted to be subject to an increase in noise level in the short-term of 1.0 dB $L_{A10,18hr}$, thus falling on the cusp of the negligible/minor magnitude of impact threshold. The remaining property (Broompark Cottage) is discussed in paragraphs 15.4.5 and 15.4.7 above.

15.4.14 A total of 85 dwellings and two other sensitive receptors will experience moderate noise benefits with 22 dwellings and one other sensitive receptor experiencing major noise benefits in the short-term with the proposed scheme in place.

15.4.15 In terms of perceptible changes, i.e. noise level change of 1 dB $L_{A10,18hr}$ or more, far more dwellings and other sensitive receptors experience decreases in noise level than increases in noise level (439 versus four). This is primarily as a result of the introduction of LNRS as part of the proposed scheme. However, the alignment of the proposed scheme would also result in the increase the distance of the noise source from a number of receptors (see paragraph 15.4.4 as an example).

Table 15.16: Detailed Assessment Summary Table: Long-term Traffic Noise Reporting Table – Do-Minimum (2019) against Do-Minimum (2034)

Scenario/Comparison: DM 2019 against DM 2034				
Change in Noise Level (dB)		**Daytime**		**Night-time**
		No of dwellings	**No of other sensitive receptors**	**No of dwellings**
Increase in noise level	0.1 – 2.9	110	2	2
	3.0 – 4.9	0	0	0
	5.0 – 9.9	0	0	0
	10+	0	0	0
No Change	0	46	0	0
Decrease in noise level	0.1 – 2.9	484	8	14
	3.0 – 4.9	410	10	0
	5.0 – 9.9	0	0	0
	10+	0	0	0

15.4.16 Table 15.16 shows the benefit of LNRS which it is assumed will be in place by the design year if the proposed scheme does not proceed. A total of 410 dwellings and 10 other sensitive receptors

are predicted to experience daytime minor noise benefits without the proposed scheme. A total of 110 dwellings and two other sensitive receptors would experience negligible daytime adverse noise impacts; however, no perceptible adverse changes (i.e. 3 dB $L_{A10,18hr}$ or more) are predicted.

15.4.17 Two dwellings would experience negligible adverse night-time noise impacts, whilst 14 dwellings would experience negligible night-time noise benefits.

Table 15.17: Detailed Assessment Summary Table: Long-term Traffic Noise Reporting Table – Do-Minimum (2019) against Do-Something (2034)

Scenario/Comparison: DM 2019 against DS 2034				
Change in Noise Level (dB)		**Daytime**		**Night-time**
		No of dwellings	**No of other sensitive receptors**	**No of dwellings**
Increase in noise level	0.1 – 2.9	258	3	5
	3.0 – 4.9	1	0	0
	5.0 – 9.9	0	0	0
	10+	0	0	0
No Change	0	13	1	0
Decrease in noise level	0.1 – 2.9	731	15	4
	3.0 – 4.9	37	1	5
	5.0 – 9.9	10	1	5
	10+	0	0	0

15.4.18 Table 15.17 shows that a total of 47 dwellings and two other sensitive receptors are predicted to experience long-term perceptible daytime noise benefits with the proposed scheme.

15.4.19 One dwelling (Broompark Cottage) is predicted to experience a perceptible noise increase. The reasons for this increase are discussed previously in paragraphs 15.4.5 and 15.4.7, and proposals to reduce this potential impact are explained in Section 15.5 (Mitigation).

15.4.20 Four dwellings are predicted to experience negligible night-time noise impacts. A total of 10 dwellings are predicted to experience perceptible night-time noise benefits with the proposed scheme.

15.4.21 In terms of perceptible changes in noise level, there are more dwellings and other sensitive receptors experiencing decreases in noise level than dwellings and other sensitive receptors with increases in noise level (49 versus one).

Noise Change Contours

15.4.22 The noise changes in the short and long-term with the proposed scheme in place are highlighted in Figures 15.4 and 15.5, which show the potential noise change contours in terms of the magnitude of impacts categories provided in HD 213/11.

15.4.23 It should be noted that the noise change contours on the figures in the vicinity of Broompark Cottage do not take into account the proposed vegetation removal, as the noise modelling software does not allow for this. However, the software does take into account a proposed 2m timber noise fence (see Section 15.5: Mitigation).

15.4.24 The noise changes in the long-term without the proposed scheme in place are highlighted in Figure 15.6, which shows the potential noise change contours in terms of the magnitude of impacts. The contours demonstrate the benefits of the use of LNRS.

Qualitative Assessment

15.4.25 On opening with the proposed scheme in place, sensitive locations within 600m to 1km are not anticipated to experience perceptible increases in noise levels compared to the Do-Minimum situation. For the majority of sensitive receptors within 600m to 1km there is likely to be a decrease in noise level on opening with the proposed scheme in place compared to the Do-Minimum situation. However, some receptors to the south of the proposed scheme may experience an adverse negligible noise impact on opening.

15.4.26 In the design year, with the proposed scheme in place, no sensitive locations within 600m to 1km are anticipated to experience perceptible increases in noise level compared to the Do-Minimum situation in 2019. For the majority of sensitive receptors there are likely to be noise benefits. However, it is considered that adverse noise impacts and noise benefits are likely to be negligible.

Noise Nuisance

15.4.27 Calculations of the change in noise nuisance have been undertaken for all dwellings within the HD 213/11 calculation area for the assessment of permanent traffic noise impacts. Table 15.18 below provides the results of the noise nuisance assessment undertaken.

Table 15.18: Noise Nuisance Assessment

Scenario/Comparison: Noise Nuisance Assessment			
Change in Nuisance Level		**Do-Minimum**	**Do-Something**
		No of dwellings	**No of dwellings**
Increase in nuisance level	<10%	110	38
	10% - <20%	0	508
	20% - <30%	0	19
	30% - <40%	0	0
	>40%	0	0
No Change	0	46	39
Decrease in nuisance level	<10%	894	434
	10% - <20%	0	12
	20% - <30%	0	0
	30% - <40%	0	0
	>40%	0	0

15.4.28 Table 15.18 shows that in the DM situation the vast majority of dwellings would experience a <10% change in nuisance level, with most properties experiencing a decrease in nuisance level.

15.4.29 With the proposed scheme in place 565 dwellings would experience an increase in nuisance level between <10 and <30%. Whereas 446 dwellings would experience a decrease in nuisance level between <10 and <20%. Although a number of dwellings are predicted to experience increases in nuisance levels greater than 10% under the DS scenario, it should be noted that the changes predicted in the short-term represent a larger percentage increase in nuisance levels, e.g. a 0.9 dB increase in noise level is equivalent to 20% increase in the noise nuisance level in the short-term. In other words, as noted in Annex 6 of HD 213/11, people are more sensitive to abrupt changes in traffic noise than gradual changes. Therefore, the sensitivity to new schemes is an effect that can last for a number of years, when in fact gradual changes in noise levels can represent higher overall noise increases.

Vibration Nuisance

15.4.30 Changes in vibration nuisance have been calculated for all dwellings within 40m of roads that are within the HD 213/11 calculation area. Table 15.19 provides the results of the vibration nuisance assessment undertaken.

Table 15.19: Vibration Nuisance Assessment

Scenario/Comparison: Vibration Nuisance Assessment			
Change in Nuisance Level		**Do-Minimum**	**Do-Something**
		No of dwellings	**No of dwellings**
Increase in nuisance level	<10%	52	57
	10% - <20%	0	0
	20% - <30%	0	0
	30% - <40%	0	0
	>40%	0	0
No Change	0	15	12
Decrease in nuisance level	<10%	58	42
	10% - <20%	0	14
	20% - <30%	0	0
	30% - <40%	0	0
	>40%	0	0

15.4.31 Table 15.19 shows that in the DM situation all dwellings would experience a <10% change in nuisance level. A total of 52 dwellings would experience an increase in nuisance level with 58 dwellings experiencing a decrease in nuisance level.

15.4.32 With the proposed scheme in place 57 dwellings would experience an increase in nuisance level of <10% with 42 dwellings experiencing a <10% decrease and 14 dwellings experiencing a 10 to <20% decrease in nuisance level. Overall, in terms of vibration nuisance, the proposed scheme can be considered largely neutral.

Construction Impacts

15.4.33 There are a number of receptors in the vicinity of the proposed scheme and the associated construction works. There are a number of activities associated with the construction works that may result in an impact on nearby receptors. This assessment has been undertaken with reference to available information on likely construction works and programming, as set out in Appendix A4.1 (Construction Information). Given the level of information currently available the noise and vibration assessment should only be considered indicative.

15.4.34 For the purposes of this assessment it is assumed that the majority of construction works will normally take place between 07:30 - 18:00 Monday to Friday and 08:00 to 13:00 on Saturday. As noted in Appendix A4.1 (Construction Information), there may be exceptions to these hours, such as for oversize deliveries or works requiring low traffic flows on existing carriageways.

15.4.35 Appendix A4.1 (Construction Information) indicates that the construction activities are anticipated to be divided into three phases. Phase 2 is the reconfiguration of traffic management in advance of Phase 3. Details of the plant assumed can be found in Appendix A15.4 (Assumed Construction Plant and Equipment).

15.4.36 Table 15.20 details the various construction scenarios considered.

Table 15.20: Construction Scenarios

Scenario	Construction Activity
1	Phase 1 Earthworks, Structures and 4 haul routes
2	Phase 1 Drainage, Structures and 4 haul routes
3	Phase 1 Formation, Structures and 4 haul routes
4	Phase 1 Paving/Surfacing, Structures and 4 haul routes
5	Phase 3 Earthworks, Structures and 4 haul routes

Scenario	Construction Activity
6	Phase 3 Drainage, Structures and 4 haul routes
7	Phase 3 Formation, Structures and 4 haul routes
8	Phase 3 Paving/Surfacing, Structures and 4 haul routes

15.4.37 Using the indicative construction activities and plant contained in Appendix A15.4 (Assumed Construction Plant and Equipment), construction noise levels have been predicted at representative receptors. These receptors are those located closest to the proposed construction works.

15.4.38 The noise predictions take into account plant specification details, plant numbers, expected daily operating times of each plant, distance of plant to the receptors, and topographical information between the plant and the receptors. The noise model assumes typical locations for activities working simultaneously.

15.4.39 Appendix A15.4 (Assumed Construction Plant and Equipment) provides predicted noise levels for the various construction scenarios at each of the representative receptors. Predicted construction noise levels are compared against baseline ambient noise levels (LAeq,T). The ambient noise levels are derived from the day-time predicted $L_{A10,18hr}$ road traffic noise levels using the TRL report *'Converting the UK traffic noise index $L_{A10,18h}$ to EU noise indices for noise mapping'*. It can be observed from Appendix A15.4 (Assumed Construction Plant and Equipment) that potentially significant impacts, as set out by BS 5228, are predicted at approximately 20 properties.

15.4.40 The earthworking and surfacing scenarios (Scenarios 1, 3, 4 and 8) are responsible for the majority of the potentially significant noise impacts. Given the transient nature of such works, the total duration of significant noise impacts is likely to be relatively short (i.e. less than a week for the earthworks and a matter of days for the surfacing works).

Construction Vibration Impacts

15.4.41 Construction activities proposed which have the potential to give rise to largest levels of vibration at receptors would be associated with vibratory earthwork compacting works. Such works would be associated with the construction of structures.

15.4.42 Predicted vibration levels from vibration compaction plant are presented in Table 15.21. Predictions are provided for representative sensitive receptors nearest to compaction activities. In addition, predictions assume the soil compaction plant at the closest likely location to the sensitive receptors.

15.4.43 Annex E to BS 5228: Part 2: Vibration, provides guidance on the prediction of ground-borne vibration for compaction activities. It is assumed that the vibratory rollers will have two vibrating drums, with a drum width of 1m and a maximum amplitude of drum vibration of 0.5mm. Scaling factors of 50%, 33.3% and 5% are detailed related to the probability of the predicted value being exceeded. The predicted vibration levels detailed in Table 15.21 assume a 5% probability of being exceeded as a worst-case approach.

Table 15.21: Predicted Ground-borne Vibration from Vibratory Soil Compaction Plant

Receptor	Nearest distance to vibratory soil compaction (m)	Predicted ground-borne vibration level mm/s (ppv)	
		Steady State	Start up/Run down
Broomspark Cottage	27	0.9	1.2
Newmill	3	17.2	14.7
Glenordie	4	12.3	10.9
Ordie View	24	1.1	1.3

15.4.44 Based upon the prediction methodology contained within BS 5228: Part 2: Vibration, the ground-borne vibration level at the closest residential properties to the works would be 17.2 mm/s ppv. In accordance with the Standard, the probability of vibration exceeding this level would be 5%, and therefore likely that levels would fall below this.

15.4.45 A vibration level of 17.2 mm/s ppv has the potential to cause cosmetic damage based on the guidance detailed in BS 5228 Part 2 vibration. In accordance with the Standard, the probability of vibration exceeding this level would be 5%, and therefore it is likely that vibration levels would fall below this. For comparison it shall be noted that a vibration level of 4.7 mm/s ppv is predicted when using a scaling factor representing a 50% probability of exceedance. This indicates the level of uncertainty with regard to the vibration predictions.

15.4.46 As vibration passes through the foundations of a building the level will alter as the vibration is transferred (referred to as the 'transfer function'). Such transfer functions will differ between properties; however, a general reduction in vibration from free-field to foundations of 60% is often applied, as recommended by guidance provided in Measurement & Assessment of Groundborne Noise & Vibration (ANC, 2001). However, for the purpose of this assessment no reduction has been assumed and is therefore a conservative assessment approach considering the worst-case.

15.4.47 Despite the uncertainty with the vibration predictions highlighted above, it is highly likely that those properties contained within Table 15.21 would be subject to perceptible levels of vibration, which in accordance to BS 5228 could lead to complaint from local residents. However, the soil compaction works are transient in nature; therefore the worst-case vibration levels shown in Table 15.21 would be experienced for short duration, e.g. two to three days, when the compaction works occur at the nearest position to the residents. After this time, vibration levels will significantly reduce due to predicted levels of vibration being heavily influenced by distance of works to receptor.

15.5 Mitigation

Operational

15.5.1 HD 213/11 advises that a short-term increase of 1 dB $L_{A10,18hr}$ or more or a long-term increase of 3 dB $L_{A10,18hr}$ or more should be mitigated where possible. This chapter identifies that without mitigation measures, Broompark Cottage would be subject to noise increases that meet both these criteria, due to the necessary removal of an area of vegetation due to the proposed works.

15.5.2 A noise barrier is proposed between Broompark Cottage and the A9 in order to reduce the potential noise impact to a residual impact of negligible significance. It is anticipated that this can be achieved with a timber acoustic fence 2m high running approximately 4m back from the retaining wall and on top of adjacent earthwork, for a total length of approximately 130m. The height, distance from the retaining wall, and, total length of this noise barrier may be adjusted during detailed design subject to achieving a negligible residual impact (**Mitigation Item NV1**). The location of the noise fence is also shown on the landscape mitigation drawings (Figure 11.2).

Construction

15.5.3 Construction works are predicted to result in potentially significant short-term noise and vibration levels at a number of properties. It is anticipated that these can be managed through application of appropriate mitigation measures related to best practice. As noted in Section 15.3 (Baseline Conditions), the A9 Dualling Programme SEA also recommends that projects '*schedule and control the timing of construction activities to minimise noise impacts on sensitive receptors*'.

15.5.4 All work would be undertaken to the guidance detailed in BS 5228: 2009 - Code of Practice for noise and vibration control on construction and open sites, Part 1: Noise and Part 2: Vibration. It is anticipated that the following mitigation measures should be employed on site to ensure that noise and vibration levels are attenuated as far as possible (**Mitigation Item NV2**):

- the use of 'best practicable means' during all construction activities, as defined in Section 72 of the Control of Pollution Act to minimise noise (including vibration) during construction;
- switching off plant and equipment when it is not in use for longer periods of time;
- establish agreement with the local authority on appropriate controls for undertaking significantly noisy works or vibration-causing operations close to receptors;
- programming works so that the requirement for working outside normal working hours is minimised (taking into account the highway authority's statutory duties under the Traffic Management Act 2004);
- use of low noise emission plant where possible;
- piling will be bored to protect sensitive sites:
- the use of temporary noise screens around particularly noisy activities;
- regular plant maintenance; and
- monitoring of vibration when compaction activities are near to properties.

15.5.5 It is anticipated that a scheme of noise and vibration monitoring would be agreed with the Environment Services Department of Perth & Kinross Council, and noise and vibration limits be contained within any Construction Environmental Management Plan agreed. The Contractor will be required to develop and implement a Noise and Vibration Management Plan to meet these requirements (**Mitigation Item NV3**).

15.5.6 BS 5228 advises that effective community engagement providing prior notification of particularly noisy or vibratory activities can reduce perceived nuisance/disturbance experienced by local residents. The contractor will be required to develop a communications strategy to manage this process, including establishing an enquiries and complaints procedure (to include a contact telephone number and email address) (**Mitigation Item NV4**).

15.6 Residual Impacts

Operational

15.6.1 Table 15.22 shows the resulting residual noise levels at Broompark Cottage with the introduction of the proposed noise fence. Predicted noise levels are shown in the short-term and long-term along with a residual negligible magnitude of change, which is not considered perceptible.

Table 15.22: Comparison of Predicted Day-time Noise Levels for Do-Minimum (2019) and Do-Something Scenario (2034)

Year of Assessment	DM 2019 LA10,18h (dB)	DS LA10,18h (dB)	Noise Level Change (dB)	Magnitude of Change
2019	64.0	64.1	+0.1	Negligible
2034	64.0	65.0	+1.0	Negligible
2034 (Night)	51.6	52.2	+0.6	Negligible

Construction

15.6.2 This chapter identifies that a number of receptors are likely to be subject to adverse noise and vibration impacts associated with the proposed construction works. Mitigation measures are proposed to minimise impacts as far as is reasonably practicable. Whilst it is considered that significant residual impacts would be minimised, the fact remains that construction activities inherently give rise to high levels of noise and vibration and adverse impacts are likely where sensitive receptors are located nearby.

15.6.3 Given that the much of the construction work is transient in nature, the duration of impacts for the majority of receptors will be restricted to periods where the works are closest. During such times, occupants are likely to be affected; however, through a proactive approach by the contractor to community liaison, the implementation of an appropriate mitigation strategy and through using a best practice approach to the works, impacts will be minimised.

15.7 References

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