45 Traffic Noise and Vibration

This chapter considers likely noise and vibration impacts due to road traffic for receptors in the vicinity of the Fastlink.

A total of 411 residential properties and 38 sensitive receptors/areas were identified within 500m of the Fastlink section of the proposed scheme. Noise modelling was undertaken for all of the 179 properties within 300m and 21 were selected as sample receptors to obtain a geographical representation of the route, to represent the noise environment at other non-sample receptors nearby and to illustrate the predicted noise in the Year of Opening and the Design Year, both with and without the proposed scheme.

Where possible, noise mitigation is proposed for potential impacts of Moderate or worse significance with a noise level of over 59.5dB $L_{A10(18hr)}$. Mitigation includes incorporated elements of the road design such as embankments and low noise road surfacing, plus acoustic screens to provide noise attenuation for specific receptors.

At ground floor for both the Year of Opening and the Design Year, with proposed mitigation, an estimated 38 properties within 300m would experience an increase in noise level of at least 1dB and 9 would experience a decrease of at least 1dB. At an estimated 41 properties, the change in the noise level would result in an increase in the percentage of people bothered by noise and 137 properties where the change would result in a decrease.

At ground floor, with proposed mitigation, it is predicted that no properties in the Year of Opening and 1 property in the Design Year would experience residual impacts that exceed the desired mitigation threshold. The results also indicate that no properties qualify for noise insulation at ground floor.

At first floor for both the Year of Opening and the Design Year, with proposed mitigation, an estimated 38 properties within 300m would experience an increase in noise level of at least 1dB and 9 would experience a decrease of at least 1dB. At first floor there are an estimated 41 properties where the change in the noise level would result in people being more bothered by noise and 138 properties where the change would result in people being less bothered. The results also indicate that 2 properties at first floor may qualify for noise insulation

There is 1 residential building within 40m that would exceed the DMRB 58 dB $L_{A10,18h}$ lower threshold for vibration assessment in the Design Year. However, vibration annoyance is not considered to be a significant issue for this scheme.

45.1 Introduction

45.1.1 This chapter provides an assessment of the noise and vibration impacts due to road traffic for receptors in the vicinity of the Fastlink section of the proposed scheme.

Noise

45.1.2 The World Health Organisation (WHO, 1999) has defined noise as unwanted sound, and sound is measured in terms of decibels (dB). Whilst the audible range of hearing extends from 20 Hertz (Hz) to 20,000Hz, human hearing is not equally sensitive to all frequencies. Consequently, the A-weighting is used to simulate the response of the human ear and environmental noise is generally measured in terms of dB(A).

45.1.3 Generally, noise fluctuates over time and to compare different types of time-varying sound it is therefore necessary to obtain representative levels. For environmental noise this is commonly the equivalent continuous sound pressure level, the L_{eq}. It is also possible to represent time-varying noise by means of statistical parameters such as analysis of the distributions of sound levels. For example, L_{90}, is the level exceeded for 90% of the measurement time and L_{10} is the level exceeded for 10% of the measurement time period. The index adopted by the Government to assess traffic noise is the $L_{A10(18hr)}$, which is the arithmetic mean of the noise levels exceeded for 10% of the time in each of the one hour periods between 06:00h and midnight.

45.1.4 For the purposes of assessment noise impacts are considered as increases or decreases in road traffic or construction noise relative to the noise levels within the area potentially affected without the scheme in place. When considering noise levels it may be of assistance to note that doubling or halving of the otherwise similar traffic flow is equivalent to a change of approximately 3dB(A), and a subjective impression of a doubling of loudness generally corresponds to a 10dB(A) sound level increase. As noise is assessed as a logarithmic ratio of pressure levels (i.e. decibels), it is sometimes helpful to consider the relationship between the subjective evaluation of noise and the actual objective levels, and examples are therefore provided in Table 45.1.

Table 45.1 – Typical Noise Levels and Subjective Evaluation

Noise Level dB(A)	Description
120	Threshold of pain
95	Pneumatic drill (unsilenced); 7m distance
83	Heavy diesel lorry (40 km/h at 7 metres distance)
81	Modern Twin-engined Jet (at take-off at 152 metres distance)
70	Passenger Car (60 km/h at 7 metres distance)
60	Office Environment
50	Ordinary Conversation
40	Library
35	Quiet Bedroom
0	Threshold of hearing

45.1.5 When considering noise from traffic, the main sources of noise can be separated into two 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 contributes a significant proportion of low frequency noise and is particularly apparent from heavy goods vehicles (HGVs) when accelerating, braking or changing gear. The second noise source component is generated from the interaction of tires with the road surface; this 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.

45.1.6 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 by the residents of a property, and these can be separated into two categories. First are factors that affect the noise emissions at source, such as volume and speed of traffic, the composition of the traffic (i.e. the percentage of HGVs), and the gradient and surface characteristics of the carriageway. Second 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.

Vibration

45.1.7 Traffic-induced vibration is a low frequency disturbance which can be transmitted through the air or ground. Vibration can be measured in terms of peak particle velocities, or PPVs (i.e., the maximum speed of movement of a point in the ground during the passage of a vibration). For traffic vibration generally a PPV of 0.2mm/s measured on a floor in the vertical direction is imperceptible; at about 0.5mm/s it is perceptible and may become disturbing or annoying at higher levels. Air-borne vibration from traffic is produced by the drive-train of the vehicle; the engines and exhausts, whereas ground-borne vibration is produced by the interaction between rolling wheels and the road surface.

45.1.8 There are two effects of traffic vibration that need to be considered; the effects on buildings, and the disturbance caused to occupiers of properties. However, extensive research has been carried out on a range of buildings of various ages and types, and no evidence has been found to support the theory that traffic-induced, ground-borne vibration is a source of significant damage to buildings (Watts, 1990). As such, ground-borne vibration is not assessed in this chapter. Ground-borne vibration is much less likely to be the cause of disturbance to occupiers than air-borne vibration (Baughan and Martin, 1981, Watts, 1984). Although there is no evidence that traffic-induced air-borne vibration can cause even minor damage to buildings, it can be a source of annoyance to local people, causing vibrations of flexible elements within properties close to the carriageway (e.g. doors, windows and occasionally floors). This chapter therefore addresses the issue of DRMB defined nuisance at properties caused by air-borne vibration.

45.2 Approach and Methods

45.2.1 This chapter describes the impacts that would be expected on properties in the vicinity of the Fastlink section during operation of the proposed scheme, including changes to noise and vibration levels, and perceived noise and vibration DMRB defined nuisance. Noise and vibration impacts due to construction are addressed separately in Chapter 48 (Disruption due to Construction).

45.2.2 The assessment of noise is made in terms of the difference between the level of noise that would be likely to be experienced with the proposed scheme (the Do-Something scenario) and without the proposed scheme (the Do-Minimum scenario) for both the Year of Opening and the Design Year (15 years later). The existing, or ambient, noise in the 'base' year of 2005 is also reported at sample properties. The use of 2005 as base year is consistent with the Air Quality assessment (Chapter 44) and available traffic data. Paragraphs 5.3.1-5.3.2 of Chapter 5 (Overview of Assessment Process) provides a description of the traffic predictions on which this assessment is based.

Legislation and Guidance

45.2.3 This assessment has been carried out with reference to the following documents:

- Design Manual for Roads and Bridges (DMRB) (The Highways Agency et al., 1993);
- Calculation of Road Traffic Noise (CRTN) (Department of Transport, 1988);
- The Noise Insulation (Scotland) Regulations 1975 (NISR);
- Memorandum on the Noise Insulation (Scotland) Regulations 1975
- World Health Organisation (WHO), Guidelines for Community Noise, 1999 and
- Scot-TAG: Scottish Transport Appraisal Guidance (STAG)

45.2.4 The definitions of "Core Study Area" and "Wider Area" are provided in paragraph 45.2.5. In accordance with the requirements of DMRB Volume 11, Section 3, Part 7, a Stage 3 assessment has been carried out by:

- identifying sample noise sensitive locations and calculating the ambient and proposed noise levels to determine possible noise changes due to the scheme. Properties within the Core Study Area, (including side roads) were assessed using a three dimensional model;
- identifying properties predicted to experience an increase of 25%, or a decreases by 20% in traffic flow (equivalent to a 1dB change) outwith the Core Study Area were also assessed as part of the Wider Area assessment reported in Chapter 54 (Cumulative Impact Assessment);
- identifying appropriate mitigation methods to reduce the impact of any adverse effects within 300m either side of the road centrelines (see mitigation criteria as detailed in paragraphs 45.2.34 – 45.2.3);

- undertaking a noise nuisance assessment for properties within the Core Study Area which experience a noise change of 1dB(A) or more;
- considering traffic-induced vibration; and
- estimating the number of properties likely to be eligible in terms of NISR.

Study Area

45.2.5 The operational noise has been considered within a 500m 'Core Study Area' extending to each side of the proposed scheme centreline, and a 'Wider Study Area' encompassing any predicted indirect changes to noise levels (by +25%, or -20%) as a consequence of changes to traffic flows on the existing road network. The Core Study Area has been extended from the more commonly accepted 300m because of the rural nature of some of the proposed scheme. It is however acknowledged that DMRB advises that beyond 300m the varying effects of wind and temperature render forecasting difficult in most circumstances and the area between 300m and 500m from the proposed scheme is therefore included to provide additional comparative information. The Core Study area is indicated on Figure 45.1. The Wider Study area is necessary because the introduction of an entirely new route may change traffic flows on roads some distance from the proposed scheme. Hence the proposed scheme may affect the noise levels, and the level of perceived noise nuisance, experienced by some local residents already exposed to road traffic noise.

45.2.6 As explained in Chapter 1 (Introduction), the noise impacts of the proposed scheme have been considered within three separate study areas. This chapter is therefore limited to the consideration of noise and vibration impacts of the proposed scheme on properties located within the Fastlink Core Study Area as indicated on Figures 45.1a-f and 45.3a-f for ground and first floor unmitigated levels respectively. Any properties located to the north of the dividing line at Cleanhill Junction, as shown on Figures 45.1a-f and 45.3a-f are considered in Chapter 30 (Southern Leg: Traffic Noise and Vibration). Impacts of traffic utilising the full proposed scheme (i.e. not the Fastlink traffic in isolation) are considered for each receptor.

45.2.7 Within the Core Study Area indicated on Figures 45.1a-f and 45.3a-f, the traffic noise assessment has classified locations according to their measured ambient levels, in bands of: below 50 dB(A), 50 to <60 dB(A), 60 to <70 dB(A) and ≥70 dB(A). For each band, the number of properties and other receptors subject to the following increases or decreases have been assessed: 1 to <3 dB(A), 3 to <5 dB(A), 5 to <10 dB(A), 10 to 15 dB(A) and over 15 dB(A).

45.2.8 A 'Wider Study Area' was also assessed and is reported separately in Chapter 54 (Cumulative Impacts). The Wider Study Area assessment considers the indirect changes to noise levels as a result of altered traffic flows on the existing wider road network (caused by operation of the proposed scheme). This indirect impact on noise levels and the level of perceived noise nuisance experienced by local residents already exposed to road traffic noise may therefore occur beyond the Core Study Areas of the Northern Leg, Southern Leg and Fastlink.

Impact Assessment Criteria

45.2.9 The assessment of the significance of noise impacts was based on the sensitivity of noise receptors and the magnitude of impact in terms of predicted noise levels and extent of noise change.

45.2.10 The significance of impact was assessed by comparing future years scenarios, (i.e. Year of Opening and Design Year, 15 years after opening, with and without the scheme). The difference in noise levels, together with the sensitivity of the receptors, determines the significance of impact as explained previously in this section.

Sensitivity

45.2.11 The criteria used for classification of the sensitivity of receptors to noise resulting from the proposed scheme are defined in Table 45.2.

Table 45.2 – Criteria used to Define Noise Sensitive Receptors

Sensitivity	Description	Examples of Receptors
High	Receptors where people or operations are particularly susceptible to noise	Residential Quiet outdoor areas used for recreation Conference facilities Auditoria/studios Schools in daytime Hospitals/residential care homes
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance	Offices Restaurants
Low	Receptors where distraction or disturbance from noise is minimal	Residences and other buildings not occupied during working hours. Factories and working environments with existing high noise levels.

Impact Magnitude

45.2.12 When considering two sounds of similar acoustic properties, i.e. similar spectral and temporal characteristics, a change of more than 3 dB(A) is regarded as being just perceptible to the human ear. The magnitude of impact can therefore be based on this acoustic 'rule of thumb', supplemented with the evidence contained within DMRB Vol. 11, Section 3, Part 7, Chapter 3, and Paragraph 3.5. The latter highlights that 'people are more sensitive to abrupt changes in traffic noise associated with new road schemes than would be predicted from the steady state evidence. In the period following a change in traffic flow, people may find benefits or disbenefits when the noise changes are as small as 1 dB(A)'.

45.2.13 The magnitude of impact has been assessed by comparison between the increase or decrease in noise levels between the future year 'Do-minimum' and 'Do-something' (Preferred route scheme scenarios, i.e., Year of Opening and Design Year). The magnitude of impact is defined as shown in Table 45.3.

Table 45.3 – Magnitude of Impacts due to Changes in Road Traffic Noise

Change in Noise Level	Magnitude of Impact
5 dB(A) and greater	High adverse
3 to < 5 dB(A)	Medium adverse
1 to < 3 dB(A)	Low adverse
0 to < 1 dB(A)	Negligible adverse
0 dB(A)	No impact
0 to <-1 dB(A)	Negligible beneficial
-1 to < -3 dB(A)	Low beneficial
-3 to < -5 dB(A)	Medium beneficial
-5 dB(A) and greater	High beneficial

Significance of Impact

45.2.14 The significance of noise impacts was determined according to the relationship between magnitude and sensitivity, as shown in Table 45.4.

Table 45.4 – Significance of Noise Impacts

Magnitude	Sensitivity		
	Low	Medium	High
High	Moderate	Moderate/Substantial	Substantial
Medium	Slight/Moderate	Moderate	Moderate/Substantial
Low	Negligible/Slight	Slight/Moderate	Moderate
Negligible	Negligible	Negligible/Slight	Slight

Assessment Methods

45.2.15 Sample properties within the scheme study area were assessed in accordance with DMRB. However, for discussion purposes some properties and locations were selected as representative on the basis of one or more of the following principles:

- where it has been considered that buildings may qualify for sound insulation;
- where it has been anticipated that properties will experience significant changes in noise level; and
- where properties are representative of surrounding buildings and the effects of noise will be similar.

Baseline (Ambient) Noise Monitoring

45.2.16 With regard to the determination of existing (ambient) noise levels, DMRB advises that there are three basic types of ambient noise situations which can occur:

(i) where the ambient noise is dominated by traffic noise;

(ii) where the ambient noise is comprised of a combination of several undefined sources, such as might be encountered in low noise sites in rural settings; or

(iii) where the ambient noise is dominated by noise from non-road traffic sources, such as

aircraft or trains.

45.2.17 For condition (i) the ambient noise should be measured using the L_{A10} noise metric. For condition (ii) it is advised that the L_{A10} noise metric may be inappropriate and suggests that, while the L_{Aeq} parameter could be considered, the L_{A90} noise metric is a more suitable alternative. For condition (iii) DMRB recommends the use of the L_{A90} noise metric. Where the existing noise climate is determined by road traffic noise, the existing ambient levels can also be predicted using the methodology set out in the 1988 Department of Transport publication 'Calculation of Road Traffic Noise' (CRTN).

45.2.18 Ambient noise monitoring was undertaken during June, July, August, and September 2006 and also during March 2007 at representative locations along the route of the proposed scheme. All instrumentation was calibrated before, and after, each measurement, and there was no significant shift in the calibration level recorded. A summary of the results together with the instrumentation used is contained within 45.1. The site notes are also included as Appendix A45.2.

45.2.19 The sample monitoring locations are listed below and results shown on Figures 45.1a-f and 45.3a-f. The properties were selected on the basis of obtaining a geographical representation of the route and to represent the noise environment at other non-sample receptors nearby:

- Blaikiewell Steading, Aberdeen, AB1 5YX (Figure 45.1f)
- Bayview Ury, Stonehaven, AB3 3QA (Figure 45.1a)
- Megray Farm Steading, Stonehaven, AB3 3QA (Figure 45.1a)
- 3 New Mains Of Ury Cottages, Stonehaven, AB3 3QA (Figure 45.1a)
- Kempstone Hill, Stonehaven, AB3 3QE (Figure 45.1b)
- Ardchoille, Stonehaven, AB3 3QB (Figure 45.1b)
- Foresters Croft, Stonehaven, AB3 3QA (Figure 45.1a)
- Elrick Cottar House, Stonehaven, AB3 3RU (Figure 45.1c)
- Strathgyle Cottage, Stonehaven, AB3 3SN (Figure 45.1c)
- Broomhill Cottage, Stonehaven, AB3 3SN (Figure 45.1c)
- Curlews Cottage, Stonehaven, AB3 3RU (Figure 45.1c)
- Fishermyre, Stonehaven, AB3 3QE (Figure 45.1b)
- North Cookney Croft, Stonehaven, AB3 3SB (Figure 45.1d)
- Mains Of Cookney, Stonehaven, AB3 3SA (Figure 45.1d)
- Gowanlea, Stonehaven, AB3 3RU (Figure 45.1c)
- North Rothnick, Stonehaven, AB3 3QX (Figure 45.1e)
- Meadowbank, Stonehaven, AB3 3SD (Figure 45.1d)
- Greens Of Crynoch, Aberdeen, AB1 5YX (Figure 45.1e)
- Crossley, Stonehaven, AB3 3QU (Figure 45.1e)
- Lee Meng, Stonehaven, AB3 3QU (Figure 45.1e)
- Burnside Farm, Stonehaven, AB3 3RR (Figure 45.1c)

45.2.20 Unless otherwise specified, all measured noise levels were taken in free field conditions (i.e. not at the façade of the property, and at least 3.5m away from any hard reflecting surface other than the ground). The measured noise readings therefore require to be adjusted to be comparable with the calculated noise levels, which are determined at the property façade (+2.5dB to the measured free field). A summary of the field results is contained in Appendix A45.2.

45.2.21 In all areas further than 300m from a georectified road (i.e. a road for which traffic data was provided and subsequently attached to the road centre line as an attribute for use in the three dimensional modelling), the ambient descriptor was taken to be the $L_{A90(T)}$. It should be noted that for a one hour period, the L_{A90} is determined by the quietest six minutes, whereas the predicted level of traffic noise is described by the L_{A10}, which is determined by the noisiest six minutes. Therefore, it is possible that in evaluating the effects for areas with no existing traffic, the DMRB comparison of the L_{A10} and the L_{A90} can in certain circumstances lead to some distortion of impact. DMRB expects that once the scheme is in place, the L_{A90} will tend towards the L_{A10}. It is possible that there may be an exaggeration of impact when considering the measured results for L_{A90} and L_{A10} for areas where the existing noise climate is dominated by road traffic.

Traffic Noise Prediction

45.2.22 The prediction of traffic noise levels were calculated using Cadna® software, which adopts the algorithms contained within the 1988 Department of Transport publication 'Calculation of Road Traffic Noise' (CRTN). Ground contours were supplied by Jacobs, and the building locations were identified using OS Mastermap data under license from the Scottish Executive (in some instances these locations were amended by the Jacobs Survey Department). In addition to this, buildings were classified by type (e.g. residential, commercial) using Address Point Data.

45.2.23 Using the methodology set out in CRTN, noise levels were calculated at sample properties within 500m of the current road network; with the base year, as well as for the Do-minimum and Do-something scenarios in the Year of Opening and the Design Year. Calculations were based on measurements at a point 1m in front of the most exposed façade (unless in open areas, where the levels are reported as free field levels). All calculations are based on the predicted traffic flows as summarised in Chapter 4 (The Proposed Scheme). Noise calculations have been undertaken using the AAWT (Annual Average Weekday Traffic - 18hr, 5 day average) provided by MVA. All traffic data has been derived using the ASAM3B traffic model. The traffic modelling is fully explained in Chapter 5 (Overview of Assessment Process).

Noise Nuisance Assessment

45.2.24 DMRB states that a noise nuisance assessment should be carried out for properties with a 1dB change. Due to variability in individual responses, DMRB recommends that community annoyance ratings are used for each noise level. It is therefore important to note that the results of the DMRB nuisance assessment should not be related to individual annoyance response.

45.2.25 The term 'nuisance' in DMRB means the percentage of people bothered by traffic noise (i.e. those who say they are 'very much' or 'quite a lot' bothered on a four point worded scale).

45.2.26 DMRB details procedures for estimating changes in traffic noise nuisance when a new road scheme is planned. This method is based on the results of surveys which examined the relationship between objective measures of road traffic noise outside residential properties, and the percentage of people bothered by road traffic noise. The 1977 National Environmental Survey (England) (Harland and Abbot, 1997), has shown that once people become accustomed to a change in noise, their general dissatisfaction with traffic noise does not alter until changes in level on the $L_{A10(18h)}$ scale exceed at least 3dB(A). However, in the period immediately following the completion of a road scheme, people may find appreciable benefits or disbenefits when noise changes are less than 3dB(A). Prior to the publication of DMRB, available research (1977) indicated that an abrupt change in traffic noise as small as 1dB(A) may result in a 21% change in the number of people bothered 'very much' or 'quite a lot' by road traffic noise. A noise disturbance assessment was therefore made for all properties with an expected noise change of 1dB(A) or greater due to the proposed scheme. This change in noise level would be produced by a change in traffic flow of approximately +25% or -20%, assuming that other factors, such as the average speed and the percentage of HGVs remain unchanged.

45.2.27 Noise nuisance predictions for the proposed scheme are based on the highest nuisance levels expected during the first 15 years after opening. These assessments have been undertaken in accordance with the predictive technique presented in DMRB, although the method has limitations as discussed in paragraphs 45.2.31- 45.2.33.

45.2.28 DMRB also requires an indication of the number of properties which are likely to be eligible for statutory insulation. The Noise Insulation (Scotland) Regulations 1975 provide for acoustic insulation to be offered for residential properties. The qualifying criteria are detailed within the Regulations, and within the Memorandum on the Noise Insulation (Scotland) Regulations 1975 (NISR), Regulations 3 and 6. The qualifying criteria 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 centre-line of the existing road from the terminal points, and 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 centre line of the carriageway;
- a straight line can be drawn from any point of the property to a point on the carriageway without passing through 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).

Vibration

45.2.29 Investigations have determined a relationship between the number of people affected by the traffic noise and those adversely impacted by air-borne vibration. It was found that the $L_{A10(18h)}$ index was among the physical variables most closely associated with average vibration disturbance ratings. The relationships between the percentage of people affected by largely air-borne vibration, and this noise exposure index, are similar to that for noise nuisance. However, it is recommended in DMRB that the percentage of people bothered by vibration is 10% lower than the corresponding noise nuisance figure, and that at noise levels below 58dB $L_{A10(18h)}$ it should be assumed that no people would be affected.

45.2.30 In accordance with DMRB Volume 11, the prediction of disturbance caused by air-borne vibration is made for properties within 40m of the road centreline which are un-screened.

Limitation to Assessment

45.2.31 The surveys on which the DMRB methods for noise nuisance assessment are based were conducted at sites where road traffic was the dominant noise source, noise levels ranged from 65 to 78 $dBL_{A10,18h}$, the changes in traffic noise were up to 10 dB $L_{A10,18h}$, and properties were up to 18m from the road. Therefore, it is only at these noise levels and distance ranges that the method is strictly valid. The DMRB method is also valid only for noise changes caused by alterations in traffic flow and will not necessarily give a good prediction if traffic noise changes are brought about by other means, such as barriers or low noise road surfaces. The Fastlink section of the proposed scheme has areas where the ambient levels are dominated by road traffic noise, such as around the Stonehaven end of the route. However, throughout the scheme there are many areas where the ambient noise climate is not dominated by road traffic noise. The ambient descriptor will therefore be the L_{A90} or L_{A10} as appropriate (refer to paragraphs 45.2.16 and 45.2.17), but as the nuisance assessment is based on changes in road traffic noise level, the noise nuisance results are strictly not applicable where the L_{A90} is used. However, DMRB, Volume 11, Section 3, Part 7, Chapter 8, Paragraph 5.10 states that 'Strictly, the method should not be used outside the noise and distance ranges covered by the surveys, or when the ambient noise is not from traffic. However, it seems likely that the mechanisms underlying the survey results will operate outside these ranges. Until better information becomes available, it is recommended that the method is

used to predict nuisance changes outside these noise and distance ranges, albeit with caution'.

45.2.32 As the method for assessing vibration is similar to noise nuisance, it is subject to the same limitations as discussed above.

45.2.33 The prediction method detailed within the NISR Memorandum for considering requirements for statutory noise insulation has been improved since 1975. While DMRB does allow for the use of the method detailed within the NISR Memorandum, the prediction methodology employed in this assessment uses the more detailed and accurate predictive methods set out in CRTN. However, to ensure compliance with NISR the assessment uses as a proxy a CRTN predicted level of 65dB(A) as a preliminary indicator of the need to utilise the full NISR Memorandum methodology assessment of eligibility, where all the other qualifying criteria are met.

Threshold for Mitigation

45.2.34 As best practice, mitigation should be implemented, where practicable, where the significance of impact is in the Design Year is found to be 'Moderate Adverse' or worse at ground floor. This is an onerous target as mitigation is therefore considered where there is an increase of greater than 1dB irrespective of the absolute noise level (in recognition of the sudden change effects as reported within DMRB), and must be applied with caution in rural areas where there are at present no traffic sources. For guidance on onset of effects, reference was made to the current WHO document entitled 'Community Noise' (WHO, 1999). This document does not contain recommendations, but provides guideline values based on the precautionary principle. The WHO document states that 'To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55dB L_{Aeq} on balconies, terraces and in outdoor living areas. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level should not exceed 50dB L_{Aeq}. Where it is practical and feasible, the lower outdoor sound level should be considered the maximum desirable sound level for new development'.

45.2.35 The WHO refers to a daytime time base of 16 hours ($L_{Aeq(16hr}$), and CRTN predictions are in terms of $L_{A10(18hr)}$. To translate the WHO $L_{Aeq(16hr)}$ to $L_{A10(18hr)}$ a correction of approximately +2dB is therefore required, with a further +2.5dB necessary to translate into façade levels. This translation applied to 55dB $L_{Aeq,16hr}$ gives an equivalent threshold façade level of 59.5dB $L_{A10(18hr)}$.

45.2.36 In addition, it is necessary that in all cases where it is considered, mitigation should comply with acceptable standards in terms of traffic, safety, environmental and economic issues (DMRB Volume 11, Section 2, Part 3, Mitigation, Paragraph 1.2(a)). Examples which could preclude the use of mitigation are disproportionate cost and unacceptable visual impact.

45.2.37 In summary, taking into account the above WHO and DMRB guidance, mitigation was considered where the significance of impact at a receptor was assessed as Moderate Adverse or worse, and where the predicted façade level exceeded 59.5dB $L_{A10(18hr)}$. As noted in paragraph 45.2.5, noise prediction beyond 300m may be inaccurate, and the mitigation threshold was therefore only applied to receptors within 300m in accordance with DMRB.

45.3 Baseline Conditions

45.3.1 A total of 444 potentially sensitive receptors were identified within 500m of the Fastlink of the proposed scheme. Of these, 411 are categorised as residential and 38 as non-residential, including five which are considered within both receptor categories (i.e. residential properties that are also historic buildings).

45.3.2 Table 45.5 illustrates the number of potentially sensitive receptors within each category. As explained above, certain receptors are listed in more than one category, as indicated in the table footnote.

Table 45.5 – Number of Properties within 500m

Distance from Centreline	Residential	Commercial/ Industrial	Amenity/ Recreational	Farms	Educational	Woodlands	Historic	Footpath	SSSI
0 – 50m	6	0	0	1	0	3	0	1	0
50 – 100m	23	0	0	0	0	2	1	0	0
100 – 200m	66	1	1	2	0	2	1	0	0
200 – 300m	84	0	1	1	0	1	1	1	0
300m – 500m	232	0	1	2	1	3	10	0	1
Total	411*	1	3	6	1	11	13*	2	1

* includes 5 also categorised as residential

45.3.3 DMRB requires that the assessment also include 'all relevant locations' and relevant is further defined as 'e.g. sports fields, canals, footpaths'. References to Figures 45.1a-f are provided where appropriate below. These include the locations of all 21 sample receptors reported in this assessment, and a representative selection of sensitive receptors within 500m of the proposed scheme.

Educational:

- Mackie Academy, near Slug Road, Stonehaven

Historical:

- Slug Road, South Lodge including Boundary Walls and Gatepiers, Fetteresso
- Cowie Mains Farmhouse, Fetteresso (also known as Main of Cowie) [note: also categorised as 'residential' in Table 45.5]
- Cowie Mains Steading, Fetteresso
- Cowie House, Fetteresso (also known as Gardener's Cottage) [note: also categorised as 'residential' in Table 45.5]
- Cowie House, Offices, Fetteresso
- Ury - North Lodge, Fetteresso [note: also categorised as 'residential' in Table 45.5]
- Cookney Church Fetteresso [note: also categorised as 'residential' in Table 45.5]
- East Crossley
- Slug Road, New Lodge Boundary Walls And Gatepiers, Fetteresso (also known as South Lodge) [note: also categorised as 'residential' in Table 45.5]
- Cowie Chapel, near Cowie Castle
- Cowie Chapel - Dead-House, Fetteresso
- Cowie House, Enclosure Walls, Fetteresso
- Castle Of Cowie

Amenity/Recreation

- Golf Course, A90 Den of Cowie
- Mineralwell Park (Cararvan), Near Mackie Academy, Cowie
- Stonehaven Golf Club, AB39 3RH

Footpaths:

- Near Hill of Megray
- Near Cookney

SSSI:

- Garron Point, Aberdeen

Woodland:

- Near Strathisla , Fetteresso
- Megray Wood, Near North Lodge Ury, Fetteresso
- Limpet Wood, Fetteresso
- Near Limpet Wood , Fetteresso
- Megray Wood, Fetteresso
- Near Foresters Croft, Fetteresso
- Near Golf Course, Fetteresso
- Near Bruce Plant Ltd, Fetteresso
- Near Highfield Way, Fetteresso
- Near Glenury Crescent, Fetteresso
- Near The Steading, Fetteresso

Farms:

- Blaikiewell Farm, Aberdeen, Blairs, AB12 5YX
- Broomhill Farm, Stonehaven, Netherley, AB39 3SN
- North Cookney Farm, Stonehaven, Netherley, AB39 3SL
- Elrick Farm, Stonehaven, Bridge Of Muchalls, AB39 3RU
- Floors Farm, Stonehaven, Muchalls, AB39 3PL
- Burnside Farm, Stonehaven, Bridge Of Muchalls, AB39 3RR

Commercial/Industrial:

- Mains Of Cookney, Stonehaven, Netherley, AB393SA

45.3.4 All Listed Historic Buildings within 500m of the proposed scheme were considered during identification of receptors (i.e. 13), however, noise climate is not one of the listing criteria and as such noise would not have any cultural heritage implications. Impacts on the 13 historic buildings/sites have been included in this assessment, as shown on Figures 45.1a-f.

45.4 Potential Impacts

Noise Model Calibration

45.4.1 To calibrate the 3D noise model of the existing road network model, generated predicted noise levels were compared with the measured noise levels at a selection of the sample receptors previously listed (see paragraph 45.2.19). For comparison, predicted noise levels were determined for ground floor level, and compared to the measured noise levels at these locations, as shown in Table 45.6. It must be noted that there will rarely be perfect agreement between predicted and measured levels as the modelled levels use flow data for an 18 hour period and the measured levels are based on the short term measurement period, and DMRB does not expect this. The CRTN shortened measurement procedure advises that where a measurement is made over three consecutive hours, a correction factor of -1dB should be applied to obtain an 18 hour value. In essence, the short term measured levels are likely to be slightly higher than the predicted levels.

Table 45.6 – Modelled Predicted Noise Levels versus Measured Noise Levels

Sample Receptor	Modelled Predicted (dB) $L_{A10(18hr)}$	Equivalent Measured (dB) $L_{A10(18hr)}$
Bayview of Ury	68.8	64.7
Foresters Croft	55.2	52.6
Newmains of Ury	65.5	65.7

45.4.2 The results in Table 45.6 do show reasonable agreement between the modelled predicted noise levels and the measured noise levels, and therefore effectively calibrate the 3D noise model created. It is stated in DMRB that with regard to the actual measured levels 'Care is needed in the interpreting of the levels of the $L_{A10,18h}$ recorded. These will vary from day to day during the year, depending on the influence of varying traffic and weather conditions and seasonal effects'. It is therefore recommended that where road traffic noise presently dominates the noise climate the predicted Do-Minimum levels of $L_{A10(18hr)}$ provide a more reliable measure for an average day than the measured level and therefore the predicted ambient levels are, where possible (see paragraph 45.2.17 for an explanation of where the predicted $L_{A10(18hr)}$ is not used), used in this future year comparison assessment.

Traffic Noise

45.4.3 The finalised road traffic model for the Fastlink section incorporates design elements which will mitigate traffic noise, such as sections of embankments/false cutting. These are summarised in Section 45.5 (Mitigation) and have been developed iteratively through discussion between the road engineers, Jacobs landscape team and Hamilton & McGregor noise specialists. The potential impacts described in this section are based on the finalised road model and therefore take these measures into account.

45.4.4 Section 45.6 (Residual Impacts) takes account of the incorporated measures plus further receptor specific measures to further reduce impacts as described in Section 45.5 (Mitigation).

45.4.5 In total, there are 179 residential properties within 300m of the proposed Fastlink section. The results for the 21 selected sample receptors, deemed to represent the noise environment at other non-sample receptors nearby, at ground and first floor levels, for both the Year of Opening and the Design Year with and without the proposed scheme are presented in Table 45.7(a) and Table 45.7 (b) together with the associated significance of impact. It should be appreciated that, in order to determine the change in noise level between scenarios, the following process has been adopted: receptor points were located at a distance of 1m from each façade of each building, and the receptor location that had the highest noise level in the Do-Something scenario was then compared with the same receptor location in the Do-Minimum scenario. The results in Table 45.7(a) and Table 45.7(b) for ground and first floor levels respectively are shown in Figures 45.1a-f and 45.3a-f.

45.4.6 As explained in paragraph 45.2.21, where a property is outwith 300m of a road the $L_{A90(T)}$ noise parameter has been used to characterise the noise at that property. Although it was not feasible to take noise measurements at every property beyond 300m, the arithmetic average of the $L_{A90(T)}$ noise level as measured at all sample properties has been used as a proxy for the $L_{A90(T)}$ for all properties. Where appropriate, this 34.9dB $L_{A90(T)}$ noise level has been used in the noise assessment with the assumption that the existing noise climate will not change significantly at these locations in the absence of the proposed Fastlink.

45.4.7 The noise related impacts for the Wider Area Network are presented in Chapter 54 (Cumulative Impact Assessment).

Table 45.7(a) – Predicted Noise Impacts at Sample Properties at Ground Floor (receiver height=1.5m, ** = $L_{A90(T)}$)

DS = Do-Something (i.e. With Proposed scheme), DM = Do-minimum (i.e. without scheme)

Building Type	Building Type	Base 2005 $L_{A10(T)}$ or $L_{A90(T)}$ as appropriate	Noise Levels dB $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Blaikiewell Steading, Aberdeen, AB1 5YX**	Residential	41.8	41.8	55.9	41.8	56.5	Substantial Adverse	Substantial Adverse
Bayview Ury, Stonehaven, AB3 3QA	Residential	68.8	70.1	59.6	70.5	60.0	Substantial Beneficial	Substantial Beneficial
Megray Farm Steading, Stonehaven, AB3 3QA	Residential	57.6	58.3	56.1	58.6	56.3	Moderate Beneficial	Moderate Beneficial
3 New Mains Of Ury Cottages, Stonehaven, AB3 3QA	Residential	68.7	69.3	68.8	69.6	69.1	Slight Beneficial	Slight Beneficial
Kempstone Hill, Stonehaven, AB3 3QE**	Residential	38.9	38.9	60.0	38.9	60.5	Substantial Adverse	Substantial Adverse
Ardchoille, Stonehaven, AB3 3QB**	Residential	37.4	37.4	56.4	37.4	56.9	Substantial Adverse	Substantial Adverse
Foresters Croft, Stonehaven, AB3 3QA**	Residential	34.0	34.0	55.1	34.0	55.7	Substantial Adverse	Substantial Adverse
Elrick Cottar House, Stonehaven, AB3 3RU**	Residential	32.8	32.8	57.3	32.8	57.8	Substantial Adverse	Substantial Adverse
Strathgyle Cottage, Stonehaven, AB3 3SN	Residential	34.9	34.9	59.6	34.9	60.2	Substantial Adverse	Substantial Adverse
Broomhill Cottage, Stonehaven, AB3 3SN**	Residential	35.1	35.1	51.8	35.1	52.4	Substantial Adverse	Substantial Adverse
Curlews Cottage, Stonehaven, AB3 3RU**	Residential	34.5	34.5	53.5	34.5	54.1	Substantial Adverse	Substantial Adverse
Fishermyre, Stonehaven, AB3 3QE	Residential	37.7	39.0	50.5	39.4	51.0	Substantial Adverse	Substantial Adverse
North Cookney Croft, Stonehaven, AB3 3SB**	Commercial/Industrial	39.0	39.0	64.1	39.0	64.6	Substantial Adverse	Substantial Adverse

Building Type	Building Type	Base 2005 $L_{A10(T)}$ or $L_{A90(T)}$ as appropriate	Noise Levels dB $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Mains Of Cookney, Stonehaven, AB3 3SA**	Commercial/Industrial	27.0	27.0	52.4	27.0	52.9	Moderate/Substantial Adverse	Moderate/Substantial Adverse
Gowanlea, Stonehaven, AB3 3RU**	Residential	32.4	32.4	58.9	32.4	59.5	Substantial Adverse	Substantial Adverse
North Rothnick, Stonehaven, AB3 3QX**	Residential	30.1	30.1	52.5	30.1	53.0	Substantial Adverse	Substantial Adverse
Meadowbank, Stonehaven, AB3 3SD**	Residential	32.9	32.9	59.6	32.9	60.2	Substantial Adverse	Substantial Adverse
Greens Of Crynoch, Aberdeen, AB1 5YX**	Residential	31.6	31.6	58.6	31.6	59.1	Substantial Adverse	Substantial Adverse
Crossley, Stonehaven, AB3 3QU**	Residential	30.6	30.6	56.9	30.6	57.3	Substantial Adverse	Substantial Adverse
Lee Meng, Stonehaven, AB3 3QU (identical to and represented by Crossley on Figures 45.1-2a-f)	Residential	34.9	34.9	57.0	34.9	57.5	Substantial Adverse	Substantial Adverse
Burnside Farm, Stonehaven, AB3 3RR**	Farm	33.2	33.2	57.4	33.2	57.9	Moderate Adverse	Moderate Adverse

Table 45.7(b) – Predicted Noise Impacts at Sample Properties at First Floor (receiver height=4.5m, ** = $L_{A90(T)}$)

DS = Do-Something (i.e. With Proposed scheme), DM = Do-minimum (i.e. without scheme)

Building Type	Building Type	Base 2005 $L_{A10(T)}$ or $L_{A90(T)}$ as appropriate	Noise Levels dB $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Blaikiewell Steading, Aberdeen, AB1 5YX**	Residential	41.8	41.8	57.0	41.8	57.7	Substantial Adverse	Substantial Adverse
Bayview Ury, Stonehaven, AB3 3QA	Residential	70.3	71.6	60.5	72.0	60.8	Substantial Beneficial	Substantial Beneficial
Megray Farm Steading, Stonehaven, AB3 3QA	Residential	58.9	59.6	57.5	59.9	57.6	Moderate Beneficial	Moderate Beneficial
3 New Mains Of Ury Cottages, Stonehaven, AB3 3QA	Residential	71.0	71.7	71.2	71.9	71.5	Slight Beneficial	Slight Beneficial
Kempstone Hill, Stonehaven, AB3 3QE**	Residential	38.9	38.9	61.5	38.9	62.1	Substantial Adverse	Substantial Adverse
Ardchoille, Stonehaven, AB3 3QB**	Residential	37.4	37.4	58.0	37.4	58.5	Substantial Adverse	Substantial Adverse
Foresters Croft, Stonehaven, AB3 3QA**	Residential	34.0	34.0	55.9	34.0	56.4	Substantial Adverse	Substantial Adverse
Elrick Cottar House, Stonehaven, AB3 3RU**	Residential	32.8	32.8	58.2	32.8	58.7	Substantial Adverse	Substantial Adverse
Strathgyle Cottage, Stonehaven, AB3 3SN	Residential	34.9	34.9	61.9	34.9	62.4	Substantial Adverse	Substantial Adverse
Broomhill Cottage, Stonehaven, AB3 3SN**	Residential	35.1	35.1	54.2	35.1	54.7	Substantial Adverse	Substantial Adverse
Curlews Cottage, Stonehaven, AB3 3RU**	Residential	34.5	34.5	54.3	34.5	54.9	Substantial Adverse	Substantial Adverse
Fishermyre, Stonehaven, AB3 3QE	Residential	39.5	40.7	52.9	41.1	53.4	Substantial Adverse	Substantial Adverse
North Cookney Croft, Stonehaven, AB3 3SB**	Commercial/Industrial	39.0	39.0	65.5	39.0	66.0	Substantial Adverse	Substantial Adverse

Building Type	Building Type	Base 2005 $L_{A10(T)}$ or $L_{A90(T)}$ as appropriate	Noise Levels dB $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Mains Of Cookney, Stonehaven, AB3 3SA**	Commercial/Industrial	27.0	27.0	53.3	27.0	53.9	Moderate/Substantial Adverse	Moderate/Substantial Adverse
Gowanlea, Stonehaven, AB3 3RU**	Residential	32.4	32.4	60.0	32.4	60.5	Substantial Adverse	Substantial Adverse
North Rothnick, Stonehaven, AB3 3QX**	Residential	30.1	30.1	53.3	30.1	53.8	Substantial Adverse	Substantial Adverse
Meadowbank, Stonehaven, AB3 3SD**	Residential	32.9	32.9	62.2	32.9	62.7	Substantial Adverse	Substantial Adverse
Greens Of Crynoch, Aberdeen, AB1 5YX**	Residential	31.6	31.6	59.3	31.6	59.8	Substantial Adverse	Substantial Adverse
Crossley, Stonehaven, AB3 3QU**	Residential	30.6	30.6	57.9	30.6	58.4	Substantial Adverse	Substantial Adverse
Lee Meng, Stonehaven, AB3 3QU (identical to and represented by Crossley on Figures 45.3-4a-f)	Residential	34.9	34.9	58.0	34.9	58.5	Substantial Adverse	Substantial Adverse
Burnside Farm, Stonehaven, AB3 3RR**	Farm	33.2	33.2	58.4	33.2	58.9	Moderate Adverse	Moderate Adverse

Ground Floor

45.4.8 Table 45.7a shows the predicted noise levels for the 21 selected sample residential receptors at ground floor level. For the 179 residential properties within 300m of the proposed Fastlink section, there are 17 residential properties which experience 'No change' in the Year of Opening and ten in the Design Year. There are nine properties both in the Year of Opening and the Design Year that experience a significance of impact that is Moderate Beneficial or better. There are also 67 properties in the Year of Opening and 86 properties in the Design Year that experience a significance of impact that is Slightly Beneficial.

45.4.9 Beneficial impacts occur mainly in the Stonehaven area because there is a reduction in the flow of traffic on the southbound A90 from approximately AAWT 13,000 to AAWT 8,000 between the Do-minimum and the Do-something scenarios.

45.4.10 Of the 179 residential properties within 300m of the proposed Fastlink section, there are 38 properties in the Year of Opening and in the Design Year that experience a potential significance of impact that is Moderate Adverse or worse. This is mainly because the properties are, to a large extent, remote from significant road traffic noise at present. Of the properties that experience a potential significance of impact that is Moderate Adverse or worse, there are five properties in the year of opening and six in the Design Year that also exceed $L_{A10(18hr)}$ of 59.5dB and will therefore warrant mitigation, where practicable. These properties are as follows (with applicable assessment years shown in brackets, and where the property is a selected sample receptor, reference to the appropriate figure has been included):

- North Cookney Croft, Stonehaven (Design Year, Year of Opening) (see Figure 45.1c);
- Kempstone Hill, Stonehaven (Design Year, Year of Opening) (see Figure 45.1e);
- Strathgyle Cottage, Stonehaven (Design Year, Year of Opening) (see Figure 45.1d);
- North Cookney Farm, Stonehaven (Design Year, Year of Opening);
- Gowanlea, Stonehaven (Design Year) (see Figure 45.1d); and
- Meadowbank, Stonehaven (Design Year, Year of Opening) (see Figure 45.c).

First Floor

45.4.11 Table 45.7b shows the predicted noise levels for the 21 selected sample receptors at first floor level. For the 179 residential properties within 300m of the proposed Fastlink section, there are 12 residential properties which experience 'No change' in the Year of Opening and 16 in the Design Year. There are nine properties in both the Year of Opening and Design Year that experience a significance of impact that is Moderate Beneficial or better. There are also 68 properties in the Year of Opening and 65 in the Design Year that experience a significance of impact that is Slight Beneficial.

45.4.12 Of the 179 residential properties within 300m of the proposed Fastlink section, there are 38 properties in the Year of Opening and 38 properties in the Design Year that experience a potential significance of impact that is Moderate Adverse or worse. Of the properties that experience a potential significance of impact that is Moderate Adverse or worse, there are six properties in the Year of Opening and seven in the Design Year that also exceed $L_{A10(18hr)}$ of 59.5dB and will therefore be considered for mitigation. These properties are listed below. The applicable assessment years shown in brackets and where the property is a selected sample receptor, reference to the appropriate Figure has been included:

- North Cookney Croft, Stonehaven (Design Year, Year of Opening) (see Figure 45.3c);
- Kempstone Hill, Stonehaven (Design Year, Year of Opening) (see Figure 45.3e);
- Strathgyle Cottage, Stonehaven (Design Year, Year of Opening) (see Figure 45.3d);

- North Cookney Farm, Stonehaven (Design Year, Year of Opening);
- Gowanlea, Stonehaven (Design Year, Year of Opening) (see Figure 45.3d);
- Meadowbank, Stonehaven (Design Year, Year of Opening) (see Figure 45.1c); and
- Greens of Crynoch, Aberdeen (Design Year) (see Figure 45.3a).

45.5 Mitigation

45.5.1 Mitigation is considered in terms of incorporated mitigation (i.e. measures included as part of the assessed road model as explained in paragraphs 45.2.34-35 and receptor specific mitigation for the properties identified above in Section 45.4 with potential impacts of Moderate Adverse or worse significance and a noise level exceeding 59.5dB $L_{A10(18hr)}$

45.5.2 Mitigation measures comprise substantial acoustic screens, and some revised earthworks. It should also be noted that properties situated further back from the road may experience further noise reduction from intervening buildings.

Incorporated Mitigation

Earthworks

45.5.3 Earthworks mitigation is fully described within the Chapter 41 (Landscape) and one location is proposed for the Fastlink:

- false cutting at Kempstone Hill (ch2250 – 2500)

Low Noise Surfacing

45.5.4 Low noise road surfacing is proposed throughout the scheme. Quieter road surfaces such as Stone Mastic Asphalt (SMA), or a pervious material, would be likely to reduce noise levels by approximately 2.5dB $L_{A10\ 18h}$ compared with conventional hot rolled asphalt surfacing. This benefit is related to the speed of the traffic on the road, and is likely to be significant at speeds above approximately 50kph.

Receptor Specific Mitigation

Acoustic Screens

45.5.5 Noise mitigation will be positioned as close to the carriageway as possible to ensure maximum attenuation, taking into account alignment requirements, land available, and landscaping and visual requirements. Noise barriers set close to a road can provide protection to garden areas as well as the living space of properties.

45.5.6 The acoustic screens may be in the form of an earth bund, or a combination of an earth bund and a noise fence. It should be noted that basic acoustic fencing will be of a minimum surface density of 15kg/m^2 with no holes or gaps. Timbers must be overlapped to allow for shrinkage and timber screens should be well bedded in gravel (or equivalent) to avoid soil erosion, which could create gaps underneath the screens, reducing their noise attenuation effectiveness. The full detailed barrier specification for each of the barriers will be detailed in the Employers Requirement prepared for scheme construction should the scheme proceed. The barrier specification will comply with all relevant British Standards.

45.5.7 The specific additional mitigation measures are summarised below in Table 45.8, and have been incorporated to minimise the impacts at properties meeting the threshold described in paragraphs 45.2.34-35 for consideration of mitigation where practicable (see paragraph 45.2.36). Figure 45.2c-e and 45.4c-e shows the locations of the proposed acoustic screens.

Table 45.8 – Acoustic Screen Noise Mitigation

Address	Height	Length	Approximate Chainage
Kempstone Hill, Stonehaven, AB3 3QE	1.0m (and 0.5m bund)	109m	2400
Strathgyle Cottage, Stonehaven, AB3 3SN	1.5m	202m	4100
North Cookney Farm, Stonehaven, AB3 3SB	1.0m	67m	6200
North Cookney Croft, Stonehaven, AB3 3SB	3.0m	154m	6400
Meadowbank, Stonehaven, AB3 3SD	1.0m	69m	7000

Noise Insulation

45.5.8 As noted in paragraph 45.2.28, Regulation 3 of the Noise Insulation (Scotland) Regulations 1975 (NISR), confers a duty on the roads authorities in certain instances to offer insulation to eligible residential properties affected by noise.

45.5.9 The results of this noise assessment indicate that with receptor specific mitigation measures in place the following two properties at first floor may qualify in terms of the NISR (due to noise level exceedence at first floor level only) for both the Year of Opening and the Design Year:

- North Cookney Croft Farm (Residential), Stonehaven; and
- North Cookney Croft, Stonehaven.

45.5.10 The list of properties that may be eligible will be confirmed in advance of the construction stage. Prevailing noise levels will be assessed pre-construction for these properties in accordance with NISR and within 12 months of the opening of the road, further assessments will be undertaken to determine eligibility. NISR also require that eligibility for noise insulation is reviewed at defined intervals (5, 10 and 15 years) after the road is opened. The statutory noise insulation assessments will be undertaken by Scottish Executive or its nominated representatives.

Summary of Mitigation

45.5.11 The aims of the proposed mitigation is summarised in Table 45.9.

Table 45.9 - Summary of General Aim of Measures Employed to Address Noise Potential Impacts

Type of Measure	Description
Prevent	None.
Reduce	Construction of noise barriers, earthworks bunds and the use of low noise surfacing will reduce the predicted traffic noise levels.
Offset	A list of properties that may be eligible for noise insulation due to increase in noise caused by the new road will be drawn up and assessed prior to construction.
Enhance	None.

45.6 Residual Impacts

45.6.1 Residual impacts are reported assuming the implementation of all mitigation measures described in the preceding section

Traffic Noise

45.6.2 The residual predicted noise levels and associated derived residual significance of impact for the selected sample properties are presented in Tables 45.10a and 45.10b.

Table 45.10(a) - Residual Impacts at Ground Floor (receiver height=1.5m, ** = $L_{A90(T)}$)

DS = Do-Something (i.e. With Proposed scheme), DM = Do-minimum (i.e. without scheme)

Building Type	Building Type	Base 2005 $L_{A10(T)}$ or $L_{A90(T)}$ as appropriate	Noise Levels dB $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Blaikiewell Steading, Aberdeen, AB1 5YX**	Residential	41.8	41.8	55.9	41.8	56.5	Substantial Adverse	Substantial Adverse
Bayview Ury, Stonehaven, AB3 3QA	Residential	68.8	70.1	59.6	70.5	60.0	Substantial Beneficial	Substantial Beneficial
Megray Farm Steading, Stonehaven, AB3 3QA	Residential	57.6	58.3	56.1	58.6	56.3	Moderate Beneficial	Moderate Beneficial
3 New Mains Of Ury Cottages, Stonehaven, AB3 3QA	Residential	68.7	69.3	68.8	69.6	69.1	Slight Beneficial	Slight Beneficial
Kempstone Hill, Stonehaven, AB3 3QE**	Residential	38.9	38.9	59.0	38.9	59.5	Substantial Adverse	Substantial Adverse
Ardchoille, Stonehaven, AB3 3QB**	Residential	37.4	37.4	56.4	37.4	56.9	Substantial Adverse	Substantial Adverse
Foresters Croft, Stonehaven, AB3 3QA**	Residential	34.0	34.0	55.1	34.0	55.7	Substantial Adverse	Substantial Adverse
Elrick Cottar House, Stonehaven, AB3 3RU**	Residential	32.8	32.8	57.3	32.8	57.8	Substantial Adverse	Substantial Adverse
Strathgyle Cottage, Stonehaven, AB3 3SN	Residential	34.9	34.9	59.0	34.9	59.5	Substantial Adverse	Substantial Adverse
Broomhill Cottage, Stonehaven, AB3 3SN**	Residential	35.1	35.1	51.8	35.1	52.3	Substantial Adverse	Substantial Adverse
Curlews Cottage, Stonehaven, AB3 3RU**	Residential	34.5	34.5	53.5	34.5	54.1	Substantial Adverse	Substantial Adverse
Fishermyre, Stonehaven, AB3 3QE	Residential	37.7	39.0	50.5	39.4	51.0	Substantial Adverse	Substantial Adverse
North Cookney Croft, Stonehaven, AB3 3SB**	Commercial/Industrial	39.0	39.0	59.2	39.0	59.7	Substantial Adverse	Substantial Adverse
Mains Of Cookney, Stonehaven, AB3 3SA**	Commercial/Industrial	27.0	27.0	52.4	27.0	52.9	Moderate/Substantial Adverse	Moderate/Substantial Adverse

Building Type	Building Type	Base 2005 $L_{A10(T)}$ or $L_{A90(T)}$ as appropriate	Noise Levels dB $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Gowanlea, Stonehaven, AB3 3RU**	Residential	32.4	32.4	58.9	32.4	59.4	Substantial Adverse	Substantial Adverse
North Rothnick, Stonehaven, AB3 3QX**	Residential	30.1	30.1	52.5	30.1	53.0	Substantial Adverse	Substantial Adverse
Meadowbank, Stonehaven, AB3 3SD**	Residential	32.9	32.9	59.0	32.9	59.5	Substantial Adverse	Substantial Adverse
Greens Of Crynoch, Aberdeen, AB1 5YX**	Residential	31.6	31.6	58.6	31.6	59.1	Substantial Adverse	Substantial Adverse
Crossley, Stonehaven, AB3 3QU**	Residential	30.6	30.6	56.9	30.6	57.3	Substantial Adverse	Substantial Adverse
Lee Meng, Stonehaven, AB3 3QU (identical to and represented by Crossley on Figures 45.3-4a-f)	Residential	34.9	34.9	57.0	34.9	57.5	Substantial Adverse	Substantial Adverse
Burnside Farm, Stonehaven, AB3 3RR**	Farm	33.2	33.2	57.3	33.2	57.9	Moderate Adverse	Moderate Adverse

Table 45.10(b) - Residual Impacts at First Floor (receiver height=4.5m, ** = $L_{A90(T)}$)

DS = Do-Something (i.e. With Proposed scheme), DM = Do-minimum (i.e. without scheme)

Building Type	Building Type	Base 2005 $L_{A10(T)}$ or $L_{A90(T)}$ as appropriate	Noise Levels dB $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Blaikiewell Steading, Aberdeen, AB1 5YX**	Residential	41.8	41.8	57.0	41.8	57.7	Substantial Adverse	Substantial Adverse
Bayview Ury, Stonehaven, AB3 3QA	Residential	70.3	71.6	60.5	72.0	60.8	Substantial Beneficial	Substantial Beneficial
Megray Farm Steading, Stonehaven, AB3 3QA	Residential	58.9	59.6	57.5	59.9	57.6	Moderate Beneficial	Moderate Beneficial
3 New Mains Of Ury Cottages, Stonehaven, AB3 3QA	Residential	71.0	71.7	71.2	71.9	71.5	Slight Beneficial	Slight Beneficial
Kempstone Hill, Stonehaven, AB3 3QE**	Residential	38.9	38.9	60.5	38.9	62.1	Substantial Adverse	Substantial Adverse
Ardchoille, Stonehaven, AB3 3QB**	Residential	37.4	37.4	58.0	37.4	58.5	Substantial Adverse	Substantial Adverse
Foresters Croft, Stonehaven, AB3 3QA**	Residential	34.0	34.0	55.9	34.0	56.4	Substantial Adverse	Substantial Adverse
Elrick Cottar House, Stonehaven, AB3 3RU**	Residential	32.8	32.8	58.2	32.8	58.7	Substantial Adverse	Substantial Adverse
Strathgyle Cottage, Stonehaven, AB3 3SN	Residential	34.9	34.9	60.6	34.9	62.4	Substantial Adverse	Substantial Adverse
Broomhill Cottage, Stonehaven, AB3 3SN**	Residential	35.1	35.1	54.0	35.1	54.7	Substantial Adverse	Substantial Adverse
Curlews Cottage, Stonehaven, AB3 3RU**	Residential	34.5	34.5	54.3	34.5	54.9	Substantial Adverse	Substantial Adverse
Fishermyre, Stonehaven, AB3 3QE	Residential	39.5	40.7	52.9	41.1	53.4	Substantial Adverse	Substantial Adverse
North Cookney Croft, Stonehaven, AB3 3SB**	Commercial/Industrial	39.0	39.0	61.2	39.0	66.0	Moderate/Substantial Adverse	Moderate/Substantial Adverse
Mains Of Cookney,, Stonehaven, AB3 3SA**	Commercial/Industrial	27.0	27.0	53.3	27.0	53.9	Moderate/Substantial Adverse	Moderate/Substantial Adverse

Building Type	Building Type	Base 2005 $L_{A10(T)}$ or $L_{A90(T)}$ as appropriate	Noise Levels dB $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Gowanlea, Stonehaven, AB3 3RU**	Residential	32.4	32.4	60.0	32.4	60.5	Substantial Adverse	Substantial Adverse
North Rothnick, Stonehaven, AB3 3QX**	Residential	30.1	30.1	53.3	30.1	53.8	Substantial Adverse	Substantial Adverse
Meadowbank, Stonehaven, AB3 3SD**	Residential	32.9	32.9	61.5	32.9	62.7	Substantial Adverse	Substantial Adverse
Greens Of Crynoch, Aberdeen, AB1 5YX**	Residential	31.6	31.6	59.3	31.6	59.8	Substantial Adverse	Substantial Adverse
Crossley, Stonehaven, AB3 3QU**	Residential	30.6	30.6	57.9	30.6	58.4	Substantial Adverse	Substantial Adverse
Lee Meng, Stonehaven, AB3 3QU (identical to and represented by Crossley on Figures 45.3-4a-f)	Residential	34.9	34.9	58.0	34.9	58.5	Substantial Adverse	Substantial Adverse
Burnside Farm, Stonehaven, AB3 3RR**	Farm	33.2	33.2	58.4	33.2	58.9	Moderate Adverse	Moderate Adverse

Ground Floor

45.6.3 Of the 179 residential properties within 300m, there remain 17 properties in the Year of Opening and ten properties in the Design Year that are predicted to experience 'No change' at ground floor level. At ground floor, there remain nine properties in both the Year of Opening and Design Year that are predicted to experience a residual significance of impact that is Moderate Beneficial or better. These beneficial impacts are indicated on Figures 45.2a-f.

45.6.4 At ground floor level within 300m, 38 properties in both the Year of Opening and Design Year are predicted to experience a residual significance of impact of Moderate Adverse or worse. Of these properties, only one is predicted to exceed the threshold of $L_{A10(18hr)}$ 59.5dB. This property is North Cookney Croft with a predicted noise level of $L_{A10(18hr)}$59.7dB.

First Floor

45.6.5 At first floor, there remain 12 properties in the Year of Opening and 16 in the Design Year that are predicted to experience 'No change' in the Do-Minimum and Do-Something noise levels. There are 9 properties in both the Year of Opening and Design Year that are predicted to experience a residual significance of impact that is Moderate Beneficial or better. These beneficial impacts are indicated on Figures 45.4a-f.

45.6.6 At first floor level, there remain 38 properties in both the Year of Opening and Design Year that are predicted to experience a residual significance of impact that is Moderate Adverse or worse. However of these, only six properties in the Year of Opening and seven properties in the Design Year also exceed the mitigation threshold of $L_{A10(18hr)}$ 59.5dB. These residential properties are listed below. The year in which the mitigation threshold, $L_{A10(18hr)}$ 59.5dB, remains exceeded is shown as a bracketed term, and where the property is a selected sample receptor, reference to the appropriate figure has been included:

- North Cookney Croft, Stonehaven (Design Year, Year of Opening) (Figure 45.4d);
- Kempstone Hill, Stonehaven (Design Year, Year of Opening) (Figure 45.4b);
- Strathgyle Cottage, Stonehaven (Design Year, Year of Opening) (Figure 45.4c);
- North Cookney Farm, Stonehaven (Design Year, Year of Opening);
- Gowanlea, Stonehaven (Design Year, Year of Opening) (Figure 45.4c);
- Meadowbank, Stonehaven (Design Year, Year of Opening) (Figure 45.4d); and
- Greens Of Crynoch, Aberdeen (Design Year) (Figure 45.4e).

45.6.7 Generally, the adverse impacts will be experienced due to the introduction of the proposed scheme where no road previously existed. As mentioned earlier in the text, the beneficial impacts will accrue from traffic reductions on the existing roads, as occur as detailed in paragraph 45.4.9.

45.6.8 A summary of the residual impact significance is provided in Table 45.11.

Table 45.11 - Residual Impacts in Terms of the Significance of Impact For Residential Properties within 300m of the Scheme

Significance of Impact	Ground Floor				First Floor			
	Unmitigated		Mitigated		Unmitigated		Mitigated	
	Year of Opening	Design Year	Year of Opening	Design Year	Year of Opening	Design Year	Year of Opening	Design Year
Substantial Adverse	38	38	38	38	38	38	38	38
Moderate/Substantial Adverse	0	0	0	0	0	0	0	0
Moderate Adverse	0	0	0	0	0	0	0	0
Slight Adverse	48	36	48	36	52	51	52	51
No Change	17	10	17	10	12	16	12	16
Slight Beneficial	67	86	67	86	68	65	68	65
Moderate Beneficial	6	6	6	6	6	6	6	6
Moderate/Substantial Beneficial	1	1	1	1	1	1	1	1
Substantial Beneficial	2	2	2	2	2	2	2	2

Noise Nuisance

45.6.9 An assessment of noise nuisance has been carried out for selected properties in accordance with the predictive techniques presented in DMRB.

45.6.10 All changes in terms of noise and nuisance levels are reported in A45.3 for each of the DMRB defined ambient noise bands at ground floor and first floor. It is acknowledged that in assessing nuisance, changes of residual impacts the DMRB nuisance assessment method is based on noise changes caused by changes in traffic flow alone. Traffic noise changes will not therefore give a good prediction of nuisance where brought about by means other than traffic flow, such as, barriers or low noise road surfaces.

45.6.11 Overall, within the Core Study Area, more properties will be subject to an increase in noise level than to a decrease and this is very apparent in areas of existing low ambient noise. This is evidenced in the nuisance assessment in A45.3 which shows that for the <50dB ambient noise band there are 62 properties predicted to experience noise level increases of 10dB or greater. This results in 64 properties being subject to increases in DMRB defined nuisance of $\geq$40%. In contrast there would appear to be very few properties subject to decreases in noise level of between 1 and 3dB, but, this masks the fact that there are around 43 properties that will experience small decreases in noise level of less than 1dB. This is evidenced by the number of properties predicted to experience a reduction in the level of DMRB defined nuisance in the <50dB ambient noise band.

45.6.12 The properties that presently experience noise levels within the 50-60dB ambient band immediately prior to the scheme opening are concentrated in the Stonehaven area, and as was highlighted in paragraph 45.4.9 these properties will experience a slight decrease in noise levels with the scheme in place because there is a reduction in the flow of traffic on the southbound A90 from approximately AAWT 13,000 to AAWT 8,000 between the Do-minimum and the Do-something scenarios. However, for the Do-minimum scenario there will be a slight increase in noise levels within the Stonehaven area, yet this increase is predicted to be less than 1dB and, as such, do not appear in the DMRB summary tables in Appendix A45.3. This increase in noise level is evidenced by the relatively large number of properties that are predicted to experience an increase in DMRB defined noise nuisance without the scheme in place.

45.6.13 There are also a number of Stonehaven properties in the 60 – 70dB ambient noise band that will also be subject to relatively small decreases in predicted road traffic noise levels. Also, properties close to the B979 will benefit from the reduced flow of traffic on this road after the AWPR scheme is opened to traffic. These effects can be seen by reference to the 60-70dB ambient noise band summary table in Appendix A45.3 where it can be seen that there are more properties subject to increases in DMRB noise nuisance for the Do-Minimum scenario than for the Do-Something scenario. However, it must also be remembered that changes in noise level of less than 1dB are not recorded in the DMRB summary tables.

45.6.14 Finally, there are very few properties that are within the >70dB ambient noise band. These properties are 24, 26, 28 30 and 34 Highfield Way in Stonehaven and 4 & 5 New Mains of Ury. These properties will be subject to an increase in noise level of less than 1dB for the Do-minimum scenario and, with the scheme in place, the nuisance levels will decrease by less than 10%. This is as a consequence of decreases in noise level of less than 1dB, which will occur mainly due to a reduction in the flow of traffic on the A90(T) between Stonehaven and Aberdeen and B979.

Vibration

45.6.15 As explained in Section 45.2 (Approach and Methods), nuisance caused by vibration is considered in terms of noise nuisance categories, but reduced by 10%, and properties experiencing noise levels below 58dB $L_{A10,18h}$ and/or outwith 40m of the road will not experience nuisance from vibration.

45.6.16 There is 1 residential building within 40m of the proposed main line that will exceed the 58dB $L_{A10,18h}$ lower threshold for vibration assessment. The predicted level is 1.4dB in excess of the vibration threshold and therefore if the community based response figures within DMRB could be used they would indicate a 13% change in the number of people like to be bothered by vibration and this is unlikely to be significant.

45.7 References

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